

Nepal Electricity Authority
(A Government of Nepal Undertaking)
Distribution and Consumer Services Directorate



BIDDING DOCUMENT
FOR
Design, Supply, Delivery, Installation, Testing and
Commissioning of 33/11kV Substations and 33kV Lines

Single-Stage, Bidding Procedure

Invitation for Bids No. : GSEEP/W/ICB-2

IDA Cr.	:	Credit No. 5566-NP
Project Name	:	Grid Solar and Energy Efficiency Project
Issued on	:	July 03, 2016
Employer	:	Nepal Electricity Authority
Country	:	Nepal

PART 2 (A) OF 3

July 2016

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Acronyms

BDS	Bid Data Sheet
CIF	Cost, Insurance and Freight
CIP	Carriage and Insurance Paid to (<i>named place of destination</i>)
CPM	Critical Path Method
DDP	Delivered Duty Paid (<i>named place of destination</i>)
EDI	Electronic Data Interchange
ENAA	Engineering Advancement Association of Japan
EXW	Ex factory, ex works or ex warehouse
FCA	Free Carrier
FIDIC	Fédération Internationale des Ingénieurs Conseils (International Federation of Consulting Engineers)
FOB	Free on Board
GCC	General Conditions of Contract
IBRD	International Bank for Reconstruction and Development
ICC	International Chamber of Commerce
IDA	International Development Association
IFB	Invitation for Bids
ITB	Instructions to Bidders
SBD	Standard Bidding Document
SCC	Special Conditions of Contract
TS	Technical Specifications and Drawings
UNCITRAL	United Nations Commission on International Trade Law

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PART 2 (A) – Employer's Requirement

For Substations

Single Stage Bidding

VI. Technical Specifications & Drawing for Substations

A. Technical Specification

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CHAPTER - 1

GENERAL INFORMATION AND SCOPE for Substations

1. Description of the Project:

1.1 General:

One of the component under "Grid Solar and Energy Efficiency Project" includes 33kV distribution system expansion and reinforcement in various districts of Nepal. Supply and installation of 6 nos. of new 33/11kV 3 MVA substations, 2 nos. of new 33/11kV 6/8 MVA substations and 33kV new lines (on turnkey basis) for energizing those substations will be the scope of this contract.

1. These Bidding Documents cover the supply and installation of substation works and all the necessary civil, structural, mechanical and electrical works, including the design, supply, manufacturing, delivery, erection, construction, commissioning, trial operation and test of the equipment, works and materials as specified or referred to in the Technical Specifications of these Bidding Documents.
2. If any discrepancies in the specifications and drawing are found, shall be discussed and rectified before or at the time of final approval of drawings.
3. The Contractor shall have adequate manpower to execute the works at all the 8 substation sites and 33 kV line simultaneously to complete the work within the scheduled time.
4. The bid price shall include any necessary relocation or arrangement works that has to be carried out by the contractor to minimize the shutdowns. The dismantled equipment has to be handed over to the owner to the store of the respective branch office.

1.2 Interface with other Contractors

- i. Contractor will supply and install all the 12kV underground cables up to compound boundary of the corresponding 33/11kV substation construction site. From those 12kV cable heads, outgoing 11kV overhead lines will be constructed by distribution line contractor. Distribution line contractor will install all insulators, conductors and hardware & take connections from 12kV underground cable head to the outgoing feeder(s). All other connections from the 33kV lines to the substation equipment shall be the responsibility of the contractor.
- ii. In general, all plants, equipments, gantry structures and civil construction for substations and all 12kV cables and cable termination kits for substations and outgoing 11kV lines shall be supplied and installed and terminated by the Contractor. The exact length of cables for 11kV outgoing lines may be varied and payment will be adjusted according to the Unit Price in proposed schedule.

1.3 Sites

The Contractor shall not pay nor include any money in his proposal for Substation Site acquisition. The Employer will assist in acquiring all substation sites.

1.4 Equipment and Materials

All equipment and materials shall be delivered by the Contractor to his designated store area. Such material shall be delivered, unloaded and placed in stores in an acceptable manner and approved by the Employer or his authorized representative.

1.5 Erection

When the supply and installation of substation(s) and 33kV line(s) has been completed and accepted by the Employer, the Contractor will make an inventory of the assemblies erected, and submit it to the Employer for approval and final payment.

Before the Taking-Over of the work, the Contractor shall clean up all areas in which he has worked, place all unused materials in the designated stores and settle any claims, which may have resulted from his work and occupancy of the area. He shall then remove all equipment, vehicles, manpower and facilities, which he has brought in, except those which may be specifically exempt by the Employer.

1.6 Nature of Works:

Nepal Electricity Authority, Grid Solar and Energy Efficiency Project intends to reinforce the distribution system of following districts of Nepal with the loan assistance received from the World Bank under Credit No.: 5566 –NP and the counterpart fund received from Government of Nepal and Nepal Electricity Authority:

S.N.	Name of District
1.	Ramechhap
2.	Sindhuli
3.	Gulmi
4.	Arghakachi
5.	Kapilbastu

This section outlines all major work components to be carried out by the Contractor at the construction of new substations. All designs, supply of equipments and materials and construction/installation works will be carried out by the contractor. All engineering design and materials shall be subjected to the Employer/Employer's Representative prior approval.

The Contractor shall undertake a detailed design for new installation and obtain all necessary data to enable construction of 6 nos. of new 33/11kV 3 MVA substations and 2 nos. of new 33/11kV 6/8 MVA substations. Also, supply and installation of 33kV lines (on turnkey basis) required for feeding/energizing those substations will also be the sole responsibility of the contractor and their tentative line length, routes are described in *Part 2(B) of Employer's Requirement*.

1.7 Contract Scope

The works in this contract involve design, supply, storage, construction/ installation, testing, commissioning and handover of the 33/11kV substations at the

following Seven (8) places of Ramechhap, Sindhuli, Gulmi, Argakhachi and Kapilbastu districts on turnkey basis:

- | | | |
|-----|---|---------|
| (1) | 33/11kV 3MVA substation at Bamti VDC, Ramechhap | - 1 set |
| (2) | 33/11kV 3MVA substation at Doramba VDC, Ramechhap | - 1 set |
| (3) | 33/11kV 3MVA substation at Baseshwor VDC, Sindhuli | - 1 set |
| (4) | 33/11kV 3 MVA substation at Lampantar VDC, Sindhuli | - 1 set |
| (5) | 33/11kV 3MVA substation at Marbhung VDC, Gulmi | - 1 set |
| (6) | 33/11kV 3MVA substation at Hansapur VDC, Arghakhachi | - 1 set |
| (7) | 33/11kV 6/8MVA substation at Labani VDC, Kapilbastu | - 1 set |
| (8) | 33/11kV 6/8MVA substation at GorusingeVDC, Kapilbastu | - 1 set |

Employer will not procure & supply any materials or erection tools or tackles.

All these above proposed substations are new constructions, among them Bamti and Doramba Substations will receive power from existing Makaibari-Khimti-Manthali 33kV Line. Similarly, proposed Khurkot and Lampantar Substations will receive power from existing Sindhuli-Manthali 33kV Line. Marbhung substation will be energized from proposed Bastu-Marbhung 33kV line in Gulmi District. Hansapur substation will be energized from existing 33 kV line at Hansapur. The single line diagram (Conceptual) of 33/11 kV substation is shown in drawing No. SS-01, SS-02, SLD-01 and SLD-02. For the location of substation sites please refer map Dwg. N1 of Nepal and Dwg. N2, N3, N4 & N5 attached herewith.

The major works include supply and installation of new equipment, but not limited to the following in each substations at Bamti, Doramba, Khurkot, Lampantar, Hansapur and Marbhung substations:

- 1×3MVA, 33/11kV Power Transformer
- Station service power system (33/0.4kV Transformer)
- 2×33 kV VCB
- Disconnecting switches
- 4×12 kV switchgears
- 240AH batteries/battery charger
- Control relay panels
- Site preparation, Control Building & civil works.
- Steel and other switchyard structures.
- 6/10 kV power cable for takeoff.
- Earthing system and all other accessories to complete the specified scope of works.

The major works include supply and installation of new equipment, but not limited to the following in each substations at Labani & Gorusinge substations:

- 1×6/8MVA, 33/11kV Power Transformer
- Station service power system (33/0.4kV Transformer)
- 3×33 kV VCB

- Disconnecting switches
- 4×12 kV switchgears
- 240AH batteries/battery charger
- Control relay panels
- Site preparation, Control Building & civil works.
- Steel and other switchyard structures.
- 6/10 kV power cable for takeoff.
- Earthing system and all other accessories to complete the specified scope of works.

2. Special Requirements of the Project

2.1 General

2.1.1 This specification covers the general requirements for design, manufacture, assembly, shop test, delivery, field, test, dismantling and installation commissioning of works for substation equipment.

2.1.2 Any deviation from this specification or the Technical Specification shall be clearly stated with reasons.

2.2 Conditions of Service

2.2.1 All plant and equipment supplied under this Contract shall be suitable for the following system and site conditions.

(a) System electrical parameters		
(1)	System voltage	33 kV, 11 kV, 400V & 230V
(2)	Number of phase	3
(3)	Frequency	50Hz
(b) Climatic conditions		
(1)	Ambient temperature	
-	Maximum	55 deg. C
-	Minimum	0 deg. C
-	Annual average	32 deg. C
(2)	Wind velocity	
-	Maximum	34.4m/sec
(3)	Relative humidity	
-	Maximum	100%
-	Minimum	20%
(4)	Monsoon season	June-August
(5)	Precipitation	
-	Maximum	1,000mm/month
-	Minimum	Zero/month

(c)	Altitude of site	Less than 2700 m from sea level
(d)	Seismic force	0.15G
(e)	Isokeraunic level	50

The information in this Sub-Clause is given solely for the general assistance of Bidders and no responsibility for it will be accepted nor will any claim based on this article be considered. The Bidder is advised to survey the Sites covered under this Contract to acquaint himself with site conditions.

2.2.2 The Contractor shall be responsible for surveying, borings, geologic and subsoil conditions for all foundations, and for the precise location of each substation in the project.

2.2.3 All necessary soil tests to determine the earth resistivity, the design of the ground grid and all foundations shall be performed by the Contractor at each substation site.

2.2.4 The Contractor shall locate, and record on the construction drawings, all interfacing utility lines or other obstructions.

Damage to existing line equipment and structures shall be repaired by the Contractor at his expense.

2.3 Codes and Standards

2.3.1 All plants and equipment supplied under this Contract shall conform to or be of higher quality than the latest applicable standard as listed in the following:

IEC	- International Electrotechnical Commission
ANSI	- American National Standard Institute
BS	- British Standard
NEMA	- National Electrical Manufacturers Association
IEEE	- Institute of Electrical and Electronics engineers
ASTM	- American Society of Testing and Materials
ASME	- American Society of Mechanical Engineers
IPCEA	- Insulated Power Cable Engineers Association
ISO	- International Organization for Standardization
ASCE	- American Society of Civil Engineers
ACI	- American Concrete Institute

NEC	- National Electrical Code (ANSI CI)
ISI	- Indian Standard Institute

- 2.3.2 If the Specifications contained in this Contract conflict in any way with any of the reference standards, the Specifications shall take precedence. If there are conflicts between different specified reference standards covering the same material or equipment, the standard which will provided the highest quality and most suitable application as determined by the Employer/ Employer's Representative shall prevail.
- 2.3.3 References to standards or to equipment of a particular manufacturer shall be regarded as followed by the words "or equivalent" except as otherwise noted. The Contractor may propose alternative standards, or equipment, which shall be equal to those, specified. If the Contractor for any reason proposes alternatives to or deviations from the above standards, or desires to use equipment not covered by the above standards, the Contractor shall state the exact nature of the change, the reason for making the change, and shall submit, for the approval, relevant specifications of the equipment in the original language, and in case that these specifications are written in language other than English, the English version shall be attached and shall govern. The decision of the Employer/Employer's Representative in the matter of equality will be final.

2.4 Scope of Works

- 2.4.1 The scope of works under this Contract shall include design, manufacture, shop test, delivery to each substation site in the Contract, receiving, assembly, erection, installation, transportation, equipments field test, all civil work, and commissioning of all equipment necessary for complete operation of each substation. The work includes but is not limited to the following:
- (a) Lattice type steel structures for transmission line incoming/outgoing, supporting structures, all nuts, bolts and miscellaneous steel required for mounting and installation of all the equipment and materials furnished.

Support structure for 33 kV Air Break (Disconnecting switch) shall be the part of the switch itself. That is to say extra payment shall not be made.

Support structure of 33kV vacuum circuit breaker (VCB) shall also be the part of the circuit breaker. No extra payment shall be made for this.

Steel structure excluding above items shall cover under heading of galvanized steel structure for gantry and support as mentioned in the price schedule. Any specifically mentioned items shall not come under this steel structure.

- (b) Outdoor type 33kV VCB, switchgears including circuit breakers, disconnecting switches, power fuse, instrument transformers, lighting arresters, insulators and bus materials complete with all fittings and connectors.
- (c) Cables, wires, ground rods, fittings and connectors for the entire, grounding and static protection systems for each substation.
- (d) Power transformers, 12kV VCB switchgears, station service transformers, and panel boards for substation AC/DC supply.
- (e) Maintenance free Batteries and appropriate battery chargers for 110V DC supply system.
- (f) All panels for control, metering, relaying, alarms, recording of events, etc. required for operation and protection of the entire substation.
- (g) Cables and wires complete with terminal lugs and accessories for control, metering, relaying, alarms, carrier, and communication. AC and DC station power and lighting, and any other cables and wires required to interconnect all equipment of the entire substations.
- (j) All civil works including new control building, foundation and cable duct.

All works described herein and other works necessary to complete the job for proper coordination and operation, even if not stated, shall be within the scope of the Contractor's work and the cost of such works shall be considered to be included in the bid price.

2.4.2 The Contractor shall submit detailed drawings, instruction and maintenance books, and spare parts lists with recommended stock quantities for the equipment furnished, prepare and submit detailed engineering, design and construction drawings pertaining to all mechanical and electrical equipment and installations in each substation. The drawings to be furnished by the Contractor for each individual substation shall include, but not be limited to the following:

- (a) Single line and three-line diagram for proposed new substations.
- (b) General layout of substation and property plan layout
- (c) 33kV electrical layout and elevations, plans and details
- (d) Structural erection and fabrication drawings
- (e) Substation grounding calculation, plans, elevations and details
- (f) Foundation layouts, plans and elevations indicating top of foundations, details for anchor bolt installation, including all data required for civil works.
- (g) Cable trench, duct and conduit layout plan, elevation and details
- (h) One line diagram for AC and DC station service power supply
- (I) Substation lighting and convenience outlet plan, elevation, and details
- (j) Substation control building electrical equipment layout, plan, elevation and details, including cable trench, cable tray, wire gutters, conduits, and specifying location and installation details for equipment furnished.

- (k) Detailed material list for each substation
- (m) Elementary AC and DC diagram for control, metering, relaying, communication, alarm etc., required to describe in detail the operation of all systems in each substation. Wire numbers and terminal numbers for each device shall be clearly marked on all AC and DC elementary and schematic diagram.
- (n) Interconnection diagram for all substation equipment. AC and DC station service equipment and all building equipment.
- (o) Detailed cable schedule list and cable summary, specifying cable identification number, routing and length of each cable for each substation.
- (p) Switchgear and panel board front and rear elevation drawings showing dimensions and identification of each device and complete nameplate schedule.
- (q) Calculation and coordination of protection relays.
- (r) Instruction books, spare parts lists, material lists and any other documents pertaining to each substation and required for construction, operation, maintenance and repair.

All the instructions, manuals and relevant information in the drawings must be in English. Unless otherwise specifically mentioned, the drawings and data pertaining to the Works shall be according to this clause.

a) General

All drawings shall be prepared in AutoCAD and the Contractor shall submit 3 sets of such electronic drawing files in Compact Disc to the Employer and the Consultant.

- b) The Contractor shall submit the drawings and data to the Employer for approval in the following manner and designated deadlines.

For supply of equipment and/or installation work

Item	No. of Copies	Deadline & Remarks
Proposed work program	3	Within 30 days from the date of signing of Contract.
Principal equipment drawings for approval	3	Within 90 days from the date of signing of Contract.
Principal installation drawings for approval	3	Within 120 days from the date of signing of Contract.
Revised drawings for approval	3	Within 30 days after receiving drawing for revision.
Final drawings with reproducible copies	5	Within 30 days after receiving approval.
AutoCad files of Final Drawings in Compact Disc	2	Within 30 days after receiving approval.

Schedule of manufacturing and transportation	2	Within 30 days from the date of signing of Contract.
Plan for shop tests	2	Not less than 45 days before testing
Results of shop tests for approval	4	Upon completion of tests
Records of shop tests	4	Upon approval of results of shop tests
Plan for field-tests	2	Not less than 15 days before testing
Report for field tests	4	Within 7 days after completion of each test
As-built drawings	5	Within 30 days after completion of installation work
AutoCad file of as-built drawings	3	Within 30 days after completion of installation work
Instruction manuals and drawings with reproducible copies for installation	5	30 days after shipment of Equipment

For Civil Works

Item	No. of Copies	Deadline & Remarks
Detail construction schedule & method	3	Within 30 days from the date of signing of Contract
Drawing for approval (principal drawings for construction)	3	Within 90 days from the date of signing of Contract.
Revised drawings for approval	3	Within 15 days after receiving drawings for revision
AutoCad file of approved drawings in Compact Disc	2	Within 15 days after receiving drawings for revision
Reports of Field Tests	4	Within 7 days after completion of each test
As-built drawings	5	Within 30 days after completion of construction works
AutoCad files of as-built drawings in Compact Disc	3	Within 30 days after completion of construction works

Others

Item	No. of Copies	Deadline & Remarks
Monthly Progress Reports with photographs	3	By 10th of following month
Packing list (copy)	5	At each shipment

Invoice (copy)	5	At each shipment
Bill of lading (copy)	5	At each shipment
Certificate of origin (copy)	1	At each shipment

In addition to the general requirements mentioned above, the following shall also be observed for the Civil Works:

- I. Work Schedule Within 30 days after signing of the contract
 II. Approval drawings for:

A. Switchyard

General Layout Plan	3 copies within 30 days after signing of the contract
Foundation Layout Plan	3 Copies within 30 days after approval of General Layout Plan
Detail Structural Design/ calculation Equipment foundation/ Structure	5 Copies within 30 days after approval of Foundation Layout Plan
Detail Working Drawing of Equipment foundation /Structure	5 Copies within 30 days approval of Structural design

2.4.2.1 Drawings: Titles, scales and Sizes

The title of the drawing, Contract Number, the sdate shall appear in the bottom ri

Project Name:.....

Contract No.....

Name of the Substation

Item No.....

Brief Description

In general the scales of the drawings shall be 1:200. The Contractor, however, can prepare and submit drawing in any other appropriate scales with the prior approval of the Employer.

The Contractor shall use any one of the following sizes for the preparation of drawings as appropriate:

A0	841 x 1189 mm	(33.11 x 46.81 in)
A1	594 x 841 mm	(33.39 x 33.11 in)
A2	420 x 594 mm	(16.54 x 23.39 in)
A3	297 x 420 mm	(11.69 x 16.54 in)
A4	210 x 297 mm	(08.27 x 11.69 in)

2.4.2.2 Employer's approval

The Employer will approve each drawing within thirty-five (35) days after receipt at his office. One print of each of the drawings submitted for approval will be returned by the Employer or Employer's Representative, marked either

"APPROVED", "APPROVED EXCEPT AS NOTED", or "RETURNED FOR CORRECTION".

- (a) The notations "APPROVED", or "APPROVED EXCEPT AS NOTED" will authorize the Contractor to proceed with the manufacturing drawings, subject to the corrections, if any indicated thereon. The notation "RETURNED FOR CORRECTION" shall require the Contractor to make the necessary revisions on the drawings and submit for approval within thirty-five (35) days in the same manner as before. Approval of the Contractor's drawings shall not in any way relieve the Contractor of any part of his obligation to meet all the requirements of the Contract or of the responsibility for the correction of the drawings.
- (b) Reproducible: Reproducible of all final approved drawings shall be made on CDs.
- (c) All final as-built drawings shall be supplied in CD-ROMs (three sets).

2.4.3 The Contractor shall provide spare parts and tools for each substation as specified in this specification.

2.4.4 Furnish qualified supervision and construction personnel for the installation, testing, commissioning and final system testing and checking out of the equipment listed above and detailed in the Schedule of Materials. The work shall be performed in close cooperation and collaboration with the Employer/Employer's Representative.

2.4.5 Coordination of the substation work with the installation of others shall be the responsibility of the Contractor. The Employer will furnish the information needed to coordinate the substation work with the other work.

2.5 Assistance by the Employer

The Employer will give assistance to the Contractor as much as possible in the following; this however will be without any obligations, legal or otherwise.

- (a) Facilitating access to all locations involved in carrying out the works.
- (b) General guidance to the Contractor for all negotiations with the Authorities in Nepal.

2.6 Variation in Quantities of Work

The Quantities listed in the Prices Schedules represent the estimated quantities for tender purpose only. The Contractor shall carryout detail design and shall submit final bill of quantity. The actually required quantity may vary from the quantity as listed in price schedule. The Contractor agrees to make no claim for anticipated profits or for alleged losses because of any difference between the quantities actually furnished and installed and the estimated quantities as indicated in these Tender Documents.

2.7 Time Schedule and Progress Report

2.7.1 Within 30 days from the date of signing of the Contract, the Contractor shall

submit to the Employer/Employer's Representative a time schedule and progress chart covering work to be done at each manufacturing plant and installation at site. The Contractor shall show the several salient features of the work.

- 2.7.2 The proposed project period is as specified in the General Condition of Contract. Failure to meet these dates may result the Employer to enforce the provisions of "Liquidated Damages" to the Contractor. The Bidder shall submit the project schedule prepared by PERT/CPM with the Tender.
- 2.7.3 The Contractor shall submit the actual progress and the estimated earnings at the end of the month. Three (3) numbers of copies shall be furnished to the Employer/Employer's Representative with the monthly report.
- 2.7.4 The time schedule will be subject to review by the Employer/Employer's Representative for compliance with the Contract Documents and shall be revised if necessary by the Contractor to bring it into such compliance. The schedule shall be reviewed and revised if necessary at intervals not to exceed four weeks. In addition, the Employer/Employer's Representative shall be advised promptly of any proposed changes in the schedule.
- 2.7.5 The Contractor shall prepare and submit monthly to the Employer/Employer's Representative a report covering the progress on design, manufacturing and installation work at the Site during the month of record. The reports shall be accompanied by suitable illustrations and photographs and by copies or working schedules as necessary to effectively evaluated and document the progress of the work. The reports shall cover at least the following activities:
- (a) Manufacturing status of equipment at each factory
 - (b) Shipping status
 - (c) Arrival of equipment and schedule for arrival of other required equipment
 - (d) Installation of Contractor's equipment at the Site
 - (e) Performance record of critical items of Contractor's equipment
 - (f) Quantitative progress on work at the Site
 - (g) Scheduled progress for work at the Site
 - (h) Description of conditions encountered that have affected the progress of the Works adversely and of action taken to alleviate the conditions and regain the anticipated progress.
 - (I) Description of matters, which the Contractor anticipates, will require contract interpretation, engineering decisions, or policy determinations.
 - (j) Numbers of employees in various categories at the Site and projected numbers for the following three months.
 - (k) Schedule showing the progress of planned and actual for each salient activities of the work.

The Contractor shall submit the report by 10th of the following month.

- 2.7.6 The employer has provided a time schedule for the execution of the work with this document. The contractor may revise the schedule of different items but the total completion time shall remain the same.

2.8 Drawings and Data

- 2.8.1 The Contractor shall prepare and furnish to the Employer/Employer's Representative such drawings, calculations, and data on materials and equipment (hereinafter in this provision called data) as are required for the proper control and completion of the work, including but not limited to those drawings, data and calculations specifically required elsewhere in the Technical Specifications.
- 2.8.2 The Metric System shall be used and notations shall be in English. Drawings, calculations, and data shall be furnished as specified. All drawings and data will be subject to review by the Employer/Employer's Representative conformity with the Technical Specifications and Contract Drawings and upon meeting review requirements shall become Employer.
- 2.8.3 Within 30 days from the date of signing of the Contract, the Contractor shall prepare and furnish to the Employer/Employer's Representative a schedule for submission of all drawings and data. Each drawing to be submitted for the work of the Contract shall be listed on the schedule, and the schedule shall contain separate columns for scheduled submitted dates and actual submittal dates. The schedule will be reviewed by the Employer/Employer's Representative and the Contractor shall correct any defects noted therein. The schedule shall at all times present a complete plan for orderly submission of such drawings and data and shall be updated and resubmitted monthly showing actual submittal dates and revised scheduling. The Contractor shall promptly notify the Employer/Employer's Representative of any occurrence requiring substantial revision of the schedule giving a detailed explanation of the cause of the revision. Revised schedules will be revised and corrected in the same manner as the original schedule.
- 2.8.4 Neither the review nor lack of review of any drawings, calculation or data shall waive any of the specification or Contract drawings, or responsibility for correctness of the drawings, calculations or data and defective work, materials, and equipment may be rejected notwithstanding conformance with drawings, calculations and data reviewed by the Employer/Employer's Representative. The Employer/Employer's Representative shall have the right to require the Contractor to make any changes in the design which may be necessary, to make the apparatus conform to the requirements and intent of the specifications, with no additional cost to the Employer.
- 2.8.5 Any drawing changed by the Contractor during the development of his design after review by the Employer/Employer's Representative shall be submitted for approval.

2.9 Quality Control

- 2.9.1 The Contractor shall provide and maintain a Quality Control Plan (QCP) to ensure compliance with quality standards of the Technical specification, the Contractor shall furnish to the Employer/Employer's Representative six (6) copies of his complete quality control procedures, manual, and a description of the quality control organization.
- 2.9.2 The Employer/Employer's Representative will monitor the Contractor's methods,

procedures and processes for compliance with the QAP and the quality standards of these specifications Failure of the Contractor to effectively maintain the quality control program throughout all phases of the work will be considered a failure to prosecute the work with the diligence required by the Contract Documents.

2.10 Painting

- 2.10.1 All sheet steel work shall be phosphated in accordance with the following procedure and in accordance with BS 2569 and BS 5493.
- 2.10.2 Oil, grease, dirt shall be thoroughly removed by emulsion cleaning.
- 2.10.3 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.
- 2.10.4 After phosphating, through rinsing shall be carried out with clean water, followed by final rinsing with dilute dichromate solution and even drying.
- 2.10.5 The phosphate coating shall be sealed by the application of two coats of stoving type zinc chromate primer. The first coat may be 'flash dried' while the second coat shall be stoved.
- 2.10.6 After application of the primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by stoving. Touch up shall be applied after completion of tests. All panels should have same color. The color for the finishing paint shall be approved by the Employer/Employer's Representative.
- 2.10.7 The final finished thickness of paint film on steel shall not be less than 100 microns.
- 2.10.8 Finished painted surface of panels shall present at aesthetically pleasing appearance free from runs and drips.
- 2.10.9 A small quantity of finishing paint shall be supplied for minor touching up required at site after the installation of the panels.

2.11 Packing and Shipment

- 2.11.1 The Contractor shall prepare all materials and equipment for shipment in such manner as to protect them from damage in transit and in storage prior to installation. Materials that might otherwise be lost shall be boxed or wired in bundles.
- 2.11.2 All finished surfaces or ferrous metals, including screw threads that will be exposed during shipment or while awaiting installation shall be cleaned and shall be given a heavy uniform coating of rust-preventive compound devices subject to damage shall be suitably wrapped or otherwise protected from damage.
- 2.11.3 Each complete field assembly shall be given an identification number or letter, and each part of each field assembly which is not permanently connected in shop assembly shall be legibly marked. Except on bolts and other small parts, all such marks shall be made with oil-resistant paints. Diagrams showing all such markings shall be supplied. Each place of subassembly separately packed for shipment shall be labeled or tagged with the specification number and the mark number of such piece or the numbers of the parts grouped in such subassembly, or contained in the

package. The individual substation name shall be clearly and legibly marked on each package and crate.

- 2.11.4 The spare parts shall be packed separately from other articles. Packages of spare parts shall be clearly identified and shall be accompanied by a list of contents, which set forth directions for storing.
- 2.11.5 The Contractor shall prepare a packing list for each and every shipment made. In the case of several packages included in a single shipment, more than one package may be included on one packing list, providing all required information is shown for each package.

The following information shall be provided for each package:

- (a) Description of package, i.e. box, crate, drum, bundle etc.
- (b) Package number
- (c) General description of contents corresponding to the invoice
- (d) Equipment number where applicable
- (e) Gross, tare and net weights in kilograms

2.11.6 Painting of Control Building:

It shall cover the followings:

- a. Two coat of cement paint shall be inside and outside of the control building. The color choice shall be of the owner.
- b. The paint shall be from reputed manufacturer. The Contractor shall have to take the written consent from the owner for the make of the paint to be used, failing to do so may lead to non-payment. Please note that thinner shall not be allowed for diluting the metal or wood prima, enamel paint i.e. paint be used without diluted.
- c. One coat of wooden prima and two coats of enamel point shall be used for wooden parts of window and door. Same shall hold for grill of window.

2.12 Tools and Appliances

The Bidder shall supply complete, new and unused sets of all special tools or gages, which will be required for normal operation and maintenance. The Bidder shall furnish the list of tools and appliances in the Tender Document. To the Greatest extent possible, the tools for each specific operation shall be stored in a single, locked, portable, steel box suitably and clearly marked for convenient identification. These shall be the part of equipments.

2.13 Spare Parts

- 2.13.1 The Bidder shall propose recommended spare parts required for three years maintenance in addition to the spare parts specified in the price schedule of Tender Document and shall include a price list of these parts in a separate sheet of paper. The price of such spare parts proposed by the bidder shall not be taken into account for financial evaluation. Sufficient information shall be provided to permit the Employer/Employer's Representative to estimate spare parts requirements.
- 2.13.2 All spare parts supplied under the Contract shall be strictly interchangeable with

the parts for which they are intended to be replaced and shall be treated and packed for long storage under the climatic conditions prevailing at the site. Each spare part shall be clearly marked or labeled on the outside of its packing with its description and purpose, and when more than one spare part is packed in a single case or other container, a general description of its contents is to be shown on the outside of such cases or container and a detailed list enclosed inside. All cases, containers and other packages must be suitably marked and numbered for purpose of identification.

- 2.13.3 All cases, containers or other packages are liable to be opened at the site for such examinations as the Employer/Employer's Representative may consider necessary, and all such opening and subsequent repacking shall be at the expense of the Contractor.
- 2.13.4 All spare parts must be delivered to Site in advance of the trial operation. The Contractor shall ultimately prepare and deliver five (5) copies of the final consolidated spare parts list, arranged specifications-wise.
- 2.13.5 It shall be in the interest of the Contractor to organize the delivery and systematic storage of spare parts before the trial operation to obviate post erection difficulties and delays. Any spare part consumed by the Contractor before Performance Certificate shall be replaced without any cost to the Employer.

2.14 Technical Requirements

2.14.1 Electrical auxiliary power supply

The electrical auxiliary and control power source shall be as follows:

- (a) AC auxiliary power source
 - 3 phase, 4-wire, 50Hz. 400/230V
 - 1 phase, 50Hz, 230V
- (b) DC control power source: 110V

2.14.2 Creepage distance of insulator and bushing

Unless specified elsewhere in the specification, the creepage distance of post insulator and bushing of substation equipment shall comply with the following:

<u>System Voltage</u>	<u>Highest Voltage</u>	<u>Minimum Creepage distance</u>
33kV	36kV	720mm

2.14.3 Wiring

The equipment to be provided as part of this Contract shall be fully wired in accordance with the following general requirement.

- (a) All wiring shall be carried out in general purpose 600 volt grade PVC copper wire complying with the requirements of IEC. The wire core size shall not be less than 2.5sqmm. All wire cores shall be multistranded and flexible.
- (b) Wires shall be neatly bunched and adequately supported so as to prevent sagging and strain on termination.
- (c) All inter panel wiring between panels that directly adjoin one another shall be

made through suitable holes in the common panel side sheets. All inter panel wiring shall start and terminate on terminal blocks; direct wiring between other items of equipment will not be acceptable.

- (d) Joints or splices in panel and inter panel wiring not be acceptable.
- (e) The wiring of panels, cubicles or kiosks shall be identical.
- (f) All wire termination shall be made with compression type connectors. Wires shall not be spliced or tapped between terminal points.
- (g) Not more than two wires shall be connected to any terminal at each end. If necessary, a number of terminals shall be jumpered together to provide additional wiring points.
- (h) Wiring leads and cable cores shall be permanently marked at both ends with an approved type of marking device having black letters and numbers impressed on a white background.

2.14.4 Terminal Blocks

- (a) Multiway terminal blocks complete with screws, nuts, washers and marking strips for terminal identification shall be furnished for terminating the internal wiring and outgoing cables.
- (b) Control terminals shall be washers head screw type, each suitable for connection of at least two numbers copper conductor cables of requisite cross-section at each end through compression type (solderless) lugs. Screw type terminals with screw directly impinging on conductor or any other of terminal, which does not accept compression type lugs, are not acceptable. The successful Bidder shall have to take prior approval of the terminals to be used in the block from the Employer/Employer's Representative.
- (c) Each terminal shall be marked with designations obtained from schematic diagrams.
- (d) Terminal blocks to be used with the Current Transformer secondary wiring, both at the panels and cubicles, shall be provided with the shorting links with facility to open circuit or short circuit the CT secondary.

At least 20% spare terminals shall be provided in the terminal blocks.

2.14.5 Nameplate

- (a) Nameplates or rating plates shall be stainless steel and shall be engraved in English language. Instruction plates, warning signs and any other marking whatever on the equipment and parts and accessories thereof shall be in English.
- (b) The switch handles shall be carved with the function number or word colored in white.
- (c) The details of the matters to be shown on the nameplates, etc. shall be indicated in the drawings for approval.

2.14.6 Switchyard Surface Cleaning:

The scope of works under this heading comes as following:

1. Taking out grass from its root, So that the chances of sprouting are minimized. The realignment and leveling of existing switchyard gravel.

2.14.7 Surface Dressing with Crushed Stone:

It covers the followings:

1. Filling up by gravel in the patch
2. Filling up the in the switchyard if it not.
3. Crushed stone to be used shall be 40 mm size and depth of 15 cm.

2.14.8 Switchyard Painting:

It shall cover the followings:

- a. One coat of red oxide point and two coat of Aluminum point
- b. The point shall be from reputed manufacturer. The contractor shall have to take the prior written acceptance from the owner for the manufacturer of the point.
- c. Thinner shall not be used.
- d. Painting of transformer and equipment shall be by spray gun.
- e. Special care shall be taken to avoid spray on bushing and name plate
- f. Painting shall be done on the followings:
- g. Gantry / Steel Structure, Transformer and other equipment's.
- h. Galvanized steel structure shall not be painted.

3. **Construction and Installation Works:**

It shall include construction, erection, assembly, installation, testing and commission of the equipments and steel structure. After the construction and installation works the equipments shall run trouble free and smooth.

3.1 Foundation Works: It shall include the following:

- a. Foundation works shall be per the specification provided in Section VII

3.2 Clamp: Clamp to be used for fixing the channel to the pole shall be made of mild steel strip of 500mm × 5 mm section. This shall be hot dip galvanized. The zinc costing shall be 610 gram per square meter.

3.3 Trolley of V.C.B.:

This shall be the trolley of V.C.B. cubicle, complete with vaccum interrupter etc. It shall be purchased as spare.

3.4 Galvanization: All the steel structures used as support to the equipments, gantry and column shall be galvanized through the process as prescribed in IS/ IEC standard but the zinc coating shall be 610 gram per square meter (85 micron).

3.5 Lightning Mast: The Lightning Mast shall be designed, supplied and installed as per the standard practices and as per the site conditions. The design details of the Lightning Mast shall be submitted to the owner for approval.

3.6 Minor Items and Works:

While constructing substations under this contract, minor items like shifting of switchyard lighting poles, dismantling of existing wall/ fence etc, which are not

mentioned in the price schedule shall have to be done for completing the substations electrically and mechanically sound. These items and works may include labour and materials. It is not practical to mention such minor items specifically in the price schedule. The cost of such items and works shall be included and spread up in the different items of construction and installation works as mentioned in the price schedule. No extra payment shall be made to the contractor for such minor items and works. So the bidders are requested to send an expert to each substation sites to assess the requirements of such items and works for completing the substation technically sound and to submit the bid accordingly.

4. Training of the Employer's Staff

The Contractor is responsible for providing necessary training required for operating and maintenance personnel for Pre Commissioning of the facilities. The Employer shall provide operating staff to receive training from the Contractor during Pre commissioning. The Contractor shall provide any material required for Pre Commissioning.

The Contractor shall plan for the Employer's staffs' participation, either continuously or on a regularly recurring basis, in the commissioning work and,

Allow the Employer's staffs to become familiar with the operating and maintenance aspects of the new equipment supplied by him,

Maintain a continuing assessment with the Employer of the precautions required in or possible consequences of, initial energization of equipment,

Allow for the above two necessary objectives in the preparation of schedules.

The Contractor shall station at site, at least, one technical expert for a minimum of six months continuously after commissioning to rectify any problems, as well as train the Employer's attending staffs. If required, the length of his stay shall be extended as per requirement, which shall be at the Employer's discretion.

5. Environmental Mitigation Measures

5.1 Physical Environment

The following mitigation measures shall be undertaken to reduce the adverse impacts on the physical environment during construction of the substation.

- (i) Changes in land use and landscape:** The construction activities will be planned properly. The construction material will be stored at the designated places and the haphazard dumping of the construction spoils will be strictly prohibited. Discharge of cement slurry, garbage and other solid wastes generated by the construction activities and workforce will be avoided where possible.
- (ii) Disposal of the construction spoils:** The excavated material will not be left haphazardly. It will be leveled on the ground. Further, the disposal material

of substation will be carried out within the acquired land for substation.

- (iii) **Stockpiling of the construction materials:** The Contractor will have to negotiate with the owner of the property for the use of their premises even if it is for the short period.
- (iv) **Nuisance to the nearby properties:** Although some nuisances may be unavoidable, the Contractor will have to minimize such nuisance. The Contractor will have to work in close-coordination with the local community while working in the settlement areas.
- (v) **Impact on the infrastructure:** The Contractor shall ensure that there will be no interference with the existing infrastructure including utility facilities during contraction.
- (vi) **Change in air quality:** Though change in water quality is unlikely during construction activity, sprinkling of water shall be carried out by the Contractor at least once a day during dry season.

5.2 Biological Environment

None

5.3 Socio-economic and cultural Environment

In the construction phase following mitigation measures shall be adopted to minimize the impacts:

- (i) **Loss of farmland and other category of land:** Any damage to the farmland by the construction activity will have to be restored and rehabilitated.
- (ii) **Occupational safety and hazard:** The Contractor will provide appropriate training in handling equipment and machinery to the workers and laborers before contraction. All workers employed by the Contractors shall be insured against accident.
- (iii) **Loss of standing crops:** The Contractor shall make compensation for the loss of standing crops due to project activities.
- (iv) **Employment of project affected people:** Priority will be given to the project affected people while hiring workers and laborers during project construction. Nepal being a signatory to the International Convention against the Child Labor, the Contractor shall not employ child labor in construction

Chapter 2

Specification of Electrical Equipment for Substation

1. POWER TRANSFORMER

General

This specifications covers the design, manufacture, assembly, shop test, supply, delivery, installation works and field test of the power transformers complete with all accessories, fittings and auxiliary equipment for efficient and trouble free operation as specified hereinafter.

The equipment specified in this Section of the Contract shall conform to the latest edition of the appropriate IEC specifications and/or other recognized international standards. In particular:

IEC 60076 Power transformer

IEC 60137 Insulating bushings for alternating voltages above 1 kV

IEC 60156 Insulating liquids - Determination of the breakdown voltage at power frequency – Test method

IEC 60296 Specification for unused mineral insulating oils for transformers and switchgear

IEC 60551 Determination of transformer and reactor sound levels

IEC 60616 Terminal and tapping markings for power transformer

IEC 60722 Guide to the lightning impulse and switching impulse testing of power transformers and reactors

Manufacturer of power transformer shall hold valid ISO 9001 (including design) quality certificate.

Equipment to be furnished:

33/11 kV, 3 MVA Power Transformers and 33/11 kV, 6/8 MVA Power Transformers.

The equipment to be furnished shall strictly be in accordance with the specifications and the Price Schedule.

1.1 DESIGN REQUIREMENT

- 1.1.1 The Transformer shall be connected to Three Phase 50Hz system with Higher side Voltage being 33 kV.
- 1.1.2 The Transformer shall be installed Outdoor in the hot and humid atmosphere. The Transformer shall be Oil Immersed and designed for the cooling system as specified in the Appendices.
- 1.1.3 The Transformer should be capable of operating continuously at its rated output without exceeding the temperature rise limits as specified in the appendices.
- 1.1.4 The Transformer winding shall be designed to withstand short circuit stresses at its terminal with full voltage maintained behind it for a period as per IEC-60076.

- 1.1.5 The Transformer shall be capable of operation at the rated output under the following conditions:
 - i. The voltage varying $\pm 10\%$ of rated Voltage.
 - ii. The Frequency varying $\pm 5\%$ of rated Frequency.
- 1.1.6 The Transformer shall be capable of delivering its rated output at any tap position.
- 1.1.7 The Transformer shall be free from annoying hum and Vibration when in Operation even at 10% over Voltage. The noise level should be as per respective IEC Standards.
- 1.1.8 The Transformer shall be designed and constructed so as not to cause any undesirable interference in radio or communication circuits.

1.2 CONSTRUCTION FEATURES

1.2.1 Tank

The Tank should be suitable to house complete core, and maintain oil level up to the top of the core and windings even when the cover is open. The Tank shall be all welded Construction and fabricated from the sheet steel of adequate thickness. All seams shall be properly welded to withstand requisite impact during short circuit without distortion. All welding shall be stress relieved.

The Tank shall be reinforced by stiffener of structural steel for general rigidity. The Tank shall have sufficient strength to withstand stress without any deformation by mechanical shock during transportation and vacuum filling in the field.

The Transformer's tank cover shall be bolted on to the tank with weather proof, hot oil resistant, resilient gasket in between for complete oil tightness. If gasket is compressible, metallic stops should be provided to prevent complete compression. Bushing turrets, cover of access holes and other devices shall be designed to prevent leakage of water into or oil from the tank during normal or abnormal conditions. The tank cover shall be provided with two numbers of grounding pads and connected separately to tank grounding pads.

The tank shall be provided with sets of bi-directional flanged wheels for rolling the Transformer parallel to either central line on the rail.

All heavy removable parts shall be provided with mounting rails along with the eye bolt for ease of handling and necessary lugs and shackles shall be provided to enable the whole Transformer to be lifted by the Crane or other means. Manholes of sufficient size shall be provided for access to leads, windings, bottom terminal of bushing and taps.

There shall be the provisions for the opening of the part of the Tank cover for cleaning of the Cores and Coils with Hot oil during overhauling.

1.2.2 Core & coils:

The Transformer shall be of Core type. The Core shall be constructed with interleaved grade non-aging, low loss, non-ageing, high permeability, grain oriented, and cold rolled silicon steel lamination, properly treated after being sheared, to remove any burr and shall be re-annealed to remove any residual stresses. The coils shall be manufactured from electrolytic copper of suitable grade. They should be properly insulated and stacked.

All Steel sections used for the support of the core shall be thoroughly sand blasted after cutting, drilling and welding.

Coil assembly shall be suitably supported between adjacent sections by insulating spacers and barriers. Bracing and other insulation used in the assembly of the winding shall be arranged to ensure a free circulation of the oil and to reduce the hot spot of the winding.

All lamination shall be properly insulated with the materials that will not deteriorate due to pressure and hot oil.

The core shall be rigidly clamped to ensure adequate mechanical strength. Core and Coil assembly shall be capable of withstanding the vibrations and shock during transportation, Installation, service and adequate provision shall be made to prevent movement of core & coil assembly relative to the tank during these conditions. The core and coil assembly shall be securely fixed in position so that no shifting or deformation occurs during movement

The bidder shall submit following documents, as applicable, as a proof towards use of PRIME CORE MATERIALS before manufacturing a Transformer.

- i. Invoice of the supplier.
- ii. Mill's Test Certificates
- iii. Packing List.
- iv. Bill of Lading
- v. Bill of Entry certificate by the Customs.

Core Materials shall be directly purchased either from the manufacturer or through their accredited marketing organization of repute and not through any agent.

The core shall be provided with lifting lugs suitable for lifting complete core and Coil assembly of transformer.

The Coils shall be manufactured from electrolytic copper of suitable grade as per relevant IS. The maximum current density for design of the transformers shall not exceed 320A/Sq.cm. They should be properly insulated and stacked. All Insulating materials shall be of proven design. Coils shall be so insulated that impulse and Power Frequency Voltage stresses are minimum.

All leads from the windings to the terminal board and bushings shall be rigidly supported to prevent injury from vibration or short circuit stresses. Guide tube shall be used where practicable.

The Core and coil assembly shall be securely fixed in position so that no shifting or deformation occurs during movement of transformer or under short circuit stresses.

1.2.3 Tapping

1.2.3.1 No Load Tap as specified in the appendices shall be provided on the high voltage winding of the Transformers upto 3 MVA capacity and On- load Tap changer shall be provided for transformers of 6/8 MVA capacity. The manufacturers of OLTC shall be ABB Sweden or MR Germany make.

1.2.3.2 The Transformer shall be capable of operation at rated output at any tap position provided the primary does not vary by more than $\pm 10\%$ of the rated voltage corresponding to the normal tap.

The winding including the tapping arrangement shall be designed to maintain the electromagnetic balance between H.V. and L.V. winding at all voltage ratios.

All other parts and accessories required for installation and normal operation of No-Load Tap Changer and On-Load Tap Changer shall also be furnished.

1.3 Transformer Oil

The Transformer Oil shall conform to the latest revision of IEC Publication 60296, properly inhibited for preventing of slugging. The oil shall be non-PCB type.

The necessary first filling of oil shall be supplied for the Transformer in non-returnable container suitable for outdoor storing. Ten percent (10%) excess oil shall also be provided to take wastage into account.

1.4 Oil Preservation System

Oil preservation shall be by a means of conservator tank or by a sealed tank system.

1.4.1 Conservator Tank System

- 1.4.1.1 The Conservator Tank shall be mounted on a bracket fixed on the Tank.
- 1.4.1.2 The Conservator Tank shall be provided without compartment, for the main Transformer Tank.
- 1.4.1.3 The Conservator Tank/Compartment shall be connected with the Main Transformer tank by pipes through double float Bucholz Relay (Gas Operated Relay) with valves at both ends.
- 1.4.1.4 Contact of the Oil in the compartment for the Main Tank with atmosphere shall be prohibited by using a flexible urethane air cell. The cell shall be vented into the atmosphere through a silicagel breather and shall inflate or deflate as Oil volume changes.
- 1.4.1.5 The Conservator Tank/Compartment shall be provided with its own breather, filler cap and drain plug.

- 1.4.1.6 The Conservator Tank/Compartment shall be provided with dial type Level Indicator visible from the ground level and fitted with low oil level alarm Contact and Plain oil level gauge shall also be provided to each compartment.

1.4.2 Sealed tank system

In the sealed tank system, nitrogen gas space shall be provided above the insulating liquid. The nitrogen gas space shall serve as a cushion against changes in pressure caused by expansion and contraction of the oil due to change in ambient temperature and/or loading. There shall be no contact between oil and atmospheric air within a specified range of ambient temperature. A pressure-vacuum bleeder shall be provided to automatically prevent any harmful pressure from developing in the system.

1.5 Temperature Indicators

- 1.5.1 One set of Winding Temperature Indicator shall be supplied and fitted locally so as to be readable at a standing height from ground level. Necessary Current Transformer and Heating Coil for obtaining thermal images of winding temperatures and detector elements shall be furnished and wired or fitted inside the transformer marshaling box.
- 1.5.2 The above Winding Temperature Indicator shall be provided with necessary contacts to take care of the following:
- i. Starting cooling Units in stages with the rise of Temperature.
 - ii. Alarm on High Temperature.
 - iii. Trip on Higher Temperature.

One set of Oil Temperature Indicator with Maximum reading Pointer and Electrically Separate sets of Contacts for Alarm and Trip shall be mounted locally so as to be readable at the standing height from ground level.

1.6 Bucholz Relay (Gas Operated Relay – For Conservator Type of Oil Preservation)

- 1.6.1 The Bucholz relay shall be provided with two floats and two pairs of electrically separate contacts – One pair for Alarm & other pair for Tripping function.
- 1.6.2 The Bucholz relay shall be provided with the facility for Testing by Injection of air by hand pump and with cock for draining and venting of air.
- 1.6.3 Sudden Pressure Relay

A Sudden Gas Pressure relay shall be furnished and mounted on top of the Tank in the region of the Gas Space. The Relay shall respond to sudden increase in the internal Gas Pressure in the Transformer due to internal arcing. The Relay shall be provided with trip contact.

The above relay shall be stable during change in Oil or Gas pressure due to change in ambient temperature and / or loading.

1.7 Transformer Bushings

All Bushings shall confirm to the requirements of the latest revisions of IEC Publication 137.

The Bushings shall be located so as to provide adequate electrical clearances between phases and also between phase and ground as per relevant standards.

All Bushings shall be porcelain type and shall be furnished complete with terminal connectors of adequate capacity. The porcelain used in bushings shall be Homogenous, Nonporous, Uniformly glazed to Brown colour and free from Blisters, Burns and other defects.

Stresses due to expansion and contraction in any parts of the Bushings shall not lead to deterioration.

Liquid / Oil filled Bushings for 36kV and above shall be equipped with Liquid Oil level Indicators and means for sampling and draining of liquid. The angle of inclination to vertical shall not exceed 30°.

Oil in oil filled Bushings shall meet the requirement of the Transformer Oil standards specified.

1.8 Marshaling Box

A Sheet metal weatherproof marshaling box of IP-55W construction shall be provided. The box shall contain all the auxiliary devices except those which must be located directly on the Transformer. All terminal blocks for external cable connections shall be located in this box.

The Marshaling Box shall have the following but not limited to them.

- 1.8.1 Load Disconnects Switch for Incoming Power Supply for Auxiliaries.
- 1.8.2 Cooler Fan and Pump Motor starters.
- 1.8.3 FAN START STOP Control Switches for ONAF type only.
- 1.8.4 AUTO-MANUAL Switches.
- 1.8.5 Wiring and Termination individually of the following alarm contacts for remote per trip alarm.
 - Bucholz relay alarm for Main Tank.
 - Winding Temperature High Alarm.
 - Oil Temperature High Alarm.
 - Tank Oil Level Low Alarm.
 - Tap Change incomplete alarm.
- 1.8.6 Wiring and Termination individually of the following Trip Contacts for remote trip and trip alarm.
 - Winding Temperature High Trip
 - Oil temperature High Trip

- Buchholz Relay Trip or Sudden Oil Pressure Relay Trip
- Pressure Relief Device.

Cubicle Illumination lamp with door switch and space heater with thermostat and ON-OFF switch shall be provided.

1.9 Wiring

Wiring shall be done as specified

1.10 Cable Termination

Marshaling box shall be designed to facilitate cable entry from bottom. Removable plates shall be furnished with compression type cable glands to make entry dust proof and no weight is transferred to the terminal. The glands shall be suitable for terminating Cable Armor.

Sufficient space shall be provided to avoid sharp bending and for easy connection. A minimum space of 200mm from the gland plate to the nearest terminal block should be provided.

1.11 Terminal Blocks

1.12 Painting Works

Terminal Blocks shall be as specified

All painting works shall be done as specified

1.13 Auxiliary Supply

All indication, alarm and trip contacts provided shall be suitable for separation on a nominal 110V DC system.

1.13.1 Current Transformer

The Bidders are required to propose the detail **scheme of ac circuit** after making a Site visit and studying the existing ac system of the Transformer Protection and Metering. The existing data are enclosed. The details about the Current Transformer will be finalized after the approval of the scheme or as instructed by the Owner.

1.14 TESTS

1.14.1 Routine Tests

During Manufacturing and on Completion, the Transformer shall be subjected to the following Routine Tests but not limited to as laid down in the latest revision of the IEC Publication 76.

- i. Applied Voltage Tests
- ii. Induced Voltage Tests
- iii. No-Load and Excitation Current Test
- iv. Impedance Voltage and Load Loss Test.
- v. Resistance Measurement
- vi. Ratio Test
- vii. Polarity and Phase Relation Test
- viii. Leakage Test.
- ix. Insulation Resistance Test
- x. Insulation Power Factor Test

1.14.2 Special Tests

The Following tests shall be performed.

- i. Zero Phase Sequence Impedance measurement.
- ii. After fabrication, the tank fitted with all Valves, Covers, Conservator Tank etc shall be completely filled with Transformer Oil and subjected to a pressure of 25% over the Normal pressure of the Oil. This pressure shall be maintained for 12Hours during which time there should be no leakage of oil nor there shall be permanent set when pressure is released. If any leakage or permanent set occurs, the test shall be conducted again after rectification of the defects.
- iii. The Transformer Tank shall be subjected to full Vacuum as far as possible for 12 Hours.
- iv. After assembly, each core shall be pressure tested for 1 minute at 2kV AC between all bolts, side bolts, structural steel works and core.
- v. Excitation loss and current measurement shall be made at 90%, 100% and 110% of rated Voltage.

1.14.3 Design Tests

Following design Test shall be performed on the Transformer in accordance with latest revision of IEC Publication 76, if such tests have not yet performed by the Manufacturer earlier in size commensurate with the Tendered Transformer. However, if such had been performed earlier, then the design tests can be submitted. If the submitted design tests in the opinion of the Owner, can not be approved, then such tests have to be conducted.

- i. Temperature Rise Test
- ii. Impulse Voltage Withstand Test
- iii. Short Circuit Test

1.14.4 Tests of Miscellaneous Components

The various components of the Transformer such as insulating oil, Bushings, Current Transformers etc. shall be tested with the relevant Standards.

The bodies of all valves and pipe works shall withstand a hydraulic pressure of 20psig for 15 minutes. The Testing medium shall be insulating oil as per IEC Publication 296.

1.14.5 Test Certificates

Test Certificates should be submitted in required number of copies for approval.

The Routine, Special and Design Test Certificates of the Transformer shall be furnished for approval before the delivery of the Equipment from the Factory.

The Routine and Type test Certificates of miscellaneous components shall be furnished for approval.

1.14.6 Field Tests

After Installation at Site, the Transformer shall be subjected but not limited to the following field tests

- i. Construction Inspection & Completeness inspection
- ii. Insulating Oil Test
- iii. Insulation Resistance Measurement
- iv. Ratio Test
- v. Tap Changer Operation Test
- vi. Magnetizing Current Test
- vii. Vector Group Test
- viii. Winding Resistance Test
- ix. Calibration of WTI & OTI.
- x. Setting of Alarm / Trip and cooler Controls and operation Check.

1.15 TENDER EVALUATION

1.15.1 Capitalization of Transformer Losses

When evaluating the individual bid received from various Bidders, the transformer shall be evaluated for the cost of losses based on the following relation

$$P_E = P_b + K_L * L_L + K_{NL} * L_{NL}$$

P_E = Evaluated Price

P_b = Bid Price

K_L = Value of Load Loss

L_L = Guaranteed load losses at rated current (Maximum MVA base)

K_{NL} = Value of no load Loss

L_{NL} = Guaranteed no load losses

The transformer losses shall be capitalized as follows:

Value of No Load Loss = US\$ 4,684 per KW

Value of Load Loss = US\$ 1,180 per KW

- 1.15.2 The Bidder shall furnish guaranteed no load and full load loss data at rated load with the bid for all rating of transformers contained herein. The supplier shall furnish a test certificate for each transformer supplied, which shall show the actual no load and full load losses of the transformer at rated load. For the purpose of evaluation, the higher values of no-load and load losses shall be considered from the values guaranteed by the Bidder and the values given in the test reports.

- 1.15.3 If the actual no load and full load losses of any transformer exceed the guaranteed values then the contract price for that transformer shall be reduced by the following calculated amounts for the losses in excess of the guaranteed values:

No Load Loss = US\$ 4,684 per KW

Load Loss = US\$ 1,180 per KW

Any transformer shall be rejected if losses exceed the guaranteed value by an amount in excess of the following

Total losses: 10%

Component losses: 15% (unless the total loss exceeds 10 %)

1.16 PERFORMANCE GUARANTEE

The Performance figures quoted on the Technical data shall be guaranteed within the tolerances permitted by relevant standards listed below, and will be a part of the successful Tender's Contract.

1.17 DRAWINGS, DATA & MANUALS

1.17.1 Submission

Submission of Drawings, Data & Manuals by the Tender along with the Tender Document and that after the Award of Contract for approval shall be as follows:

1.17.2 Drawings and Details to be submitted with the Tender

- i. Tender's proposed typical general arrangement drawing showing Constructional Features of
 - Tank including Conservator, level Gauge etc.
 - Bushing Configuration Arrangement.
 - Cable Termination Arrangement.
 - Wheel Base Dimension and Detail.
 - Head Clearance required for De-tanking of Coil Assembly.
- ii. Routine and Type Test Certificates of Similar Transformer as quoted
- iii. Technical Manuals on Accessories such as
 - Buchholz Relay, Sudden Gas Pressure / Oil Pressure Relay
 - Temperature Indicators
 - High and Low Voltage Bushings

1.17.3 After Award of Contract

After Award of Contract, the successful Bidder shall submit the required numbers of copies of following data for approval

- i. Outline Detail Drawing showing the general arrangement, indicating the space required for:
 - Cable Termination Arrangement
 - Wheel base Dimension & Details
- ii. Head Clearance required for De-tanking of Core and Coil Assembly
- iii. Foundation Plans and Loading
- iv. Transport / Shipping details with net weight and weights of various parts.
- v. Final calculation of the Impedance for Each Transformer.
- vi. Schematic flow diagram of cooling System showing the number of Cooling Units.
- vii. Technical details along with Control Schematic and Wiring Diagram for Marshaling box, Remote Tap Changer Control Panel.

- 1.17.4 Any other relevant Data, Drawings and information necessary for the review of the items under **Clause 1.17.3 of this section** whether specifically mentioned or not, shall be furnished along with this information.
- 1.17.5 The General Arrangement Drawing, the Schematic Wiring Diagram showing the Control Scheme, Cable Termination Arrangement, Location of Terminal Blocks, etc. shall be furnished for comment / approval in compliance with the **Clause 1.17.3 of this Section**. The Employer / Owner will return those drawings after their review with the comments and / or and the Configuration and the arrangement of the accessories fitted on the Transformer. The Contractor on receipt of their returned drawings, with comments from the Owner, shall prepare final schematic drawing, and coordinate the terminal markings of their final wiring diagram. The outgoing terminals of the wiring diagram shall be specially indicated for different functions, such as closing, tripping, alarm, indication etc. The responsibility for correctness of the wiring diagram shall lie with the Contractor.

The Owner will only check the final schematic diagram after submission. If any modification, addition or alteration is considered necessary thereon to comply with the Owner approved schematic drawing stated hereinabove, the said modification, addition, or alteration shall be carried out by the Contractor either at works if it is before delivery or at site after delivery at no cost to the Owner.

1.18 NAME PLATE

Each Transformer shall be provided with a nameplate of weather resistant material fitted in a visible portion showing but not limited to the following items.

- i. Kind of Transformer.
- ii. Number of the Specification.
- iii. Manufacturer's Name
- iv. Year of Manufacture.
- v. Manufacturer's Serial Number
- vi. Number of phases and Frequency.
- vii. Rated Power
- viii. Rated Voltages and Currents
- ix. Connection Symbol.
- x. Impedance Voltage at Rated Current.
- xi. Type of Cooling
- xii. Total Weight
- xiii. Insulating Oil Weight
- xiv. Class of Insulation
- xv. Temperature Rise
- xvi. Connection Diagram
- xvii. Insulation Levels
- xviii. Weight of Transportation and untanking.
- xix. Details regarding Tapping.
- xx. No-Load losses

xxi. Load Losses

1.19 SPARE PARTS

The following spare parts shall be provided in required quantities as listed in the Price Schedule.

- (a) 33 kV bushing
- (b) Dial type thermometer, oil level gauge
- (c) 10% of spare insulating oil, supplied in non-returnable sealed drums.
- (d) Five tap changer contact (moving and stationary) for diverter switch.
- (e) 50% of all indicating lamps used.
- (f) 50% of all fuses used.
- (g) 20 kg of silica gel
- (h) One complete set of gaskets
- (i) One set of all type of auxiliary current and voltage relays
- (j) One complete set of replacement parts likely to be damaged upon operation of pressure relief device.
- (k) One CT of each type
- (l) One cooler fan and fan motor.
- (m) Ten (10) liters of paint.

1.19 TRANSPORTATION

The Core and Coils shall be completely dried before shipment and Assembled with Tank and with Oil or Dry Nitrogen depending upon the size of the Transformers. In order to facilitate Handling and shipping, as many external accessories as practical, including bushing shall be removed and replaced by special shipping covers.

Bushings, Radiators and other accessories which may be affected by moisture shall be packed in moisture proof containers.

1.20 TECHNICAL PARTICULARS

The Technical Details of the Transformer shall be as per Appendices enclosed with this specification.

1.21 TRANSFORMER ACCESSORIES

The List of Transformer Accessories is given in the Appendices enclosed with this (Appendix A-1).

**APPENDIX A-1.1:
TECHNICAL PARTICULARS OF POWER TRANSFORMER AND
ACCESSORIES**

S.No.	Description	For different locations	For different locations
1.	Rated Capacity	3 MVA	6/8 MVA
2.	Quantity Required	As per price schedule	
3.	Service	Outdoor	Outdoor
4.	Type	Oil Immersed	Oil Immersed
5.	Type of Cooling	ONAN	ONAF
6.	Temperature Rise above 45°C ambient temperature		
a)	In Oil by Thermometer	50°C	50°C
b)	In winding by Resistance	55°C	55°C
7.	Number of Phases	3 phase, 50 Hz.	3 phase, 50 Hz.
8.	Maximum Voltage (Phase to Phase)		
a)	Primary, kV	36	36
b)	Secondary, kV	12	12
9.	Rated Voltage (Phase to Phase)		
a)	Primary, kV	33	33
b)	Secondary, kV	11	11
10.	Insulation Level of Winding		
a)	Basic Impulse level as per IEC 76		
	Primary, kV	170	170
	Secondary, kV	75	75
b)	Frequency Induced Over Voltage (Impulse)		
	Primary, kV	70	70
	Secondary, kV	28	28
11.	Connections		
a)	Primary	Delta	Delta
b)	Secondary	Star	Star
12.	Vector Group Reference		
	Primary-Secondary	Dyn 11	Dyn 11
13.	Tap Changer		
a)	Type of Tap Changer	No-Load	On-Load
b)	Range of Taps	±10%, Step 2.5%	±2.5%, ±5%
c)	Number of Taps	9	5
d)	Method of Tap Changer Control		
	Mechanical Local	Yes	
14.	Percentage Impedance Voltage at Rated MVA and 75°C	4%	7%
15.	System Grounding		
a)	Primary	Ungrounded	Ungrounded
b)	Secondary	Solidly Grounded	Solidly Grounded
16.	System Fault Level	10kA at 33kV	20kA at 33kV
17.	Neutral Terminals		
a)	Primary	No	No
b)	Secondary	Yes	Yes

APPENDIX A-1.2**Transformers furnished under this Specification shall be equipped with**

- *1. Oil Conservator with one compartment with filler caps and drain plugs.
- *2. Two sets of Silica Gel Breather with Connecting Pipes and Oil Seals.
- *3. Air Release Plugs.
- *4. Double float Bucholz Relay with Electrically Separate Trip and Alarm Contacts for Transformer Tank
- *5. Two Nos. of Shut-Off valves at both sides of each Bucholz.
- **6. Sudden Gas Pressure relay with Trip Contact.
- 7. Mechanically Operated Self Resetting type Pressure relief Device with visible Operation Indicator and Trip Contact.
- 8. 150mm Dial Magnetic level Gauge with Low Oil level alarm.
- 9. Direct reading Plain Oil Level Gauge.
- 10. 150mm dial Oil Temperature Indicator with Maximum Reading pointer and Individually adjustable Separate Sets of Contact for Alarm and Trip.
- 11. 150mm Dial Winding Temperature Indicator with individually adjustable electrically separate sets of Contacts for two stage cooler control, Alarm and Trip with detector element complete with Heating Coil, CT's etc.
- 12. Drain Valve with Threaded Adapter.
- 13. Sample Valve (Top and Bottom)
- 14. Filter Valve with Threaded Adapter (Top and Bottom)
- 15. Cover Lifting Eyes
- 16. Jacking Pads, Hauling and Lifting Lugs.
- 17. Bi-directional Wheels.
- 18. Rails
- 19. Clamping Device with Nuts & Bolts for clamping the Transformer on Foundation rails.
- 20. Ladder with Safety device for access to the Transformer top and Bucholz relay.
- 21. Grounding Pads each with 2nos. tapped holes, bolts and washer for Tank, Radiator and cable end box Grounding.
- 22. Rating Plates and Terminal marking plate.
- 23. Marshaling Box for housing Cooler Control Equipment and Terminal Connections.
- 24. Any other Accessories.

* For conservator type of oil preservation system.

** For sealed tank of oil preservation system.

BLANK

2. SILICON STEEL CORE TYPE STATION SERVICE TRANSFORMER

1. Scope

These specifications cover the requirements of oil-immersed, naturally cooled three-phase distribution transformers suitable for outdoors installation on 33 kV, 50 Hz distribution systems.

2. Service Condition

The transformers shall be designed and constructed for outdoor installation and operation under the following conditions:

Ambient temperature: -5°C to 45°C

Relative humidity: up to 95%

Altitude: up to 2000 m above the mean sea level

3. Standards and Quality Certification

- 3.1 The equipment specified in this Section of the Contract shall conform to the latest edition of the appropriate IEC specifications and/or other recognised international standards *equivalent to IEC Standards*. In particular:

IEC 60076 Power transformers

IEC 60137 Insulating Bushings for alternating voltages above 1 kV

IEC 60156 Insulating liquids-Determination of the breakdown voltage at power frequency-test method

IEC 60296 Specification for uninhibited mineral insulating oils for transformers and switchgear

IEC 60551 Determination of transformer and reactor sound levels

IEC 60616 Terminal and tapping materials for power transformer

IEC 60722 Guide to lightning and switching impulse testing of power transformers and reactors

IEC 60733 Determination of water in insulating oils.

IEC 5493 Protective coating of iron and steel structures against corrosion.

- 3.2 The manufacturer of the offered transformers must have been accredited with valid ISO 9000 quality certification with design in its scope of registration.

4. Description

- 4.1 Technical details are given in Table 1. The quantity of the transformers to be supplied shall be as given in the Price Schedule.

4.2 Tank

The tank shall be of welded construction and fabricated from mild steel of adequate thickness. All seams shall be properly welded to withstand requisite impact during short circuit without distortion. All welding shall be stress relieved. The tank cover shall be bolted on to the tank with weatherproof, hot-oil resistant, resilient gasket in between for complete oil tightness. Pressed-steel radiators shall be mounted on transformer-tanks of 100 kVA and higher rating transformers. The radiator shall be of

pressed-steel of corrugated type design. Heat dissipation calculation in respect of the number, size and length of the radiators are to be satisfied by design calculation.

Each transformer shall be provided with a case of rigid construction, which shall be oil-tight and gas-tight. The thickness of all tank sides except the tank-bottom and cover shall not be less than 3.2 mm. The thickness of tank-bottom and cover shall not be less than 4.0 mm. The tank shall be capable of withstanding, without leakage or permanent deformation, a pressure 25% greater than the maximum operating pressure. The tank cover shall be bolted on to the main-tank. Each transformer shall be provided with earthing terminal with clamp type connector.

4.3 Painting

All sheet steel works shall be phosphated in accordance with the following procedure and in accordance with BS 2569 and BS 5493.

The tank body shall be sand/shot blasted to remove the welding scales. Oil, grease, dirt 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. After phosphating, thorough rinsing shall be carried out with clean water, followed by final rinsing with dilute dichromate solution and even drying. The phosphate coating shall be sealed by the application of two coats of stoving type zinc chromate primer. The first coat may be "flash dried" while the second coat shall be stoved. After application of the primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by stoving. Touch up shall be applied after completion of tests. The color for the finishing paint shall be light gray or as approved by Employer. The final finished thickness of paint film on steel shall not be less than 60 microns. Finished painted surface shall present aesthetically pleasing appearance free from runs and drips. A small quantity of finishing paint shall be supplied for minor touching up required at site.

4.4 Core

The transformer shall be of core type. The cores shall be constructed with prime core-material of interleaved grade non-aging, low loss, high permeability, grain oriented and cold rolled silicon steel laminations, properly treated after being sheared to remove any burrs and shall be re-annealed to remove any residual stresses. The steel shall be thin in lamination.

The yoke laminations shall be in single piece instead of pieces to reduce chances of introducing more air gaps in the core construction.

All steel sections used for the support of the core shall be thoroughly sand blasted after cutting, drilling and welding.

All laminations shall be properly insulated with the materials that will not deteriorate due to pressure and hot oil.

The core shall be rigidly clamped with positive locking device to ensure adequate mechanical strength. Core and coil assembly shall be capable of withstanding the vibrations and shock during transportation, installation, service and adequate provision shall be made to prevent movement of core and coil assembly relative to the tank during these conditions.

The core shall be provided with lifting lugs suitable for lifting complete core and coil assembly of transformer.

Permissible Flux Density and Over Fluxing

Flux density at rated voltage and frequency shall not exceed 1.6 T. The no-load current at rated voltage and at 112.5% voltage shall not exceed the values given below with tolerance as indicated.

At 100% rated voltage	2% of rated full load current + 30% as tolerance.
At 112.5% rated voltage	max 4% of rated full load current

The bidder shall submit the design calculation in support of flux density and no-load current at 100% and 112.5% voltage along with drawings of core-steps, limb-diameter, window-height, limb-center, etc.

4.5 Winding

The design, construction and treatment of winding shall give proper consideration to all service factors. The winding shall be so designed that all coil assemblies are of identical voltage ratio and shall be interchangeable. All delta leads should be clamped tightly on to the special frame/bracket making pie (π) frame. The leads leading to the bushing terminals should be clamped to the horizontal support base of the pie frame so that vibration during short circuit is not passed on to the windings. The completed assembly of core and coils shall be dried in a vacuum sufficient to ensure elimination of air and moisture within the insulating structure. After the drying process, the assembly shall be immediately impregnated with dry oil to develop full electrical strength in the windings. The windings of the transformer shall be fabricated from copper materials for 50 KVA and higher rating transformer, whereas it may be of copper or aluminum for lower rating transformers.

Current Density

Current density for any part of the winding shall not exceed the following values:

Copper winding transformers	$\leq 2.8 \text{ amp/mm}^2$
Aluminum winding transformers	$\leq 1.5 \text{ amp/mm}^2$

4.6 *Oil Preservation System*

The transformers up to 25 kVA of voltage rating 11/0.4 kV and 11/0.23 kV shall be completely oil filled type. The transformers of higher ratings shall be provided with conservator. The conservator vessel shall have a capacity between highest and the lowest levels of not less than 7.5% of the total cold oil volume of the transformer.

Each conservator vessel shall be fitted with a sufficient-size breather in which silica-gel shall be used as the drying agent. Windows in the silica-gel breathers shall be sufficiently large enough to allow crystal color change to be easily observed from a distance of 6 m. The position of the silica gel breather shall be such that maintenance can be carried out without the need to de-energize the transformer.

4.7 *Tap Changer*

An externally - operated tap changer for transformers rated 100 kVA and above shall be furnished with each transformer, to be operated only when the transformer is de-energized. The tap changer shall include an operating handle, visible indication of tap position and means for locking the tap changer in any desired position. The locking device shall be arranged to prevent locking the tap changer in an off position. Mechanical means shall be provided for limiting the maximum and minimum travelling of the extreme tap positions to be at the maximum and minimum position of the tap changer.

4.8 *Insulating Oil*

The insulating oil shall be refined mineral oil. Necessary quantity of oil for the transformer shall be furnished by the contractor.

4.9 *Bushings*

The bushings shall be made of homogeneous and well vitrified porcelain. The color of the insulator shall be brown and the surface shall have polished glaze.

The high voltage bushings shall have clamp-type terminal lugs suitable for terminating 30-120 mm² stranded conductor.

The low voltage bushings shall have clamp-type terminal lugs suitable for terminating aluminum conductor compatible to the kVA rating (with 100% factor of safety) of the transformer.

The low voltage neutral bushings shall include a clamp-type terminal lug for terminating together an earth-wire and an aluminium conductor of neutral circuit of the LV system.

4.10 *Temperature rise*

Maximum oil-temperature rise and maximum winding-temperature rise above ambient-temperature of 45°C when carrying maximum continuous rated current shall not exceed the following;

- a. In oil by thermometer 50°C
- b. In winding by resistance 55°C

The temperature rise of the insulating oil shall be measured near the top of the main tank.

4.11 Gaskets

All sealing washers / Gaskets shall be made of oil and heat resistance nitrile / neoprene/ synthetic rubber bonded with cork gasket. Gasket made with natural rubber and cork shall not be acceptable. The thickness of the tank cover gasket shall not be less than 6 mm before compression.

4.12 Clearances

Minimum electrical clearances between the phases and phase to earth shall not be less than the values given below:

Voltage	Medium	Phase to phase, mm	Phase to earth, mm
33 kV	Air	330	320
11 kV	Air	255	205
400 V	Air	75	55

The clearances shall be maintained by fixing the bimetallic connectors in position.

4.13 Accessories

The following accessories shall be provided with each transformer.

- ☐ Lower oil filter and drain valve
- ☐ Liquid level gauge
- ☐ Lifting Lug
- ☐ Name plate
- ☐ Tank grounding terminal connector suitable for grounding cable
- ☐ Pressure relief device of explosion-vent type for 25 kVA and higher ratings

4.14 Rating and Terminal Marking Plate

Each transformer shall be provided with a non detachable rating and terminal marking plate of weather proof material, preferably of brass fitted in a visible position mentioning the following information:

- Guaranteed No Load Loss and Load loss
- Details of rating (rated output, voltage, phases, frequency etc.)
- Cooling
- Connection and vector diagram
- Weights (Total, weight of core, weight of winding and weight of oil)
- Name of manufacturer and year of manufacture
- Standards of manufacture
- Physical dimension of the transformer
- Any other relevant information

The face of the transformer body shall display the words "Property of Nepal Electricity Authority" on two sides written in indelible paint.

5. Tests

Tests shall be performed in accordance with these specifications in line with relevant IEC standards.

Type Tests

The Bidder shall submit, along with the Bid, type test reports (detail) on the following tests performed on identical units.

- Temperature rise tests
- Dielectric Type test
 - i) Impulse voltage tests
 - ii) Separate source AC withstand voltage test

The type test certificates shall be furnished for each type of transformer offered which, in addition to other required data, shall show the actual no-load and full-load losses of the transformer at rated load. For the purpose of evaluation, the higher values of no-load and load losses shall be considered from the values guaranteed by the Bidder and the values given in the type test reports. The test of the transformer shall have been conducted by an accredited independent laboratory.

5.2 Routine Tests

The following tests shall be performed on each unit of transformer by the manufacturer before dispatch and submit the test-reports to the Employer.

- Applied voltage test
- Induced voltage test
- No load loss and excitation current test
- Impedance voltage and load loss tests
- Winding resistance measurement
- Ratio tests
- Polarity and phase relation tests
- Tank leakage tests
- Insulation resistance tests
 - Separate source power frequency voltage withstand test
 - Dielectric breakdown strength of oil

The bidders are required to furnish the details of testing facilities available at the manufacturer's premises for conducting the tests listed above in 5.2

5.3 Tests to be witnessed by the Employer

The Employer's representative(s) shall witness at the manufacturer's plant (a) temperature-rise test, (b) dielectric type-test for each type (and rating) of transformer and routine-tests on at least 2 (two) % of each type (and rating) of transformer to be procured. The sample shall be selected by the Employer's representative(s) from the complete-lot ready for dispatch. **No additional costs shall be paid for such tests.**

The Contractor shall carry-out [which the Employer's representative(s) shall witness] the following tests in a laboratory owned or nominated by the Employer after delivery in Nepal.

- a) Temperature rise test on at least one transformer of each rating.
- b) No Load Loss and Load Loss test on 100 (hundred) % of transformer
(Only 10% sample may be tested until the Employer is in a position to instruct or conduct 100% testing)

The sample shall be selected by the Employer's representative(s) from the complete-lot of delivered transformers. **Cost for such tests shall be quoted in the Price Schedule (100% or 10% as Applicable).**

6. Evaluation

- 6.1 The transformer no-load and load losses shall not exceed the following prescribed values. If the guaranteed no load and load losses exceed the prescribed values below, the offer shall be rejected.

For 33/0.4/0.23 kV

<i>S.N. Rating</i>	<i>No Load Loss (watts)</i>	<i>Load Loss (watts)</i>
1. 50 kVA, 3-ph	140	800
2. 100 kVA, 3-ph	290	1800

- 6.2 Transformers shall be evaluated for the loss values (no-load losses and load losses) during bid evaluation based on the following loss capitalization formula:

$$P_E = P_b + K_L L_L + K_{NL} N_{LN}$$

Where,

P_E = Evaluated price

P_b = Bid price

K_{NL} = Value of no-load loss

K_L = Value of load loss

L_L = Guaranteed load losses at rated current

L_{NL} = Guaranteed no-load losses.

The transformer losses shall be capitalized as follows:

$$K_{NL} = \text{Value of no-load loss} = \text{USD } 4,684 / \text{kW}$$

$$K_L = \text{Value of load loss} = \text{USD } 618 / \text{kW}$$

- 6.3 Penalty for Excessive losses: During testing, if it is found that the actual measured losses are more than the values guaranteed by the bidder (provided that they are within the limit specified in Clause 6.1 above), a penalty shall be recovered from the bidder at double the loss capitalization rates arrived at clause 6.2 above. For fraction of a kW, proportionate penalty will be recovered.

- 6.4 For the purpose of this Specification type tests are defined as tests performed on similar transformers of the same general arrangements, same ratings and same mechanical and electrical characteristics.
- 6.5 If at any stage it is established that the type test report submitted by the bidder is not satisfactory, discrepant or ambiguous, then NEA reserves the right to ask the bidder/supplier to conduct the type test on the rating/s of transformers chosen by the NEA in the presence of their representative at reputed national/international testing laboratory prior to its mass production *and/or* dispatch. The costs involved in organizing and conducting such tests shall be borne by the bidder/supplier.

7. Bid Documentation

- 7.1 The Bidder shall furnish with the Bid, the following documentation:
- a) One (1) clear copy of the IEC standards governing fabrication and testing of the transformers.*
 - b) Two (2) clear certified copies of type tests carried out for each rating as required by the governing IEC standard and the specifications.*
 - c) Two (2) copies of certified outline drawings for each kVA rating showing dimensions, arrangements, and locations of all parts.*
 - d) A clause-by-clause commentary on the specification, specifying compliance or deviations, if any.*

RATINGS AND FEATURE FOR DISTRIBUTION TRANSFORMER**TABLE 1**

Type	Three-phase, 33/0.4 kV
Rated power	As specified in the Price Schedule
Rated voltage	- Primary 33kV - Secondary 400/230V
Max system voltage	- Primary 36 kV - Secondary 440V
Rated Frequency	50Hz
Connection	- Primary Delta - Secondary Grd.Wye
Cooling System	ONAN
Vector group	Dyn 11
Rated impedance voltage	3.5 - 4.5%
BIL for windings and bushings for primary side	170 kV
Withstand voltage, 50 Hz, 60 Sec.	- Primary 70 kV - Secondary 3 kV
No load tap changer	+/- 2.5%, +/- 5% on HV side (For 100 kVA and above)
Mounting	Platform
Insulation levels (IEC) 76	LI 170 AC 70/AC 3
Insulation temperature class (IEC 76)	A
Maximum allowable noise level at 3 metre hemispherical radius	<44 dB
Applicable standard	These Specifications and IEC

3. 33KV CIRCUIT BREAKER

3.1 General

This specification covers the design, manufacture, assembly, shop test, supply, delivery, installation works and field test of 33kV vacuum circuit breakers complete with all accessories for efficient and trouble free operation as specified here in under.

Circuit breakers shall be offered from reputed makes like Hitachi /GE /ABB /Mitsubishi /LG /Fuji / Siemens or Areva or equivalent.

The equipment specified in this Section shall conform to the latest edition of the appropriate IEC specifications and/or other recognized international standards. In particular:

IEC 60056 High-voltage alternating switchgear

IEC 62271 High-voltage alternating switchgear and control gear

IEC 60376 Specification and acceptance of new sulphur hexafluoride

IEC 60529 Degree of protection provided by enclosures

IEC 60694 Common specifications for high-voltage switchgear and control gear standards

3.2 Equipment to be furnished

3.2.1 The equipment to be furnished shall strictly be in accordance with the specifications and the Price Schedule.

3.3 Design Requirements

3.3.1 The circuit breakers shall be suitable for 3 phase, 50Hz in 33kV system.

3.3.2 Circuit breaker shall be installed outdoor in a hot and humid climate. All equipment and accessories shall be provided with tropical finish to prevent fungus growth.

3.3.3 The maximum temperature rise in any part of the equipment at specified rating shall not exceed the permissible limit as stipulated in relevant standards. The de-rating of the equipment shall be made taking 45 deg. C as an ambient temperature of the site, if it is designed for any lower ambient temperature.

3.3.4 The rated peak short circuit current or the rated short time current carried by the equipment shall not cause:

- (a) Mechanical damage to any part of the equipment.
- (b) Separation of contacts.
- (c) Insulation damage of "Current Carrying Part".

3.3.5 Technical particulars of the circuit breaker shall be as per **Appendix 2**.

3.3.6 All auxiliary equipment shall be suitable for 3 phase 4 wire, 50Hz, 400 V.

3.4 Construction Features

3.4.1 This circuit breaker shall be outdoor, three phase, single throw, pneumatically or spring charged motor operated, vacuum type, trip free in any position, complete with operating mechanism and supporting structure.

3.4.2 Bushing or tanks shall be accurately aligned and assembled with the operating mechanism

as a complete rigidly mounted unit on a structural steel base or frame at the factory, to permit shipment and installation as an assembled unit.

3.4.3 Contacts

The contacts shall be designed to have adequate thermal and current carrying capacity for carrying full-rated current without exceeding the allowable temperature rise as specified by IEC standards. They shall be designed to have long life so that frequent replacement or maintenance will be unnecessary. The surfaces of either of both moving and stationary arcing contacts, which are exposed directly to the arc, shall be faced with suitable arc resisting material.

3.4.4 Local test switch

Each mechanism shall be equipped with a local test switch for electrically testing the closing and tripping operations of the circuit breaker. A separate manually operated cutout device to disconnect the circuits to remote closing, re-closing and tripping devices shall be provided on each circuit breaker. A warning nameplate requiring operation of this device before operation of the local test switch shall be mounted adjacent to the local test switch.

3.4.5 Emergency trip

Each circuit breaker shall be provided with an emergency hand trip device. This device shall be provided with mechanically interlocked contacts to disconnect circuits from remote closing and re-closing devices.

3.4.6 Position indicator

The circuit breaker shall be equipped with mechanical position indicator. The indicator shall be provided for each pole.

3.4.7 Operating mechanism

The operating mechanism of the circuit breakers shall be spring charged by 110V D.C. motor and with mechanical charging.

The tripping circuit mechanism and the closing control circuit mechanism shall each have a nominal voltage rating of 110 volts DC. The tripping circuit shall operate satisfactorily for a tripping operation over a voltage range of 70-110%. The closing control circuit shall operate satisfactorily over a voltage range of 85-110%.

3.4.8 Operation Counter

There shall be the counter to read the number of operation of VCB.

3.4.9 Accessories

The Contractor shall furnish following accessories as an integral part of the circuit breaker:

- (a) Padlocks and duplicate keys
- (b) Operation counter
- (c) Earthing terminals
- (d) Nameplate
- (e) Other necessary accessories
- (f) Operating handle

3.4.10 Spare parts

Following spare parts shall be provided in required quantities as listed in Price Schedule.

3.5 Tests

3.5.1 Routine tests

One circuit breaker of each type ordered under the Contract shall be fully assembled at the manufacturer's works and subjected to routine tests in accordance with IEC 56 and shall comprise but not limited to the following.

- (a) Construction inspection
- (b) Leakage test
- (c) Operating speed check
- (d) Dielectric test
- (e) Pressure test
- (f) Control and secondary wiring check test
- (g) Mechanical operation test
- (h) Operating mechanism system check

3.5.2 Design tests

The Contractor shall conduct the following design tests on one circuit breaker being furnished. However, if these tests have been previously conducted on identical circuit breakers, the Contractor may furnish certified copies of such previous reports instead of performing tests on the actual circuit breakers being furnished. The Bidder shall submit the copy of design test for identical circuit breaker with the proposal.

- (a) Bushing tests
- (b) Dielectric withstand test
- (c) Current carrying test
- (d) Normal current switching test
- (e) Short circuit switching test
- (f) Mechanical operation life test

If a circuit breaker has been used for design tests, the test breaker will not be accepted unless the following minimum maintenance are completed, including any other provisions not included herein, but required to render the breaker equivalent of a new breaker:

- (a) Replace all latches and pins
- (b) Replace all major parts which are subject to fatigue, including, but not restricted to, contacts, movable cross-heads, spring and linkages.

3.5.3 Field tests

After installation at Site, the circuit breaker shall be subjected but not limited to the following field tests:

- (a) Construction inspection
- (b) Measurement of insulation resistance
- (c) Operating speed check
- (d) Mechanical operation test
- (e) Operating mechanism system check

3.6 Performance Guarantee

The performance guarantee figures quoted on the schedule of technical data shall be guaranteed within the tolerances permitted by relevant standard and will become a part of successful Tender's Contract.

3.7 Drawings, Data and Manuals

3.7.1 The following drawings and data shall be furnished along with the Tender.

- (a) General equipment layout
- (b) Outline drawings of the breaker and control cubicle with accessories

3.7.2 After award of Contract the successful Bidder shall submit the required number of copies of the following drawings and data for approval of the Employer/Employer's Representative.

- (a) General equipment layout
- (b) Outline drawing of the breaker and control cubical with accessories.
- (c) Loading data and foundation detail.
- (d) Elementary control wiring diagram.
- (e) Internal wiring diagram.
- (f) External connection diagrams, showing terminal boards and other external connection points for each assembly and the required interconnecting wiring.
- (g) Drawing showing typical cross-section of the operating mechanism and breaker mechanism.
- (h) Drawing showing typical cross-section and assembly of interrupting device.
- (i) Drawing showing assembly of principal component parts and accessories.
- (j) Drawing showing details of bushing or porcelain supporting columns, including dimension details of flanges and outline dimensions.
- (k) Drawing to show details at all points where adjustments may be made to operating dimension mechanism, breaker mechanisms and contacts.
- (l) Any other drawings and data required for design and installation of circuit breaker.
- (m) Instruction manual for storage, installation, operation and maintenance of circuit breaker and operating mechanism.

3.8 Nameplate

Each circuit breaker shall be provided with nameplate of weather resistant material fitted in a visible position showing the following items as a minimum.

- (a) Manufacturer's name
- (b) Manufacturer's serial number and type designation
- (c) Year of manufacture
- (d) Rated voltage, kV
- (e) Rated insulation level, kV
- (f) Rated frequency, Hz
- (g) Rated normal current, A
- (h) Rated short-circuit breaking current, kA
- (i) Rated interrupting time cycles
- (j) Weight of circuit breaker, kg

3.9 Special Tools

In addition to the tools, which are regularly furnished with such breakers, the Contractor shall also supply all necessary special tools or equipment for assembling and disassembling the breaker. The Contractor shall submit an itemized list of such equipment.

APPENDIX 2
TECHNICAL PARTICULARS OF 33 kV CIRCUIT BREAKER

1. Type	Vacuum, outdoor type
2. Quantity required	As per Price Schedule
3. Voltage rating	
(a) Nominal system voltage	33kV
(b) Rated maximum voltage	36kV
4. Insulation level	
(a) Impulse withstand voltage	170kV
(b) Power frequency withstand voltage(1 min)	75kV
5. Frequency	50Hz
6. Current rating	
(a) Rated continuous current at 45 deg. C ambient	800A
(b) Rated interrupting current	25 kA
7. Re-closing duty cycle (Rated operating sequence)	0-0.3 sec-CO-3 min.-CO
8. Auxiliary supply	
(a) Control circuit	DC 110V
(b) Space heater and auxiliary equipment	AC, 3Ph-4W, 400V, 50Hz
9.	
Total maximum break time	60 ms
First pole to clear factor	1.5
Additional Auxiliary Contacts	8 NO, 8 NC
Maximum make time	120 ms
Spring charging motor	110 V DC

4. 33 kV DISCONNECTING SWITCH

4.1 General

This specification covers the design, manufacture, assembly, shop test, supply, delivery, installation works and field test of disconnecting switches complete with all accessories for efficient and trouble-free operation as specified herein under.

The equipment specified in this Section shall conform to the latest edition of the appropriate IEC specifications and/or other recognized international standards. In particular:

IEC 60129 High-voltage alternating current disconnectors and earthing switches
IEC 60529 Degree of protection provided by enclosures

Manufacturer of isolator shall hold valid ISO 9001 quality certificate.

4.2 Equipment to be furnished

33 kV Disconnecting Switch

- 4.2.1 The equipment to be furnished shall strictly be in accordance with the specifications and the Price Schedule.

4.3 Design Requirements

- 4.3.1 The disconnecting switches shall be used for the 33kV, 50Hz, 3 phase system.
- 4.3.2 The equipment shall be installed outdoor in a hot, humid climate. All equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth.
- 4.3.3 The maximum temperature rise in any part of the equipment at specified rating shall not exceed the permissible limits as stipulated in relevant standards. The derating of the equipment shall be made taking 45 deg. C as an ambient temperature of the site, if it is designed for any lower ambient temperature.
- 4.3.4 The rated peak short circuit current or the rated short time current carried by the equipment shall not cause:
- (a) Mechanical damage to any part of the equipment
 - (b) Separation of Contacts
 - (c) Insulation damage of "Current Carrying Part."
- 4.3.5 The grounding switch shall be capable of making to a dead short circuit without damage of the equipment or endangering operator.

The disconnecting switches shall be rotating post type with contact blades moving

through horizontal plane.

- 4.3.6 The rating, the accessories to be furnished and the schedule of equipment are detailed in Appendices.
- 4.3.7 The disconnecting switches shall be able to carry the rated current continuously and rated short time current for three seconds without exceeding the temperature limit specified in the relevant standard.
- 4.3.8 The disconnecting switches shall be capable of withstanding the dynamic and thermal effects of maximum possible short circuit current at the point of its installation.

4.4 Construction Features

- 4.4.1 The 3-pole disconnecting switches shall be gang operated type so that all the poles make and break simultaneously.
- 4.4.2 The disconnecting switches shall be designed for upright mounting on steel structure.
- 4.4.3 The disconnecting switches shall have padlocking arrangement in both "open" and "closed" positions.
- 4.4.4 All current carrying parts shall be non-ferrous metal or alloy. All live parts shall be designed to avoid sharp points and edges.
- 4.4.5 All metal parts shall be of such material and treated in such a way as to avoid rust, corrosion and deterioration due to atmospheric conditions. Ferrous parts shall be hot-dip galvanized.
- 4.4.6 Bolt nuts, pins, etc. shall be provided with appropriate locking arrangement such as locknuts, spring washers, key etc.
- 4.4.7 Bearing housing shall be weatherproof with provision for lubrication. The design, however, shall be such as not to require frequent lubrication.
- 4.4.8 All bearings in the current path shall be shorted by flexible copper conductor of adequate size (minimum-70sqmm) to allow the specified fault current through it without injury.
- 4.4.9 Main contacts

The main contacts shall be of silver-plated copper alloy and controlled by powerful springs designed for floating and pressure point contact.

The contacts shall have sufficient area and pressure to withstand the electromagnetic stresses developed during short circuit without excessive heating liable to pitting or welding.

Contacts shall be adjustable to allow for wear, shall be easily replaceable and shall

have minimum movable parts and adjustments.

The blade shall be made of electrolytic copper tube or aluminum tube of liberal section. Rotating feature of the blade at the end of tube travel for contact wiping shall be provided.

Arcing horns shall be provided to divert the arc from main contacts to the separating horns after the main contacts have opened. Arcing horns shall be renewable type.

4.4.10 Insulators and terminals

Insulators shall be post type, brown glazed and composed of stacked units.

The porcelain used for insulators shall be manufactured by wet process and shall be homogeneous and free from cavities and other flaws.

Caps and pins shall be of the highest quality malleable iron or forged steel and smoothly galvanized.

Arcing horn as required shall be furnished.

All insulators of identical ratings shall be interchangeable.

The terminals of the disconnecting switch shall be provided with terminal connectors.

4.5 Operating Mechanism

4.5.1 Disconnecting switches for 33kV.

The operating mechanism for 33kV shall be manually operated.

The manual operating mechanism shall be of torsion type suitable for operation in the horizontal plane. The operating handle shall be equipped with each switch and shall be arranged for mounting on the steel base supporting structures. Means shall be provided on each switch for taking up loose motion in the operating mechanism and for adjusting the travel of each blade independently. The Contractor shall furnish all supplemental members required to secure the installation of the complete switch mechanism to the supporting structures.

All switches shall be self-locking in the open and closed positions independent of the control shaft restraint. Each mechanism shall be provided with an indicator showing direction of rotation for opening or closing, and shall be provided for grounding and for padlocking in the open and closed positions.

Each operating mechanism shall be furnished complete with all necessary operating pipes, interphase shafts, pipe couplings, guide bearings, ground braids, mounting brackets, mounting bolts, operating handle, auxiliary switches and offsets required for operation from the ground. All operating rods and levers shall be cut to length and all machining operations and threading shall be complete in

the factory.

The manually operated disconnecting switches shall also be provided with a minimum four (4) normally closed and four (4) normally open auxiliary contacts for remote indications.

4.6 Assembly

Each disconnecting switches along with its base frame and operating mechanism shall be completely assembled and checked at manufacturer's works for correct alignment and operation prior to dispatch.

All parts and accessories shall have appropriate match marks and part number for identification at site.

4.7 Tests

- 4.7.1 Type and routine tests on the equipment and components shall be in accordance with latest revision of IEC Standards or equivalent standards approved by the Employer/Employer's Representative.

Each switch shall include but not limited to the following tests:

- (a) Routine tests
 - Power frequency voltage dry test
 - Measurement of resistance of main circuit
 - Control and secondary wiring check test
 - Mechanical operation test
- (b) Design tests
 - Insulator test
 - Dielectric test, including impulse withstand test
 - Radio influence test
 - Short-time current test
 - Voltage drop test the voltage drop across one complete phase of a switch shall be measured when carrying rated current.
 - Temperature Rise Test

If type tests have been previously conducted on identical disconnecting switch, the Contractor may furnish the certified copies of such previous reports instead of performing tests. The Bidder shall submit copy of design test report from accredited testing laboratory for the disconnecting switch of the offered model along with the bid.

- 4.7.2 The type and routine test certificate shall be furnished in the required number of copies to the Employer/Employer's Representative for approval before dispatch of the equipment from the works.

4.7.3 Field tests

After installation at Site, the disconnecting switches shall be subjected but not limited to the following field tests:

- (a) Construction inspection
- (b) Measurement of insulation resistance
- (c) Mechanical operation test

4.8 Drawings, Data and Manuals

4.8.1 The following drawings and data shall be furnished with the Tender.

- (a) General arrangement drawing with different sections showing constructional features.
- (b) Technical leaflets on disconnecting switches offered explaining the function of various parts, principle of operation and special features (if any).
- (c) Typical type test results on identical equipment offered in the Tender.

4.8.2 The various drawings, data and manuals shall be submitted for approval and afterwards for final distribution in quantities and in procedures as set-up elsewhere. The various drawings and data to be furnished shall include:

- (a) Outline dimensional drawings of the equipment showing general arrangement and location of fittings.
- (b) Transport/shipping dimensions with weights.
- (c) Foundation and anchor bolt details including loading condition.
- (d) Assembly drawing for erection at site with part numbers and schedule of materials.
- (e) Electrical schematic and wiring diagram.
- (f) Any other relevant drawings and data necessary for erection, operation and maintenance.
- (g) Instruction manual and data sheets.
- (h) Any other relevant data, drawing and information necessary for review of the items stated above.

APPENDIX A-3**TECHNICAL PARTICULARS OF 33kV DISCONNECTING SWITCH
(WITH GROUNDING SWITCH)**

1. Type	3-pole, single throw, outdoor
2. Quantity required	As per Price Schedule
3. Voltage ratings	
(a) Nominal system voltage	33kV
(b) Rated maximum voltage	36kV
4. Frequency	50Hz
5. Insulation levels	
(a) Basic impulse level (BIL)	170kV
(b) Power frequency withstand voltage (1 min.)	75kV
6. Current ratings	
(a) Continuous current	800A
(b) Short time current (1 seconds)	25 kA
(c) Peak short time current	32kA
(d) Making current of grounding switch	32kA
7. Operating mechanism	Manually gang operated

APPENDIX A-4**TECHNICAL PARTICULARS OF 33kV DISCONNECTING SWITCH
(WITHOUT GROUNDING SWITCH)**

1.	Type	3-pole, single throw, outdoor
2.	Quantity required	As per Price Schedule
3.	Voltage ratings	
(a)	Nominal system voltage	33kV
(b)	Rated maximum voltage	36kV
4.	Frequency	50Hz
5.	Insulation levels	
(a)	Basic impulse level (BIL)	170kV
(b)	Power frequency withstand voltage (1 min.)	75kV
6.	Current ratings	
(a)	Continuous current	800A
(b)	Short time current (1 seconds)	25kA
(c)	Peak short time current	32kA
7.	Operating mechanism	Manually gang operated

5. POWER FUSE

5.1 General

This specification covers the design, manufacture, assembly, shop test, supply, delivery, installation works and field test of power fuse.

Manufacturer of fuse shall be holder of valid ISO 9001 Certificate

5.2 Equipment to be furnished

- 5.2.1 The equipment to be furnished shall strictly be in accordance with the Price Schedule.

5.3 Design Requirements

- 5.3.1 Power fuse shall be in accordance with IEC standards. The fuse set shall be of drop out type and fuse shall be contained inside fiberglass suitable for outdoor use in a tropical climate. Complete fuse mountings and holders shall be furnished as specified in Technical Particulars enclosed. Refill units are to be furnished separately.
- 5.3.2 All terminals shall be of high conductivity copper alloy and all terminals for aluminum shall be plated with hot-flowed electro-tin or cadmium.
- 5.3.3 The insulated stick furnished for replacing the fuses shall be 6m (20 feet) and a combination type suitable for operating hook stick disconnecter. The stick shall be of fiberglass or plastic over a wood or plastic foam cane and have voltage withstand rating of 246kV per meter.
- 5.3.4 Technical particulars of power fuse shall be as per Appendices enclosed.

5.4 Tests

In addition to the manufacturer's routine production tests, power fuse of each type and rating shall be subject to the tests in accordance with IEC standards.

5.5 Data

The contractor shall furnish complete data for applying and coordinating the fuses supplied. This data shall include log-log time-current curves of minimum and maximum clearing for each fuse size furnished.

APPENDIX A-5**TECHNICAL PARTICULARS OF POWER FUSE****A. 33kV POWER FUSE.**

1. Type	Single pole, single throw, drop out, hookstick operated, outdoor type
2. Quantity required	
(a) Power fuse	As per Price Schedule
3. Voltage ratings	
(a) Nominal voltage class	33kV
(b) Rated maximum voltage	36kV
4. Basic impulse level (BILL)	170kV
5. Current rating	100A
6. Interrupting rating (Max. rms)	8kA (Symmetrical)
7. Mounting position	
(b) Power fuse	Horizontal

6. INSTRUMENT TRANSFORMER

6.1 General

This specification covers the design, manufacture, assembly, shop test, supply, delivery, and installation works and field test of instrument transformers as specified herein under.

The equipment specified in this Section shall conform to the latest edition of the appropriate IEC specifications and/or other recognized international standards. In particular:

IEC 60044 Voltage transformers

IEC 60044 Instrument transformers

IEC 60529 Degree of protection provided by enclosures

Manufacturer of instrument transformer shall hold valid ISO 9001(including design) quality certificate.

6.2 Equipment to be furnished

The Following Equipment shall be furnished, if seemed necessary, after the approval of Schematic Diagram submitted by the Bidders or as Instructed by the Owner. The Schematic diagram should be prepared and submitted by the Bidders with Technical Proposal, after studying the existing Protection and Metering System, such as to provide necessary and adequate Protection to the Transformer Bay as a Whole. The Bidders are required to make the Site visit and access necessary Data and Drawings from the respective Substation. Similarly, the details about the Ratio / Burden / Class will be finalized after the approval of the Schematic Diagram or as Instructed by the Owner.

i. 33 kV Current Transformer for Measurement & Protection

ii. 33 kV Bushing current Transformer for Protection

iii. 11kV Current Transformer for Measurement & Protection.

iv. 11kV / 110V Potential Transformer for measurement & Protection

6.3 Design Requirements

6.3.1 Instrument transformers shall be suitable 33kV 50Hz. 3 Phase with neutral solidly grounded system.

6.3.2 Instrument transformers shall be installed outdoor in a hot, humid climate. All equipment and accessories shall be provided with tropical finish to prevent fungus growth.

Burden of the instrument transformers stated herein is the minimum value required. Where higher burden is required to suit the designs, the Contractor shall

supply the same without additional cost.

6.4 Construction Features

- 6.4.1 The instrument transformers shall be oil-filled construction and shall be designed for outdoor service and suitable for vertical mounting.
- 6.4.2 The core and coils of current transformer shall be mounted in a steel tank on the top of the unit with the primary coil leads extending through insulated bushings for series or multiple connections. A steel base shall support the high voltage bushing and tank. The high voltage bushing shall be sealed to the tank and the base with oil-tight joints.
- 6.4.3 The primary terminals of instruments shall include provisions for externally connecting the primary winding. The secondary terminals shall be enclosed in a weatherproof terminal box.
- 6.4.4 Porcelain bushings shall have adequate mechanical and electrical strength. The color of porcelain shall be brown.
- 6.4.5 Junction boxes

Junction boxes shall be rigid weatherproof type complete with terminal blocks suitable for cable size having the range up to 2x6 sq. mm for termination of the secondary connections (such as delta or wye connection). They shall be made of metal, which will resist corrosion on both inside and outside surfaces; otherwise they shall be suitably protected by galvanizing. Cover of the junction box shall be of hinge door type complete with door handle. Two drainage holes shall be provided at the bottom of the junction box. In case the junction boxes are steel sheet, the thickness of such steel sheet shall be at least 1.2mm. Junction boxes shall be sized and arranged to provide easy access for external cables and adequate space for internal wiring and installed equipment. Enclosure protection class of the junction boxes shall be IP55W

The terminal blocks used should be provided with shorting links on the top of the unit with the primary coil leads extending through insulated bushing for series or multiple connections. A steel base shall support the high voltage bushing and tank. The bushings shall be sealed to the tank and the base with oil tight joints.

6.4.7 Termination

(a) Current transformers

All current transformer secondary winding terminals shall be connected to terminals on terminal located in the junction boxes. In addition, a short -circuit type terminal block shall be provided for each maximum ratio of each core at the terminal blocks in both the secondary terminal box and junction box.

(b) Potential transformer

All PT's secondary terminals shall be connected to terminals on terminal blocks located in the junction boxes.

6.4.8 Protective devices

- (a) The secondary phase wire for external connection shall be equipped on all potential transformers with switch and fuse. Fuses shall be rated to provide external short-circuit protection and shall be high rupturing capacity non-deteriorating type. Switches shall be rated not less than 250V AC 50Hz. Switches and fuses shall be contained within the junction box provided for termination. Supply fuse failure supervision shall be provided.

6.4.9 Accessories

The following items shall be provided for each instrument transformer:

- (a) Nameplate
- (b) Oil level gauge
- (c) Oil valves or plugs
- (d) Power factor test terminals
- (e) Necessary terminal connections
- (f) Grounding terminals
- (g) Other necessary accessories

6.5 Tests

Tests shall be performed as specified hereunder.

6.5.1 Current transformer

- (a) Routine tests
Each current transformer shall be subjected to the following tests.
- Applied potential test
 - Induced potential test
 - Accuracy tests (including excitation curve for relaying class)
 - Polarity check
 - Winding resistance measurement for each ratio

(b) Design tests

Type test records of an identical unit of current transformer shall be submitted to Employer/Employer's Representative. In case type test records are not available, the actual tests shall be performed. The items of test shall be as follow:

- Short time current test
- Temperature rise test
- Power frequency withstand voltage (wet) test
- Impulse voltage withstand test
- Temperature rise test

6.5.2 Potential transformer

(a) Routine tests

Each capacitor voltage transformer shall be subjected but not limited to the following tests:

- Power frequency withstand voltage (dry) test.
- Dielectric tests for electromagnetic unit
- Accuracy tests
- Polarity check
- Ratio test

(b) Design tests

Type test records of an identical unit of potential transformer shall be submitted. In case type tests records are not available, the actual tests shall be performed. The items of test shall be as follows:

- Voltage test between phase and ground terminals
- Power frequency withstand (wet) test
- Impulse test
- Radio-influence voltage test
- Short-time over voltage test
- Thermal burden test

6.5.3 Field tests

After installation at Site, all instrument transformers shall be subjected but not limited to the following tests:

- (a) Constructions inspection
- (b) Polarity check
- (c) Ratio test
- (d) Measurement of insulation resistance

6.6 Drawings, Data and Manuals

6.6.1 The following drawings and data shall be furnished with the Tender.

- (a) Outline dimensional drawings of the equipment
- (b) Characteristics and performance data
- (c) Type test certificates of similar equipment

6.6.2 After award of Contract the successful Bidder shall submit the required number of copies of the following drawings for approval of the Employer/Employer's Representative.

- (a) Outline dimensional drawings of the equipment
- (b) Transport/shipping dimensions with weights
- (c) Foundation and anchor bolt details
- (d) Characteristic and performance data including ratings, ratio and phase angle curves, accuracy for standard burdens, and thermal burden ratings.
- (e) Instruction books including complete information for installation, testing, operation and maintenance with renewal parts data.
- (f) Any other relevant drawings and data necessary for review of the items stated above.

APPENDIX A-6
TECHNICAL PARTICULARS OF 33kV CURRENT TRANSFORMER

1. Type	Outdoor, oil immersed for protection and metering
2. Quantity required	As per Price Schedule
3. Rated primary voltage	33kV
4. Max. system voltage	36kV
5. Impulse withstand voltage	170kV
6. Rated frequency	50Hz
7. Number of cores	2
8. Current Ratio *	300(150)-75/5 A 800(400)-200-100/5 A
9. Rated Burden*	50 VA
10. Accuracy	5P/20 and 0.5 for metering
11. Power Factor	0.85
12. Over voltage factor	1.1 Continuous 1.5 For 30 sec
13. No of secondary windings	as required
14. Over load factor	200%
15. Short time thermal rating	25 kA

*** CT ratio and Burden will be decided during drawing approval.**

APPENDIX A-7
TECHNICAL PARTICULARS OF 33kV POTENTIAL TRANSFORMER

1. Type	Outdoor, oil immersed
2. Quantity required	As per Price Schedule
3. Rated primary voltage	33/ $\sqrt{3}$ kV
4. Max. system voltage	36kV
5. Impulse withstand voltage	170kV
6. Rated frequency	50Hz
7. Connection	Line to ground
8. Number of secondary winding	2
9. Voltage ratio	33,000/ $\sqrt{3}$ /110/ $\sqrt{3}$ V
10. Rated burden for each winding	100 VA
11. Accuracy	3P and 0.5 for metering
12. Power factor	0.85
13. Rated voltage factor	1.1 continuous, 1.5 for 30 sec

7. LIGHTNING ARRESTER

7.1 General

This specification covers the design, manufacture, factory test, delivery, field test and installation of lightning arresters, complete with all accessories.

The equipment specified in this Section shall conform to the latest edition of the appropriate IEC specifications and/or other recognized international standards. In particular:

IEC 60099-4 Metal-oxide Surge arrester without gap for a.c. system
IEC 60099-5 Surge arrester - Selection and application recommendations
IEC 60529 Degree of protection provided by enclosures

Manufacturer of instrument transformer shall hold valid ISO 9001(including design) quality certificate.

7.2 Equipment to be furnished 30 kV Lightning Arrestor

7.2.1 The equipment to be furnished shall strictly be in accordance with the specifications and the Price Schedule.

7.3 Design Requirements

7.3.1 The lightning arresters shall be station type, single pole, gap less type rated voltage 30kV for 33kV system. The nominal discharge current shall not be less than 10kA.

7.3.2 The active part of the lightning arresters shall be accommodated in porcelain insulators which are suitably reinforced to prevent explosion of an arrester.

7.3.3 Pressure relief device shall be provided for the safe discharge of internal pressure.

7.3.4 The lightning arresters shall be mounted on galvanized steel structure. Terminal connectors for both line and ground terminals shall be furnished.

7.3.5 Surge monitoring device consisting of surge counter, etc., along with insulating bases for mounting at the bottom of the arrester, shall be furnished.

7.4 Test

7.4.1 All routine tests shall be performed on each piece of arrester as per IEC. In addition, the following tests shall be carried out.

(a) Construction test

(b) Insulation resistance test and leak current test

7.4.2 Type test certificates on similar equipment and routine test certificate carried out

for following tests shall be furnished for approval of the Employer/Employer's Representative.

- (a) Voltage withstand test
- (b) Impulse voltage characteristic test
- (c) Discharge voltage characteristic test
- (d) Discharge current withstand test
- (e) Duty cycle test
- (f) Pressure relief test
- (g) Contamination test

7.5 Drawings and Data

7.5.1 The following documents shall be furnished along with the Tender.

- (a) Standard catalog identifying the models and ratings being furnished.
- (b) Outline drawings including dimensions

7.5.2 The following drawings and data shall be furnished in required number of copies after award of contract for approval of Employer/Employer's Representative.

- (a) All updated documents furnished with the Tender.
- (b) Outline drawings including dimensions
- (c) Foundation and anchor details including dead load
- (d) Transport/shipping dimensions with weight
- (e) Any other relevant data, drawings and information

7.6 Nameplate

Each lightning arrester shall be provided with a nameplate of weather resistant material fitted in a visible position showing the following items as a minimum.

- (a) Manufacturer's name
- (b) Manufacturer's serial number and type designation
- (c) Year of manufacture
- (d) Rated voltage
- (e) Nominal discharge current

APPENDIX A-8**TECHNICAL PARTICULARS OF 30kV LIGHTNING ARRESTER**

1. Type	Outdoor, station type
2. Quantity required	As per Price Schedule
3. Mounting	Pedestal
4. Rated frequency	50Hz
5. System voltage	33kV
6. Rated voltage	30kV
7. Impulse withstand voltage (BIL)	170kV
8. Power frequency withstand voltage	70kV
9. Nominal discharge current	10kA
10 Surge Counter	shall be the ISO 9001 holding company

8. CONTROL AND RELAY PANEL

8.1 General

8.1.1 This specification covers Study, Design, Manufacture, Assembly Factory Test, Supply, Delivery, Installation works and Field Test and Commissioning of Control and Relay Panels as specified herein under. The panel shall be used for the protection of the following:

- a. Transformer
Protection equipment/ relays as required shall have to be supplied and installed accordingly.
- b. 33 kV outgoing and incoming line.
Protection equipment/ relays as required shall have to be supplied and installed accordingly.

8.1.2 It is not the intent to specify completely herein all details of Design and Construction of Equipment supplied. However, the equipment supplied shall conform, in all respects, to high standards of Engineering, Design and Workmanship and be capable of performing in continuous commercial operation up to Contractor's guarantee in a manner acceptable to the Employer who will interpret the meaning of Drawings and Specifications and shall have the power to reject any work or material which in his judgment are not in full accordance therewith.

The Tenderer shall submit his proposed Control Panel Arrangement & Layout. The Tenderer is warned that the available space in the existing control rooms is very limited and the panels shall be of such size to fit in available space.

The cost of any relocation of equipment in the control room and outdoor switchyard necessary to complete the specified works shall be included in his bid price and no additional payment will be made for such work.

8.1.3 The indication and annunciation schemes for existing substations shall be compatible with the existing system as far as possible.

8.1.4 Manufacturers for Protection Equipment

All protection relays like over current, earth fault, differential, definite time over current etc shall be of static type and shall be from following manufacturers or equivalent. **The bidder must submit the documentation evidence from internationally recognized agencies to support the equivalency of the equipments.**

- | | |
|------------|------------------------------|
| a) ALSTHOM | b) Fuji |
| c) CGELEC | d) Reyrolle / Easun Reyrolle |
| e) ABB | f) Siemens |
| g) Toshiba | h) Mitsubishi |

8.2 Equipment to be furnished

8.2.1 Control and Relay panels shall be more or less of the color matching with the existing one

8.2.2 In addition to the above, the following shall be supplied:

- (a) Floor channel seals, vibration damping pads, kick plates, earthing pads and holding down bolts and nuts.
- (b) Special tools and tackle.

8.3 CONSTRUCTION FEATURES

8.3.1 The Panel Dimensions specified are tentative only and it is the responsibility of Tenderer to ensure that all the equipment required can be properly accommodated in the respective space. The panels shall also be of a size & type which can be easily accommodated within the space of existing Panels & existing control room without the necessity for expansion of the control room. Such oversized panels will not be accepted.

8.3.2 The 33 kV panel shall be of Simplex type or Duplex type as per the layout of the respective Substation.

- i. In case, the Panels are Duplex type, it shall comprise two vertical front and rear panel sections connected back-to-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. Both ends of the corridor shall be provided with double leaf doors with lift off hinges.

Doors shall have handles with built-in locking facility. Separate cable entries shall be provided for the front and rear panels. However, interconnection between panels shall be by means of inter panel wiring at the top of the panels.

- ii. If the panels are of Simplex type, it shall comprise of two vertical fronts side by side, with door at rear sections with built in locking facility.

8.3.3 Panels shall be completely metal enclosed and shall be dust, moisture and vermin proof. Panel enclosures shall provide a degree of protection not less than IP 54 as per IEC.

8.3.4 Panels shall be free standing, floor mounting type and shall comprise rigid welded structural frames enclosed completely with specially selected smooth finished, cold rolled sheet steel of thickness not less than 3mm for front and rear portions and 2mm for sides, top and bottom portions. There shall be sufficient reinforcement to provide level surfaces, resistance to vibration and rigidity during transportation and installation.

8.3.5 All doors, removable covers and panels shall be gasketed all around with gaskets.

Ventilation louvers, if provided, shall have screens and filters. The screens shall be made of either brass or GI wire mesh.

- 8.3.6 Design, materials selection and workmanship shall be such as to result in neat appearance inside and outside with no welds, rivets or bolt heads apparent from outside, with all exterior surfaces true and smooth.
- 8.3.7 Panels shall be suitable for floor mounting. Metal sills in the form of galvanized steel channels properly drilled shall be furnished along with anchor bolts and necessary hardware for mounting to a concrete floor. Any irregularity between the sills and flooring shall be sealed to prevent entry of dust, moisture and vermin. Panels shall have additional rolled channel plinth at the bottom with smooth bearing surface. The panels shall be fixed on the sills with intervening materials. The type of anti-vibration strips which shall be supplied by the Contractor shall be subject to the approval of the Employer.
- 8.3.8 Cable entries to the panels shall be from the bottom unless otherwise specified. The bottom plates of the panels shall be fitted with removable plates of adequate size for holding the cables using cable connectors to seal from dust and moisture. All cable connectors required shall be provided by the Contractor and shall be screwed type and shall be suitable for PVC armored cables.

Control and relay panel enclosure protection class shall be of IP 54. When in closed position there shall not be any chances of entering lizards, mouse etc inside the panel

8.4 Component Mounting

- 8.4.1 All equipment on front of panel shall be mounted flush or semi-flush. In case of semi-flush mounting, only flange or bezel shall be visible from the front.
- 8.4.2 Equipment shall be mounted such that removal and replacement can be accomplished individually without interruption of service to adjacent equipment. Equipment mounted inside the panel shall be so located that terminals and adjacent devices are readily accessible without the use of special tools. Terminal markings shall be clearly visible.
- 8.4.3 Cut-outs and wiring for free issue items, if any, shall be according to corresponding equipment manufacturer's drawings. Cut-outs, if any, provided for future mounting of equipment shall include cover plates.
- 8.4.4 The centerline of switches, push buttons and indicating lamps shall be not less than 750mm from the bottom of the panel. The centerline of relays with targets and/or requiring adjustment, motors, test switches, and recorders shall be not less than 450mm from the bottom of the panel. No components shall extend below 200mm.

It will be preferable if existing panel layout is used to give uniform appearances.

- 8.4.5 The centerline 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.

- 8.4.6 No equipment shall be mounted on the doors without prior approval of the Employer.
- 8.4.7 In the existing substation, panels shall be as far as possible matched with the existing panels in the control room in respect of Dimensions, Color, Appearance, Size and Arrangement of equipment on the front.
- 8.4.8 The standard phase arrangement when facing the front of the switch-board shall be R-S-T from left to right, from top to bottom, and front to back. All relays, instruments, other devices, buses and equipment involving three phase circuit shall be arranged and connected in accordance with the standard phase arrangement.

8.5 Mimic Diagrams

- 8.5.1 Mimic diagrams shall be provided on panels as required. Mimic diagrams shall be screwed on to panels and shall be made of anodized aluminum or plastic of approved fast color material which can be easily cleaned. The width of the mimic bus shall be subject to approval of the Employer.
- 8.5.2 The colors for the various voltages in the mimic diagram shall be as per the existing colors.
- 8.5.3 When semaphore indicators are used for disconnecting switch positions, they shall be so mounted in the mimic that the disconnecting switch's 'close' position shall complete the continuity of the mimic. Similarly, when control switches of stay-put type are mounted in the mimic, the 'close' position of the switch shall complete the mimic.

8.6 Annunciators

- 8.6.1 Annunciators of the visual and audible type shall be provided on the panels when called for in the equipment lists, if enclosed. Annunciators shall be suitable for operation for the voltages specified.
- 8.6.2 Annunciators shall be of facia type with 35mm x 50mm (minimum) translucent plastic window for each alarm point. Annunciator facia plates shall be engraved in block letter with respective alarm inscriptions, which will be furnished to Contractor by Employer. Alarm inscriptions shall be engraved on each window in not more than three lines and size of the lettering shall be not less than 3mm. The inscriptions shall be visible only when the respective light is lighted. If any other type of Annunciators are to be used, prior approval from the Owner should be taken before manufacturing..
- 8.6.3 The annunciators shall be suitable for operation with normally open fault contacts which close on a fault. When specified in bill of materials, some of the annunciator points shall be suitable for operation with normally closed faults contacts which open on a fault. It shall be possible at site to change annunciators from "open to fault" to "close to fault" and vice versa. Annunciators shall be suitable for accepting fleeting faults of duration not less than 15 milliseconds.

- 8.6.4 Annunciators shall be compact self-contained units with associated relays mounted behind the facia units. In case the associated relays cannot be housed behind the annunciator facia units, these shall be mounted and wired in a separate panel which shall be included in the offer. However, the latter arrangement is not preferred due to additional space requirement and wiring interconnections. Alarm relays and facia units shall be interchangeable.
- 8.6.5 Annunciator facia units shall be suitable for flush/semi-flush mounting on panels. Replacement of individual facia inscription plates and lamps / LED / LCD shall be possible from front of the panels.
- 8.6.6 One alarm buzzer common to annunciators on all the panels shall be provided. Similarly, "Sound Cancel", "Acknowledge", "Reset" and "Lamp Test" push buttons common to annunciators on all the panels shall be provided. These common devices shall be located in a particular panel as determined by the Employer.
- 8.6.7 In case of static annunciator schemes, special precaution shall be taken by the Contractor to ensure that spurious alarm conditions do not appear due to false influence of external magnetic fields on the annunciator wiring and switching disturbances from the neighboring circuits.
- 8.6.8 Each annunciation window shall be provided with two lamps to provide safety against lamp failure. Lamps shall operate in parallel such that failure of one will not affect operation of the other.
- 8.6.9 Sequence of Operation of the Annunciator shall be as follows:

Alarm Condition	Fault	Contact	Audible Alarm	Visual Alarm
Normal	Open		Off	Off
Abnormal	Close		On	Flashing
Sound cancel	Close or Open		Off	Flashing
Acknowledge	Close or Open		Off	Steady On
Back to Normal	Open		Off	Steady On
Reset	Open		Off	Off
Lamp Test	Open		Off	Steady On

In case 'RESET' push-button is pressed before abnormality is cleared, the lamps shall continue to glow steady and shall go out only when 'Normal' condition is restored.

- 8.6.10 Any new annunciation appearing after the operation of "Sound Cancel" for previous annunciation, shall provide a fresh "Audible Alarm" with accompanied "Visual Alarm" even if the process of "Acknowledging" or "Resetting" of previous alarm is going on or yet to be carried out.
- 8.6.11 Provision of testing facilities for flasher and audible alarm circuits of annunciators shall be provided.

8.7 Specific Protection Requirements

8.7.1 Relay Protection

8.7.1.1 Overcurrent and Earthfault Protection

- i. Non-Directional Phase Overcurrent Protection shall:
be single pole & have an inverse characteristic with a definite minimum time of 3sec.at 10times setting.
have a variable setting range of 20-200% of rated current
- ii. Non-Directional Earth Fault Protection shall :
be single pole type.
have an inverse characteristic with a definite minimum time of 3sec. at 10 times setting.
have an adjustable setting of 10-80% of rated current.

8.7.1.2 Directional Overcurrent Protection (not applicable)

- i. Phase over current relay shall:
be single pole X 3 type
have an inverse characteristic with a definite minimum time of 3secs. at 10 times setting.
have a variable setting range of 50-200% of rated current.
have a characteristic angle of 45 degree.
have a directional controlled low transient over-reach high set instantaneous unit of continuously variable setting range 200-1200% times of rated current.
be of voltage polarized directional controlled type.

- ii. Directional Earthfault overcurrent protection (not applicable)

Earth fault overcurrent relay shall :
Single pole type.
be of zero-sequence voltage polarized directional controlled.
have an inverse characteristic with a definite minimum time of 3 secs. at 10 times setting.
have an adjustable setting range of 10-80% of rated current.
have a directional controlled low transient over reach high set with a continuously variable setting range of 5-20 times of rated current.
have a characteristics angle of 45 degree.

8.7.1.3 Local Breaker Back Up Protection

Relay shall:

- be triple pole type.
- have an operating time of less than 15 milliseconds.
- have 2 over current and 1 Earth fault elements.
- have a re-setting time of less than 15 milliseconds.

- have a setting range of 30-320% of rated current.
- have a separate time delay relay with a continuously adjustable setting range of 0.1-1 second.
- have necessary auxiliary relays to make a comprehensive scheme.
- have a continuous thermal withstand two times rated current irrespective of setting.
- provide both retrip and back-up trip output contacts.

8.7.1.4 Differential Relay

The Differential Relay shall be used for 6/8 MVA & 10/13.3/16.6 MVA transformer Protection. It shall be of Three phase with Six through current restraint inputs. The Relay shall have built in trip relay, indicator & test switch. It shall have complete phase and Earth fault Protection.

The Harmonic restrained operation time of the Relay shall be Approximately 30ms at 3times of pickup current. Similarly, unrestrained operation time shall be 10-20ms at 2times pickup current with minimum impulse time of 3minutes.

The Relay shall have variable percentage restraint for external fault, even at use of OLTC.

The Relay shall have second harmonic restraint from all the three phases for inrush security & fifth harmonic restraint for all three phase for over excitation security. The sensitivity shall be settable to 10 - 50% of rated current of 1A.

Un-restrained operation settable to 20 times of rated current.

The relay shall be provided with separate interposing CT for ratio and Phase Angle matching and equalizing of zero sequence current, or by other programming method.

8.7.2 Manufacturer of Protection Relay shall be as specified

8.7.3 Other Requirements

- i. Layout of panel in the control room, individual panel layout incorporating the hardware and control wiring diagrams and schematics shall be prepared by the Contractor and be sent to the Employer for approval.
- ii. All auxiliary relays, if and when required for the completeness of the various protection schemes covered in this order, shall be deemed to be included in the scope of supply whether or not such items are specifically mentioned in the enclosed bill of material.
- ii. Omission of hardware specifically mentioned in Price schedule material such as auxiliary relays/protective relays, etc. if found necessary during detailed engineering shall be shipped to the Employer with spare parts, without any extra cost to the Employer.
- iv. All terminal blocks for CT and PT circuits shall be of disconnecting line type. Suitable plastic covers for all terminal blocks shall be provided in order to

prevent dust accumulation.

- v. Panels shall be mounted to concrete foundation on galvanized steel channels with an intervening layer of anti-vibration strips made of shock absorbing materials which shall be supplied by the Contractor.
- vi. Cable entries for all the panels shall be from bottom. The bottom plates of the panels shall be fitted with removable plates of adequate size for holding cables and sealing from dust and moisture.
- vii. A ground bus of bare copper strip of minimum size 25 x 6mm along the length of each panel shall be provided and shall be connected to the ground mat of the station.

8.8 ENERGY METERS

8.8.1 SPECIFICATION FOR SOLID STATE ENERGY METERS

1. Scope

This specification covers the design, engineering, manufacture, assembly, testing and delivery at site of CT and VT operated A.C. static watt hour meter. The meters shall be 3-Phase 4 wire and 3-Phase 3 Wire 0.5 accuracy class for measurement of active, reactive (lead & lag) and apparent power and energy as per power tariff requirement of A.C. balanced and unbalanced load at nominal frequency in the range of 47.5Hz to 52.5Hz using Digital Technology. Meter shall be manufactured using latest and „state of art“ technology and methods prevalent in electronic industry.

It is not the intent to specify completely herein all the details of the hardware, software, communication and design of the system. The material shall, however, conform in all respects to the best standards of engineering, design and workmanship and shall be capable of performing for continuous commercial operation.

Energy meters shall be numeric type and shall be offered from reputed makes like Landis & Gyr, ABB or EDM I or equivalent.

2.0 Service Conditions

The meters to be supplied against this specification shall be suitable for satisfactory continuous operation under the following tropical conditions:

Environmental Condition

- | | |
|--|------------|
| a) Maximum ambient temperature | -5 to 55°C |
| b) Maximum ambient temperature in shade | 45°C |
| c) Minimum temperature of air in shade | 35°C |
| d) Maximum daily average temperature | 40°C |
| e) Maximum yearly weighted average temperature | 32°C |
| f) Relative Humidity (%) | 10 to 95 |

- g) Maximum Annual rainfall (mm) 1450
- h) Maximum wind pressure (Kg/m.sq) 150
- i) Maximum altitude above mean sea level (meters) Upto 2700
- j) Isoceraunic level (days/year) 50
- k) Seismic level (Horizontal acceleration) 0.3g
- l) Climate: - Moderately hot and humid tropical climate conducive to rust and fungus growth.

The meters should be designed for tropical condition and shall be constructed to be capable of withstanding all severe stresses and vibrations and dust environments likely to encounter in actual practice.

3.0 Applicable Standards, Accuracy and Certification

The meters shall conform (for testing, performance and accuracy) in all respects the relevant /International standards with latest amendments thereof.

<i>S.No</i>	<i>Standard No.</i>	<i>Title</i>
1.	<i>IEC62053-22 Ed. 1.0 B – 2003 with latest amendment.</i>	<i>A.C. Static Watt-hour Meters For Active Energy, Class 0.5s / 0.2 s</i>

There should be no drift of accuracy, which means that the initial accuracy is sustained over the entire life of the meter and there should be no need for adjustment of the accuracy after installation.

The manufacturer of the offered meter must have been accredited with ISO 9001 (including design) quality certification.

4.0 Rating & Type of Service

The energy meters shall be outdoor type connected with the secondary side of outdoor current and voltage transformers.

<i>S.No</i>	<i>Item</i>	<i>Specification</i>
i)	<i>Type of Installation</i>	<i>Outdoor, encased within metallic box</i>
ii)	<i>CT Secondary</i>	<i>1 A/, 5 A</i>
ii)	<i>VT Secondary</i>	<p>For 3 Phase 3 Wire and 4 Wire (HT Metering): <i>110 V/√3 Volts (Phase to Neutral)</i> <i>110 V Volts (Phase to Phase)</i> For 3 Phase 4 Wire (LT Metering): <i>400 V/√3 Volts (Phase to Neutral)</i> <i>400 V Volts (Phase to Phase)</i></p> <p>The voltage range shall be +15% to – 40% of <i>rated voltage (Secondary side of Voltage Transformer).</i></p>

<i>S.No</i>	<i>Item</i>	<i>Specification</i>
<i>iv)</i>	<i>Power Factor range</i>	<i>Zero Lag-Unity-Zero Lead. For leading Power factor the value of KVAh should be equal to KWh, for the purpose of calculation of average power factor (on the basis of KWh / KVAh). i.e. The value of KVAh shall be based on lagging value of KVARh & KWh.</i>
<i>v)</i>	<i>Power consumption</i>	<i>As per IEC62053-22–2003 with latest amendment.</i>
<i>vi)</i>	<i>Frequency range</i>	<i>50Hz \pm5%</i>
<i>vii)</i>	<i>Earthing System</i>	<i>Solidly Grounded</i>

The maximum continuous current of the meter for guaranteed accuracy is 2 times (200 %) of I_b . The starting current for the meter should be 0.1% of I_b . The meter shall not register with no-load. It should also meet the requirements of withstanding short time over current for 1.0 second up to 20 times I_b . The meter shall be suitable for balanced as well as unbalanced loads at all power factors. Unbalance in load should not affect the accuracy of meter.

5.0 General and Constructional Requirements

- 5.1 The meter should be housed in a safe high grade Thermo engineering plastic/ polycarbonate casing and is dust/moisture proof conforming to IP: 52. The meter cover should be made up of moulded flame retardant polycarbonate, which is tough, resilient and can be fixed up with the help of screws. Provision should be made for sealing the cover also.
- 5.2 The meter shall have Poly –carbonate opaque base and cover of Poly-carbonate material. The thickness of material for meter cover and base shall be 2 mm (minimum).
- 5.3 (a) The terminal block should be made out of moulded bakelite/ polycarbonate and should house solid brass terminals with 2 fixing screws per terminal. The terminals should be liberally designed to permit high overload withstand capability. The engineering plastic used for terminal block and cover shall withstand the heat deflection test as per ISO: 75 and Glow wire test as per IEC:62053-22.

The terminal block should have cover which should be separately sealable at two places and housed at the bottom of the meter and once sealed should prevent unauthorized tampering.

- (b) The terminals in the terminal block shall be of adequate length in order to have proper grip of conductor with the help of two screws.
- (c) Dust proof window of any transparent material (Toughened glass or poly carbonate), which shall not fade in prolonged use, shall be provided to permit clear view of the register. The fixing arrangement shall be such that the window glass cannot be removed without

breaking the seals.

- (d) The extended terminal cover shall be transparent.
- (e) Meter shall be designed in such a fashion that it should be installed in a separate box (surface type) which may be fixed on the electric pole in outdoor condition.
- (f) All the insulating materials used in the construction of the meter shall be of non-hygroscopic, non-ageing and of tested quality.
- (g) The entire design and construction shall be capable of withstanding the severest stress likely to occur in actual service. The soldering shall be perfect without dry solders.
- (h) All parts that are likely to develop corrosion under normal working condition shall be effectively protected against corrosion by suitable method to achieve durable results.
- (i) The meters shall be designed with application of specific integrated circuits. The electronic components shall be mounted on the printed circuit board using latest Surface Mount Technology (SMT).
- (j) The meter shall have a suitable test output device for testing meter. Preferably the blinking LED or other similar device like blinking LCD shall be provided. The test output device should have constant pulse rate i.e. Pulse/kWh and pulse/kVAR and its value (meter constant) should be indelibly printed on the name plate.
- (k) The Push button shall be provided for high resolution reading of display, as brought out elsewhere in this specification.
- (l) The meter accuracy shall not be affected by AC/DC magnetic field upto 0.2 Tesla on all the sides of meter i.e. front, sides, top and bottom of the meter. Moreover meter accuracy shall not be affected if permanent magnet of 0.5 Tesla is applied for 15 minutes.
- (m) The meter shall also be capable to withstand and shall not get damaged if phase to phase voltage is applied between phases & neutral for five minutes.
- (n) Non specified display parameter in the meter should be blocked and it should not be accessible for reprogramming at site.
- (o) Complete metering system should not be affected by the external electromagnetic interference such as electrical discharge of cables and

Capacitors, harmonics, electrostatic discharges, external magnetic fields and DC current in AC supply etc. The meter shall withstand any type of High Voltage and High Frequency surges which are similar to the

surges produced by induction coil type instruments without affecting the accuracy of the meter. The manufacturers should have type test certificates for the same.

- (p) The meter should have facility for data retrieval through optical port using CMRI and Laptop PC and RS232 communication port for remote meter reading facility.
- (q) The meter PCB should be wireless to avoid improper and loose connections/ contacts.

5.4 Sealing

Proper sealing arrangement shall be provided on the meter to make it tamper proof and to avoid mishandling by un-authorized person. At least two (2) seals on the body, two (2) seals on the terminals block and one seal each on maximum demand resetting device and communication ports shall be provided. Meter base and cover shall be tightened from rear side with at least two nos. so that meter body could not be opened at site in any case and two nos. firms stickers seals bearing serial no., which should not be repeated shall be provided between meter base and cover.

The meter shall be totally sealed and tamper-proof with no possibility of any adjustment at site.

6.0 Connection Diagram & Terminal Marking

The connection diagram of the metering module shall be clearly shown inside portion of the terminal cover and shall be of permanent nature. The meter terminals shall also be marked and this marking should appear in the above diagram. In case any special precautions need to be taken at the time of testing the meter the same may be indicated along with the circuit diagram.

7.0 Marking of Meter:

The marking on every meter shall be in accordance with IEC 62053. The basic marking on the meter name plate shall be as follows:-

- i. Manufacturer's name and trade mark.
- ii. Type designation
- iii. Number of phases and wires
- iv. Serial number
- v. Month & year of manufacture
- vi. Reference voltage/ PT ratio
- vii. Frequency
- viii. Rated secondary current of CT (-/1 or -/5 A).
- ix. Principal unit(s) of measurement.
- x. Meter constant (impulse/kWh).
- xi. Class index of meter.
- xii. Text "SUPPLIED BY NEPAL ELECTRICITY AUTHORITY"
- xiii. P.O. No. & Date.
- xiv. Guarantee period

8.0 Real Time Clock

The real time quartz clock shall only be used in the meter for maintaining time (NS) and calendar. The time accuracy shall be as per provision of relevant IEC Standard. Facility for adjustment of real time should be provided through CMRI and Laptop with proper security.

9.0 M.D. Registration and Demand Resetting

9.1. The meter shall continuously monitor & calculate the average demand in kVA during the Integration period and maximum out of these shall be stored along with date & Time in the meter's memory. The integration period shall be programmable for 15/30/60 minutes on real time basis on block / sliding window principle that should also be programmable.

9.2 The meter shall also display M.D. reset count. The M.D. resetting should be possible in following way:-

- a. Automatic reset on a predetermined date & time of the month.

10. T.O.D. Compatibility

There shall be provision for at least 8 (Eight) different TOD register at least in 6 channels for maximum demand kVA, kWh, kVARh and power factor. Similarly, there shall be provision for at least 4 (Four) TOD time zones for energy and demand. The number and timings of these TOD time Zones shall be programmable from base computer as per the requirements of Employer.

11. Self Diagnostic Features.

11.1 The meter shall be capable of performing complete self diagnostic check at regular interval to monitor the circuits for any malfunctioning to ensure integrity of data memory location all the time. The meter shall also keep log in its memory for unsatisfactory functioning or nonfunctioning of Real Time Clock battery, also it shall be recorded and indicated in reading file at base computer software.

11.2 All display segments: "LCD Test" display shall be provided for this purpose.

12. Display of Measured Values

12.1 Permanently backlit LCD panel shall show the relevant information about the parameters to be displayed. The corresponding non-volatile memory shall have a minimum retention time of 12 years. In the case of multiple values presented by a single display it shall be possible to display the content of all relevant memories. When displaying the memory, the identification of each parameter applied shall be possible. The principal unit for the measured values shall be the kilowatthour (kWh) for active energy, kVARh for reactive energy and kVAh for apparent energy.

- 12.2 The display shall be minimum full 8 or more digit type display of liquid crystal display (LCD). The display shall be digital type with non-destructive read out. The meter should have non-volatile memory (NVM) so that the registered parameters will not be affected by loss of power. An additional LCD display should show the legend of the quantity. The size of digit should be minimum 9X5 mm. The adequate back up arrangement for storing of energy registered at the time of power interruption shall be provided. The meter should have alternate display modes for showing required information. Default mode should be auto scroll type. The number of parameters and the scrolling period shall be field programmable. In alternate mode, required parameters should be displayed and should be possible to view the parameters using push button.
- 12.3 There shall be arrangement for displaying of consumer ID, consumer no, name and address for which record number field should be at least of 8 digits.
- 12.4 The meter shall be capable of recording and displaying automatically the following:

Display Parameters (Auto Display)

Following parameters shall be displayed continuously in cyclic order on the meter face to enable NEA to know the parameter at any instant. The time for display shall be programmable and shall not drift throughout the life cycle of meter.

1. Active and Reactive Power, kW & kVAR (forward and reverse)
2. Cumulative Active Energy, kWh (forward and reverse)
3. Cumulative Reactive Energy, kVARh (forward and reverse)
4. Cumulative Apparent Energy, kVAh (forward and reverse)
5. TOD Active Energy, kWh (forward and reverse)
6. TOD Reactive Energy, kVARh (forward and reverse)
7. TOD Apparent Energy (kVAh) (forward and reverse)
8. Maximum Demand kVA since Reset (forward and reverse with occurrence, Date & Time)
9. M.D. Reset Count
10. Last month MD (between reset)
11. Date of last month MD reset
12. Cumulative MD
13. Instantaneous Power Factor
14. Line Frequency
15. Instantaneous phase currents
16. Phase voltage (Instantaneous)
17. Real time & date
18. Self diagnostic (LCD) segment check and Battery check
19. CT & PT Ratio

Display Parameters (Push Button)

After using pushbutton the following parameters should be displayed.

1. Active and Reactive Power, kW & kVAR (forward and reverse)
2. Cumulative Active Energy, kWh (forward and reverse)
3. Cumulative Reactive Energy, kVARh (forward and reverse)
4. Cumulative Apparent Energy, kVAh (forward and reverse)
5. TOD Active Energy, kWh (forward and reverse)
6. TOD Reactive Energy, kVARh (forward and reverse)
7. TOD Apparent Energy (kVAh) (forward and reverse)
8. Maximum Demand kVA since Reset (forward and reverse with occurrence, Date & Time)
9. M.D. Reset Count
10. Last month MD (between reset)
11. Date of last month MD reset
12. Cumulative MD
13. Instantaneous Power Factor
14. Line Frequency
15. Instantaneous phase currents
16. Phase voltage (Instantaneous)
17. Real time & date
18. Self diagnostic (LCD) segment check and Battery check
19. CT & PT Ratio

NOTE : *The meter display should return to Default Display mode (mentioned above) if the ' Push button ' is not operated for more than 15 seconds.*

- 12.5 The meter should measure & record total energy consisting of energy due to harmonics.
- 12.6 Maximum Demand Integration Period: - Integration period for kVA MD should be of 30 minutes real time based. However, it shall be programmable to 15 minutes if required.

13. Memory

The data stored in the registers should not be lost in the event of power failure and the meter should have non-volatile memory, which does not even need battery back-up. Each meter shall have a non-volatile memory and the data stored on the NVM should be retained upto twelve years without power.

Following monthly data should be stored for 12 months in the non-erasable memory along with the name of the month and shall be accessible for reading through Lap Top.

- i. Active energy import, kWh
- ii. Active energy export, kWh
- iii. Maximum Demand, kVA
- iv. Average power factor or kVARh
- v. Average frequency for each successive 15-minute block
- vi. Reactive Energy Import (while Active Import/Export)

14. Billing History and Load Survey

The meter shall have sufficient non-volatile memory for recording history of following billing parameters and load survey.

14.1 Monthly records for billing

Following monthly data should be stored for at least 18 months (FIFO) with date & time of Reset in the non-erasable memory along with the name of the month and shall be accessible for reading through Lap Top.

- a. Cumulative Active energy, kWh Forward Direction
- b. TOD Active energy, kWh Forward Direction
- c. Cumulative Active energy, kWh Reverse Direction
- d. TOD Active energy, kWh Reverse Direction
- e. Maximum Demand, kVA
- f. Consumer Number
- g. CT & PT Ratio
- h. Meter Serial Number

14.2 Load survey parameters :-

Storage in non-volatile memory for more than 120 days with 30 minutes time integration period of the following parameters – kWh / kW, kVAh / kVA, Phase wise currents, Phase Voltages, Average Current, Average Voltage, Power Factor– shall be provided on non time based basis. Whenever meter is taken out and brought to laboratory the L/S data shall be retained for the period of actual use of meter. This load survey data can be retrieved as and when desired and load profiles shall be viewed graphically / analytically with the help of meter application software. The meter application software shall be capable of exporting / transmitting these data for analysis to other user software in spreadsheet format. The time required for downloading this data should be as minimum as possible.

15. Tamper and Fraud Detection/Evidence

The meter shall detect and correctly register energy only in forward direction under following tamper conditions:

- 15.1 The meter accuracy shall not be affected by change of phase sequence. It should maintain the desired accuracy in case of reversal of phase sequence.
- 15.2 The meter should continue to work even without neutral.

- 15.3 The meter should work in absence of any two phases i.e. it should work on any one phase wire and neutral, to record relevant energy. It should also work with two phases in case of missing neutral.
- 15.4 The meter should keep registering correct energy when all the CT polarities are reversed.
- 15.5 The meter shall not get damaged or rendered non-functional even if any phase and neutral are interchanged.

15.5 Tamper Events

The meter should have features to detect the occurrence and restoration of the following abnormal events.

Missing potential and potential imbalance

The meter shall be capable of detecting and recording occurrence and restoration with date and time the cases of potential failure and low potential, which could happen due to disconnection of potential leads (one or two). The log report should contain the date, time, TOD energy, Consumer Number and the Meter Serial Number. The threshold time for the recording of such events should be programmable and at least 200 sec.

Current unbalance

The meter shall be capable of detecting and recording occurrence and restoration with date and time of current unbalance (30% or more for 15 minutes). Higher of the 3 phase currents shall be considered as reference for this purpose.

Current Reversal

The meter shall be capable of detecting and recording occurrence and restoration with date and time of reversal of current with phase identification.

Power ON / OFF

The meter shall be capable to record power ON/OFF events in the meter memory. All potential failure should record as power off event.

Current circuit short

The meter shall be capable of detecting and recording occurrences and restoration of shorting of any one or two phases of current.

The meter shall keep records for should keep record of at least **500** such tamper events all the events (Occurrence +Restoration). For above abnormal conditions the recording of events shall be on FIFO basis. It shall be possible to retrieve the abnormal event data along with all related snap shots data through the meter optical port with the help of CMRI & downloaded the same to the base computer.

All the information shall be made available in simple & easy to understand format.

16. Data Communication Capability

- 16.1 Each meter shall have an optical port on its front for tapping all data stored in its memory. Portable or hand held data collection devices/ Lap Top PC shall be used for this purpose. The overall intention is to tap the data stored in the meter's memories once in a month, and transmit the same to a central computer. It shall also be possible to obtain a print out (hard copy) of all data collected from the meters, using the local PC. The data transfer should be reliable and fraud proof.
- 16.2 Additionally, the metering system shall have a serial RS232 port for transferring the meter data to a remote location via a suitable communication infrastructure.
- 16.3 The metering system shall be compatible with suitable Base Computer software.
- 16.4 All meters of the same model shall be totally identical in all respects except for their unique identification codes. They shall also be totally sealed and tamper proof, with no possibility of any adjustment at site, except for clock correction.
- 16.5 There shall be magnetic device at optical port to hold up one end of communication cable (used to download the data to Lap Top). The bidder shall supply a minimum of 40 numbers of optical probe for connection with the Lap Top computers. The price of the optical probe shall be included in the price of the meter itself.

17. Software:

The purchaser shall have the right to use the software as required for the operation of the meter. The supplier shall not charge extra costs for the use of the software. Further, the software should be able to display the three-phase voltages and current waveforms measured by the meter. It should be able to display the phasor diagram.

The following software shall be supplied by the meter manufacturer without any extra cost.

- 17.1 Software for reading and programming the meter contents through CMRI/Laptop Computer.
- 17.2 Base Computer software for accepting data from CMRI and downloading instructions from Base Computer to MRI.
- 17.3 Base Computer should have facility to program the display and/or other required parameters in the meter.
- 17.4 The meters should be capable to communicate directly to Lap Top Computer.
- 17.5 The base computer software shall be executable on MS Windows 98/2000/XP/Vista system.

- 17.6 For efficient and speedy recovery of data downloaded through CMRI/Laptop PC on base computer, licensed copies of base computer software shall have to be supplied. This software will be used at numbers of places up to Branch level. As many copies of base computer software as required up to Branch level shall be provided free of cost. If there is common software for downloading of data to be given out to branch offices and the operation of software is restricted through security code, a code generating software shall be provided by the manufacturer. The code so generated will be distributed from central level to the branch offices as per requirements.
- 17.7 The base computer software shall be Window based & user friendly. The data transfer shall be highly reliable and fraud proof (No editing shall be possible on base computer by any means).
- 17.8 The protocol used in the meter shall have to be provided at the time of supply for the purpose of Automatic Meter Reading System. The Suppliers shall also have to submit the protocol for meters supplied in the past and ensure that protocol corresponds to the type of meter supplied. The protocol shall be shared by NEA.
- 17.9 Security Features
1. Communication session count should be available though display and with Lap Top.
 2. The meter should log the date and time of at least last five program changes in a billing period.
 3. The meter should have programmable facility to restrict the access to the information recorded at different security level such as communication read, communication write etc.
- 17.10 The Supplier or Manufacturer shall provide a software for generating a report in concise and desired format so that these can be used for billing, meter data management, outage management etc.

18. Additional Features

18.1 External Power Supply

Meter shall be provided with super capacitor and battery. The rated shelf life of battery shall be of 15 years. Super capacitor will provide carry over power for all normal power outages at least for 36 hr. duration. Battery will work when super capacitor is discharged or when programmed meter is stored for extended period without electric supply. No auxiliary supply should be required for the meter.

18.2 Meter Calibration

The meter should have a blinking LED, which blinks and is analogous to the

rotation of the disk in an electro-mechanical meter for calibration of kWh. The watt-hour per pulse constant is definable by the manufacturer.

18.3 Recovery of Data

The meter shall have provision to communicate with the CMRI/PC even in event of failure of display. In event of failure of component affecting more than just LCD function, manufacturer shall extract the stored data at no cost to the purchaser during the warranty period. All the cost (including transportation to and fro) involved in the process shall be borne by the supplier. Similarly, the memory of the meter shall be suitably protected and secured against unexpected fault conditions.

18.4 Connection Check

The meter should have capability to check the correctness of connections at site.

18.5 Missing Voltage Indication

There shall be visual display of the missing voltage on the face of the meter.

19. Guarantee

The Meter shall be guaranteed for the period of five years from the date of commissioning of meter. Meters found defective/ functioning abnormally within the above guarantee period shall be replaced / repaired by the supplier free of cost within one month of receipt of intimation. If the defective meters are not replaced/ repaired within the specified period above, the NEA shall recover an equivalent amount plus 15 % supervision charges from any of the bills of the supplier.

20. Tests

- 20.1 **Type Tests:-**The Meter shall be fully type tested as per the relevant standards within 5 years from the date of opening of Tender. The type test reports of the offered meters shall be submitted along with the offer. All the Type Test shall be carried out from an internationally recognised independent meter test laboratory, such as PTB, Germany; PTP, Austria; KEMA, Holland; NMI, Holland; CESI, Italy; Falcon, UK etc, Ofgem (formerly known as Offer) and test lab recognised and approved by ANSI (American National Standards Institute) or testing laboratories and authorities duly accredited by the Internationally recognised accreditation body like International laboratory Accreditation Co-operation (ILAC) to prove that the Meters meets the requirements of the specification. In case of test lab recognised and approved by ANSI/ILAC, the certificate of approval/ recognition shall be submitted with the Bid. Type Test Reports conducted in manufacturers own laboratory and certified by testing institute shall not be acceptable. The purchaser reserves the right to demand repetition of some or all the type tests in presence of purchaser's representative at purchaser's cost. For this purpose, the tenderer shall quote unit rates for carrying out each type test. However, such unit rates will not be considered for evaluation of the offer. In case the meters is type tested earlier to 5 years from the date of opening of tender, the

supplier/manufacture have to carry out the fresh type tests at their cost before signing the contract.

20.2 **Acceptance Tests:-**All acceptance tests as per relevant IEC standard shall be carried out on the meter.

20.3 **Routine Test:-** All routine tests as per relevant IEC standard shall be carried out on all the meters.

21. **Guaranteed Technical Particulars**

The technical particulars as specified in IEC shall be guaranteed and statement of guaranteed technical particulars shall be furnished along with tender.

22. **Drawings Leaflets**

Two sets of drawing showing clearly the general arrangements, fitting details, electrical connections and design features of each component part should accompany the tender. Technical leaflets or brochures giving operating instructions should also be furnished along with the tender. ***TENDERS without DETAILS ARE LIABLE FOR REJECTION.***

23. **User's Manual**

The supplier shall furnish the operation & maintenance manual of the Meter offered and the required software for the smooth functioning of the meter.

24. **Departure from Specification**

If the supplier wishes to depart from this specification in any respect, he should draw the attention to such points of departure explaining fully the reasons thereof. Unless this is done, the requirements of this specification shall be deemed to have been accepted in every respect.

25. **Bid Documentation**

25.1 The Bidder shall provide the following with the Bid:

- a) One (1) clear copy of the governing standard referenced, and
- b) Certified type test results for all characteristics of the meter as per [IEC62053-22](#).

8.8.2 **Miscellaneous Accessories**

1. **Space Heater**

Each panel shall be equipped with space heaters to prevent moisture condensation within the enclosure and shall be completed with switch fuse units for power supply. Space heaters and switch fuse units shall be suitable for continuous operation.

2. Plug Point

A 230 V, 1 phase, 50Hz AC plug point shall be provided in the interior of each cubicle with on-off switch for connection of hand lamps.

8.9 Tests

8.9.1 Relay and Control Panels shall be subjected but not limited to the following tests:

- i. Mechanical operation test
- ii. Verification of degree of protection
- iii. Calibration test for meters
- iv. Characteristic test for relays
- v. High voltage test of insulation (2000 volts for 1 minute)
- vi. Electrical control, interlock and sequential operation tests
- vii. Verification of wiring as per approved schematic diagram.

8.9.2 Type tests and routine tests shall be carried out on all associated equipment as per relevant standards approved by the Employer.

8.9.3 Certified copies of all type and routine test certificates shall be submitted for the Employer's approval before dispatching the control and relay panel.

8.9.4 After completion of the installation, panels shall be subjected but not limited to the following field tests:

- i. Electrical control, interlock and sequential operation tests
- ii. Calibration test for meters
- iii. Measurement of insulation resistance
- vi Characteristic test for relays

8.9.5 Transformer Protection

33/11 kV, 3 MVA, 6/8 MVA transformer shall be protected by the following relays

- a. Over current relay
- b. Earth fault relay
- c. Differential relay (if applicable)
- d. Definite over current relay (if applicable)

APPENDIX: 9**BILL OF MATERIAL**

The bill of materials shall cover only the major equipment or such information as will require particular information from the Tenderer. Tenderer is to be understood that, all other associated auxiliary equipment and accessories, although not listed in the bill of materials, but necessary for the complete and sound function of the control board as described in this specification, shall be furnished by the Contractor.

TRANSFORMER CONTROL & RELAY PANEL**1. Major Components**

	Legend	Description	Quantity per Panel
1.	ANN	Annunciator assembly, 24 active points, 110V DC, 4 rows high by 6 columns wide, flush mounted, and with:	1Lot
		3-separately mounted push buttons 2-separately mounted indicating lamps, one white lamp, and one red lamp Following minimum annunciation shall be provided:	
		1. Transformer HV Backup Protection trip	
		2. Transformer LV Backup Protection trip	
		3. Transformer Differential Protection trip (6/8 MVA Transformer)	
		4. Transformer Bucholz Alarm / Trip	
		5. Transformer Low Oil Level	
		6. Tap Changer Bucholz Alarm / Trip	
		7. Tap Changer Low Oil Level	
		8. Circuit Breaker Trip	
		9. Transformer Winding Temperature High	
		10. Transformer Winding Temperature Extra High	
		11. Tap changer Temperature High	
		12. Tap changer Out of Step	
		13. Transformer Cooling System Fail	
		14. Pressure Relief Device Operated	
		15. AC Fail	
		16. DC Fail	
		17 –22. Spare	
2.	Relay	Only main relays and instruments are listed here. All the trip relays and auxiliary relays required for satisfactory operation of the scheme shall be included by the Contractor.	
2.1	50/51/50N/51N	Overcurrent and Earth Fault Protection with Instantaneous Protection	1Lot
2.2	50B	Breaker Failure Protection	1Nos
2.3		Trip circuit supervision relay	1Nos
2.4	51E	Transformer Protection	1Nos

2.5	87	Differential Relay	1Nos
2.6		Interlocks, Switching & Tripping Relay	1Lot
3.	A	Indicating ammeter , Digital 0-100A; 0-200A 300-200-100/1A	3Nos
4.	MWH	Electronic type with 0.22 Class	To be Supplied by NEA
5.	P.F.	Power factor 0.6-1-0.6 lead	1Nos
6.	KVA	0-10 MVA	1Nos
7.	CS	Breaker control switch, and with : 2-separately mounted indicating lamps,	1Nos
8.	CS	Disconnecting control switch, and with: 2-separately mounted indicating lamps	1Nos
9.		Electrically operated mimic disconnect device, 110V DC, to indicate the position of disconnecting switch	1Lot
10.		Electrically operated mimic connected to position of line ground switch	1Lot
11		Trip Transfer Switch, for transferring trip signal, reclosing relay, PT circuit to bus tie Breaker. (wherever required)	1Lot
12		Multiple Adjustable Ratio Intermediate Current Transformer for Differential Protection, if required	1 Set

9. 12kV SWITCHGEAR

9.1 Scope of work:

- 9.1.1 All the works/material as specified in Bill of Quantity and the scope of work shall be the integral part of the job and all the cost reoccurred in this respect and shall be included in the bid price. Only the cost of specifically mentioned work/ material shall be born by NEA. So the bidder is requested to visit the site and contact the Owner in case of any items/ works not understood before the bid submitted.
- 9.1.2 12KV cubicle type Indoor Switchgear Panel shall be an air insulated metal clad switchgear with withdraw able vacuum circuit breaker with the fault interrupting capacity of at least 25 KA at 11KV solidly grounded system. The switchgear shall be arranged in single bus bar. The cubicle shall be of modular design provided with space heaters, with the following modules integrated neatly to form a dead front type switchgear capable of extension on the both side, forming a single row, single bus bar switchgear panels.
- Breaker compartment.
 - Bus bar Compartment
 - Cable, C.T. and P.T. Compartment
 - Instrument and Relay Compartment (LV Compartment)
- 9.1.3 All Switchgear operation shall be performed behind a close door. Additionally it shall even be possible to perform all preparations for work inside the cubicle with full degree of protection.
- 9.1.4 The use of insulation material shall be reduced to minimum; only ripped insulators with high-anti-tracking characteristics shall be used for necessary conductor supports.
- 9.1.5 Cubicle front shall be covered by a door with inspection windows for mechanical indication for CB ON/OFF position, spring charged and counter indication of CB operation.
- 9.1.6 The cubicle shall be of modular design consisting of separate modules for busbar, circuit breaker, cable and low voltage compartment, and instrument component. Each compartment shall have its own pressure relief flap. The fixed contact shall be mounted in bushing moved by circuit breaker carriage.
- 9.1.7 Earthing to cable feeder and bus bar shall be done via earthing switch manually operated from panel front.
- 9.1.8 Fixed contacts shall have flat silver plating and contact pressure of male and female contacts during connected position according to the International Standard.

- 9.1.9 Bus bars and Jumpers shall have made of flat electrolytic bare copper contact with special heat shrinkable sleeves which provide effective insulation between phases or phase to earth, even if bridged by vermin or other conducting body and suitable for rated current not less than 2000 A. Bus bar shall be latched per panel and easy to replace by standard normal material. Flexible insulation shrouds shall cover the bus bar to Jumper Joints and jumper to stationary contact joints.
- 9.1.10 Bottom of the cubicle shall be covered with a bottom mica plate through which cables are passed into the panel through the appropriate cable glands.
- 9.1.11 The proposed switchgear panel shall be extendible.
- 9.1.12 The proposed switchgear panel shall be suitable for mounting of standard Current and Voltage Transformer according to IEC standard.
- 9.1.13 It is observed that most of the fault and damages inside the CB is due to the short circuit condition carrier out by crawling animals like rat , lizards etc. So the special attention shall be given during design and fabrication for preventing them to enter into the chamber.
- 9.1.14 Panel shall be of enclosure protection of class IP54

9.2. WITHDRAWABLE PART (CARRIAGE)

- 9.2.1 The chassis shall be made of sheet-steel section and shall carry the switching device, moving mechanism, 4 rolling contact bearings for movement and interlocking mechanism. Movement for carriage shall be done manually and shall be independent from switch room floor.
- 9.2.2 Moving contacts shall be double flat contact with silver plated contact pieces. The flexible fixing shall allow high tolerance and avoiding overheating.
- 9.2.3 Connection of auxiliary supply to the fixed part shall be verified via multi-pole plug which shall be included in the interlocking system. For the easy and assured insert of the plug the hose should come from the fixed part and the plug shall be on the withdraw able part.
- 9.2.4 CB and Isolating Switch Carriage shall have the provision to operate mechanically behind the closed door in Operating and Test Position.
- 9.2.5 Carriage of the same rating shall be exchangeable. It shall be possible to insert CB with higher current in lower rated cubicle but not vice versa.

9.3 11 KV METALCLAD SWITHGEAR:

9.3.1 Main Equipment Characteristics

9.3.1.1 Insulation:

- i 12KV primary equipment shall be insulated to meet or exceed the following

criteria:

- Rated Lightning Impulse Withstand Voltage (KVp): 75
- Rated Power Frequency Withstand Voltage (Kvrms): 28

ii 12KV cubicles shall be designed to provide phase segregation within the enclosures.

9.3.1.2 Clearances:

- i 12KV Primary Equipment clearances between phases and phase to earth shall not be less than as in BS162 or in this specification, whichever is greater.
- ii The layout of the equipment shall provide for safe access for operation and maintenance whilst the remaining sections equipment are alive.
- iii Minimum clearances in air for the 12KV 'Indoor' Primary Equipment shall not be less than:
 - Phase to Phase (mm): 127
 - Phase to Earth (mm): 76.2
- iv. The busbars shall be insulated by High Grade Phase Insulation. Busbars partitioning shall be done by means of a bushing plate with Cast-Resin Insulators and Cubicles shall be partitioning with earthed sheet metal barriers.

9.3.2.3 Current Carrying Capacity:

- i Switchgear 12KV Bus bars and Connections thereto shall be designed to carry current corresponding to Maximum Permissible Overload of the connected equipment without exceeding temperature rise specified in the Relevant Standards.
- ii Switchgear 12KV bus work shall be designed to safely withstand with an appropriate margin of the Mechanical and Thermal Effects corresponding to at least the following short circuit currents:

Symmetrical three-phase

- (Is) (KA) rms: 25
- Peak making Current (KA)p : 63

9.3.2 Circuit Breakers:

9.3.2.1 General

The 12 KV Circuit Breakers shall be Vacuum type, easily withdraw able and

housed in a cubicle. It shall consist of three Vacuum Interrupter, three Supports and the Operating Mechanism. The Operating Mechanism shall have Motor Charged Spring Operated with provision of hand operated mechanism. With the breaker in close state, spring energy shall be for a "Trip/Close/Trip" Cycle.

9.3.2.2 Main Data:

Type: Metal enclosed, Indoor switch type: Metal enclosed Indoor switchgear cubicle type with vacuum interrupters.

Nominal Service Voltage (kV)	: 11
Rated Voltage (kV)	: 12
Rated Frequency (Hz)	: 50
Rated Nominal Current (A) :-	
Breaker for Bus Coupling	: 1200A /2000A
Feeder Breaker	: 630A/ 800A
Incomer for Main Power Transformer	: 1250A
Rated Short-Time Breaking Current (asymmetrical) at Rated Voltage, KA	Arms : 25
Rated Short-Time Making Current at Rated Voltage (KA) _p	: 62.5
Rated Operating Mechanism Provision for Manual Operation.	: Motor-spring operated.
Bus Bar Rating	: 2000 A.

9.3.2.3 Technical Requirements:

- i The Circuit Breakers shall meet requirements of BS 5311 and IEC 56.
- ii Vacuum Interrupter: The Arcing chamber with the two stem connected contacts shall be located between two ceramic insulators. One contact shall be fixed to the housing and the moving contact shall be connected to the housing via vacuum tight bellows. The metal bellows shall enable the moving contact to carry out its strokes. The metal bellows must be able to withstand the movement corresponding to 30,000 make / break operation without failing. The insulators shall be made of metalized aluminum oxide ceramic which permits them to be brazed to metal so that there is no need to use conventional seals. The Vacuum Interrupter shall remain vacuum tight throughout its working life.
- iii. The Transformer CB shall be capable of interrupting the corresponding 11KV distribution lines in the event of failure of the respective feeder

breakers.

- iv. The Operating Mechanism shall have two Trip Coils and be electrically Trip- Free and Anti pumping.
- v. The Spring Charging Motor, the Closing Coil, the Tripping Coils and all other control devices of all circuit Breakers shall be suitable for 110V d.c Operation.
- vi. A Manually Operated Mechanism for closing and tripping shall be provided in the breaker cubicle for Maintenance and Emergency Operation. This device shall be so interlocked that while it is operative, the breaker cannot be operated remotely.
- vii. Each Circuit Breakers shall be equipped with an Operation Counter (to register tripping operations) and position indicator, on the cubicle front.
- viii. Provision shall be made for Remote alarm/indication of the following status through a pair of NC+NO contacts:
 - Circuit Breaker "Open".
 - Circuit Breaker "Closed".
 - Circuit Breaker "Trip".
 - Circuit Breaker "Device Mechanism Faulty".
 - Trip Circuit Healthy.
 - Circuit Breaker "Failure"
- ix. The circuit breaker shall be equipped with a local control switch and local remote selector switch auxiliary contacts for remote indication. All contacts shall be wired to terminal block in the breaker cubicle.
- x. Each of the circuit breakers shall be housed in a free standing indoor type cubicle. This cubicle (and others comprised in the 11KV metal clad switchgear) shall be of standard construction and shall be suitable for attachment of cable connection as described in relevant cubicles. These cubicles shall be equipped with copper earthing bus bars of not less than 200 Sq.mm.
- xi. Plugging contact apertures shall be fitted with fully automatic metal safety shutters to close the apertures and prevent access to live part when truck partition is withdrawn and to open when the truck partition is being plugged in. The shutters shall form reasonable dust, drip, fire and insect proof enclosures over the apertures. The respective sets of shutters shall be clearly, boldly and permanently marked 'Bus bars' and 'Feeders' respectively.
- xii. Auxiliary Switches shall be provided as required for Indication, Control,

Protection and Interlocking. In addition, a minimum of two Normally Open and two Normally Closed Auxiliary Contacts shall be provided as spare contacts. All available contacts of Auxiliary Switch Assembly shall be wired to the Terminal Blocks on the fixed portion of the equipment of the switches and terminals shall be such as to facilitate future extension.

- xiii. All auxiliary switches shall have contacts with strong wiping action. The switches shall be located in an accessible position and adequate physical protection shall be provided.
- xiv. The Circuit Breakers shall be tested in accordance with BS5311 and IEC56 and IEC60 and shall include the following routine tests:
 - Mechanical operating tests
 - Power Frequency Voltage withstand tests.
 - Tests on auxiliary and control circuits
- xv. The quality assurance of the equipments and their auxiliary shall be based on ISO9001 Standard.
- xvi. The Minimum Operating Cycle (without maintenance) of Interrupters and Operating Mechanisms shall be suitable for operation over 10Years or 10,000 operations with rated current or 100 operation with rated short circuit current and overall life shall be more than 30,000 operating cycles.
- xvii. The Vacuum Circuit Breaker installed in the Switchgear shall move into following position in the Circuit Breaker Components:

➤ Running Position (Run)

Main Circuit and Control Circuit connected to all circuits.

➤ Test Position (Test)

Main circuit separated from the circuit and only Control Circuits are connected.

➤ Disconnected Position

As a Control Circuit Connector that would be plugged by hand during the test position both Main and Control circuit are disconnected from the Circuit.

9.4. EARTHING SWITCHES

The Earthing Switch is operated by means of detachable lever from outside the cable compartment. It shall be mechanically interlocked with the CB so that the earthing switch in close position in section of CB truck into the service position is not possible. The operation of the Earthing Switch shall not be possible as long as the CB is not in isolated position.

- 9.4.1 The 11KV metalclad switchgear shall include earthing switches to facilitate earthing of each cubicle as specified.

9.4.2 Main Data

Rated Voltage kV 12
Rated Current A 2000, 1250 & 800
Short Circuit Current withstand capability (as specified above)
Bus Bar Rating A = 2000

9.4.3 Technical Requirements:

- i. The Earthing Switches shall meet the requirements of BS 5253 and IEC 129.
- ii. Auxiliary Switches shall be provided as specified for the Circuit Breakers.
- iii. Provision shall be made for padlocking in the Open and Closed position.
- iv. Manual control of the switches and position indicator external to the cubicle shall be provided.
- v. The Earthing Switch shall be interlocked manually with transformer circuit breakers.

9.5. INTERLOCKING

The following operation shall be taken place only when the under stated interlocking conditions are fulfilled to ensure Personal and Operational Safety.

- 9.5.1 Transferring withdraw able part from the Disconnecting Position to the Service Position:

- i. Control Circuit Plug Inserted
- ii. High Voltage Compartment Door closed.
- iii. Circuit Breaker in OPEN Position.
- iv. Earthing Switch in OPEN Position

- 9.5.2 Transferring the Withdrawable part from the Service Position to the Disconnected Position.

- i. Circuit Breaker in OPEN Position.

- 9.5.3 Operating the Circuit breaker

- i. Withdraw able part in the Interlocked Final Position (Service or Disconnecting

position)

9.5.4 Operating the Earth Switch

- i. Withdraw able part in the interlocked disconnected position. windows shall be provided to allow visual inspection.

The Switches shall be tested in accordance with BS5253, IEC129 and IEC265 and shall include the following routine tests:

- Operating and Mechanical tests
- Measurements of the resistance of the main circuit.

9.5.5 Safety Device

Individual explosion vents should be provided for breaker / bus bar / cable chambers on the top of the panel to let out the gases under pressure generated during an unlikely event of fault.

Cubical with the front plate is pressure tested for the internal arc fault as per PHELA recommendations.

Circuit breaker and the sheet metal enclosures are fully earthed.

9.6. LOW VOLTAGE COMPARTMENT:

The Low Voltage Compartment of the Switchgear shall be located on the top front of the Panel and shall be accessible with a separate door and partitioned against high voltage part. Connection of control and Metering cable is by means of a multiple plug to the withdraw able part possibly at front face of the breaker. Low voltage devices metering and protection equipment shall be mounted flush in the door or on the mounting plate inside.

Wiring inside the cubicle shall be done by 2.5 Sq.mm insulated stranded copper wires for current circuits and 1.5 Sq.mm for voltage circuits.

The following equipments shall be mounted in the low voltage compartment.

- 1 No Ammeter, Digital Type of class C designation, with selector switch. (for incoming and outgoing circuit breaker)
- 1 No Voltmeter, Digital type, with Voltage Selector switch.(for incoming circuit breaker only)
- 1 No KVA meter, Digital type of class designation. .(for incoming circuit breaker only)
- 1 No Energy meter 3Phase 4 wire, 3Element, as specified. .(for incoming and outgoing circuit breakers)

- 1 No Power Factor Meter Digital type 3Ph, 4Wire, 3Element. .(for incoming and outgoing circuit breaker only)
- 3 Nos Over current Relay Static Type 5A secondary current with .(for incoming and outgoing bus coupler circuit breaker)
- Setting range 50-200% (for Over current element)
- Setting range 200-400-600% (for High Set Element)
- 1 Earth fault Relay, Static Type, with Secondary Current 5A and with Instantaneous tripping Setting range 10-40% (For incoming and outgoing circuit breaker)
- Auxiliary relay and coupling relay if required
- Anti condensation heater (for incoming and outgoing circuit breaker)

9.7 CURRENT TRANSFORMERS:

9.7.1. The 12kV Metalclad Switchgear shall include protection and metering Current Transformers as specified. The Current Transformers shall be Epoxy Resin insulated block type Current Transformers as follows :

	Circuit	Ratio	Accuracy Class	Burden
For Incoming	Core 1 (for Protection)	1200/600/5	5P20	30VA
	Core 2 (for Metering)	1200/600/5	0.5	30VA
	Core 3 Differential		PS	30VA
For Bus coupler	Core 1 (for Protection)	1200/600/5	5P20	30VA
	Core 2 (for Metering)	1200/600/5	0.5	30VA
For Outgoing	Core 1 (for Protection)	800/400/5 (400-200/5)	5P20	30VA
	Core 2 (for Metering)	800/400/5 (200-100/5)	0.5	30VA

9.7.2 The current transformer shall comply with the requirements of BS 3938 and IEC 185 shall confirm to the specified insulation requirements and shall withstand without damage the applicable short-circuit current specified. Primary ratio taps shall not be accepted. The ratio given above is tentative one, the final decision shall be taken prior approval of the drawing

9.7.3 The manufacturer of current transformer shall be the holder of valid ISO 9001 certificate.

9.7.4 Maximum temperature rise at rated primary current shall not exceed 50 degree centigrade.

- 9.7.5 Accuracy classes for the protection and metering shall not be less than 5P20 and 0.5 respectively. Burden and accuracy class shall be adequate to ensure correct operation of associated protective devices and instruments. Saturation curves shall be provided with C.T. Characteristics.
- 9.7.6 Each set of secondary windings shall be wired to suitable terminal blocks and earthed at the first control or relay panel to which they are connected. Differential Protection Circuits (involving more than one set. of CT's) shall be earthed at one location only.
- 9.7.7 The Current Transformers shall be tested in accordance with BS 3938 and IEC 185 and shall include the following Routine Tests:
- i. Verification of terminal markings polarity etc.
 - ii. Power frequency tests on primary windings.
 - iii. Power frequency tests on secondary windings.
 - iv. Overvoltage inter-turn tests.
 - v. Determination of ratio error and phase displacement.

9.8. VOLTAGE TRANSFORMERS

- 9.8.1. The 11kV Metal clad Switchgear shall include Voltage Transformers in incomer as required by the Single Line Diagram as follows:
- i. Type : Epoxy-resin insulated, single pole with 7.3A Primary side fuses
 - ii. Basic Impulse Level : 75kV
 - iii. Primary Voltage : $11/\sqrt{3}$ kV
 - iv. Secondary Circuit : $110/\sqrt{3}$ V
 - v. Rated burden : 100 VA
 - vi. Accuracy classification : 0.5 Class
- 9.8.2. The voltage transformers shall comply with the requirements of BS 3941 and IEC 186. Accuracy class for the metering case shall be 0.5 Bidder shall insure whether 100VA is sufficient for the smooth operation.
- 9.8.3 The voltage transformers and their fuses shall meet the specified insulation requirements and have a rated primary voltage of 11kV with knee of saturation curve not lower than 12kV and ratios per single line diagram.
- 9.8.4 The voltage transformer shall be provided with high rupturing capacity (HRC) fuses for primary and secondary circuits. The fuses shall be rated for the short circuit levels specified.
- 9.8.5 The voltage transformers shall be tested in accordance with BS 3941 and IEC 186, and shall include the following routine tests:

- i. Verification of terminal markings.
- ii. High voltage power frequency withstand test on primary windings.
- iii. High voltage power frequency withstand test on secondary windings.
- iv. Tests for accuracy.

9.8.6 The voltage transformer shall be installed at the suitable place in the incoming circuit breaker.

9.9 CONTROL PROTECTION AND INSTRUMENTATION:

9.9.1 This covers the detailed requirements 11kV switchgear panel cubicles, and design, manufacture, transport, installation and commissioning of new 12KV Metal clad VCB switchgear.

9.9.2 The substation will normally be attended and operation will be semi-automatic. Normally closing of circuit breakers shall be manual operation and operation of earthing switches will be manual if it is not mentioned.

9.9.3 Local control facilities adjacent to the equipment shall be provided for maintenance, inspection and emergency operation.

9.9.4 The control system shall be designed to permit the following operating modes:

9.9.4.1 Automatic start/stop operation refers to spring-charged motor for operating mechanism of 11KV VCB.

9.9.4.2 Automatic tripping of 11KV VCB, LV MCB if faults occur in protected lines equipments or circuits.

9.9.5 The control system shall be arranged in such way that it is possible to change between local automatic and local manual control any time.

9.9.6 Solid state modular equipment shall be used wherever possible.

9.9.7 The designs shall be in general conformity with the single line diagrams and layout drawings accompanying this specification.

9.9.8 Under manual control the individual operations shall each be subject to safety interlocks being satisfied.

9.9.9 The control scheme shall be operationally simple, safe, easy to maintain and functionally consistent.
Each module shall have sufficient test points to facilitate fault finding. Control circuits shall be brought out to isolating terminals to permit efficient trouble shooting.

9.9.11 Each cubicle shall be provided with a sufficient point annunciator to identify an alarm condition, including audible alarm, test, acknowledge and reset push buttons.

9.9.12 Control switches for circuit breakers shall be of the discrepancy type. Two

independent movements shall be required to initiate an operation. The position of manually operated disconnect shall be indicated by means of discrepancy indicators.

- 9.9.13 The design shall be such that as to avoid nuisance alarms and shall block those devices which assume alarm conditions when the equipment is under shutdown. Annunciator windows shall be engraved with identification of the alarm condition.

9.9.14.1 Annunciators shall have the following sequence:

Condition	Lamp	Alarm
Normal	Off	Off
Alarm Flashing	On	On
Acknowledge	On	Off
Reset after return		
Normal	Off	Off
Lamp test	On	Off

9.9.14.2 Required signals or alarm systems :

- CB Off/On position by green/red lamp
- Flag or lamp indication of faults for :

Over current Protection, E/F Protection, DC Supply Failure, CB Failure, MCB tripped, AC supply failure, Interlocking system disturbed, CB driving faults.

- 9.9.15 The annunciator shall be of solid state type and suitable for operation at 110 V dc and shall be able to withstand IEC 255 class 3 tests without malfunctioning.

9.9.16 Protection required :

- i. For incoming & outgoing O/C and E/F protection with instantaneous tripping
- ii. For bus coupler panel O/C protection.

9.9.17 Transformer Protection:

Following protection shall be provided for the step-down power transformers in incomer feeders:

9.9.17.1 Over current (if applicable)

Backup protection shall be provided in the form of inverse time over current relay connected into the transformer LV neutral connected current transformer.

9.10 FACTORY TESTS:

- Factory tests shall include inspection and routine testing of all relays and devices as per BS and IEC publications. Continuity and insulation testing of all devices and wiring and complete control sequences testing shall be performed to the extent feasible in the plant.
- All electronic equipment items and the subsystem shall be operated continuously for a minimum of two hundred (200) hrs. Prior to shipment in accordance with the approved testing procedures to ensure the operational integrity of each component and of the total system.
- Type test reports for each protective relay shall be provided.
- Each component of protective equipment shall be tested at the Manufacturer's work or at site to establish its performance characteristics.

9.11 MINIMUM REQUIREMENT FOR SWITCHGEAR

9.11.1 All 11kV feeder and bus coupler cubicles shall house single circuit breaker per pound. Each circuit and feeder shall be equipped with the following devices and equipment

Withdraw able module with:

- | | |
|--|-------|
| • Hand operated drive mechanism | 1 Set |
| • Auxiliary block with 4NO+ 4NC contacts for position indication | 1 No |
| • Multiple pole lug for control signals | 1 No. |
| • Motor operated spring charged mechanism | 1 No. |
| • Close/trip buttons | 1No. |
| • Trip coil | 1No. |
| • Closing coil | 1No. |
| • Counter indicating number of switching operation | 1No. |
| • Auxiliary block with 11NO + 11NC 1Wi (alarm contact) | 1No. |
| • Auxiliary switch for spring charged indication | 1 No. |
| • Service track for removing of withdraw able module | 1 No |
| • Breaker carriage (if applicable) | 2No |

9.11.2 Bus Coupler (If applicable)

- | | |
|--|--------|
| • Copper bus bars, rating shall be 2000A | 1 Set |
| • Epoxy resin insulated block type current transformer as mentioned above in clause 9.7. | 2 Nos. |

1st Core: 0.5 class 30 VA (for measurement)

2nd Core: 5P20 30 VA (for protection)

- | | |
|--------------------|------|
| • Breaker Carriage | 1No. |
|--------------------|------|

9.11.3 Trunking (Adaptor) Chamber:

Trunking Chamber should have the voltage rating 12 kV and the current rating of the bus bar shall not be not less than 2000 A. Contractor must verify the overall dimension by inspection at the site for accurate fitting .It is up to manufacturer / designer whether needed or not .If it is needed then its cost should be within the cost of required VCB. Its cost shall not be paid separately.

9.11.4 Specification of Meter to be installed

Please refer above in the Energy Meter

10. CABLES

10.1 General

This specification covers the design, manufacture, factory test, supply, delivery, field test and installation of all Power, Control and Instrumentation cables required for the entire project.

Manufacturer of 36 & 12kV power cable shall be holder of valid ISO 9001 (including design) Certificate

10.2 Equipment to be furnished:

- a) 36 & 12 kV XLPE Power Cable
- b) 1100/600 volt power cable
- c) Control and instrumentation cable
- d) Communication cable

10.2.1 The equipment to be furnished shall strictly be in accordance with the specifications and the Price Schedule.

10.2.2 The Contractor shall be responsible for estimating and supplying the quantity of various types and sizes of the cables. In course of actual execution if it is found that additional cross-section, types or quantities of cables are required than those indicated in his proposal, the same shall be supplied without any additional charge to the Employer.

10.3 Design Requirement

10.3.1 36 & 12kV power cable

(a) General

The 36 & 12kV power cable shall be cross linked polyethylene insulated, shielded and armored cable.

The scope shall include the supply, laying and connection of power cables to connect the power transformer secondary to the 11 kV incomer and also outgoing feeders. The cables shall be supplied with necessary terminations and accessories for both connecting ends. The scope of work covers supply and installation of the cable up to the first termination pole of the 11 kV overhead lines.

(b) Conductor

Conductor shall consist of stranded annealed aluminum wires. They shall comply with IEC Publication. The maximum conductor temperature shall be 90 deg.C.

(c) Current rating

The maximum current rating for the cable routes and conditions of installation shall be stated for 36 & 12kV power cable by the Contractor.

- (d) Anti-termite covering
Anti-termite protection shall be applied to the cable and shall consist of a non-magnetic metallic barrier and shall meet the requirements of IEC standard.
- (e) Outer covering
The outer covering of the cable shall be extruded, continuous black PVC suitable for the operating temperature of cable and shall meet the requirements of IEC standard.
- (f) Cable drum
Cable drum shall be non-returnable and shall be made of timber, pressure impregnated against fungal and insect attack. Alternatively cable drum may be made of steel suitable protected against corrosion.
- (g) Outdoor and indoor termination for high voltage cable.
Outdoor and indoor termination shall be done by heat or cold shrinkable type termination kits.

Termination for cable shall be provided in sufficient quantities for complete installations of substations.

- (h) Jointing accessories
Cable shall be installed in maximum possible length and straight through jointing between shorter lengths will not be permitted without the prior written authority of the Employer/Employer's Representative. Jointing accessories for stranded copper conductor cables shall be designed for identification ferrules.
- (I) Voltage identification
The plastic over sheath shall be embossed with the name of the manufacturer, name of the Employer, number of conductors, the cross sections, type of insulation followed by:

Electric cable - 36,000, 12,000 volts

- (j) Phase identification
Phase identification for either triplexes or multi conductor cable shall be in accordance with follows:
 - Phase A (R): Red
 - Phase B (S): Yellow
 - Phase C (T): Blue

10.3.1.1 Installation requirements

11 kV incoming cable shall be laid in the cable trench. Whereas, the outgoing feeder cables shall be buried in a safe depth. A depth of 1.2 m shall be considered as safe depth of burial. Before laying the cable at least 10 cm thick layer sand shall be placed and after laying the cable 15 cm thick layer of sand shall be placed. Above the second layer of sand flat stone soiling shall be provided to protect the cable. For the Highway crossing NP 3 grade Hume-pipe shall be used.

10.3.2 1100 volt PVC insulated cable.

- (a) General
The low voltage cables shall be 1100v grade polyethylene insulated, armored and PVC sheathed. Low voltage power cables shall be suitable for grounded neutral with phase to phase voltage level of 400V and phase to neutral voltage of AC system and 110V DC system.
- (b) Conductor
Conductor shall consist of stranded annealed copper wires. They shall comply with IEC publication. The cable is intended for use at normal conductor operating temperatures not exceeding 75 deg.C.
- (c) Insulation
The electrically and thermally stable polyethylene insulation shall be extruded onto the conductor so as to prevent contamination and voids in the insulation.
- (d) Current rating
The maximum continuous current rating for the cable routes and conditions of installation shall be stated for low voltage power cable by the Contractor.
- (e) Anti-termite covering
Anti-termite protection shall be applied to the cable and shall consist of a non-magnetic metallic barrier.
- (f) Jacket
The cable core assembly shall be covered with a flame retardative and moisture resistant PVC jacket, which is free-stripping from the insulation. The overall jacket shall be clean, dry, and free of grease and shall be suitable for ink or paint application.
- (g) Identification
Each cable shall have a printed legend on the overall jacket with a manufacturer's name, name of the Employer, voltage class, the number and size of conductors, type of insulation.

The colors for core identification and color sequence shall be in accordance with follows:

- | | |
|----------------|-----------------------------|
| - Single-core: | Black |
| - Twin: | Red and black |
| - Three-core: | Red, yellow and blue |
| - Four-core: | Red, yellow, blue and black |

10.3.3 600 Volt Power Cable

- a) General
The low voltage cables shall be 600 V grade polyethylene insulated and PVC sheathed. Low voltage AC power systems will be solidly grounded neutral with phase to phase voltage level of 400 V and phase to neutral voltage of 230V AC system and the DC system with 110V. The size of the single core conductor shall not be less than 2.5 sq. mm for lighting and 4 sq. mm for power. The main (incomer) cable to AC distribution panel shall be three & half (3.5) core and not less than 120 sq. mm.
- b) Conductor
Conductor shall consist of stranded annealed copper wires. They shall comply with IEC publication. The cable is intended for use at normal conductor operating temperatures not exceeding 75 degree C.
- c) Insulation
The electrically and thermally stable polyethylene insulation shall be extruded onto the conductor so as to prevent contamination and voids in the insulation.
- d) Current Rating
The Contractor shall state the maximum continuous current rating and conditions of installation for low voltage power cables.
- e) Jacket
The cable core assembly shall be covered with a flame-retardative and moisture resistant PVC jacket, which is free stripping from the insulation. The overall jacket shall be clean, dry, and free of grease and shall be suitable for ink or paint application.
- f) Ant termite protection shall be applied to the cable and shall consist of either a non-magnetic metallic barrier or layer of nylon sheathing.
- g) Identification
 - 1) Each cable shall have a printed legend on the overall jacket with the manufacturer's name, voltage class, the number and size of conductors, type of insulation.
 - 2) The colors for core identification and color sequence shall be in accordance with follows
 - Single core : Black
 - Twin : Red and black
 - Three core : Red, yellow and blue
 - Four core : Red, yellow, blue and black

10.3.4 Control and instrumentation cable

- (a) General
All control and instrumentation cable shall be 600V grade as per IEC multicore, color-coded, PVC insulated, cable armored cable. Each

multicore cable shall have not less than 20 percent or 4 spare cores whichever is the greater.

- (b) Conductor
Copper conductor shall be stranded circular non-compacted copper conductor of minimum cross-section of 2.5 sq. mm.
- (c) Insulation
The electrically and thermally stable PVC insulation shall be extruded onto the conductor so as to prevent contamination and voids in the insulation.
- (d) Assembly
Multi conductor cables shall be assembled in accordance with applicable IEC standard.

A flame retardative binder tape may be used underneath the overall jacket of multi-conductor cables, if required to achieve the desired flame retardative characteristics. Tapes, if used, shall be non hygroscopic.

- (e) Anti-termite covering
Anti-termite protection shall be applied to the cable and shall consist or a non-magnetic barrier.
- (f) Jacket
The cable core assembly shall be covered with a flame retardative and resistant jacket, which is free-stripping from the insulation.
The overall jacket shall be clean, dry, and free of grease and shall be suitable for ink or paint application.

Cable jacketing and the interstices within the jacket shall be free of water. Evidence of water shall be grounds for rejection of the cable.

- (g) Identification
Each cable shall have a printed legend on the overall jacket, with the manufacturer's name, name of the Employer, voltage class, the number and size of conductors, and a unique number or code indicating the production run or batch. The identification shall remain legible for the life of the cable.

10.4 Special Requirement

Small cut piece lengths of cables will not be accepted. Cables up to 500 meters in length or as approved by Employer/Employer's Representative shall be of one length shipped in a drum of adequate size. For higher quantities, multiple lengths/drums may be shipped subject to the approval of Employer/Employer's Representative.

10.5 Drawings, Data & Manuals

The following information shall be furnished along with the Tender.

- (a) Manufacturer's leaflets giving constructional details, dimensions and characteristics of different cables.
- (b) Current rating of cables including de-rating factor due to grouping, ambient temperature and type of various installation.
- (c) Write-up with sketches illustrating the manufacturer's recommendation for splicing, jointing and termination of different types of cables.
- (d) Type test report of all types of power, control and instrument cables. The Bidder shall clearly describe the type and routine tests to be performed on cables.
- (e) Drum length for each type of cable.

10.6 Tests

11.6.1 Routine and design tests

Routine test in accordance with the provision of standard as listed in Sub-Clause 2.3 of Section IVA shall be carried out for each drum of cable.

Type test and acceptance test as per standards as listed in Sub-Clause 2.3 of Section IVA shall have to be carried out to prove the general qualities and design of a given type of cable and for the purpose of acceptance of the lot. The test certificate shall be approved by Employer/Employer's Representative before shipment.

The following tests shall be included in the routine test by the manufacturer at the factory as minimum requirements for this specification:

- (a) Construction inspection
- (b) Conductor resistance test
- (c) High voltage test
- (d) Insulation resistance test
- (e) Physical and aging test for insulation and jacket

10.6.2 Field tests

After installation at site, cables shall be subjected but not limited to the following tests:

- (a) Measurement of insulation resistance
- (b) DC dielectric test

10.7 Performance Guarantee

The performance figures quoted on schedule of Technical Data shall be guaranteed within the tolerance permitted by relevant standard and shall become a part of the Contract. In case of failure of the cables to meet the guarantee, the Employer/Employer's Representative reserve the right to reject the equipment. The Contractor shall have to rectify the defect no extra cost to the Employer and without delaying the commissioning schedule.

11. BATTERY AND BATTERY CHARGER

11.1 General

This specification covers the design, manufacture, delivery, installation and field test of the maintenance free battery and suitable battery charger for 110V DC system complete with all necessities for efficient and trouble-free operation as specified herein under.

Manufacturer of battery and battery charger shall be holder of valid ISO 9001 Certificate

The Battery charger shall also include D.C. distribution board.

11.2 Equipment to be furnished

110 V Battery and Battery Charger

11.2.1 The equipment to be furnished shall strictly be in accordance with the specifications and the Price Schedule.

11.3 Design Requirements

11.3.1 Battery & battery charger

11.3.1.1 Maintenance free Battery

(a) The Maintenance free Battery shall be rated for supplying total DC load of the each substation. The duration of the load shall be ninety (90) minutes. The total DC load cycle shall consist of the following:

- | | | |
|--------------|---|--|
| 0-1 min. | - | Simultaneous tripping of all breakers on under voltage. In case the circuit breakers charge after tripping, starting current of the spring charged motor of all the above circuit breakers shall be considered for the entire 0-1 minute period. |
| | - | Emergency lighting load |
| | - | Control, indication, protection and annunciation load |
| 1-89 minutes | - | Emergency lighting load |
| | - | Control, indication, protection and annunciation load. |
| Last minute | - | Control, indication, protection and annunciation load, emergency lighting load. |
| | - | Closing of breaker-one at a time and spring charging if spring charging occurs after closing of breaker. Consider starting current of one spring charging motor |

and running current of another spring charging motor to occur simultaneously during the entire one minute a period.

The Contractor shall compute the Ampere hour rating (10 hour rating) of the battery considering margin over the above duty cycle so that the battery shall be capable of delivering the ultimate DC load of the substation when the future switchgear and its protection panel will be installed in the same substation. The minimum capacity shall be not less than 240 AH.

- (b) The Contractor shall compute the Ampere-hour capacity at 10-hour discharge rate based on the above cycle and furnish the calculation. The minimum ambient temperature shall be 5 deg. C. The minimum voltage at the end of the load cycle shall not be less than 1.75 volts per cell.
- (c) The batteries shall be storage type as specified.
- (d) The cells shall be maintenance free Lead acid type.
- (e) Each cell shall be in a suitable leak proof container with sealed cover.
- (f) The batteries shall be furnished complete with cell interconnectors and a suitable rack protected with acid resistant paint. The arrangement of the rack shall be such as to allow easy access and adequate space for normal maintenance in battery room.
- (g) Rated life of each battery shall be at least ten (10) years.
- (h) The Bidder shall furnish along with the Tender, his proposed layout of the battery racks to suit the space available.
- (i) The manufacturer of above said maintenance free battery shall be holder of ISO 9001 certificate.

11.3.1.2 Battery charger

- (a) The battery charger shall be suitable for maintenance free batteries and solid-state electronic type using silicon rectifiers and complete with all switches, fuses, contactors and instruments.
- (b) The battery charger shall be suitable for 400 volts +10%, 3-phase, and 50Hz supply. The charger shall have fully automatic voltage regulation and electronic current limiting. The voltage regulation shall be within +1% for a 0-100% load variation and +10% voltage variations on the AC side. Cooling shall be by means of natural convection.
- (c) The minimum rating of the battery charger shall be not less than 75 amperes.
- (d) The battery charger shall be housed in a freestanding floor mounted cabinet with enclosure protection of IP-30 as per IEC.

- (e) The instruments, switches and lamps shall be flush or semi flush mounted on the front panel.
- (f) The battery charger shall be constant voltage type with provision of voltage variation from float charging to boost charging voltage. The float charging voltage shall be between 2.1 to 2.2 volts per cell or at any other voltage recommended by the battery manufacturer. At float charging voltage the charger shall furnish the continuous DC load consisting of control, indication, annunciation, breaker spring charging mechanism and continuously "On" emergency light as well as float charge its associated battery. The boost charging voltage shall be about 2.4 to 2.5 volts/cell or at any other voltage recommended by the battery manufacturer. During equalizing or boost charging, the continuous DC load shall be fed by the charger. The loads that cannot tolerate the high equalizing or boost charging voltage shall be connected through dropper diode. The battery charger shall recharge the completely discharged battery to fully capacity in 9 hours. The charger shall have 10% excess capacity.
- (g) The manufacturer of above said battery charger shall be holder of valid ISO 9001 certificate. In case such manufacturer is not available the contractor has to take the written permission from the employer.

11.3.2 Wiring

The wiring shall be complete in all respects so as to ensure proper functioning of control, protection and metering scheme.

All wiring shall be completed up to terminal blocks.

Wiring shall be done with 2.5sqmm (minimum) Class 5 stranded copper conductor, flexible PVC insulated wire. The wire shall have a voltage grade of 600V as per IEC. Lower cross section of wires may be used for solid-state devices only.

Each wire shall be identified at both ends with wire designations in accordance with the approved wiring diagram. Interlocking type ferrules shall be used for identification.

Not more than two wires shall be connected to any terminal at each end. If necessary, a number of terminals shall be jumper together to provide wiring points.

Wires shall be neatly bunched and adequately supported so as to prevent sagging strain on termination. Wires shall not be spliced or tapped between terminal points.

All spare contacts of relays and contactors shall be wired up to the terminal block.

11.3.3 Cable termination

The equipment shall be designed to facilitate cable entry from bottom. Removable plates shall be furnished with compression type cable glands to make entry dust tight and no weight is transferred on the terminal. The glands shall be suitable for

terminating cable armor. Compression type cable lugs as required shall be furnished for termination of power and control cables.

Sufficient space shall be provided to avoid sharp bending and for easy connection. A minimum space of 200mm from the gland plate to the nearest terminal block shall be provided.

11.3.4 Terminal blocks

Terminal blocks shall be specified in Technical Requirements under Sub-Clause 2.4 of Section VA.

11.3.5 Ground bus

A copper ground bus of 25mm x 6mm cross section shall be furnished along the entire length of each panel.

All devices shall be grounded to the ground bus.

11.4 Accessories

11.4.1 The following accessories shall be furnished for the batteries:

- (a) One (1) connector bolt wrench
- (b) One (1) cell testing voltmeter with leads.
- (c) Battery racks
- (d) Other necessary accessories

11.4.2 The charger shall be complete with the standard accessories including but not limited to the following:

- (a) Solid state surge protectors on the AC and DC sides
- (b) AC failure alarm relay
- (c) DC time delay low voltage relay
- (d) Ground detection alarm for positive and negative leads
- (e) Manual voltage adjust switch
- (f) DC ammeter and voltmeter

11.5 Tests

11.5.1 Type and routine tests at manufacturer's works and acceptance test at site shall be carried out on battery as per stipulation of latest standard of IEC.

The test shall include following tests:

- (a) General inspection.
- (b) Leakage test and internal short test for each cell.
- (c) One cell shall be type tested for discharge at ten-hour rate to 1.85V DC at 25 deg. C.

After initial charging the following tests shall be performed at site :

- (a) Capacity test
- (b) Efficiency test

11.5.2 The battery charger shall be subjected to the following tests at manufacturer's works:

- (a) Measurement on insulation resistance
- (b) High voltage test
- (c) Performance test
- (d) Temperature rise test

11.5.3 Test certificates shall be submitted to the Employer/Employer's Representative for approval.

11.6 Drawings, Data and Manuals

11.6.1 The following drawings and detail shall be furnished with the Tender:

- (a) Layout arrangement of battery and battery charger in the available space shown in the drawing.
- (b) Schematic and wiring diagram of battery charger
- (c) Cell voltage characteristic for battery
- (d) Technical leaflets on battery and battery charger

11.6.2 The following drawings and manuals shall be submitted by the successful Bidder for approval

- (a) Dimensional layout arrangement of battery and battery charger
- (b) Dimensional outline drawing of battery charger panel clearly showing the location of meters, switches etc.
- (c) Wiring diagram of the battery charger panel
- (d) Instruction manuals of battery and battery charger

11.7 Performance Guarantee

The performance figures quoted in Schedule of Technical Data shall be guaranteed within the tolerance permitted by relevant standard. In case of failure of the equipment to meet the guarantee, the Employer reserves the right to reject the equipment. The Contractor shall have to rectify the defect as no extra cost to the Employer and without delaying the commissioning schedule.

12. GROUNDING SYSTEM AND LIGHTNING PROTECTION

12.1 General

This specification covers the design, supply, delivery, installation and testing of the complete Grounding System as described herein.

12.2 Codes and Standards

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 section.

12.3 Equipment to be furnished

Complete installation of the ground grid, test link chamber, grounding of all equipment located in the substation as specified herein but not be limited to the supply of grounding conductors, jointing materials and all accessories to complete this grounding installation shall be covered under this specification.

12.4 Grounding Installation Features

- 12.4.1 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 workmanlike manner. Grounding conductors shall be handled carefully to avoid kinking and cutting of the conductors during laying and installation. All exposed ground conductor runs shall be taken in a neat manner, horizontal, vertical and parallel to building walls or columns and shall not be laid haphazardly. All connections to the grounding grid shall be made with the bare copper stranded cable.
- 12.4.2 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 systems, equipment enclosures, cable trays, distribution boards, equipment frames, bases, steel structure, etc., shall be by pressure type or bolting type connectors.
- 12.4.3 All lap, cross and tee connections between two grounding conductors both below and above grade 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/Employer's Representative.
- 12.4.4 Grounding conductors, when crossing underground trenches, directly laid underground pipe and equipment foundation, if any, shall be at least 500mm below the bottom elevation of such trenches/pipes.

12.5 Grounding Conductor

12.5.1 Main ground grid

The main ground system shall consist of a grounding grid buried minimum one meter below grade level. The grounding grid shall consist of one no. 100sqmm (min) stranded bare copper conductor cable.

12.5.2 Ground electrodes

The ground electrodes shall be 16mm diameter and 1.5-meter long (min.) copper clad steel. These shall be driven into ground and connected to the main ground grid.

12.5.3 Risers

The risers shall consist of stranded bare copper conductor or connected at one end to the main ground mat and at the other end to the equipment.

12.6 Design Requirement

12.6.1 The Contractor shall measure the soil resistivity and calculate the total length of buried ground conductor, number of grounding electrode and their depth and spacing to achieve a grounding system resistance of not more than 1.0 ohm.

12.6.2 The Contractor shall calculate the cross-section considering the maximum fault level.

12.7 Tests

On completion of the installation, either wholly or in sections, it shall be tested in compliance with relevant code by the Contractor in the presence of the Employer/Employer's Representative. The cost of any test including labor, material and equipment charges shall be borne by the contractor. The ground grid resistance to remote earth shall be 1.0 ohm or less. If this low 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.

12.8 Lightning Protection

The outdoor equipment of the substation and the substation building shall be protected against lightning. The lightning protection shall be achieved by one or more lightning masts or horizontal lightning conductors above the protected equipment. The design of the lightning protection system shall be subject to the approval of the Employer/Employer's Representative.

12.9 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/Employer's Representative approval. The work shall have to be started at site only after getting approval from the Engineer. If alternation is required for any work done before getting Employer/Employer's Representative approval, the same shall have to be done by the Contractor at no extra cost to the Employer.

13. LIGHTING SYSTEM

13.1 General

This specification covers the design, complete supply and installation of the lighting system for the Project including all necessary supervision, labor, tools, equipment and accessories, miscellaneous materials, testing, and putting in acceptable operation of the lighting system.

13.2 Scope of Works

13.2.1 All equipment shall be complete and operative in all details and shall be left in a satisfactory working condition. The Contractor shall furnish and install all materials and equipment, which are obviously a part of the complete illumination installation and without any additional charge to the Employer.

13.2.2 The miscellaneous materials include, but are not limited to, all conduit, wires, controls, lighting panel boards, junction boxes, fittings, supports and other accessories required for the complete installation and satisfactory operation of the indoor and outdoor lighting system.

13.2.3 The Contractor shall perform the following work in addition to furnishing and delivering of the equipment, materials and accessories specified hereinafter in this specification.

- (a) Assembling at the plant site
- (b) Erection and complete installation
- (c) Testing of all equipment
- (d) Commissioning of all equipment prior to trial operation
- (e) Trial operation and all necessary adjustments prior to initial operation.
- (f) Obtaining Employer/Employer's Representative approval and written acceptance for satisfactory operation.

13.3 Codes & Standards

The lighting installation shall meet the requirements of the latest edition of the National Electrical Code (ANSI CI) of the National Fire Protection Association of America. In addition any rules or regulations applicable to the work shall be followed. In case of any discrepancy, the more restrictive rule shall be binding.

13.4 Requirements

13.4.1 Illumination level of the new control building and outdoor switchyard complex

The illumination level above working plane in various areas in lux is as specified

below.

(a) Control room:	300 lux
(b) Battery room:	150 lux
(c) Store:	150 lux
(d) Other indoor area:	150 lux
(e) Outdoor equipment area:	20 lux
(f) Road:	10 lux
(g) Other outdoor area:	10 lux
(h) Emergency lighting:	10 lux

13.4.2 Protection of Work

The Contractor shall effectively protect, at his own expense, such of his work, materials or equipment as is liable to injury during the construction period. All openings to any part of the conduit system, as well as associated fixtures and equipment, both before and after being set in place, must be securely covered or otherwise protected to prevent obstruction of the conduit or injury due to carelessly or maliciously dropped tools or materials, grit, dirt or any foreign matters. The Contractor will be held responsible for all damages so done until his work is fully and finally accepted. Conduit ends shall be covered with capped bushings.

13.4.3 Methods and materials

All works shall be done in a first-class, neat and workmanship manner by mechanics skilled in the trade involved. All details of the installation shall be mechanically and electrically correct.

All materials shall be new, of the best of their several kinds, and without imperfections and blemishes. All materials be standard products of manufacturer's latest design. Where two or more units of the same class of equipment are required, these units shall be of same manufacturer.

All conduits and equipment shall be installed in such a manner as to preserve access to any other equipment installed.

13.4.4 Steel conduit

All conduits except otherwise stated shall be rigid steel, hot dipped galvanized. Minimum diameter of all conduits shall be 19mm.

Each piece of conduit shall be straight, free from blisters and other defects, cut square and taper reamed and shall be furnished in 3-meter lengths and threaded at

each end. Couplings shall be cleanly cut.

In no case shall the conduit be filled by more than 40 percent.

13.4.5 Installation of conduit system

The work covered by this section comprises the installation of the metallic conduit system.

Flexible steel conduit shall be used in dry and non hazardous locations to provide flexible connections between the rigid conduit system and conduit boxes, and between the rigid system and any machine subject to vibration. Flexible conduit shall be galvanized steel.

Where interference occurs, the Employer/Employer's Representative shall be notified before any relocation is made. If it should become necessary to make a field change before

consulting the Employer/Employer's Representative, every precaution shall be taken to insure that the change is coordinated with other conduit work, structural work, plumbing work, piping and architectural features; and information shall be obtained regarding the completed conduit run to insure that there will be no interference when the conduit run is extended. A complete record of such change shall be sent at once to the Employer/Employer's Representative.

Exposed conduits shall be run in straight lines parallel to column lines, walls, or beams. Where conduits are grouped, the bends and fittings shall be installed so as to present an orderly appearance. Unnecessary bending or crossing shall be avoided.

Supports for exposed horizontal conduit runs shall be provided every 1.0m for 19mm conduit and not more than every 1.5m for 25mm conduit and larger, where it is difficult to provide supports at intervals other than those specified above, the supports for 19mm conduit may be every 1.5m and supports for 25mm and larger every 2.0m as a special case and the Employer/ Employer's Representative approval must be taken. Supports for exposed vertical conduit runs shall be not more than 1.5m for 19mm and 25mm conduit and not more than 2.5m for 32mm and larger conduit.

Conduit shall be supported on approved types of galvanized wall brackets, ceiling trapeze, strap hangers, or pipe straps, secured by means of anchor bolts on hollow masonry units, expansion bolts in concrete or brick, and machine screws on metal surfaces. Wooden plugs inserted in masonry or concrete shall not be used as a base to secure conduit supports.

Conduit joints and connections shall be made thoroughly watertight and rustproof by means of the application of a thread compound, which will not insulate the joint. Each threaded joint shall be thoroughly cleaned to remove all the cutting oil before the compound is applied. Red lead is suitable for application for embedded conduits, and white lead is suitable for application for exposed conduits.

Couplings may be used in dry and exposed locations. They may also be used in wet exposed locations in vertical runs only, provided they are installed with fixed threaded connection at top. They may be used in concrete if adequately waterproofed to prevent leakage.

Standard radius bends are generally to be used for steel conduits but special long radius bends shall be used wherever specifically required, the long radius bends are to have radii as large as the physical conditions will permit.

Field bends of metallic conduit shall be made in such a manner that the internal diameter of the conduit is not materially changed, and the protective coating on the inside and also on the outside of the conduit is not injured. The bends shall be free of kinks, indentation, or flattened surfaces. Heat shall not be applied in making any conduit bends.

Structural steel shall not be cut or drilled to avoid interferences except with the specific approval of the Employer/Employer's Representative in each case. Where the Employer/Employer's Representative approves cutting holes in reinforced concrete for conduit, the reinforcing bars shall not be cut, but shall be bent to permit passage of the conduits.

Galvanized structural steel members may be drilled or punched for conduit supporting bolts, provided the holes are immediately painted with aluminum paint and galvanized or rust-resisting bolts are used.

Conduits and fittings shall be properly protected during the construction period against mechanical injury, from impact from structural steel heavy machinery, or batches of mass concrete pours. Conduits, which extend out of floors, walls, or beams, shall be boxed or otherwise protected and the ends shall be plugged or capped.

In supporting embedded steel conduit, if welding or brazing is used, extreme care should be taken to avoid injury of the surface of the conduit. Welding or brazing shall not be done on the bottom of a conduit or on the inside of a bend, or at any other location that might interfere with the pulling of conductors. The welded or brazed joint shall be painted.

Metallic conduit shall be securely fastened to sheet metal boxes and cabinets, each with a locknut and insulated bushing inside the box and a locknut outside. The conduits shall be of such length that when the bushings are screwed tight against the ends of the conduits no appreciable space will be left between the bushings and the locknuts. The locknuts shall be tightened against the box without deforming the box.

After a conduit run is completed, it shall be inspected and swabbed out. Compressed air may be used in blowing out any excessive amount of water.

In complete installation, each outlet box shall be provided with cover, unless a fixture canopy is used.

Round outlet boxes shall not be used where conduits or connectors require the use of locknuts or bushings to be connected to the side of the box. Rectangular or octagonal boxes having knockout or opening at each flat bearing surface for the locknut or bushing shall be used.

13.4.6 Wire & Cable

The contractor shall furnish and install all wire and cable required for the complete installation. All wire shall be of stranded copper conductor, PVC insulated. The wire shall have a voltage grade of 600V as per IEC. Minimum cross-section shall be 2.5sqmm. All wire shall be run in conduit.

All wiring between distribution boards and lighting panels and all outdoor branch circuit wiring shall be done using power cables as specified in Sub-Section 11.

Cables and wires shall be installed without joints as far as practicable. Where splicing or joints are required, they shall be made in accordance with the cable manufacturer's recommendations.

All splicing shall be done in outlet boxes and junction boxes and not in the conduit or on the trays. All connectors and splicers shall be of the solderless type and shall be self-insulated. In lieu of self-insulated type connectors and splices, the Contractor may use the non-insulated type, but he will wrap the connection or splice with insulating tape to the same dielectric value as the original insulation. If insulating tape is used, they shall be of a type as recommended by the manufacturer of the wire or cable.

13.4.7 Outlet and switch boxes

Furnish and install for each outlet, and outlet box suited to the use for which the outlet is to be put and to the location in which it occurs.

All outlet and conduit fittings in exposed conduit runs shall be cast metal with integral threaded hubs ("Condulets") with appropriate covers and shall be provided with gasket covers. Sealing fittings shall be furnished where required.

13.4.8 Junction and pull boxes

Junction and pull boxes for indoor use shall be made from sheet steel and shall have set-in or flange construction cover. All corners shall be placed approximately 150mm apart. Each box and cover shall be hot dipped galvanized after fabrication. All drilling for conduits or armored cable shall be done in the field. The box sizes shall be in accordance with the National Electrical Code.

Junction boxes for outdoor use shall be similar to the above except they shall be provided with screwed-on covers with gaskets to make them weatherproof. Conduit connections shall be made through threaded hubs or chase nipples welded to the box.

13.4.9 Lighting fixtures

The Contractor shall furnish, install and wire required number of lighting fixtures to meet the various maintained illumination levels as specified in this specification. It shall be noted that the illumination intensities indicated for various areas are the maintained illumination levels (and not initial illumination level) considering a maintenance factor of not more than 0.7. The Contractor shall be responsible for producing the above illumination levels for each specific area with the type of fixture specified.

Lamps - All fixtures shall have installed therein by the Contractor a lamp of wattage as noted in this specifications. They shall be of the incandescent filament, fluorescent or high-pressure mercury type as required for each unit. Lamps shall be furnished by the Contractor.

Lamps to be used shall have the longest life, from the respective kinds approved for this application. If the fixture provided has more than one lamp and it requires ballast, then one ballast per lamp shall be furnished.

Accessories - Each fixture shall be supplied with necessary straps, supports, or hangers or other miscellaneous materials and devices to install them in a satisfactory manner, and to conform to the architectural treatment in the area in which they are to be installed. All fluorescent fixtures shall be equipped with high power factor, approved ballasts and rapid starts lamps.

The Contractor shall prepare the detailed layout to meet the above requirement. The lighting layout and wiring drawings of the Contractor shall be submitted for the Employer's/Employer's Representative's approval.

Fixture type for each area is as specified below:

- | | |
|-----------------------------|---|
| (a) Control Room: | Indoor, pendant type fixture with acrylic prismatic lens, complete with two (2)-40W. cool white fluorescent lamp and glow start high p.f. ballasts. |
| (b) Switchgear Room/Toilet: | Indoor, industrial pendant type fixture with sheet steel reflector complete with two (2)-40W, cool white fluorescent lamp and glow start high p.f. ballasts. |
| (c) Battery Room: | Indoor, pendant or surface mounted moist proof and acid-proof, with sheet steel reflector complete with one (1) 60W incandescent lamp covered with clear glass globe. |
| (d) Substation/outdoor: | Outdoor, weather-proof, high pressure mercury vapor or sodium fixture, complete with one (1)-300W lamp, ballast, aluminum reflector and photo electric control. |

- (e) Emergency Lights: Indoor, recessed or pendant mounted fixture with porcelain enameled standard dome reflector Substation complete with one (1) - 60W incandescent lamp.

All the fixtures shall be approved by the Employer/Employer's Representative before shipping.

All florescent, CFL and incandescent lamps shall be LED with equivalent lux.

13.4.10 Lighting panels

The Contractor shall furnish and install all 400/230 volts lighting panels as required and shall be obviously included in the cost of electrical wiring of the building.

Each 400/230-Volt lighting panel shall be, three phase, four wire, and solid neutral. Each branch circuit shall have a 20-ampere single pole quick-make quick-break circuit breaker. Each circuit breaker shall empty thermal means of inverse time overload protection supplemented by an instantaneous magnetic short circuit trip. The maximum load on each branch circuit shall be limited to 2400W. The number of branch circuit in each lighting panel shall be determined based on the load and the above criteria. Mains shall be provided with solderless lugs.

All circuit breakers shall have a interrupting capacity suitable for the fault level fed by the preceding transformer. Power supply to 230V receptacles, as required shall be taken from this panel. The enclosure protection of the panel shall be IP-50 per IEC.

13.4.11 Emergency lighting

Emergency lighting shall be provided in Control Rood, Switchgear Room and Battery Room. The power source for the emergency lighting shall be drawn from the D.C. distribution board. The emergency lighting shall be normally "Off" type.

13.4.12 Receptacles

The Contractor shall furnish and install all receptacles and specified herein.

The receptacles shall be of 230V, 20 Ampere, 3-pole, 3 wires, polarized with third pole grounded.

The receptacles shall be provided on the walls of all the rooms at a spacing of 6m. (maximum) between two receptacles with minimum of two (2) receptacles per room.

13.4.13 Local wall switches

Local wall switches for controlling lighting cubicles shall be furnished and

installed for each enclosed area such as offices, switchgear rooms, battery room, etc. All switches shall be single pole or 3-way as required.

General indoor areas - Local switches mounted indoors shall be single pole and shall be rated 6 amperes at 230 Volts.

Outdoors and wet locations - Local switches installed in outdoor and wet locations shall be weatherproof switches, single pole or as required rated 20 Amperes at 230 Volts.

13.4.14 Grounding

Each lighting fitting shall be provided with an grounding terminal suitable for connection to the earthing conductor.

All metal or metal enclosed parts of the housing shall be bonded and connected to the grounding continuity throughout the fixture.

13.5 Tests

13.5.1 The Contractor shall thoroughly test and measure insulation resistance for all cables and equipment and prove that same are free of grounds and short circuits. If a ground or short circuit is found on any cable or equipment, the faulty condition shall be eliminated or the cable and/or equipment replaced. The minimum value of insulation resistance shall be 10 mega ohms.

13.5.2 All equipment shall be demonstrated to operate in accordance with the requirement of this specification and other specifications.

13.5.3 Functional tests shall be performed to check each requirement.

13.5.4 All tests shall be performed in the presence of the Employer/Employer's Representative. Contractor shall furnish all instruments and personnel for all tests.

13.6 Drawings

The Contractor shall furnish shop drawings, relevant catalogues, data sheets, etc., required to cover specific information for all items in any way designed for the works. None of the following items shall be installed until final approval of all the data sheets and drawings, as listed, has been given by the Employer/Employer's Representative.

- (a) Conduit
- (b) Cable
- (c) Lighting panel boards
- (d) Shop drawings or catalog cuts for all lighting fixtures and receptacles
- (e) Switches and molded case circuit breakers
- (f) Junction and pull boxes
- (g) AC and DC contactor for emergency lighting panel boards
- (h) Layout drawings showing fixtures, conduit and circuitry of fixtures
- (i) Calculation of illumination level in various areas.

14. LOW VOLTAGE DISTRIBUTION BOARD

14.1 General

This specification covers the design, manufacture, assembly, testing at manufacturer's works, supply and delivery, properly packed of low voltage distribution boards.

14.2 Standards

The equipment covered by this specification shall unless otherwise stated be designed, constructed and tested in accordance with the applicable section of the latest relevant IEC Specification. The equipment conforming to any other national standard, which ensures equivalent quality, are acceptable. In such cases the Bidder shall clearly indicate the standard adopted and furnish a copy of the English version of the standard along with the proposal. Should there be any dispute on design standard; the most stringent one shall be followed.

14.3 Equipment to be furnished

- 14.3.1 The equipment to be furnished shall strictly be in accordance with the specifications and the Price Schedule.
- 14.3.2 Each distribution board must have sufficient number of spare feeder (at least 20% of various sizes used in the Distribution Boards with a minimum 1 no. on each bus). The incoming molded case circuit breakers and bus bar ratings shall be selected considering the spares also.
- 14.3.3 The distribution boards shall be complete with all accessories and materials.
- 14.3.4 The base channel frames for the distribution boards for grouting in the floor complete with anchor bolts, nuts and leveling attachments.
- 14.3.5 Special tools and tackle for erection and maintenance of the distribution boards and other equipment.
- 14.3.6 The Contractor shall furnish as many distribution boards as required to cater to his requirements, without any additional cost. If Tender's requirement, the same shall be supplied without any extra cost to the Employer.

14.4 Design Requirements

- 14.4.1 The AC distribution board is meant for miscellaneous loads such as but not be limited to battery charger, illumination, ventilation and air conditioning, space heater, station auxiliaries, etc.
- 14.4.2 The DC distribution board is meant for distribution of DC power to switchgear, control, relay and metering panel, emergency lighting fire protection system etc.
- 14.4.3 The distribution boards will be located indoor in a hot and humid atmosphere. All

equipment, accessories and wiring shall be provided with suitable finish for prevention of fungus growth.

14.4.4 The AC distribution board shall be designed for operation in a 400V +10%. 3 phase, 4-wire, 50Hz +5% neutral ground system. The DC distribution board shall be designed for 110V DC, 2-wire system.

14.4.5 The de rating of the equipment shall be done taking 45 deg. C as an ambient temperature of the site, if it is designed for lower ambient temperature. Furthermore, design and selection of all equipment shall be made liberally with a good margin of safety factors.

14.5 Construction Features

14.5.1 General

The distribution boards shall be self standing sheet steel cubicle or wall mounted panel having following features:

- (a) The construction shall be compartmentalized.
- (b) All distribution boards shall be dead front type. All switches, circuit breakers, etc. shall be operable from the front.
- (c) All bolts and nuts exposed to external atmosphere shall be cadmium plated or zinc passivated.
- (d) The working height shall be limited to a maximum of 2,000mm. The design shall be such as to permit easy extension of distribution boards at site on either end.
- (e) The distribution boards shall consist of vertical sections, fabricated from a minimum of 2mm thick sheet steel, shaped and reinforced to form a rigid freestanding structure.
- (f) The minimum clearance of the power terminal lug from the bottom plate shall be maintained as 200mm.
- (g) The AC distribution board designed for 4-wire system shall have a fully insulated neutral bus of cross-section same as the main phase buses.
- (h) Anchor bolts and nuts for each distribution board shall be supplied along with the distribution board.
- (I) All distribution boards mounted indoor shall be provided with enclosure protection of IP 50 as per IEC.

14.5.2 Bus bars

Bus bars shall be copper, liberally sized for the specified current ratings (both short

circuit and continuous currents). Maximum temperature of the bus and bus connection shall be limited to 90 deg. C.

All bus bars, links, etc., shall be covered to prevent accidental contacts.

Buses shall be spaced with adequate clearance between phases and between phase and ground.

Bus supports shall be of molded insulators suitable for polluted atmosphere.

All bus works shall be braced to withstand stresses due to short circuit current, corresponding to the respective fault level of the system to which it is connected. The bus bars shall be able to withstand for 1 second the above short circuit current thermally.

Appropriate color code shall be used to identify the various phases of bus bars and the neutral (wherever applicable).

14.6 Specific Requirement

14.6.1 Molded case circuit breakers (MCCB)

The molded case circuit breakers shall be of panel mounting type. It shall have all the live parts enclosed in a molded case and all contacts shall be silver-plated. The breakers shall be trip free and with quick-make and break operating mechanism. The molded case circuit breakers shall be provided with magnetic short circuit protection and thermal overload device. The characteristic curve of these protections shall be furnished along with the offer. The protection device of the incomer MCCB shall be coordinated with feeder MCCB. Each breaker shall have a common trip, causing on overload on one pole to trip all other poles.

The MCCB handle, after breaker tripped due to a fault shall occupy a mean position. The breaker shall be capable of interrupting a RMS current corresponding to the fault level of the system to which the respective distribution board is connected.

It shall be possible to close and trip the breaker without opening the compartment door. The breaker shall be provided with mechanical On-Off indicator at the front properly marked. Each circuit breaker shall be provided with alarm switch and auxiliary switch. The rating of the MCCB's shall be so selected that maximum standardization consistent with the economy is possible. The incoming and bus section breakers shall have shunt trip coils.

14.6.2 Cable termination

Distribution board shall be designed to facilitate cable entry from bottom. Removable plates shall be furnished with compression type cable glands to make entry dust tight and no weight is transferred on the terminal. The glands shall be suitable for terminating cable armor. Compression type cable lugs as required shall be furnished for termination of power and control cables.

Sufficient space shall be provided to avoid sharp bending and for easy connection. A minimum space of 200mm from the gland plate to the nearest terminal block shall be provided.

14.6.3 Ground bus

Grounding terminals on the distribution board shall be provided at either end for connection of copper ground conductor to ground grid.

14.6.4 Nameplate

Nameplates showing “Feeder Designation” shall be provided for each module of distribution board at front door top. Also nameplate shall be furnished at the top for each distribution board.

Material for nameplate shall be a plastic sheet, 3mm thick or approved equivalent. The letters shall be white on black background.

The nameplate shall be held by self-tapping screws. The size of the nameplates shall be proportionate to the size of the modules. Also individual panel number and danger plate shall be furnished at the back of the panel.

14.7 Tests

14.7.1 Routine and type test

Type test certificates and results shall as per relevant IEC. Specification for all the equipment offered under the scope of this specification shall be furnished.

Each distribution board shall be completely assembled, wired adjusted and tested for operation under simulated conditions to ensure correctness of wiring and proper functioning of all equipment.

All component parts such as MCCB'S, meters, etc., shall be tested in accordance with relevant IEC Specification.

All current carrying parts and wiring shall be subjected to a high potential test.

All routine tests shall be conducted on all distribution boards.

14.8 Drawings, Data & Manuals

The following drawings and details shall be furnished along with the Tender.

- (a) Bidder's proposed distribution scheme in single line diagram for all distribution boards.
- (b) Bidder's proposed typical general arrangement drawing showing constructional features and layout of individual equipment along with the

following:

- Space required in the front as well as back of distribution board.
- Power cable entry points
- Bus bar clearance, phase to phase and phase to neutral
- General cross-section drawing of the cubicle

(c) Technical leaflets on: MCCB, Terminal Boards, and Insulators.

14.8.2 After award of contract the successful Bidder shall submit the following drawings for approval of the Employer/Employer's Representative.

(a) Confirmed outline dimensional drawing of all distribution boards, showing the general arrangement and indicating the following:

- Space required in the front and back
- Power cable entry points
- Bus bar clearance phase to phase to neutral
- Configuration of bus bars
- Technical details of supporting insulator and their spacing
- Outgoing power termination arrangement
- Transport/shipping dimensions with weights
- Foundation and anchor bolt details including dead load and impact load

(b) Any other relevant drawing and data necessary for approval.

15. STEEL STRUCTURE

15.1 General

This specification covers the design, manufacture, testing, delivery and installation of steel structures to be used for supporting electrical equipment and gantry structure.

15.2 Codes & Standards

The steel structure shall be designed, manufactured and tested in accordance with ASTM or equivalent.

15.3 Scope of Works

The works includes, but is not necessarily limited, the following:

- (a) Calculate and design as per requirements of this specification
- (b) Prepare complete detailed shop drawings and submit for approval of the Employer/Employer's Representative.
- (c) Prepare bill of materials and complete dispatch list.
- (d) Furnish all materials, labor, tools, plant, consumable, etc., including bolts, nuts, washers for fabrication in shop and on site and for erection.
- (e) Fabricate and deliver to job site, unload, store and erect structural steel for towers and all equipment frame.
- (f) Assemble bolt on ground at job site fabricated members for erection.
- (g) Erect fabricated materials and connect by field bolting.
- (h) Align and level erected structural steel.

15.4 Technical Requirements

15.4.1 The steel structures for extension of existing substations shall be so designed and fabricated that the connecting and joining works can be done with ease and exactness.

15.4.2 Design load of conductors shall be as follow:

Description	Tension of conductor per phase
- Incoming line	1,000 kg
- Internal bus	500 kg
- Overhead ground wire	300 kg

- 15.4.3 Steel structure dimensions, framing, member size and length, number, size and length of bolts, thickness of each filler and other necessary details to fabricate each piece shall be shown on the approved detail drawings. No change shall be made without the written approval of the Employer/Employer's Representative.
- 15.4.4 Bolts shall have hexagonal heads and hexagonal nuts with the same dimension between flats on bolt heads and nuts. Bolt holes are not to be more than 1.5mm larger in diameter than the corresponding bolt diameter. The design is to be such as to keep the number of different parts as small as possible and is to facilitate transport, erection and inspection.
- 15.4.5 No welding will be permitted in steel structure fabrication
- 15.4.6 Bill of material shall give the size, length and galvanized weight of each member and the total weights of steel structures. It shall also include the number of bolts, nuts and washers per structure.
- 15.4.7 Workmanship shall be first class throughout.
- All pieces must be straight, true to detail drawings and free from lamination flaws and other defects. All clipping, back-cuts, grindings, bends, holes, and etc. must be true to detail drawings and free of burrs.
- 15.4.8 Threads of bolts and nuts shall be cleanly rolled or cut and the face and head of nut shall be truly at right angle to the axis of the bolt.
- 15.4.9 After fabrication has been completed and accepted, all materials shall be clear of rust, loose scale, dirt, oil, grease and other foreign substances.
- 15.4.10 All materials including nuts and bolts shall be hot dip galvanized. The process of galvanization shall be as per latest version of IEC or ISI. The thickness of zinc coating shall not be less than 85 microns (610 gm/sq. m).
- 15.4.11 The material shall not be hammered or otherwise straightened in a manner that will injure the protective coating. If the material has been harmfully bent or warped in the process of fabrication or galvanizing, such defects shall be cause for rejection.
- 15.4.12 One of each type of structure shall be assembled in the shop to such extent as to insure proper field erection. Reaming of untrue holes will not be permitted. Shop-assembled parts shall be dismantled for shipment.
- 15.4.13 The structures shall include all necessary access ladders to give access to the various levels of the structures.
- 15.4.14 In addition to dead dynamic loads imposed by equipment, steel work shall be designed to withstand simultaneously wind loads as follows:

- (a) On flat surface: 121kg/sqmm

- (b) For lattice structures: 121kg/sqm on 1.71 times the times the projected area of the members of one face of the structure.
- 15.4.15 All structures shall be designed so that no failure or permanent distortion shall occur when tested with applied forces equal to 2.5 times to maximum simultaneous working loadings.
- 15.4.16 At or near ground level, all uprights shall be provided with holding down bolts provided under this contract.
- 15.4.17 Details and fastenings shall be designed to have factor of safety against failure not less than the main members of the structure.
- 15.4.18 Pockets and depressions likely to hold water shall be avoided and all parts of the structures shall be properly drained.
- 15.4.19 Bolts and nuts shall be galvanized and fitted with spring washers. Taper washers are to be added where necessary. Threads of bolts shall be spun galvanized and threads of nuts shall be oiled.
- 15.4.20 All member shall be cut to jig and holes shall be drilled or punched to jig.
- Parts shall be carefully cut and holes accurately located so that the members are in position the holes can be accurately aligned before being bolted up., Drifting of holes will not be permitted.

15.5 Tests

- 15.5.1 All tests shall be carried out by the Contractor using his own instruments, testing equipment as well as qualified testing personnel.
- 15.5.2 The following shop test shall be performed with relevant provision of ASTM or equivalent.
- (a) General inspection
 - (b) Material test
 - (c) Assembly test
 - (d) Galvanizing test
- 15.5.3 The results of all tests shall conform to the specified requirements as well as agreed guarantee figures finalizes with the Contractor.
- 15.5.4 Employer/Employer's Representative shall have the right to inspect any material, workmanship etc. of the equipment and may reject any item defective or unsuitable for the use and purpose intended, or not in accordance with the intent of the Employer/Employer's Representative.

15.6 Drawings

- 15.6.1 The Contractor shall submit the calculation sheet, design & shop drawing and guaranteed performance data.
- 15.6.2 The shop detail drawings shall show the details of all parts to be fabricated.
- 15.6.3 Erection drawings shall include bills of materials for each type of structure with the piece mark, size, length and calculated weight of each member.
- 15.7 Packing, Marking and Shipping
 - 15.7.1 Methods of packing, marking, shipping, and storing shall be submitted to the Employer/Employer's Representative for review and acceptance.
 - 15.7.2 Members of steel structure shall not be dropped or dragged on the ground and shall not be set on the ground for an extended period of time.

All steel shall be maintained clean and free of foreign matter and at no time shall it be set on wet or muddy ground.
 - 15.7.3 Boxes of bolts, nuts and similar connectors, and hardware assemblies shall be stacked off the ground and shall be covered with plastic sheets for protection from elements.
 - 15.7.4 Materials, which are defective or damaged when, delivered shall be repaired or replaced and shortages shall be made good immediately by the Contractor.

16. MISCELLANEOUS MATERIALS

16.1 General

This specification covers the design, fabrication, properly packed for transportation, deliver, installation, testing and putting into efficient and trouble-free operation of the bus material and insulator complete with all accessories.

16.2 Equipment to be furnished

16.2.1 The equipment to be furnished shall strictly be in accordance with the specifications and the Price Schedule.

16.3 Technical Requirements

16.3.1 Insulators

(a) General

All types of insulators shall satisfactorily withstand the specified climatic and service conditions. The strength of insulators as given by the electro-mechanical tests load shall be such that the factor of safety when supporting their maximum working loads shall be not less than two and a half.

Design shall be such that stresses due to expansion and contraction in any part of the insulators and fittings do not lead to development of defects.

All insulators, whether cylindrical post or string shall have plain shed profiles.

Damaged insulators shall be replaced.

Arcing horns are not required on post type and string insulators within substations.

(b) Materials

Porcelain insulators shall be in accordance with IEC where applicable. Porcelain shall be sound, free from defect and thoroughly verified and the glaze shall not be depended upon for insulation.

Porcelain glaze shall be smooth, hard, of a uniform shade of brown and shall completely cover all exposed parts of the insulators. Outdoor insulator fittings shall remain unaffected by atmospheric conditions producing weathering, acids, alkalis, dust and rapid changes in temperature that may be experienced under working conditions.

Suspension and tension insulators shall comprise porcelain units with ball and socket fittings.

Retaining pins or locking devices for insulating units shall be of phosphor bronze or other approved material, and shall effectively prevent accidental

separation of the units.

Unless otherwise approved, the individual units of both the suspension and tension insulator sets shall be identical and interchangeable.

- (c) Number of discs
String insulators shall comprise of 3 nos. of 11kV disc insulator.
- (d) Marking
Each insulator shall have marked on it the manufacturer's name or trade mark, the year of manufacture and the manufacturer's reference mark. Tension and suspension insulators shall also be marked with the guaranteed electromechanical strength. Marks shall be legible and indelible.
- (e) Post insulator
Post insulator shall be cylindrical type, solid core porcelain, provided in accordance with following requirements:
 - Rated voltage 36 kV
 - Nominal voltage 33 kV
 - Impulse withstand voltage 170 kV
 - Color Brown

Test shall be divided into three groups in accordance with IEC 168.

- (f) Standard particulars of insulator units

Insulator units shall comply with the following requirements. (IEC 305)

- Porcelain disc diameter 254mm
- Unit spacing 146mm
- Creepage distance 292mm
- Electro mechanical failing load 6,800kg
- Dry power frequency withstand voltage 70kV
- Wet power frequency withstand voltage 40kV
- Dry impulse withstand voltage 110kV
- Puncture voltage 110kV

Dimension and tolerances of ball and socket coupling shall comply with IEC Publications 120 (1977), and the internal height of the socket shall also comply with the requirements of IEC Publication 372-1.

16.3.2 Bus Conductor and fittings

- (a) General

Bus bars and electrical connections in outdoor substations shall be in accordance with BS, ASTM or equivalent national standards in respect of current rating and material analysis.

Bus conductor to be supplied shall be aluminum tube and aluminum conductor steel reinforced. Minimum size and material of each bus shall be as following

<u>Bus</u>	<u>Material</u>	<u>Min.Size</u>
- 33kV Main	ACSR/ Al-Tube	Dog /as per actual
- 33kV Branch	ACSR / Al-Tube	Dog /as per actual
- Overhead ground wire	GSW	55sqmm

In case of existing substation conductors and connectors to be used for extension shall be as nearly as possible identical with the existing equipment.

Materials used for bus bars and connections shall be stressed to not more than two-fifths of their elastic limit. Provision shall be made for expansion and contraction with variation in conductor temperature and bus bars shall be arranged so that they may be readily extended in length with a minimum of disturbance to existing equipment.

Bus bars shall be in continuous lengths between supports. Connectors shall be of approved type, and if necessary type tested. Connection dependent upon site welding techniques will not be permitted.

Unless otherwise approved, bus bars and connections shall be so arranged and supported that under no circumstances, including short circuit conditions, can the clearances between live metal and earth of earthed metal work or between other conductors be less than the specified in the drawings. The extension of bus bar in the existing substation shall match with the existing one.

(b) Strain bus and fittings

The conductor shall be aluminum conductor steel reinforce (ACSR)

The conductor shall be constructed of hard-drawn aluminum and zinc-coated steel-wires which have the mechanical and electrical properties in accordance with the latest revisions of ASTM.

The direction of lay of the outer layer shall be right-hand. The direction of lay shall be reversed in successive layers: contiguous layers shall in all cases have opposite lay.

The external form and surface of the finished conductor shall be uniformly cylindrical upon completion of manufacture and shall remain so when erected in place on the line.

The surface of the conductor shall be free from points, sharp edges, abrasions or other departures from smoothness or uniformity that would

tend to increase radio interference and corona loss. When the conductor is subjected to tensions up to 50 percent of its rated ultimate strength, the conductor surface shall not depart from its general cylindrical form, nor shall any of the strands move relative to each other in such a way as to get squeezed out of place and disturb the longitudinal smoothness of the conductor. Strands of a section of “popped” cable shall not protrude more than 1/2 of their diameter of a strand. The conductor shall be capable of withstanding the normal handling necessary for manufacture and erection, such as, reeling, unreeling, and pulling through stringing sheaves under sufficient tension to keep the conductor off the ground, etc., without being deformed from a cylindrical form in such a way as to increase radio interference and corona loss.

The make-up and lay of wires shall be such as to produce a conductor essentially free from a tendency to untwist or spring apart when cut. The steel wires shall be performed or post formed so that, when the conductor is cut and the aluminum wires are stripped away from the core as required for splicing, the steel wires can be readily regrouped and easily held in place with one hand to allow a splicing sleeve to be slipped over the steel core wire at the cut end of the conductor.

This forming of the core is required and shall be done in a manner which will not in any way scratch, scrape, remove or otherwise damage the zinc coating of the steel core wires, individually or collectively.

The conductor shall be free from excessive amounts of die grease, metal particles and dirt. The Bidder shall describe in complete detail the method which he proposes to use in normal production to clean the conductor. The effectiveness the cleaning process shall be subject to verification.

Where dissimilar metals are in contact, approved means shall be provided to prevent electro-chemical action and corrosion. Unless otherwise approved, joints and surfaces of copper or copper alloy fittings shall be tinned.

Suspension and tension conductor clamps shall be approved types and shall be as light as possible. Those for aluminum conductor shall preferably be compression type. Suspension and tension clamps shall be designed to avoid any possibility of deforming the stranded conductor and separating the individual strands.

Tension conductor clamps shall not permit slipping of or damage to, or failure of the complete conductor or any part thereof at a load less than 95 percent of the ultimate strength of the conductor.

Clamps and fittings made of steel or malleable iron shall be galvanized. All bolts and nuts shall be as specified and shall be locked in an approved manner.

(c) Tubular bus and fittings

Tubular bus shall be made of first melting aluminum alloy, cold rolled or hard drawn and assembled using corona free fittings. Continuous lengths of bare conductor shall be installed in bus to dampen aolian vibration.

The tubular bus conductor shall have adequate strength to withstand mechanical forces due to short circuit currents and its temperature when carrying full load current shall not exceed 75 deg. C. A safety factor of 2 for normal working loads and 15 with short circuit currents shall be used.

The tubular bus shall include a small drain hole in any low section. Where expansion joints are required they shall be of the thin leaf type. They are required at all potheads and as required on bus bars. Bus supports for main tubular buses shall include on rigid fixed conductor clamp with slide fit on adjacent supports.

All bus support clamps shall be cast of first melting aluminum alloy. Each clamp shall be adjustable for alignment with insulator and furnished with four galvanized steel mounting bolts.

- Bolted type clamps shall be furnished with first melting alloy bolts, nuts and washers finished with anodic coating and lubricated. The clamps for tubing shall have dimensions and section suitable for splicing two pieces of tubing in the clamp.
- Flexible elements of expansion bus support clamps shall be laminated aluminum strap, which has current capacity equivalent to the tube.

Terminal connectors for aluminum shall be of first melting cast aluminum alloy. All terminal pads shall be furnished with stainless steel bolts, nuts and Bellville washers.

The bolted type terminal connectors shall be a multi grip type terminal and furnished with first melting aluminum alloy with bolts, nuts and washers finished with anodic coating and lubricated.

Bolted type connectors listed below shall be furnished with first melting aluminum alloy with bolts, nuts and washers finished with anodic coating and lubricated.

- Angle-Connectors: All angle-connectors shall be of streamlined, bolted type and made of first melting cast aluminum alloy. Tap element sockets shall be deep enough to allow for error in cut-off.
- Couplers: All couplers shall be bolted type and made of first melting cast aluminum alloy.

- (d) Overhead ground wire
Overhead shield wire shall be galvanized steel wire, stranded with a cross sectional area of 61.7sqmm and shall comply with BS 183.

Earth wires shall be greased as for conductors and the outer strands shall have a right hand lay.

Each completed shield wire shall be bare and shall be composed of the specified number of wires.

In case of existing substation, the tubular bus and its fittings to be used for extension shall be as nearly as possibly identical with the existing one.

The nominal diameter of individual wires shall have a variation of not more than plus or minus one and an-half (1.5) percent.

Joints or splices may be made in the individual wires prior to drawings to final size or in the finished wire composing the strand. Such joints shall have protection to corrosion equivalent to that of the finished wire itself and shall not decrease the strength of the finished strand below the specified minimum breaking strength. Joints in the individual wires in the finished strand shall be separated by at least 15.2 meters.

All wires in the cable shall lay naturally in their true position in the completed cable, shall tend to remain in position when the cable is cut at any point, and shall permit re-stranding by hand after being forcibly raveled at the end of the cable. The strand shall be free from imperfections and consistent with good commercial practice with a carefully controlled finish completely free from any dirt, loose metal particles, nicks, scratches, abrasions or deformities of any nature.

Each item of material to be furnished by the contractor shall be given the wire manufacturer's routing factory tests.

16.4 Tests

- 16.4.1 The insulators shall be tested in accordance with IEC or ANSI Standards. Certified copies of the tests shall be submitted for approval to the Employer/Employer's Representative.

- (a) Type tests
- Low frequency wet withstand test
 - Critical-impulse flashover test
 - Impulse withstand test
 - Radio-influence voltage test
 - Compression strength test
 - Thermal shock test

- (b) Quality conformance tests
 - Visual and dimensional test
 - Porosity test
 - Galvanizing test
 - Cantilever strength test
 - Torsional strength test
 - Tensile strength test
- (c) Routine tests
 - Flashover test
 - Tension proof test

16.4.2 Bus materials

The following shop tests shall be performed for bus materials. All tests shall be made at the manufacturer's plant by and at the expense of the Contractor. Certified results of test shall be submitted whether or not the inspection is waived. The Employer/Employer's Representative may, at its option, waive part or the whole test.

- (a) Aluminum tube
 - General inspection
 - Chemical composition of aluminum alloy
 - Conductivity measurement of aluminum tube
 - Dimension and weight measurement
 - Certified report of aluminum alloy from the original manufacturer
- (b) Bus support clamp and connector
 - General inspection
 - Dimension measurement
 - Chemical composition of aluminum alloy
 - Certified report of aluminum alloy from the original manufacturer
- (c) Connectors for stranded conductor
 - General inspection
 - Measurement of dimension
 - Compression test
 - Certified report of aluminum alloy from the original manufacturer
- (d) Miscellaneous hardware
 - General inspection
 - Measurement of dimension
 - Tension test
 - Galvanizing test

16.5 Packing and Marking

16.5.1 Insulator

(a) Packaging

The insulators shall be packed in strong wooden boxes with a waterproof lining. These boxes shall provide adequate protection against salt spray, chemical attack and damage that might be encountered in transportation and rough handling during loading, transportation to job site, unloading to temporary storage and ocean transportation.

(b) Marking

In addition to marks required for shipping purposes, each crate and pallet shall be marked with Shipper's identity and Employer's name and address and quantity and type of contents. Also, the gross, tare and net weights in kilograms shall be stenciled on each pallet.

16.5.2 Bus materials

(a) Packing

The conductor shall be furnished on non-returnable wooden reels, and shall be properly protected to prevent displacement, chafing, distortion, damage from corrosive atmosphere or other damage to the conductor, which might be encountered in shipping, storage or handling. Each layer of conductor shall be separated from the adjacent layer in such a manner as to prevent abrasion or other damage during handling and shipping.

The non-returnable reels shall be made of a strong material suitably strengthened for ocean transport and treated to withstand rotting or any type damage due to ocean atmosphere. The reels shall be capable of withstanding all stress due to braking and string operations. The Employer will accept the use of returnable reels, but any additional costs of such reels will be the responsibility of the Contractor.

(b) Marking

In addition to marks required for shipping purposes, each reel head shall be stenciled to show serial number, type of conductor, length of conductor in meters, the gross, tare, and net weights in kilograms. Each reel shall also be plainly marked to indicate the direction in which it should be rolled to prevent loosening of the conductor on the reel. Those reels from which test samples were taken shall be marked "Tested" with the length of sample conductor removed.

16.6 Guarantee

Any defects in materials or workmanship or other failure to meet requirements of these specifications, which are disclosed prior to the Taking-Over by the Employer, be corrected entirely (including removal and replacement) at the expenses of the Contractor.

Any latent defects not disclosed before date of the Taking-Over but disclosed within guarantee period, materials and/or supplies shall have been placed in use, shall be corrected promptly by and at the expense of the Contractor.

16.7 Wall mounted Split-type Air-Conditioners

1. General

This specification covers the supply, delivery, field test and installation of Air-Conditioners at Substations.

2. Equipment to be furnished

Split-type Air-Conditioners shall be furnished with all the accessories to complete the scope of works as given in the price schedule.

3. Scope of Works

Supply, delivery and installation of the Air-Conditioners shall include but not limited to that:

- A. Civil works like breaking of wall and repairing wherever necessary.
- B. Any support structures and leak proofing compounds required for proper sealing.
- C. Bidder shall provide operation maintenance instruction translated in Nepali font in A4 size paper with good glass frame for each rating. These have to be hung on the wall of the generator house.

4. Design Requirements

- a) Type
 - Split wall-mounted (Cooling/heating)
- b) Minimum Cooling/heating Capacity for

1 Ton	12000 Btu/hr
1.5 Ton	18000 Btu/hr
2 Ton	24000 Btu/hr

- c) Indoor noise level

<	40 db for 1 ton
<	46 db for 1.5 ton
<	51db for 2 ton

- d) Compressor
 - Super silent, Power saving
 - Hermetically sealed
 - Rotary/reciprocating
- e) Rated Voltage/Frequency
 - 230 V, 50 HZ, Single Phase
- f) Fan Speed
 - Three Speed with air deflection System
- g) Operation mode with remote control
 - Heat/Cool/ Dry/Fan
- h) Air Swing
 - To be Present, Automatic
- i) Air filter
 - Anti –fungal/cleanable
- j) Refrigerant
 - R410A (Non-CFC)

5. Manufacturers

The AC shall be from the following manufacturers

- Mitsubishi
- Daikin
- Samsung

Or equivalent makes / brand

- 6. Quality Certification: ISO 9001-2000 certified and CE certification.
- 7. Warranty: 12 months from the date of commissioning.

CHAPTER 3

SPECIFICATION OF CIVIL AND BUILDING WORKS

1. SITE WORKS

1.1 Work Included

Furnishing all materials, equipment and labor and performing all operations required for the clearing, stripping, filling and compacting of substation areas and constructing access roads so indicated on the drawings, specified herein and as evidently necessary to complete to work.

1.2 Clearing and stripping

1.2.1 General

Clearing shall include removal and disposal with lead of 100m, as specified of all trees, bushes down timber, debris, posts, fences, indicted structures and other obstructions from the areas to be occupied by permanent works of the contract, and as indicated on the drawings, specified herein and as directed by the Owner/Engineer. Areas so indicated shall be stripped of 20cm thick topsoil. Topsoil approved by the Owner/Engineer shall be stockpiled for use in the finish grading and seeding work. Stockpiled topsoil shall be free from trash, vegetation, or other debris.

1.2.2 Protection

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

1.2.3 Payment

Payment for the contract item "Site cleaning and stripping top soil all over sub-station area and access roads" will be made in square meters as per bid therefore in the schedule which shall include full compensation for all costs incurred in performing the clearing and stripping, including but not limited to removal and disposal of bushes, splash, roots and debris; and stripping, stockpiling and disposal of topsoil or unsuitable earth material within lead of 100 meters.

1.3 Compacted Fill for Site Grading

1.3.1 The Contractor shall provide and compact select borrow material within the limits of the work to the lines, grades and elevations to be specified by the Owner/Engineer.

1.3.2 Common fill

This material shall be well-graded bank-run gravel, relatively free from clay, loam on vegetable matter and with no stones over 10cm in maximum dimensions, or material of equivalent strength and characteristics. Representative samples from proposed borrow sources shall be submitted to the Owner/Engineer for approval of the borrow source. Approval of borrow source shall not mean automatic approval of all materials obtained from that source. All fill materials will be subject to approval of Owner/Engineer. If any material is rejected by Owner/Nepal Electricity Authority, the Contractor shall remove it from site without any extra cost to the Owner.

1.3.3 The Contractor shall, at his option, use areas approved by the Owner/Engineer for production of select borrow or at his own expense, make arrangements for obtaining select

borrow at other sources with prior approval of the Owner/Nepal Electricity Authority.

- 1.3.4 Unless otherwise specified by the Owner/Engineer, compacting shall be to the following densities at optimum moisture contents as determined by ASTM D-1557, Method D.

(a) Fill location and required density.

- | | | |
|-----|------------------------------------|--------------|
| (1) | Under building and yard foundation | - 95 percent |
| (2) | Sub-base for roadways | - 90 percent |
| (3) | Gravel roadways top 400mm | - 95 percent |
| (4) | All other locations | - 90 percent |

- (b) It is the Contractor's responsibility to select his method for attaining the required compaction and obtain approval of the Owner/Engineer for the proposed method. Should the method of compaction prove unsatisfactory, it is the Contractor's responsibility to take remedial measures and obtain the approval of the Owner/Engineer for the changes made. For the compaction of fill, to ton vibrating roller is preferable.
- (c) The Owner/Engineer reserves the right to have compaction tests performed by an independent laboratory, with all testing costs borne by the Contractor. Any additional compaction or replacement of fill required to meet the specified density, as evidenced by the tests, shall be done by at the expense of the Contractor.
- (d) Failure of the compacted fill to reach the required density as evidence by these tests, is cause of rejection by the Owner of the work in the affected area(s). Unless the Contractor can rework and compact the fill to the required density, he shall remove the fill in the areas affected. Subsequently the Contractor shall replace the removal fill with material which he can compact to the required density.
- (e) Compaction shall be carried out in layerwise, each layer not exceeding 300mm loose thickness.

- 1.3.5 Measurements for payment for the contract item " Approach road construction with sub grade preparation, 22.5 cm thick sub grade course 15 cm thick sub base course and 15 cm thick P.C.C. 1:2:4 all complete." shall be for actual measured work in square meters for all works described in the item. Payment will be made at the unit price for square meter bid therefore in the schedule, which unit price shall include full compensation for all costs incurred in furnishing all materials and all other operations related to fill including but not limited to:

- (a) Obtaining materials from the Owner/Engineer approved source.
- (b) Transporting materials to job site from source, to temporary stockpiles and/or points or final disposition.
- (c) Placing and compacting material
- (d) Levelling the top surface to the finish grade.

1.4 Approach road construction with sub grade preparation

This work comprises of 22.5 cm thick Sub-grade course, 15 cm thick Sub-base course and 15 cm thick P.C.C. 1:2:4 pavement from bottom to top.

- 1.4.1 Mechanical compaction shall be performed after leveling the ground to the designed grade before laying Sub-grade course to the satisfaction of Engineer to attain the density of soil equal to that of original soil.
- 1.4.2 Sub-grade course shall be compacted bank run gravel or well graded quarry stone approved by the Owner/Engineer and placed to a minimum thickness of 225mm after compaction. Mechanical compaction shall be performed to the satisfaction of Engineer. The material shall consist of hard durable particles of stone, intermixed with coarse sand, showing uniform resistance to abrasion, and free from injurious amounts of loam, silt, clay, surface coatings or other deleterious matter. The material shall meet the following gradation by weight:

Sieve Size	Percent Passing
101.6mm	100
50.8mm	65-100
25.4mm	45-75
6.4mm	25-60
4.75mm	10-25
2.36mm	0-5

- 1.4.3 Sub-base course of graded crushed stone consist of hard durable particles of quarry stone, intermixed with coarse sand, showing uniform resistance to abrasion, and free from injurious amounts of loam, silt, clay, surface coatings or other deleterious matter. Mechanical compaction shall be performed to the satisfaction of Engineer for the compaction of the Sub-base course. The material shall meet the following gradation by weight:

Sieve Size	Percent Passing by weight
50 mm	100
37.5 mm	80-100
20 mm	60-90
5 mm	30-65
2 mm	20-50
1.18 mm	16-43
0.425 mm	10-30
0.3 mm	9-27
0.075 mm	0-10

- 1.4.4 Concrete Pavement of 15 cm thick shall be of P.C.C. 1:2:4 and performed accordingly as specified in clause 2.6.6 Concrete and below.

1.5 Crushed Stone filling

- 1.5.1 The Contractor shall furnish, delivery, deposit and spread crushed stone on the switchyard area. The crushed stone shall be crushed granite, gneiss or equal, 25mm size and shall be hard, durable and seamless, spread and bladed dense but not compacted. The Contractor shall spread the crushed stone on previously properly prepared subsurfaces. The cover shall be 150mm thick.
- 1.5.2 Measurement for payment for contract item. Crushed Stone filling, shall be at the number of cubic meters of crushed stone surface of crushed stone furnished and placed in accordance with Specifications, as shown on the drawings or as directed by the Owner/Engineer and shall be measured net by deducting area covered by permanent structure and fixtures.
- 1.5.3 Payment for the contract item "Crushed Stone filling" will be made at the unit price per cubic meter therefore in the Schedule, which unit price shall include full compensation for all costs incurred in furnishing all materials and all other operations related to the fill including but not be limited to:
- (a) Obtaining materials from Owner/Engineer approved source
 - (b) Transporting materials to job site from source, to temporary stockpiles and/or to points of final disposition.
 - (c) Placing and spreading material.

1.6 Site Drainage

- 1.6.1 The Contractor shall furnish all construction works for collection and disposing storm

water of all around the switchyard site into the soak pit which shall be constructed for the soaking all drained water. The drainage channel having several types of sections, such as the open channel, closed, perforated pipe with certain dimensions as shown on the drawings.

1.6.2 Grading

Locations and its direction of the elevations shall be as shown on the drawings.

1.6.3 Drainage channel materials

- (a) All concrete drains must be built to fall.
Excavating must give allowance to formwork which shall be refilled with proper compaction.
- (b) Concrete pipes
Concrete pipes shall be Np-3 class or equivalent in required size. Closed pipes shall be used at road crossing, the perforated type pipes shall be used for switchyard area. 150mm dia. Perforated pipe shall be made of asbestos cement. 250mm and 200mm dia. Perforated pipe shall be made of R.C.C. hume pipe Np-2 class or equivalent. Those pipes shall be protected with screened gravels of 25mm-40mm size.
- (c) Mortars for drainage channel shall be a mixture of cement sand mortar with a ratio of 1:3

1.6.4 Construction

Excavating, trenching and backfilling for drainage channels shall be done after all other underground utilities are installed but before road subgrade is prepared.

- (a) Trench excavation
Trenches for pipe shall be excavated to a sufficient depth and width to enable to pipe and any specified joint bedding, haunching etc. to be accommodated.
- (b) Bedding and laying of pipes
Immediately following excavation of trenches, pipes shall be laid. Pipe shall be laid so that each one is in contact with the bed throughout the length of its barrel.
- (c) Jointing of pipes
Length of each pipes shall be commercially available joints to be constructed in the field shall be factory made collar jointed with jute packing and cement sand mortar 1:3. And the joint location shall be covered by 30cm thick concrete (1:2:4).
- (d) Backfilling
After 48hrs of pipe jointing, the trenches shall be backfilled with excavated material. If excavated material is not suitable then the contractor shall replace it by select borrow. Backfilling shall be done in layerwise, each layer not exceeding 15cm.

1.6.5 Open channel type drainage

Excavation and backfilling for this type of drainage shall be done as specified before.

The surface shall be made as smooth as possible with plaster work. Side and base shall be constructed in 150mm thick R.C.C. work 1:2:4.

1.6.6 Payment for the related items necessary for the drainage system will be made item wise as per bill of quantity after actual measurement. The bid price shall include full compensation for all costs incurred in furnishing all material, equipment and labor other operations related to the scope of work.

1.7 Laying of under ground cable

Contractor shall furnish all construction work for under grounding of 12kV cables from substation outgoing cable exit point to nearest take off poles.

This work shall include excavation, sand filing upto 10cm depth, cable laying, stone soling on three sides of the cables, sand filling from the top and backfilling. All work shall be done according to the standard practice.

Cost of "12kV power cable and accessories" in the Price Schedule shall include the cost of laying of cable with required materials as described above.

1.7 Fencing

- 1.7.1 Fencing as mentioned in the item "10 SWG 50mm x 50mm size chain linked G.I. mesh fencing with 3 lines of 8 SWG support wire and 2.5 m high 65mm x 65mm x 6mm G.I. Angle section posts @ 2 m c/c with 3 lines of 13 SWG barbed wire on 0.5m top bent up portion of the post all complete as per site condition" shall be erected as shown in conceptual drawing. The contractor shall submit the design drawing for approval to the owner according to the actual site condition before commencing the fencing work.
- 1.7.2 The G.I. angle post 2.5 m high with 65mm x 65mm x 6mm G.I. Angle section shall be embedded 50mm deep with secondary concreting of 1:2:4 in 150mm×150mm× 600mm opening on the stone masonry boundary wall at 2-meter centers as shown in conceptual drawing. There shall be appropriate numbers drilled holes along the G.I. Post for tying chain link mesh and barbed wire. The contractor shall submit the design drawing for approval according to the actual site condition before commencing the fencing work.
- 1.7.3 After the erection of the G.I. post 10 SWG 50mm x 50mm size chain linked G.I. mesh is laid vertically over outer surface of the post. The mesh shall be tied with using G.I. wire with G.I. post in such a way that it shall not bulge with 13 SWG G.I. wire
- 1.7.4 Payment for the item "10 SWG 50mm x 50mm size chain linked G.I. mesh fencing with 3 lines of 8 SWG support wire and 2.5 m high 65mm x 65mm x 6mm G.I. Angle section posts @ 2 m c/c with 3 lines of 13 SWG barbed wire on 0.5m top bent up portion of the post all complete as per site condition" shall be in running meter after actual measurement. The bid price shall include full compensation for all costs incurred in furnishing all material, equipment and labor other operations related to the scope of work

1.8 Stone masonry work in cement mortar

- 1.8.1 Stone masonry work shall be performed for the construction of compound wall/fence wall, drains, apron walls, retaining walls etc. where ever necessary referring the approved drawing.
- 1.8.2 The stone shall be hard, tough, sound and durable. Stone shall be hammer dressed to secured close joint so that the stones when laid will come into close proximity. Stones shall fairly equal in size and every stone shall be fitted to the adjacent stones. No stones shall be less than 15 cm. in size.
- 1.8.3 Face stones shall be comparatively larger and uniform in size and colour to give a good appearance and breadth of the face stones should be greater than the height. Face stones should tail into wall to a sufficient depth to bond well. Stone shall be laid with broader face downward to give a good bedding. Face joints shall be broken and faces of wall shall be truly in plumb. Corner stones or quoins should be good stones and dressed correct to angles and laid as headers and stretchers.
- 1.8.4 Mixing ratio of cement mortar used for stone masonry shall be 1:6 or 1:4 as specified in

the drawing. Consistency of cement mortar for stone masonry shall be 5-7 cm. Strength of cement mortar shall be greater than 75 kg/cm^2 .

- 1.8.5 All stones shall be thoroughly wetted before laying and the masonry shall be moist cured for 7 days.
- 1.8.6 Payment for stone masonry shall be made in accordance with price listed in the bill of quantity.

1.9 Stone pitching

- 1.9.1 Stone pitching shall be used for slope protection. Stone material to be used shall be hard, not liable to weathering and free from impurities. The maximum size is 30 cm and minimum size 10 cm. The material shall be well graded and fixed by hammer in order to ensure good bond.
- 1.9.2 Payment for stone pitching shall be made in accordance with price listed in the bill of quantity.

1.10 Dismantling Work

- 1.10.1 The Dismantling work of any existing structure lying in the construction area shall be carried out after the actual measurement of the structure with relevant drawings and its approval from the Engineer.
- 1.10.2 Payment for dismantling work shall be made in accordance with price listed in the bill of quantity.

1.11 Entrance Gate

- 1.11.1 The contractor shall submit the design drawing of the entrance gate before fabrication. The M.S. entrance gates shall be fabricated with M.S. square pipe frame, #18 M.S. corrugated (rectangle) sheet panel with enamel paint finish over two coats of red oxide paint, painted and installed as per approved drawing and as directed by the site Engineer. The contractor shall produce the design drawing for the approval on his own cost.

1.11.2 Payment

Payment for the contract item. Supply and installation of entrance gate (4m x 2m) with M.S. square pipe frame, will be made in number, as in price bid. Therefore, in the schedule, the price shall include compensation for all costs incurred in furnishing all materials and labor and other operations related to Entrance gate.

2. CONCRETE FOUNDATION AND TRENCHES

2.1 Work Included

Furnish all materials, equipment and labor and perform all operations required for the design and construction of all the concrete foundations oil containment and cable trenches, as shown on the drawings, as specified herein and as evidently necessary to complete the work.

2.2 Foundation Design

2.2.1 General

The Contractor shall design all foundations specified on the bid drawings. The design shall be based on assumed soil parameters. Upon completion of the detail soil test, actual soil conditions shall be investigated and shown to be in compliance with the assumed

conditions.

2.2.2 Submittals

The Contractor shall submit design calculations, detail drawings and reinforcement steel schedules to the Owner/Engineer for review and comment before construction commences. Review of the foundation design by the Owner/Engineer in no way relieves the Contractor of his responsibility for an adequate foundation design, even though this Specification sets forth the basic foundation design criteria. Upon receiving the Owner's/Engineer's comments, the Contractor shall submit to the Owner/Engineer final drawings of all foundation details, including reinforcing steel schedules on drawing sheet sizes for record file.

2.2.3. Design load

The structure design loads are defined on the structure outline drawings and the loads used to design the foundations shall be actual working loads applied to the foundations by the equipment and structures. The foundations shall be designed to resist all vertical and lateral forces, uplift forces and overturning moments with a minimum factor of safety of 1.5.

2.2.4 Bearing loads

The Contractor shall use an allowable soil bearing pressure of 1.0kg/cm² for the design of the foundation for the purpose of bidding, but this is only reference value. After award of contract the Contractor shall carry out detail soil test and detail design of foundation based on the soil test result. There may be variation in the volume of work in final design compared to the bidding design, for which the Contractor will not get any extra payment.

2.2.5 Uplift and overturning loads

The uplift and overturning resistance of concrete spread footings shall be assumed as the weight of a volume of earth in the form of an inverted frustum of a cone or pyramid. The cone or pyramid height shall be 30cm less than the depth from finish grade to the top of the concrete mat, the base area shall be the top area of the mat and the top area shall be determined by the intersection of planes starting at the mat edges and sloping outward at a 20 degree cone angle from the vertical and the horizontal plane 30cm below finish grade.

2.2.6. Unit weights for overturning resistance

The following unit weights shall be used for design:

- (a) Soil 12,00kg/m³
- (b) Concrete 16,00kg/m³

2.2.7 Payment

Payment for the related items necessary for the concrete foundation will be made item wise as per bill of quantity after actual measurement. The bid price shall include full compensation for all costs incurred in furnishing all material, equipment and labor other operations related to the scope of work.

2.3. Soil Tests

2.3.1 Ground bearing tests

The Contractor shall carry out ground bearing tests to determine the ground bearing capacity by means of a Standard Penetrations Test and Auger Boring and tests shall be performance in accordance with the following Specifications.

- (a) The Contractor shall perform soil investigation work according to the approved plan and details of tests. Report on test results including various data collected during the investigation works and Contractor's recommendations, on which the design will be based, shall be approved Owner/Engineer.
- (b) Subsurface investigation for soil strength of foundation for structures and equipment shall conform to the following requirements.

Number of boring shall be at least 2 borings at the locations specified below:

- one at take-off structure foundation
- one at transformer foundation

Depth of boring shall be at least 6m below the natural ground level.

- (c) Thin-walled tube soil sampling in accordance with ASTM D-1587-63T shall be made at every meter for the first three meter of depth.
- (d) Standard penetration tests in accordance with ASTM D-1586-64T shall be made at every meter for the first three meter of depth and every two meters for the further depth after this-walled tube soil samples have been taken.
- (e) Every undisturbed sample collected from this-walled tube shall subject to the following series of test:
 - Natural moisture content
 - Atterberg limits
 - Sieve analysis
 - Unit weight
 - Specific gravity determination
 - Unconfined compression tests
- (f) Accurate log of all soil strata penetration resistance test unconfined compressive strength, soil classification, ground water table and other test results shall be recorded in the reports submitted.

The Contractor shall provide all necessary equipment, materials and personnel to prepare, conduct and report the tests.

2.3.2 Payment

Payment for the contract item. Soil Testing, will be made at the lump sum price bid. Therefore, in the schedule, the price shall include compensation for all costs incurred in furnishing all materials and labor and other operations related to soil testing.

2.4. Excavation and Backfill

- 2.4.1 The contractor shall excavate earth, rock, stumps and all other materials encountered as required for construction of the foundations, oil containment and trenches and drainage pipes. The Contractor shall place all suitable excavated materials in backfill or in graded embankment in the immediate area at structures. Materials found to be unsuitable for foundation backfill or grading shall be wasted and disposed off at the Contractor's own

expense as per site condition, and shall be backfilled with select borrow material.

- 2.4.2 Excavation shall be maintained in a clean, safe and sound condition until completion of the foundation construction and shall be diked to prevent flooding by surface runoff. Suitable pumping equipment shall be provided and used to dewater excavations so that all installation work and backfilling is performed in the dry state. Any previously prepared foundation bearing surface that is softened by water runoff of otherwise contaminated before placement of the structure foundation shall be excavated and replaced at the Contractor's expense.
- 2.4.3 In those excavation where the base is unstable, lies below groundwater level, or has been over excavated, the Contractor shall furnish and place a layer of crushed stone, or selected backfill, or borrow to stabilize the base for placement of foundation materials.
- 2.4.4 Backfill shall be placed in not grater than 20cm lifts before compaction. Each lift shall be thoroughly compacted before the following lift is placed. Pneumatic or equivalent tempers shall be used on cohesive materials: vibratory compactors shall be used on non-cohesive materials. Compaction shall achieve a density at least equal to that of the surrounding undisturbed earth. Large stones or rock fragments may be used in the backfill provided they do not interfere with proper compaction. Particles larger than 25cm shall be placed not nearer than 0.5m of the structure and at least 1.0m below ground surface.
- 2.4.5 Rock particles larger than 10cm shall not be in contact with the concrete.
- 2.4.6 Upon the completion of excavation a 10cm thick layer of boulder or selected borrow shall be provided at the base of each foundation.
- 2.4.7 Payment
 - a. The Contractor shall record and measure each area before and after excavation in order to determine the dimension and elevation of the original ground surface prior to the excavation and the final excavated dimensions and elevation after the excavation.
 - b. A surveying program showing the proposed surveying method and arrangement of construction control network shall be submitted five (5) days prior to excavation commencement to the Engineer or Resident Engineer for approval.
 - c. The measurement of open excavation for Payment shall be made by the volume according to the limits, slopes and dimensions showed on the drawings or to the limits, slopes and dimensions given as written instructions by the Engineer. Payment shall be made based on the unit price listed in the price schedule according to the types of excavated soil. The cost for the works like clearing, stripping & piling etc. mentioned in clause no. 1.2 and 1.3 of technical specification must be included in the unit price of excavation, unless and until those works are specified separately in the bill of quantity.

2.5 Cable Trenches

2.5.1 General

Concrete cable trenches of adequate size shall be designed and constructed in accordance with the drawings and as directed by the Owner/Engineer. Trenches shall be designed with floor drains to assure proper drainage and shall be quipped with removable covers providing for easy access. At road crossing R.C.C. Hume pipe-NP3 of sufficient size shall be provided.

2.5.2 Payment

Payment for the contract item, cable trenches, will be made at the unit price as per bid items. Therefore, in the Schedule, the unit price shall include full compensation for all costs incurred in furnishing all materials, equipment and labor and all other operations related to cable trench design and construction, including but not be limited to:

- (a) Performing detail designs and preparation of construction drawings.
- (b) Supplying transporting all materials to job site
- (c) Excavating and backfilling for the cable trenches
- (d) Constructing the cable trenches with floor drains, reinforced concrete wall, base and removable cover.
- (e) Providing road crossing conduit and pipe at foundation block.

2.6 Foundation Construction

2.6.1 General requirement

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

- (a) The Contractor will be required to remove and replace at his expense any materials incorporated in the work that do not conform to these Specifications.
- (b) The Contractor shall furnish without extra cost all materials the Owner/ Engineer may require for testing. The cost of the tests shall be borne by the Contractor.

2.6.2 Measurement

Measurement for payment for the contract item shall be on the basis of the actual measurement of the related item of bill of quantities constructed by the Contractor.

2.6.3 Payment

Payment for the contract item, Concrete foundation, will be made at the item wise unit price as per bid in the bill of quantity schedule, which shall include full compensation for all costs incurred in furnishing all materials, equipment and labor and all other operations related to concrete Foundation design and construction, including but not be limited to:

- (a) Performing detail foundation designs and preparation of construction drawing including bar-bending schedule.
- (b) Supplying and transporting all foundation materials to job site.
- (c) Excavating, dewatering, providing 10cm thick soiling layer as under Article 2.4.6 of this section, providing 5cm thick (1:3:6) lean concrete layer and back filling for the foundations.
- (d) Constructing the foundation including form work setting, reinforcement bar bending and fixing.
- (e) Grouting for base plates
- (f) Concrete testing

2.6.4 Reference to standard specifications

Standard referred to in these specifications are as follows:

- (a) ASTM refers to the latest edition of publications of American Society for Testing and Material.
- (b) ACI refers to the latest edition of publications of American Concrete Institute.

2.6.5 Measurement standards

Measurement standards referred to in these Specifications are as follows:

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

2.6.6 Concrete

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

- (a) At least on month prior to the placement of any concrete, the Contractor shall test cylinders for each trial mix under both field-cured and laboratory-cured conditions. The test cylinders shall be made and tested in accordance with the applicable standards. Also for every new batch of cement purchased one set of test cylinders shall be taken before two weeks of using that cement.

- (b) The concrete mixes shall be of such proportions as to produce a plastic and workable mix which will not separate during placing and will finish well without using excessive quantities of mixing water.
- (c) After the test results are known for the test cylinders, the Contractor shall submit test result to Owner/Engineer then Owner/Engineer will notify the Contractor of the acceptable design mixes.
- (d) When placing concrete in hot weather, the recommendations of the American Concrete Institute's publication "Recommended Practice for Hot Weather Concreting"(ACI 605) shall be followed insofar as the Owner/Engineer may direct. The use of set retarders will be at the Owner's/Engineer's discretion. For concrete placed during extremely hot weather, the aggregate shall be cooled by frequent water spraying in such a manner as to utilize the cooling effect of evaporation. Concrete with a temperature of 30 deg. C high before placement will be rejected and shall be wasted at the Contractor's expense.

2.6.7 Cement

In locations where conditions do not require high sulfate resistance, cement shall conform to the requirements of ASTM C150 type 1.

- (a) In locations where, in the opinion of the Owner/Engineer, the conditions require the use of high sulfate resistance cement, cement conforming to the requirements of ASTM C150 Type V shall be used without any extra cost to the Owner.
- (b) The aggregates shall consist of clean, natural materials or, subject to the approval of the Owner/Engineer, manufactured aggregate may be used.
- (c) Aggregates shall be separated into sand and coarse aggregate before being used. No pit or crusher run materials will be permitted without prior approval of the Owner/Engineer.
- (d) Natural fine aggregate or sand grading shall be within the following limits and the fineness modules shall be between 2.5 and 2.8:

Sieve Size	Amount finer than Each Laboratory
<u>U.S. Std.</u>	<u>Sieve. Weight Percent</u>
3/8" (9.5mm)	100
#4 (4.75mm)	95 to 100
#8 (2.36mm)	80 to 10
#16 (1.16mm)	50 to 85
#30 (600 micron)	25 to 60
#50 (300 micron)	10 to 30
#100 (100micron)	2 to 10

- (e) Natural coarse aggregate grading shall be within the following limits, depending upon the nominal size of the coarse aggregate.

U.S. Standard Sieve	Nominal 1-1/2"	Nominal 3/4" (19mm)
2" (50.8mm)	100	
1-1/2" (25-38mm)	95-100	
1" (25mm)		100
3/4" (19mm)	35-70	90-100
3/8" (9.5mm)	10-30	20-55
No.4 (4.75mm)	0-5	0-10

2.6.8 Slump

All concrete shall have a maximum slump of 102mm and minimum slump of 75mm at the time of placing. The water-cement ratio shall be determined by consideration of the specified strength, the water reducing admixtures, the slump required for proper placement, air entraining requirements, the available and maximum allowable aggregate

size and its specific gravity the fineness modulus of the fine aggregate and its specific gravity, and the amount of water carried on the aggregates. The slumps and maximum sizes of aggregate as well as the computation of trial mixes shall be as described in the American concrete Institute Recommended Practice for Selecting Proportions for Concrete (ACI 613). The minimum amount of cement per cubic meter of concrete using 38mm aggregate, shall be 6 bags (300kg) for a concrete design strength of 210 kg/sq. cm. But if 210 kg/cm² strength of 28 days concrete can not be achieved with this cement content the more cement shall be used for which the Contractor will not get any extra payment. The proportion of all materials in the concrete shall be subjected to approval by the Owner/Engineer. The Contractor shall provide all plant and equipment necessary to determine and control the actual proportion of materials entering the batch.

- (a) In calculating the total water content in any mix., the amount of water carried on the aggregate shall be included. The water on the aggregate shall be determined periodically by test and the amount of free water on the aggregate subtracted from the water added to the mix. In all cases, the amount of water to be used shall be the minimum amount required to produce a plastic mixture of the strength specified and of the required density, uniformity and workability. The consistency of any mix shall be that required for the specific placing conditions and methods of placement.
- (b) Water used in mixing and curing concrete shall not more than 1,000 parts per million chlorides no more than 1,300 parts per million sulfates, shall not have a turbidity count greater than 2,000 parts per million and shall also be free of objectionable quantities of oil and organic materials.

2.6.9 Storage of materials

Cement and aggregates shall be stored at the site of the work in such manner as to payment deterioration or intrusion of foreign matter. Special care shall be taken in storing cement to keep it thoroughly dry at all times.

- (a) Cement that has become caked in storage is still usable only if, when pressed between the thumb and fingers, it powders readily. Otherwise, its use will not be permitted.
- (b) When reinforcing steel is delivered to the job in advance of the Contractor's requirements, the Contractor shall provide suitable protection in order to prevent excessive rust developing on the reinforcing steel. It will be Contractor's responsibility to remove excessive rust.
- (c) Before starting the foundation construction all screened aggregates and sand shall be collected and stockpiled near site. So that it is free from clay, dust and other foreign material.

2.6.10 Concrete mixing

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

- (a) All mechanical equipment shall be checked before starting a concrete placement to ascertain whether or not it is in good operation condition and not shall be tuned-up, repaired, or replaces to the satisfaction of the Owner/Engineer.
- (b) When a foundation location is ready for concrete placement, the Contractor shall inform Owner/Engineer at least 24 hrs before concrete placing time so that Owner/Engineer may inspect to assure that the excavation is free of water, mud any debris; that the bottom surface of the excavation is a well leveled and properly compacted crushed stone sub-base; that the reinforcing steel is properly secured in place; and that the form-work is properly braced.
- (c) Rock surface shall be as flat as possible and projecting ridges shall be leveled off before the concrete is placed or space between the ridges shall have been filled

- with concrete to form a horizontal surface.
- (d) The Contractor shall ensure that all material that is to be embedded in the concrete has been placed before the concrete is placed. The Contractor shall be responsible for the accurate location of all embedded materials. Any work inaccurately or improperly set shall be relocated and reset at the Contractor's expense.
 - (e) All batching components of the concrete shall be accurately measured. Measuring on a weight basis is preferred, however, measuring on a volume basis will be allowed as long as careful controls are maintained. Weight measurements shall be made using standard batching equipment for large quantities and wheelbarrow scales for small quantities. Volume measurements shall be made in batching boxes. The batching boxes shall be as large as is practical.
 - (f) The batch mixer shall be rotated at a speed recommended by the manufacturer and mixing shall be continued for at least one and one half (1-1/2) minutes after all materials are in the mixes, unless the size of the batch is over 1.2 cu. m. when additional mixing time shall be required as advised by the Owner/Engineer. A mechanically-operated batch mixer shall be used for concrete mixing.
 - (g) The retempering of concrete which has partially hardened, that is, remixing with or without additional cement, aggregate or water, will not be permitted.
 - (h) Concrete shall be conveyed from the mixer to the place of final deposit within 30 minutes by methods which will prevent the segregation or loss of the materials. After 30 minutes of mixing the mixed concrete shall be rejected and replaced by fresh concrete at contractor's own expense.
 - (i) Equipment for chuting, pumping and pneumatically conveying concrete shall be of such size and design as to insure a practically continuous flow of concrete at the delivery end without separation of the materials. The chutes shall never be on a slope that is steeper than two vertical to three horizontal. Conveying equipment shall not have any aluminum parts that come in contact with the concrete.
 - (j) When the Concrete is to be placed on hard rock or other concrete, after the existing surface has been properly cleaned and otherwise prepared, the existing surface is to be wetted until it is saturated. The first batch of concrete places shall be as required. The grout shall be evenly spread on the water-saturated surface and then normal concrete shall be deposited continuously and as rapidly as practicable.
 - (k) The concreting shall be carried on at such a rate that the concrete is at all times plastic and flows readily into the spaces between the bars and so that each layer properly mixes with its predecessor. Successive layers shall be placed within 15 minutes of the proceeding layer.
 - (l) When placing concrete with free drops over 2 meters, sufficient numbers of hoppers and trunk must be provided of a size to allow for proper placing. The trunk sections shall reach within 500mm of the bottom of the placement.
 - (m) The concrete shall be consolidated during and after depositing by vibration. The concrete shall be thoroughly worked around reinforcement and embedded items and into corners of forms.
 - (n) All concrete must be consolidated by means of internal vibration except where the Owner/Engineer has given written permission to use some other method of consolidation. The type and make of vibrator must have a speed of at least 6000 vibrations per minute (VPM) when the machine is being supplied, furnish efficient transformers, compressors, etc. of approved type to operate all vibrators at the voltage, pressure, etc. specified by the manufacture.
 - (o) The Contractor shall always have at least two vibrators in operating condition at the location of the concrete placement.
 - (p) Vibrators shall not be used to transport concrete inside the forms.
- 2.6.11 The Contractor shall make at least one set of concrete compressive strength test cylinders each day or for each 100 cubic meters of concrete, or as directed by the Owner/Engineer. There shall be three cylinders to a set and the cylinders shall be made in accordance with ASTM C31. Only one cylinder shall be made from any batch containing less than 1/2

cubic meters of concrete.

- (a) The Contractor shall delivery cylinders to a location designated by the Owner/Engineer where they will be tested in accordance with ASTM C39. Two of the cylinders will be tested at 28 days. If the 28-day test cylinder shall be discarded. If the 28 day tests indicate a compressive strength of less than 210 kg/sq.cm. the remaining cylinder will be tested at 90 days. The cost of the tests will be borne by the Contractor.
- (b) If the 90-day compressive strength indicates a compressive strength of less than 210kg/sq.cm. the Owner/Engineer will determine what remedial measures are necessary and the Contractor shall perform the remedial measures at his own expense. The remedial measurement may include, but are not limited to, the replacement of the entire foundation. The Contractor shall also pay for any additional concrete tests including core drilling, and the repairs or replacements which may result from same, which the Owner/Engineer deems necessary strength.

2.6.12 Concrete formwork

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

- (a) Forms shall be provided with tie rods and clamps to have sufficient strength to withstand the pressure resulting from placement and vibration of the concrete, and shall be maintained rigidly in position. Forms shall be sufficiently tight to prevent loss of mortar from the concrete. Molding strips shall be places in the corners of forms so as to produce chamfered edges on permanently exposed concrete surfaces. All exposed surfaces shall be formed with plywood or steel sheathing. Unexposed surfaces may be formed with any material of adequate strength and tightness to hold the plastic concrete in proper position and prevent the loss of mortar.
- (b) If plywood or steel forms are not available, the Contractor may substitute wood planking provided exposed surfaces are rubbed to remove ridges.
- (c) Before concrete is places, the surfaces of all forms shall be coated with a form oil that effectively prevents sticking and will not stain the concrete surfaces. For steel forms, form oil shall consist of refined mineral oil. For steel forms, form oil shall consist of refined mineral oil compound.
- (d) Forms shall be removed only after 48 hours of concreting or when the strength of the concrete is such that form removal will not result in cracking, spalling, or breaking of edges of surfaces, or other damage to the concrete. Any concrete damages by form shall be repaired immediately.

2.6.13 Concrete finishing and curing

- (a) The exposed top surfaces of all concrete foundation piers shall be wood floated and steel troweled and shall be slightly sloped to prevent the accumulation of water.
- (b) Immediately after the removal of forms, the holes left by form tie rod fastener shall be filled with mortar and all damaged or defective concrete shall be repaired or removed and replaced to the satisfaction of the Owner/Engineer. Improperly consolidated concrete shall be removed by chipping, and the clipped openings or recesses shall be of such depth and shape as required to insure that the patching material placed in the openings or recesses will be thoroughly keyed and bonded to the concrete. "Dry pack" mortar shall be used for filling relatively deep chipped recesses with small surface dimensions. Concrete will be required for the replacement of defective concrete where surfac3e dimensions of the shipped openings or recesses are relatively large. The depth of chipped recesses for concrete patches shall extend at least 25mm beyond the nearest reinforcing steel.
- (c) To insure proper curing, all concrete shall be kept moist for a period of a least ten

(10) days. Burlap or and equivalent material or a curing compound shall be applied over exposed concrete surfaces. The burlap shall be kept moist at all times.

2.6.14 Membrane curing compound

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

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

2.6.15 Payment

- a) Concrete shall be constructed according to the technical specification described in this section. The Engineer or Resident Engineer shall inspect and accept the concrete in the course of placement.
- b) Projection and depression of placed concrete and error of vertical line elevation, datum line, side surface, grades and dimensions shown on the drawings shall be controlled within the allowable limits. Unevenness of unformed concrete surfaces shall be less than 10 mm and that of formed concrete surfaces shall be less than 5 mm. Allowable errors for concrete structures and reinforced concrete structures are specified as follows:

i. Errors on Vertical Line

Allowable error for sidewall of gate shall be 3 mm for a height of 3-m. allowable error of piers, wall and columns shall be 5 mm for a height 3 m.

- c) During the period of finish, dusting the surface with drying concrete shall not be permitted.
- d) Concrete quantity for Payment shall be measured by volume, based on the external lines of structures shown on the Drawings.
- e) Concrete for each section shall be paid at the unit prices listed in the price schedule. These prices include all the costs of labor, construction equipment, formwork and materials..
- f) Any concrete filled beyond the designated or approved excavation line due to extra excavation, or wasted concrete and any concrete placed for any other purposes not part of the permanent works shall be for the account of the Contractor.

2.6.16 Torsteel reinforcing bar

All torsteel reinforcing bar shall conform to the requirements of BS 1144 or equivalent and shall be fabricated in accordance with the "Manual of Standard Practice" of the concrete Reinforcing Steel Institute.

- (a) Mill scale, rust, oil and mud shall be removed from reinforcing steel by firm rubbing with burlap or equivalent treatment before the reinforcing steel is placed.
- (b) The minimum center-to-center distance between parallel bars shall be two and one-half (2-1/2) times the diameter of the bars. In no case shall be clear spacing between bars be less than 25mm not less than one one-third (1/1/3) times the nominal maximum size of coarse aggregate.
- (c) All reinforcing steel shall have a protective concrete cover of not less than:

- (1) 80mm - on the bottom of footing and on any surface of concrete that will be exposed to salt water.
- (2) 50mm - concrete exposed to weather or ground.
- (d) Reinforcing steel shall be accurately located and shall be secured in position by the use of annealed iron, no less than No. 16 gauge and shall be supported in a manner that will keep the reinforcement away from the exposed concrete surfaces. Concrete blocks shall be used to support the reinforcing steel in the foundation mat : broken stones or wooden blocks shall not be used for supporting the reinforcing steel.

2.6.17 Payment

Reinforcement shall be measured as the number of Kilograms of reinforcing steel placed in accordance with Bill of quantities or notes showed on the drawings and shall be paid based on the unit prices listed in the price schedule.

2.6.18 Grouting

Grouting for seating structural steel members and equipment on foundations shall be non-shrink (non-setting) Portland cement mortal grout or a suitable commercially available grout, at the Contractor's option. Grouting shall be done under pressure by means of an expanding agent or by means of a static head. Proportioning and mixing of grout shall conform to the following:

- (a) Mortal grout containing aluminum powder as an expansive agent mixture of 1 part cement and 2 parts sand, by weight, with a water-cement ratio not exceeding 0.55. The quantity of aluminum powder used shall be approximately 0.005 percent of the weight of cement, the actual quantity to be determined from tests with materials to be used, and at the temperature and under the conditions of a placement. Aluminum powder shall be blended with cement in proportions of one part powder 10 50 parts cement, by weight, and the blend shall be sprinkled over the dry batch. After all ingredients are added, the batch shall be mixed 3 minutes. Grout which has not been placed within 45 minutes shall be wasted.
- (b) In lieu of use of an expensive agent. Settlement shall be reduced by extending the mixing period or by delaying final mixture to minimize the interval between time of placement and initial set and placement the understatic header pressure. The motor grout shall be a mixture of one part cement and 2.5 parts sand, with a water-cement ratio of approximately 0.50. Slump shall be the minimum necessary to enable placement.

2.6.19 Payment

No separate or direct payment will be made to the Contractor for Grouting. All cost incurred in connection therewith shall be included in concrete work bid price for the construction of the various foundation types.

2.7 Galvanized Steel Structure

2.7.1 Galvanized Steel Structures used as equipment support structures, Gantry, accessories, fittings including nut-bolts etc. shall be as mentioned in Clause-15 Steel Structures in Vol-II –Section I Specification of Electrical Equipment.

2.7.2 Payment

Payment for the contract item. Galvanized Steel Structures, shall be measured in tons of the structure installed as per actual in accordance with the unit prices listed in the price schedule.

3. BUILDING WORKS

3.1 General

This Specification is intended to cover the complete provision and erection of control

building and furnishment of the indoor facilities for the project including all design, supervision, materials, equipment, labor and services necessary for or incidental to the construction of control building.

3.2 Scope of Works

3.2.1 The Contractor shall perform the design, construction works, furnishing and delivering of the equipment, materials and all accessories for the control building as listed below.

- (a) Excavation and Backfilling
- (b) Concrete Work
- (c) Flooring
- (d) Brick Masonry Work
- (e) Plaster and Punning Work
- (f) False Ceiling
- (g) Anodized Aluminum Door and Window
- (h) Water Proofing
- (i) Heat insulation
- (j) Plumping, Drainage and Sanitary fitting
- (k) Cable Trench paint and Glazing
- (l) Ventilation and Fans
- (m) Fire fighting
- (n) Furniture and facilities

3.2.2 All the works for the control building shall be subject to approved of Owner/Engineer. Owner/Engineer shall have the right to require the Contractor to make any changes on designs, construction works, materials and equipment to make the structures conform to the Specification, without and additional cost.

3.2.3 The Contractor shall prepare the design drawings including all facilities based on the attached architectural building drawings and submit the design drawings to Owner/Engineer for approval.

3.2.4 Bearing loads

The Contractor shall use an allowable soil bearing pressure of 1.0kg/cm² for the design of foundation for bidding purpose. But this is only reference value. After award of contract, the Contractor shall carry out detail soil test and detail design of foundation shall based on the soil test result. There may be variation in the volume of work in final design compared to the bidding, for which the Contractor will not get any extra payment.

3.2.5 The design live load for all floor slab shall not be less than 600kg/m² and 100kg/m² for roof slab.

3.3 Codes and Standards

The latest editions of Codes, Specifications and Standards listed below, but referred to thereafter by basic designation only, from a part of this Specification to the extent indicated by the references thereof.

In the event of conflicts or discrepancies between this Specification and the referenced codes, Specifications or standards, the more stringent applicable requirement shall govern.

- (a) American National Standard Institute (ANSI) Standards
- (b) American Society for Testing and Materials (ASTM) Standards
- (c) American Concrete Institute
- (d) Concrete Reinforcing Steel Institute
- (e) National Fire Protection Association (NFPA) Publications
- (f) Federal Specification
- (g) Flat Glass Marketing Association (FGMA) Publication

It is the intent of this Specification to establish acceptable standards or quality and performance. Minor deviations in details due to manufacturer's standards shop process will be considered for acceptance provided that, in the opinion of the Owner/Engineer, the proposed substitutions are equal in quality and performance to the specified material. All

deviations shall be called out in writing in the proposal and shall be specifically indicated on the shop drawings. The Contractor will not get any extra payment for increase/decrease of work volume due to such deviations.

3.4 Excavation and Backfilling

The detail Specification for the excavation and backfilling work shall be as per Article 2.4 of Section VII.

3.5 Concrete Work

The detail Specifications for the concrete work shall be as per Article 2.6 of Section VII. Concreting in control building shall be done in foundation tie beam floor slab, steps, column, beam and roof slab and parapet up to 5.0m height from floor level.

3.6 Flooring

3.6.1 Scope of work

Perform all flooring work required as per drawings and as specified herein.

3.6.2 Reference

All work and materials shall be in accordance with American Standards, ASTM, or equivalent.

3.6.3 Materials

- (a) Sand
Sand shall be coarse, clean sharp sand, free from clay, loam or other impurities. Sand shall be uniformly graded from coarse to fine and shall conform ASTM or equivalent.
- (b) Portland cement
Portland cement shall be as per ASTM C150 TYPE1 or equivalent. Only one brand of cement shall be used in the work.
- (c) Gravel
Gravel shall be well graded, hard, fresh and conform to ASTM or equivalent.
- (d) Water
Water shall be clean, fresh, and free from injurious amounts of oils, acids, alkalis and organic matter.

3.6.4 Construction

- (a) Preparation of earth
The earth is properly rammed and leveled by rammer, before gravel soiling, water is sprinkled during ramming.
- (b) Gravel soiling
Above the rammed earth well-graded gravel is laid and coarse sand is spread over the gravel bed. Water is sprinkled and compaction is done properly. The top surface is properly leveled and compacted before concrete laying.
- (c) Concrete laying
Concrete work shall be done as specified under article 2.6 in Section VII.
The flooring shall consist of (For each square meter)
 - Concrete mix : 300kg/m³ thickness 0.15m with 2% waterproofing compound.
 - Steel bar 8kg
 - Gravel layer 0.1m thick

3.7 Brick Masonry Work

3.7.1 Materials

- (a) Brick should be well burnt chimney brick, free from defects that would impair its strength or affects its service-ability.
- (b) Cement shall be ordinary Portland as per ASTM C150 Type 1 or equivalent.
- (c) Sand shall be clean, fine, sharp granules, free from foreign or deleterious matter.

- (d) Water shall be clean and free from acid, alkalis, oil or organic matter.

The Contractor should submit samples of cement, sand and lime for Owner's/Engineer's approval.

3.7.2 Mortar mixture

The type of mortar mixture for stone masonry shall be 1 part P.C. : 4-part sand

3.7.3 Brick masonry laying

- (a) Lay brick masonry in accurately spaced courses, level, plumb and true to line.
- (b) Soak bricks in clean water for one hour before laying. Units shall be damped when laid.
- (c) Lay brick in running bond with joints approximately 10mm wide.
- (d) When brick masonry walls cross the recessed floor cable trenches provide and install cast-in situ concrete Lintels of sufficient size and strength to support and carry masonry walls across the trench sprays.
- (e) Reinforced all masonry walls with cast-in-situ reinforced concrete formed flush with the masonry surfaces for cement plaster-finish.
- (f) Provide concrete pilasters and horizontal tie for every 9 square meters of masonry wall surface, plus at all corners and door jambs.
- (g) Size of wall
- (1) All the peripheries wall shall be constructed in 230mm thickness.
- (2) All the partition wall shall be constructed in 115mm thickness shall be constructed at less than 3.0m span only.

3.7.4 Curing

Spray masonry surfaces with water twice daily for a period of 10 days, or until the surface receives a plaster finish.

3.7.5 Protection

Where exposed to weather, protect top of masonry with water tied material in such a way that it will protect the completed work. Masonry wall shall set for 48 hours before any load is applied on the completed work.

3.8 Plaster and Punning Work

3.8.1 Plaster

3.8.1.1 Materials

Shall conform to the respective Specifications and other requirements specified below:

- (a) Sand
 - Sand shall be coarse, clean sharp sand, free from clay, loam or other impurities.
 - Sand shall be uniformly graded from coarse to fine.
- (b) Portland cement
 - Portland cement shall be as per ASTM C 150 Type I or equivalent. Only one brand of cement shall be used in the work.
- (c) Water shall be clean, fresh and free from injurious amount of oils, acids, alkalis and organic matter.

3.8.1.2 Construction

- (a) Thickness of plaster
Thickness of plaster from the face of the plaster base to the finish plaster surface shall be 2.0cm.
- (b) Preparation for plastering
Concrete surfaces shall be thoroughly cleaned and free of paint, efflorescence, oil, grease, acids, and other loose or foreign matter prior to application of base coats.
No plaster work shall be applied on masonry work less than 2 weeks old.
- (c) Mixing of plaster
Plaster shall be mixed in mechanical mixers where hand mixing is approved for small quantities. Caked, or lamed material shall not be used. Each batch shall be proportioned by volume, accurately measured by manual or mechanical devices, and thoroughly mixed with the minimum amount of water until uniform in color and consistency. Retempering will not be permitted and plaster that has begun to stiffen shall be discarded. Mortar 90 minutes after mixing shall be rejected for the plastering work.
- (d) Proportions
These are to be differentiated into 2 types:
 - (1) 1 PC : 3 sand
 - (2) 1 PC : 4 sandType (1) is to be used on all external walls, ceiling and floors.
Type (2) is to be used everywhere else.
- (e) Plastering
Plaster shall be done in two coatings, both shall be proportioned as mentioned in Article d) above but sand to be used in the finish coating shall be of the finest grade.
The first coating shall be applied with a spatter-dash, which is to be done by forcibly throwing the wet mix on the surface and making no attempt to level it.
The second coating will be applied after the first coating has hardened.
After this, a wet soaked sponge shall be rubbed on the finish surface.

3.9. Door and Window

The Contractor shall furnish and install doors and windows. The Contractor shall prepare and submit drawings of doors and windows to Owner/Engineer for approval, prior to the execution of the erection work floor level.

3.9.1. Anodized Aluminum doors and windows

The anodized sections and hardwares to be used for the fabrication of doors and windows shall be approved before fabrication from the Engineer. The section should be of uniform thickness, anodized in Bronze colour. The float glass with 5mm minimum thickness to withstand the rigidity according to the frame opening size shall be entertained as windshield. All the windows shall be of sliding type with insect protection net (Aluminum). The float glass shall be properly sealed with rubber gaskets and the sliding frames shall have suitable rubber gaskets with brush to make the doors and windows windproof as well as dust proof. Any slits between wall finish and the doors and window frame shall be sealed with silicon seal.

3.9.2 Carpentry

3.9.2.1 Materials

Lumber shall be subjected to Owner's/Engineer's approval.

- (a) Salwood
 - (1) Sized and pattern

Lumber shall be surfaced four sides, and worked according to patterns as are indicated or specified on the drawings. Exposed members for transparent finish shall be matched for compatibility of grain and color between adjoining members ; for paint finish, is not required. The size of frame of panel shall not be less than 40mm x 100mm and the size of door frame shall not be less than 75mm x 120mm.

- (2) Moisture content
At the time of delivery, the moisture content shall not exceed 15% for material of 2.5cm or less in thickness, and shall not exceed 19% for material over 2.5cm in thickness.
- (b) Teak plywood
All interior plywood for transparent finish shall be of equal and uniform of color and graining, such as for door panels. Hardwood plywood shall be of premium grade. Plywood for paint finish matching for compatibility is not required, such as for ceiling.
- (c) Veneers
Veneers on wood doors, panels and other exposed woodwork shall be 4mm thick.
- (d) Fasteners

Only galvanized fasteners will be used.
- (e) Glue
Fully waterproof throughout, such as "herein" or equal.
- (f) Putty
Shall conform to American Standards or equivalent.

3.9.2.2 Construction

- (a) Fastening for exposed members
Other than two positioning nails per sub-assembly of plywood no exposed nails shall be used. All exposed members are to glued using either pressure of electric wood welder. All traces of excess glue shall be removed. Tops shall be fastened to sub-or webframes with concealed clips, screws, glue blocks or similar bidden fastenings. Exposed ends shall be lock mitered and glued to face plates.
- (b) Edge treatment
Visible edge shall be banded with lumber edging, glued under pressure with no nails allowed. Species shall match the face veneers of plywood, but may be of any species on particle board.
- (c) Size of door
Unless and otherwise specified, the size of door panel shall not be less than 1.0 x 2.30m (W x h)

3.9.2.3 Hardware

Hardwares such as hinges, cylinder locks, handles and door closers shall be stainless steel of excellent quality. Samples of hardwares shall be submitted to Owner/Engineer for approval. Cylinder locks and door closers shall be installed with the doors and windows according to the instructions of Owner/Engineer. Master key for all locks shall be provided.

3.10 Water proofing

This section covers all the construction work for disposing the rainwater from the roof. To dispose rain water from roof there will be 10cm average thickness of 1:2:5 concrete for the slope of roof. A layer of tarfelt shall be provided as vapor barrier course between R.C.C slab and slop concrete. At top of slope concrete (after heat insulation layer) the waterproofing layer shall be self-adhesive bitumen/polyethylene (tarfelt) membrane of thickness about 1.5-2.0mm capable of bridging any shrinkage cracks in concrete.

The area to be applied must be dry and swept free from dust.

Prime all surfaces with primer and apply the membrane when the primer is tacky. All lap joints must have an overlap of 75mm rolled firmly against each other. The membrane has to turn up to the roof parapet, counter flashed by a metal sheet all in accordance to drawings and manufacturer's instructions.

The type and made of the membrane must first be submitted for approval by the Owner/Engineer.

- (a) A layer of 30mm round stone chipping of 2-5mm size shall be provided with bituminous bonding, to achieve water proofing.
- (b) 100mm dia G.I. rain water down spout pipe shall be installed at 4 corners of roof and it shall be connected to the manhole (40 x 40 x 60cm) at bottom, from each of the manhole 100mm of polyethylene pipe shall be used to connect to the switchyard drainage line.

3.11 Heat Insulation

This section covers the treatment of heat-insulation at roof.

Heat insulation layer shall be of 33mm thick expanded polystyrene sheets which shall be installed above slop concrete layer with hot bitumen setting bed.

3.12 Plumbing, Drainage and Sanitary fittings

3.12.2 General

The Contractor shall furnish, install and test the complete indoor Potable Water, service Water, Plumbing, Storm Drainage and Sanitary Sewer Systems.

All necessary incidentals such as sanitary fittings, wash bowl water closet, equipment supports, flashing, excavation and backfill, disposal of surplus dirt and rubbish, permits and inspections, insurance, taxes, expenses and materials required for complete, satisfactory and legal installation shall be borne by the Contractor.

The Contractor shall furnish satisfactorily functioning installations. All items of labor, material of equipment not specifically mentioned herein, but incidental to or required for a complete installation and proper operation of the above mentioned systems, shall be included.

The Contractor shall furnish and install 1 cubic m capacity of G.I. Water tank at roof and 1HP Centrifugal pump to fill the water in the elevated water tank and all necessary associated appurtenance.

3.12.3 Standards

The work shall be carried out in accordance with Codes National Plumbing code. S.U. Department of commerce, unless otherwise indicated.

3.12.4 Workmanship

The installation shall be made in neat, orderly and workmanship manner, conforming in every way to the accepted standards of the best commercial practice.

3.12.5 Design requirements

The plumbing and drainage of all the buildings shall be as per the National Standard Plumbing code.

For the potable and service water supply to the building, and over storage tank of 1 cubic m storage capacity will have to be provided by the Contractor. The tank will be mounted on the roof. The water distribution inside the building will be taken from this overhead tank.

The design of the plumbing system shall be developed by the Contractor. Floor drains, drain from washbasin and drain from the equipment shall be run separately from sanitary sewer and connected to the outdoor switchyard water drainage system.

Sanitary sewer drain from the building will be connected to the septic tank (1.0m x 2.5m x

1.5m) and outlet from septic tank connected to the soak pit (1.0m dia. And 3.0m deep). Overflow from the soak pit shall be connected to the switchyard drainage system.

- (a) Septic tank shall be constructed in 250mm thick stone masonry wall with 1:4 on cement concrete 1:2:4 150mm thick bed. The interior surfaces shall be cement plastered in 1:4 CM. The septic tank shall be provided with removable R.C.C. slab cover.
- (b) Soak pit shall be constructed in honey-combed stone wall of 250mm thick with 1:4 cement sand mortar covered with 100mm thick R.C.C. 1:2:4 slab.
- (c) Sewage pipe shall be heavy quality PVC and not less than 100mm dia. In size.
- (d) Drain pipe to connect drainage system from soak pit shall be used of 100mm dia. of PVC pipe of heavy quality.
- (e) All the water supply pipe shall be heavy quality of galvanized steel pipe required size.

3.13 Cable Trench

3.13.2 The detail design of the cable trench shall be the responsibility of the Contractor. All designs and detail shall be subject to approval of the Owner/Engineer.

3.13.3 Type of cable trench

Cable trench shall be reinforced concrete trench with one or more layer of hot dip galvanized light gauge shape steel tray. The cover of trench shall be min. 6mm thick checkered plate with steel frame and shall be galvanized.

3.14 Paint and glazing

3.14.2 Painting

3.14.2.1 General

All surfaces shall be painted except the following :

- (a) Exterior :
Roofing, paving, concrete, nonferrous metals, glass, pre-finished items.
- (b) Interior :
Glass, pre-finished surfaces, non-ferrous metals, stainless steel, attic surfaces.

3.14.2.2 Materials

A list of the painting materials and their colors which are to applied the specified surfaces shall be submitted to the Owner/Engineer for approval.

3.14.2.3 Paint application

The finished surface shall be free from runs, drops, ridges, waves, pales, brush marks, and variations in color, texture, and finish. The hiding shall be complete, and coat shall be so applied as to produce film of uniform thickness. Special attention shall be given to insure that all surfaces including edges, corners, crevices, welds, and rivets receive a film thickness equivalent to that of adjacent painted surfaces.

Adjacent areas and installations shall be protected by the use of drop cloths or other approved precautionary measures.

Metal or wood surface adjacent to surface to receive water-thinned paints shall be primed and/or touched up prior to the application of water-thinned paints. The first coat on plaster shall include such repeated touching up of suction spots or overall applications of primer sealer as necessary to produce a uniform color and gloss. The first coat on both faces of wood doors shall be applied at essentially the same time.

- (a) Coating progress
Sufficient time shall elapse between successive coats to permit proper drying. This

period shall be modified as necessary to suit adverse weather conditions.

Oil base or oleo resinous solvent-type paints shall be considered dry for recoating when the paint feels firm, does not deform or feel stickily under moderate pressure of the thumb, and the application of another coat of paint does not cause lifting or loss of adhesion of the undercoat.

Coating shall be as follows :

- (1) All interior and exterior plastered surfaces :
 - First coat : 1 coat of Alkali Resistance Primer
 - Second coat : 2 coat of weather shield Exterior wall finish in water proof snowcem paint
- (2) Gloss finish wood :
 - First coat : 1 coat of Wood Primer
 - Second coat : 2 coat of synthetic Super Gloss
- (3) Interior transparent finish wood :
 - First coat : 1 coat of Wood Primer
 - Second coat : 2 coat of Teak Oil
- (4) Metal surface :
 - First coat : 1 coat of Metal Primer Chromate
 - Second coat : 2 coats of Aluminum Paint
- (b) Storage, mining and thinning

At time of application, paint shall show no signs of hard settling, excessive skinning, livering, or other deterioration. Paint shall be thoroughly stirred, strained, and kept at a uniform consistency during application.

Where necessary to suit conditions of surface, temperature, weather, and method of application, paint may be thinned immediately prior to application in accordance with the manufacturer's directions, but not excess of 0.5 liter of suitable thinner per 4 liter. The use of thinner for any reason shall not relieve Contractor from obtaining complete hiding.

Samples shall be clearly identified by designated name, specification number batch number, project contract number, batch number, intended use, and quantity involved. At the discretion of the Owner/Engineer samples may be tested before approval, or materials may be approved for use based on the test reports furnished. In the latter case the samples will be retained by the Owner/Engineer for possible future testing should the materials appear to be defective during or after application.

3.14.3 Glass and glazing.

- (a) Sheet glass to be used for door and windows shall be 6mm thick, tinted glass except as otherwise specified. It shall be of the best quality, free of unevenness, stain or bubbles, and material appear to be defective during or after application.
- (b) Glazing compounds shall be of suitable type approved for the application.

The use of no-skimming compounds, non-resilient type performed sealers, and performed impregnated type gasket will not be permitted. Metal sash putty will not be permitted.

- (c) Channel glazing compound shall be equal in performance to, but not limited to the following :
 - (1) Non-drying, knife grade polybutene sealant
 - (2) One-part acrylic terpolymer sealant
- (d) Shop-painted items
Surfaces of fabricated and assembled items that are finish painted by the manufacture, or specified to finish painted under other sections of the Specifications, are exempted from the following schedule requirements for surface preparation and painting shopprimed items shall

receive surface preparation and finish painting as required by this section.

- (e) Colors and tints, including shades of stain, shall match the respective color specimens selected by the Owner/Engineer.

Stains shall conform in shade to manufacturer's standard color. Undercoat shall vary slightly from the color of the next coat.

- (f) Surface preparation and pretreatment
Cleaning and pretreatment of surface prior to painting shall be accomplished in accordance with the detailed requirements specified.

- (g) Cleaning
Clots and cotton waste that might constitute of fire hazard shall be placed in closed metal containers or destroyed at the end of each day. Upon completion of the work, staging, scaffolding, and containers shall be removed from the site or destroyed in as approved manner.

Paint spots, oil or stains upon adjacent surface shall be removed and the entire job left clean and acceptable.

3.15 Ventilation and Fans

Rooms shall be provided with ceiling fans and required ventilation through windows and doors.

3.16 Fire Fighting System

- 3.16.2 The Contractor shall supply and install all fire fighting system for control building and switchyard.

- 3.16.3 The Contractor shall supply two (2) sets of portable type 10 lb CO2 fire extinguisher for control room/switchgear room and one (1) set of wheeled cart type of 100 lb CO2 fire extinguisher for outdoor switchyard. The fitting accessories shall be provided with fire extinguisher. The extinguisher shall be specially suitable to rooms with electrical equipment.

3.17 Electrification work

- 3.17.2 Supply and fixing of all electrical work shall be performed in accordance to the Clause-13 Lighting System in Vol-II –Section I Specification of Electrical Equipment.

- 3.17.3 Payment
Payment for the contract item. Electrification work, will be made at the lump sum price bid. Therefore, in the schedule, the price shall include compensation for all costs incurred in furnishing all materials and labor and other operations related to electrification work.

3.18 Supply and installation of furniture and indoor facilities

- 3.18.1 Furniture and indoor facilities as listed below shall be supplied under the item "Supply and installation of furniture and indoor facilities as per specification". Payment for this item shall be in lump sum basis (in lot).

- | | | |
|----|--|---------|
| a) | 2'6"x4'6" office desk with three drawers made of Sisamwood | |
| | 6 line thick board with Teak ply finish | 1 No. |
| b) | Revolving office chair | 1 No. |
| c) | Sisam wood office chair with resin fabric covered | |
| | rubber foam cushion seat | 6 Nos. |
| d) | PVC molded chair | 10 Nos. |
| e) | Steel wardrobe (cabinet) Approximately 5'6" height | |
| | 3' width and 18" depth | 2 No. |
| f) | Sisamwood single bed with drawer | 1 No. |
| g) | 14" Multisystem Colour TV with antenna | 1 set. |
| h) | Analog Dial display digital clock with alarm | 2 Nos. |

3.19 Payment

Payment for contract item will be made on listed bid price of related items after the actual measurement of the quantities, therefore in the Price Schedule, item wise price shall include full compensation for all cost in furnishing all materials, equipment, labor and any other operation related item wise work.

CHAPTER 4

INSPECTION, TESTING AND COMMISSIONING

1.1 SCOPE OF WORK

The whole of the Works supplied under the Contract shall be subject to inspections and tests by the Employer or their Representatives during manufacture, erection and after completion. The inspections and tests shall include, but not be limited to, the requirements of this section of the Specifications.

The Contractor shall provide all costs, appliances, apparatus, supervision, labor and services necessary to carry out all tests, unless specifically stated otherwise.

The Contractor shall furnish the detailed schedule of his commissioning plan at least one month prior to the scheduled date. The schedule shall include the commissioning procedures, testing sequences and details of special testing equipment, tests and commissioning record formats, information about relevant standards etc.

The scope of the commissioning program includes the site testing and putting into successful operation of all the equipment supplied under the Contract, for 33kV, 11kV, AC & DC plants and all secondary voltages systems. Testing of energy meters and certification of their accuracy shall also be included.

1.2 OBJECTIVES

The objectives of commissioning work, prior to the successful energization of Plant at full voltage and connection to the system, are the following:

- Confirm the integrity (correctness) of installation.
- Confirm the integrity of insulation, connections and phasing.
- Ensure proof of equipment characteristics.
- Review workmanship.
- Confirm the correct implementation of the design.
- Check equipment ratings.
- Check settings and operation of protective relays.
- Check and measure resistivity of earthing grid and earthing system.

1.3 QUALITY ASSURANCE, INSPECTION AND TESTING

To assure that the supply and services under the scope of this Contract whether manufactured or performed within the Contractor's works or at his subcontractor's premises or at the Site or at any other place of work, are in accordance with the Specifications, the Contractor shall adopt suitable quality assurance program to control such activities at all points necessary. Such program shall be outlined by the Contractor and shall be finally accepted by the Employer after discussions before the award of the Contract. A quality assurance program of the Contractor shall generally cover, but not be limited to the following:

- (a) His organization structure for the management and implementation of the proposed quality assurance program.
- (b) Documentation control system.
- (c) Qualification data for bidder's key personnel.
- (d) The procedure for purchases of materials, parts, components, and selection of subcontractors' services including vendor analysis, source inspection, incoming raw materials inspection, and verification of materials purchases.

- (e) System for shop manufacturing including process controls and fabrication and assembly controls.
- (f) Control of non-conforming items and system for corrective actions.
- (g) Control of calibration and testing of measuring and testing equipment.
- (h) Inspection and test procedure for manufacture.
- (i) System for indication and appraisal of inspection status.
- (j) System for quality audits.
- (k) System for authorizing release of manufactured products to the Employer.
- (l) System for maintenance of records.
- (m) System for handling storage and delivery.
- (n) A quality plan detailing out the specific quality control procedure adopting for controlling the quality characteristics relevant to each item of supply.

The quality plan shall be mutually discussed and approved by the Employer after incorporating necessary corrections by the Contractor as may be required.

- Quality Assurance Documents

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

The Employer, through his duly authorized representatives, reserves the right to carry out Quality Audit and Quality Surveillance of the systems and the procedures of the Contractor's and the subcontractor's Quality Management and Control Activities.

- Inspection, Testing and Inspection Certificates

The provisions of the clauses on Test and Inspection of the General Conditions of Contract and Special Conditions of Contract shall be applicable to the supply and erection portions of the Works. The Employer shall have the right to re-inspect at his expenses, any material though it would have been previously inspected and approved by him at the Contractor's works before, and if, after the same are inspected at Site following the latter, material is found defective, then the Contractor shall bear the cost of this inspection and reinstatement according to specification.

1.4 TESTS AT MANUFACTURERS WORKS

1.4.1 General

Where no specific test is specified, then the various items of materials and equipment shall be tested in accordance with the relevant British, IEC, or American Standards. Where no appropriate standard is available, tests shall be carried out in accordance with the maker's standard practice, which shall be subject to the Employer's approval.

At least fourteen days' prior notice, in writing or by tele-fax, shall be given to the Employer of the readiness of the plant for test or inspection and every facility shall be provided by the Contractor and sub-Contractor (s) to enable the Employer or their Representative to carry out the inspections and witness the tests. This includes progress, test rig and packing inspections also.

Inspection of equipment will not be carried out unless the Employer has approved copies of the relevant sub-orders, drawings and test procedures. No equipment shall be packed, prepared for shipment, or dismantled for the purpose of packing for shipment, unless it has been satisfactorily inspected, or inspection has been waived by the Employer.

Functional electrical and mechanical tests shall be carried out on the completed plant after assembly in the Works. The extent and method of recording the results shall be agreed by the Employer in sufficient time to enable the tests to be satisfactorily witnessed or to make

any changes to the proposed program of tests. All instruments and apparatus used in the performance of the tests shall be subject to the approval of the Employer and, if required by the Employer, shall be calibrated to an agreed standard at a laboratory of national standing to be nominated by the Contractor and approved by the Employer. The costs of carrying out such calibration shall be borne by the Contractor in all cases.

The costs of making/performing any test shall be borne by the Contractor. This shall apply to tests performed at the site or elsewhere.

After receiving the prior information about the completion of manufacturing at the factory, the Employer will depute his personnel to the Contractor's factory to witness the fabrication, assembly and testing of any or all parts of major equipment. The number of the Employer's personnel and equipment to be witnessed will be as listed below. The duration of such visits shall be as per inspection/testing requirements.

- 12 kV Switchgear	1 persons, 1 visit
- 33 kV Circuit Breaker	2 person, 1 visit
- Power transformer	2 persons, 1 visit
- Control & Relay Panel	2 persons, 1 visit
- Battery and Battery Charger	2 persons, 1 visit
- Disconnecting Switch & LA	1 persons, 1 visit
- Instrument transformers	2 persons, 1 visit

1.4.2 Test Certificates

Within 30 days of the completion of any test, triplicate sets of all principal test records, test certificates and performance curves shall be supplied to the Employer.

These test records, certificates and performance curves shall be supplied for all tests, whether or not they have been witnessed by the Employer or his representative. The information given on such test certificates and curves shall be sufficient to identify the material or equipment to which the certificate refers and should also bear the Contract reference title. Specified requirements shall be shown on each certificate for comparison with actual test results.

When all equipment has been tested, test certificates of all factory and site tests shall be compiled by the Contractor into volumes and bound in an approved form complete with index. Two copies of each volume shall be supplied to the Consultant and five copies to the Employer.

1.4.3 Type Tests

Type tests are required to prove the general design of the equipment and the Contractor may submit certificates of such design tests, which have been carried out on identical equipment. Notwithstanding any provision in BS, IEC or ANSI Standards, the Employer shall have the right to accept such certificates in lieu of the specified type tests or to reject them.

The type tests prescribed shall be carried out at the Contractor's cost in all cases, where either such certificates are not available or are rejected by the Employer.

1.5 RESPONSIBILITIES

To ensure that the test jurisdiction and transfer of responsibilities is regulated by strict safety and handover procedures, the Contractor agrees the interface with the Employer to establish and implement handover procedures consistent with the terms of these Specifications.

The Employer shall retain full jurisdiction over all commissioning activities, which may affect the operation of the existing system. In these circumstances and when so requested, shall provide technical advices and assistances.

The Contractor shall be responsible for technical guidance and assistance in establishing the scope and method of tests, witnessing of the testing, assessment of results, and re-negotiation of the changes in test schedules which may be necessary as a result of other circumstances, such as delays in the delivery, possible equipment failures.

1.6 SAFETY PROCEDURES

The Contractor shall share the responsibility for safety procedures with the Employer. The Contractor shall establish and implement a work permit and tagging system and associated safety procedures (subject to the review of Employer) for all equipment, systems and areas not covered by the Employer's safety procedures.

The Employer will assume responsibility for the establishment and implementation of tagging, safety and work permit procedures for the protection of personnel and equipment, as soon as equipment and systems are connected to or are energizeable from the existing system.

1.7 TRAINING OF THE EMPLOYER'S STAFF

The Contractor shall plan for the Employer's staffs' participation, either continuously or on a regularly recurring basis, in the commissioning work and:

Allow the Employer's staffs to become familiar with the operating and maintenance aspects of the new equipment supplied by him,

Maintain a continuing assessment with the Employer of the precautions required in or possible consequences of, initial energization of equipment, Allow for the above two necessary objectives in the preparation of schedules.

The Contractor shall station at site, at least, one technical expert for a minimum of six months continuously after commissioning to rectify any problems, as well as train the Employer's attending staffs. If required, the length of his stay shall be extended as per requirement, which shall be at the Employer's discretion.

1.8 COMMISSIONING STAFF

The Contractor shall provide commissioning personnel including skilled and unskilled labor as required. Submit a list with names, experience and proposed duration of the stay of key personnel on site, consistent with the construction schedule, along with the commissioning program.

Ensure that only staffs assigned to commissioning fulfills that duty for the duration of the assignment.

Ensure that commissioning staffs have authorization, and the competence, to undertake minor repairs or to make temporary redesigns and to reconnect systems to meet the specified system performance to preclude delays in energization and putting into commercial service of any part of the works.

1.9 TEST EQUIPMENT

The Contractor shall ensure that all instruments, tools and other equipment required for testing and commissioning are available on site, ensure that the test equipment is of satisfactory quality and condition and, where necessary, is calibrated by an approved authority or standard.

Make arrangements for the provision of power supplies for testing with necessary vector configuration, voltage and current rating.

1.10 COMMISSIONING PROGRAM

Prepare a commissioning program for approval by the Employer and for incorporation into the Project master construction program. Allocate adequate time in this program to permit full commissioning of all components.

Carry out all testing during normal working hours as far as practicable. Tests, which involve existing apparatus and system outages, may be carried out outside normal working hours. Give the Employer sufficient notice to allow for the necessary outage arrangements to be made in conformity with the testing program.

Note that no tests listed in the agreed program will be waived except upon the instructions or consent of the Employer in writing.

1.10.1 Test Procedures

The following basic tests, in addition to others, shall be carried out:

- Measurement of insulation resistance.
- AC withstand voltage test

1.10.2 Requirements for Field Tests

The field tests shall be carried out in presence of Employer under the following conditions: AC withstand test voltages for conductors and outdoor equipment shall be normal operation voltage of the transmission line and, withstand voltage test shall be carried out for ten (10) minutes by the normal voltage mentioned above. The field tests shall be carried out by the Contractor after adjustment of all the equipment have been completed.

Expandable and lead wires and other materials required for the field tests shall be arranged by the Contractor. The Contractor shall be responsible for providing all measuring instruments, test equipment and tools required for the tests.

Preparation of the test record sheets and test reports shall be the responsibility of the Contractor and the results of the field tests shall be submitted by the Contractor for Employer's approval.

Measurement of insulation resistance of the equipment shall be performed by at least 1000 V megger.

After completion of the measurement of insulation resistance mentioned above, ac withstand voltage test shall be performed by the normal operation voltage of the existing power system in accordance with the following procedure:

- 11 and 33 kV Main Circuit: The 11 kV and 33 kV circuit breakers and disconnecting switches, except for circuit breakers receiving power for the test from the existing power system through a transmission line, shall be closed, succeeding, normal operation voltage shall be charged on the equipment and bus conductors for ten (10) minutes for ac withstand voltage test. The indication value of meters mounted on the board during the ac withstand voltage test shall be recorded on the test record sheets prepared by the Contractor.

Submit test procedures, consisting of detailed test methods and samples of the related test record forms, for all equipment to be tested, to the Employer for approval along with the commissioning program. Strictly adhere to these procedures for the commissioning tests.

Section VI. Employer's Requirement

1.10.3 Records

Maintain an up-to-date record of all commissioning activities on site.

Record the results of the tests clearly on forms and formats approved by the Employer and with clear references to the equipment and items tested, so that the record can be used as the basis for maintenance tests, in future. Submit the required number of site test records to the Employer as soon as possible after completion of the tests.

Record the details of the test equipment and instruments used in the test sheets, in those cases where the instrument or equipment characteristics can have a bearing on the test results.

1.10.4 "As-Built" Drawings

Keep an ongoing record of all changes on a master set of drawings. Produce and supply a minimum of five complete sets of marked-up "As Constructed/As-Built" drawings before leaving the Site. Correct and re-issue the original drawings as soon as possible as per this specification.

1.10.5 Test Methods

Carry out all necessary tests for commissioning the substations. The following clauses detail the tests which are considered to represent the minimum required in addition to those specified under the appropriate IEC Publications, other approved standards and the manufacturer's instructions for each item of equipment.

Strictly adhere to the methods of testing approved by the Employer.

A) Site and Commissioning Tests for Main and Auxiliary Equipment

General Checks:

Make a general check of all main and auxiliary equipment. Include a check of the completeness, correctness and condition of ground connections, labeling, arcing ring, paint surfaces, cables, wiring, pipe-work, valves, blanking plates and all other auxiliary and ancillary items.

Check for oil and gas leaks and that insulators are clean and free from external damage. Check that loose items, which are to be handed over to the Employer, e.g., blanking plates, tools, spares, etc. are in order and are correctly stored or handed over.

Power Transformers

Make all tests as per commissioning tests called for in the Manufacturers' instructions manual.

Record and submit to Employer in a hardcover binder, all test data obtained.

Circuit Breaker Tests

Check and set pressure switches settings when required. Also test mechanical operating systems.

Carry out contact resistance tests. In the case of multi-interrupter circuit breakers, perform resistance tests at each interrupter or pair of interrupters as well as through the series of interrupters on each pole.

Test local and remote trip/close operation and perform circuit breaker and auxiliary contact timing tests on all circuit breakers.

Control/ Relay Panels, energy meters and Switchboards

Carry out general testing and inspection, as referred to above. The Contractor shall also carry following tests: a) Carrier signal testing b) protective relay testing c) Instrument transformers testing c) Phase correcting testing. Functionally test and perform the timing tests on circuit breakers and AC and DC circuits, associated with stand-by auxiliary supplies and stand-by generating sets, particularly where automatic operation is defined.

Carry out insulation measurement tests of secondary circuits with a 1000 V DC megger before and after high voltage testing.

Check shutters, interlocking, earth procedures and the inter-changeability of components.

Carry out a high voltage 50 Hz dielectric test on each bus at 75% of the specified value for the equivalent factory test.

Disconnecting Switch and Earth Switches

Test all disconnecting switch and earth switches operationally to confirm contact pressures, contact resistance, simultaneous-operation of all phases and the ease of operation.

Check the local and remote indications and the operation of auxiliary contacts. Check the earthing mat at the operating positions and check the availability of connecting points for maintenance earthing arrangements.

Test the earth switches and maintenance earthing devices to confirm the opening and closing sequences and check the ground mat connections, indications and manual locking devices.

Lightning Arresters

Inspect and verify the condition and satisfactory mounting of the arresters and their earth connections, electrodes and operation counters. Note the counter readings.

Busbars and Connections

Test flexible busbars and connections to ensure that the correct tensions, sags and clearances will be maintained over the range of environmental conditions and loads without stress to other equipment. If dynamometers are used to check the sags and tensions, check them before and after use.

Check rigid busbars and connections to ensure that the busbars will not cause overloading of the supporting insulators under load conditions and under the range of climatic variations applicable to the Site. Ensure that expansion and contraction of the equipment is fully accommodated by flexible connections.

Test conductivity on selected connections and joints.

Perform high voltage DC tests on all HV cables and isolated phase busbars at 75% of the specified value for the equivalent factory test. Carry out with at least 1000 V DC megger the insulation measurement test, before and after high voltage tests.

Batteries and Battery Charging Equipment

Test the insulation to earth of the complete DC system. Test the batteries and chargers to confirm the charger ratings, adjustment, alarm systems and battery capacity for the specified length of time at maximum expected loading. Record the specific gravity and cell voltages of the batteries during the initial charge and when fully charged and maintain proper regular records until the battery is taken over by the Employer.

Interlocking: Check all interlocking arrangements, both electrical and mechanical.

B) Earthing System

Carry out the tests and measurements in accordance with IEEE Standard 80. Test the effectiveness of the bonding and earthing and make conductivity tests on selected joints on the main earthing system and at the connections to equipment and structures. Check the precautions taken to avoid corrosion attack on the earthing system.

Measure the resistance of the earthing system to the remote earth indicating method and equipment used. Separate test probes of minimum 300 to 600 meters length to effectively test the earthing system. Perform earthing resistance measurements with the transmission line earth wires disconnected from the grounding grid.

C) Area Lighting

Check all lighting circuits including the operation of relevant photoelectric cells and remote/local commands. Measure the lighting levels throughout the substation on horizontal surface 800 mm above ground level and on all vertical surfaces of transformers, marshaling kiosks, etc. Measure the lighting levels in the area surrounding the substation up to 20 m from the fence.

D) Particular Constraints and Special Tests

The Contractor shall be prepared to cooperate with any special tests requested by the Employer.

CHAPTER-5

TECHNICAL DATA SHEET

TECHNICAL DATA SHEET - 1
(To be completed by the Tenderer)

POWER TRANSFORMER

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
1.	Manufacturer and Country of Origin			
2.	Service		Outdoor	
3.	Type (Core or Shell)		Core	
4.	Applicable Standard		IEC60076	
5.	Number of winding per phase	No.	2	
6.	Type of cooling		ONAN/ONAF	
7.	Rating			
a)	Rated capacity - ONAN	MVA	3 & 6/8	
b)	Rated voltage - Primary - Secondary	kV	33 11	
c)	Rated frequency	Hz	50	
8.	Noise level			
a)	On ONAN rating	dB	<67	
9.	Temperature rise			
a)	Temperature rise above 40°C ambient -In oil by thermometer -In winding by resistance	deg.C deg.C	50 55	
b)	Hottest spot temperature in winding limited to	deg.C	55	
10.	Connection			
a)	High voltage		Delta	
b)	Low voltage		Star	
c)	Vector group reference in accordance with IEC 60076		Dyn 11	
11.	Taps			
a)	Type of tap changer		Off – circuit for 3 MVA On-Load circuit for 6/8 MVA	
b)	Tap steps	No.	5 for 3 MVA and 17 for 6/8 MVA	
c)	Tap range	%	+/- 5%	
12.	Guaranteed losses			
a)	No-load loss at rated voltage and frequency on maximum MVA base	kW	8 (max)	
b)	Load loss at rated current and 75°C on max.MVA base	kW	50 (max)	

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
13.	Impedance at rated current and frequency at 75°C winding temperature and normal tapping : on maximum MVA base	%	4 for 3 MVA and 7 for 6/8 MVA	
14.	Efficiency at 75°C winding Temperature at PF=0.9			
a)	At 100 % load	%		
b)	At 75 % load	%		
c)	At 50 % load	%	Above 99%	
15.	No load current in % of rated current referred to HV side & 50Hz			
a)	At 90 % rated voltage	%		
b)	At 100 % rated voltage	%	<1	
c)	At 110 % rated voltage	%		
16.	Minimum clearance in air HV/LV			
	-Between phases	mm	>450/340	
	-Between phase and ground	mm	>400/280	
17.	Insulation level			
a)	Power frequency withstand voltage (1 min. rms)			
	-Primary	kV	70	
	-Secondary	kV	28	
b)	b) Impulse withstand			
	-Primary	kV	170 (crest)	
	-Secondary	kV	75 (crest)	
18.	18. Detail of oil preservation system			
a)	a) Type of oil preservation system furnished	type	Conservator type	
b)	If conservator type, urethane air cell provided	Yes/No	Yes	
19.	Minimum pressure of pressure relief device set to operate at	kg/cm2		
20.	Details of bushings HV/LV			
a)	Manufacturer / Model No.			
b)	Type			
c)	Voltage class	kV	36/12	
d)	Creepage distance	mm	825/275	
e)	Reference standard		IEC	
f)	Dry flash over voltage	kV	70/28	
g)	Wet flash over voltage	kV	70/28	
h)	Impulse withstand voltag	kV peak	170/75	
21.	Insulating oil			
a)	Approximate volume of oil	liter		
b)	Whether first fill of oil with 5 % excess furnished	Yes/No	Yes	
22.	Bushing current transformer			

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
a)	Type			
b)	Voltage class (HV/LV)	kV/kV	33/11	
c)	c) Number of cores			
	-HV	No.	1	
	-LV	No.	1	
d)	d) Ratio			
	-HV (phase)	A		
	-LV(phase)	A		
	-LV(Neutral)	A		
e)	e) Accuracy class		5P20/ PS	
23.	Lightning arresters mounted on			
a)	HV side	Yes/No	yes	
b)	LV side	Yes/No	No	
24.	Approximate overall dimension (L * W * H)	mm		
25.	Approximate weight			
a)	Core and coils	kg		
b)	Tank and fittings	kg		
c)	Oil	kg		
d)	Total weight	kg		

Note:

1. If the values indicated by the bidder against parameters where the limits are indicated under the 'Requirement' column, do not conform to the requirements, the bid shall be considered as non-responsive.

2. Where values are not indicated, the bidder is required to indicate details that are in line with the technical specifications. If there are any deviations from technical requirements of these parameters, the bidder shall indicate the reasons for such deviations:

Signed :

As Representative for :

Address :

Date :

TECHNICAL DATA SHEET - 2
(To be completed by the Tenderer)

STATION TRANSFORMER

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
1	Manufacturer and Country of Origin			
2	Year of manufacturing experience			
3	Applicable Standard		IEC	
4	Type		Outdoor, oil immersed, core type	
5	Winding/Phase		Two/ 1 phase	
6	Cooling		ONAN	
7	Rating			
7.1	Rated KVA		50 & 100	
7.1.1	ONAN			
7.2	Rated Voltage			
7.2.1	Primary	kV	33	
7.2.2	Secondary	V	400	
7.3	Maximum Voltage			
7.3.1	Primary	kV	36	
7.3.2	Secondary	V	440	
8	Number of Phases		Three	
9	Rated Frequency	Hz	50	
10	Noise Level			
	On ONAN Rating	db	As per IEC	
11	Temperature Rise			
11.1	Temperature rise above 45 deg C ambient			
	In Oil by thermometer	deg C	50	
	In winding by resistance	deg C	55	
	Manufacturer for winding temperature indicator			
	Manufacturer for oil temperature indicator			
11.2	Hottest spot temperature in winding limited to			
12	Connection			
12.1	High Voltage		Delta	
12.2	Low Voltage		Star	
13	Vector Group		Dyn11	
14	Taps			
14.1	Type of Tap Changer		NLTC	

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
14.2	Tap Steps		2.50%	
14.3	Tap Range		+/- 10%	
14.4	No of Tap		9	
15	Cooling System			
15.1	Number connected	Nos		
15.2	Numbers standby	Nos		
15.3	Rated Voltage	Volts		
15.4	Adjustable Control Gear			
16	OLTC Gear			
	Manufacturer			
16.1	Rating			
16.1.1	Rated Voltage	Volts		
16.1.2	Rated Current	A		
16.1.3	Step Voltage	Volts		
16.1.4	Number of steps	No		
16.2	Control Suitable For			
	Remote/Local Operation	yes/no		
	Auto manual Operation	yes/no		
	Parallel Operation	yes/no		
	Master slave Operation	yes/no		
16.3	Rated Voltage of Drive Motor	V		
17	Guaranteed Losses			
17.1	No load losses at rated voltage and frequency on max MVA base			
17.2	Load losses at rated current and at 75 deg C on max MVA base			
17.3	Cooler losses for full load operation on max MVA base			
18	Impedance volt at rated current and frequency at 75 deg C winding Temp on ONAN, MVA base	%	3.00%	
18.1	Positive Sequence Impedence at name plate Normal Tap			
18.2	Positive Sequence at maximum voltage tap			
18.3	Positive Sequence at minimum voltage tap			
18.4	Zero sequence at Name plate tap			
19	Reactance at rated current and frequency at 75deg C on maximum MVA base at a nameplate tap			
20	Efficiency at 75deg C winding temperature			
20.1	At 100% Load			
20.2	At 75% Load			
20.3	At 50% load			
21	Load in Percentage of full load and Power Factor at which maximum efficiency occurs			
22	Regulation at full load and 75deg C			
22.1	At Unity Power Factor			

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
22.2	At 0.85 Power Factor Lagging			
23	No load Current in percentage of rated current referred to HV and 50 Hz			
23.1	At 90% rated voltage	A		
23.2	At 100% rated voltage	A		
23.3	At 110% rated voltage	A		
24	Clearances			
24.1	Minimum clearance in air HV/LV	mm		
24.2	Between phases	mm		
	Between phases and ground	mm		
25	Insulation level			
25.1	Power Frequency withstand voltage(1min rms)			
25.1.1	Primary	kV		
25.1.2	Secondary	kV		
25.2	Impulse withstand voltage			
25.2.1	Primary	kV peak		
25.2.2	Secondary	kV peak		
26	Details of Oil Preservation system			
26.1	Type		Conservator Type	
26.2	If conservator type, urethane air cell provided	yes/no		
26.3	Volume of conservator	cu.m		
26.4	Volume of oil between the highest and lowest levels			
27	Pressure relief device min pressure settings			
28	Details of bushing HV/LV/Neutral Manufacturer/ Type			
28.1	Voltage Class			
28.2	Creep Distance	mm		
28.3	Weight of Bushing	kg		
28.4	Standard reference			
28.5	Dry flash over voltage	kV		
28.6	Wet flash over voltage	kV		
28.7	Impulse withstand voltage	kV		
29	Insulating Oil			
29.1	Approx volume of oil	ltrs		
29.2	First filled of oil with 10% excess provided	yes/no	yes	
30	Bushing Current transformer			
30.1	Type and voltage class			
30.2	Number of cores			
	HV	Nos		
	LV	Nos		
30.3	Accuracy class and Burden			
	Accuracy			
	Burden	VA		
30.4	Max resistance of secondary winding	ohm		

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
31	OLTC control panel with AVR make			
32	Approximate overall dimension			
33	Approximate weight	kg		
33.1	Core and coil	kg		
33.2	Tank and fitting	kg		
33.3	Oil	kg		
33.4	Total weight	kg		
34	ISO 9001 holder	yes/no	yes	
35	ISO 9001 certificate submitted	yes/no	yes	
36	Type test certificate submitted	yes/no	yes	
37	User's certificate submitted	yes/no	yes	
38	Has exported to third country	yes/no	yes	
39	Delivery of equipment in Months following award of contract			

Signed :

As Representative for :

Address :

Date :

TECHNICAL DATA SHEET - 3
(To be completed by the Tenderer)

33 kV CIRCUIT BREAKERS

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
1.	Manufacturer and Country of Origin Model No.			
2.	Years of manufacturing experience			
3.	Applicable standard		IEC	
4.	Type		VCB Out door	
5.	Poles		Three pole	
6.	Pole breaking		Three	
7.	Rated Voltage			
7.1	Nominal	kV	33	
7.2	Maximum	kV	36	
8	Rated Current			
8.1	Continuous at 45 degree ambient	A	800	
8.2	rated interrupting current	kA	20	
8.3	Momentary	kA		
9.	Frequency	Hz	50	
10.	Temperature rise above 45 deg C ambient		As per IEC	
10.1	Contacts	Deg C		
10.2	Terminals	Deg C		
11.	Rated short circuit breaking current			
12	rated short circuit making current			
12.1	Peak	kA		
12.2	RMS symmetrical	kA		
13	Interrupting time at 100% capacity			
13.1	Maximum opening time	ms	60	
13.2	Total interrupting time	ms	60	
14	Closing time	ms		
15	Making time	ms		
16	Maximum current breaking capacity	A		
17	Insulation level			
17.1	Impulse withstand voltage (peak)	kV	170	
17.2	Power frequency withstand voltage	kV	70	
18	Operating mechanism			

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
18.1	Type		Spring Loaded	
18.2	Number of mechanism per breaker			
18.3	Single/Three phase autorecloser		not required	
18.4	Operating voltage of closing and tripping coil	V DC	110	
18.5	Operating voltage range			
	Closing	% of rated	85-110%	
	Tripping	voltage	70-110%	
18.6	Closing and tripping current	A		
18.7	Spring charging motor rating			
	Capacity	kW		
	Rated voltage	V	110 DC	
18.8	Time required for the motor to charge the spring completely	sec	<30	
18.9	Space heater and auxiliary equipment			
18.10	Push bottom for local operation	Yes/No	Yes	
18.11	Selection switch for local and remote control	Yes/No	Yes	
19	Operating counter provided	Yes/No	Yes	
20	Space heater provided for cubicle	Yes/No	Yes	
21	Thickness of sheet steel of cubicle	mm	2	
22	Number of auxiliary contacts	No	6NO, 6NC, 6MBB	
23	Operating duty cycle		0-0.3sec-CO-3min-CO	
24	Number of possible operation without maintenance under			
	Rated short circuit breaking current	No		
	Rated normal Current	No		
25	Porcelain Insulator			
25.1	Manufacturer			
25.2	Creepage distance	mm	900	
26	Pad locking provision for local cubicle	Yes/No	Yes	
27	Total weight of the cubicle	kg		
28	Mechanical dimension (L×W×H)			

Signed :

As Representative for :

Address :

Date :

TECHNICAL DATA SHEET - 4
(To be completed by the Tenderer)

DISCONNECTING SWITCH

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
1.	Manufacturer and Country of Origin Model No.			
2.	Years of manufacturing experience			
3.	Applicable standard		IEC	
4.	Type		3pole, single throw, outdoor, center rotating	
5.	Frequency	Hz	50	
6.	Rated Voltage			
	Nominal	kV	33	
	Maximum	kV	36	
7	Rated Current			
7.1	Continuous at 45 deg C ambient	A	800	
7.2	Short time for 3 sec at max kV	kA	20	
7.3	Peak short time current	kA		
8.	Temperature rise above 45 deg C ambient at normal rated current			
8.1	Contacts	Deg C		
8.2	Current carrying parts	Deg C		
9	Maximum current the switch can safely interrupt			
9.1	Bus/Line charging current	A		
9.2	Potential transformer magnetizing current	A		
10	Clearance			
10.1	Between live parts and ground	mm		
10.2	Between fixed contact and blade in open position	mm		
11.	Insulation level			
11.1	Impulse withstand voltage (peak)	kV		
11.2	Power frequency withstand voltage (1min,rms)	kV		
12	Main Contacts			
	Material of fixed contact		copper alloy	
	Coating of fixed contact		copper alloy	
	Material of moving contacts		copper alloy	
	Coating of moving contacts		copper alloy	
	Material of the contacts of the earthing		copper alloy	

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
	switch			
	Coating of the contacts of the earthing switch		copper alloy	
13	Material of Terminals			
13.1	Coating of terminals			
14	Operating mechanism		manual operation	
15	Auxiliary Contacts			
15.1	Type	Convertible or fixed	Convertible	
15.2	Continuous current at 110V DC	A		
15.3	Material		Copper	
15.4	Contacts silver plated	Yes/No	Yes	
16	No. of operation switch can withstand without deterioration of contact	No		
17	Type of interlock furnished		Electrical and mechanical	
18	Are the disconnecter and the earthing switch mechanically interlocked to each other	Yes	Yes	
19	Insulator			
19.1	Manufacturer			
19.2	Type			
19.3	Ref Standard			
19.4	No of units per stack			
19.5	Power frequency withstand voltage			
	Dry	kV		
	Wet	kV		
19.6	Impulse withstand voltage (1min)			
19.7	Creepage distance in Air	mm		
19.8	Tensile strength			
19.9	Cantilever strength			
19.10	Compression strength			
19.11	Torsional strength			
20	Enclosure Protection		IP-55w	
21	Operating mechanism		manual gang operated	
22	Type of interlock furnished		Manual	
23	Weight of Isolator	kg		
24	ISO 9001 holder	yes/no	yes	
25	ISO 9001 certificate submitted	yes/no	yes	
26	Type test certificate submitted	yes/no	yes	

Signed :
As Representative for :
Address :
Date :

TECHNICAL DATA SHEET - 5
(To be completed by the Tenderer)

CURRENT TRANSFORMER

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
1.	Manufacturer and Country of Origin Model No.			
2.	Years of manufacturing experience	Years		
3.	Applicable standard		IEC	
4.	Type		One phase outdoor, oil immersed	
5.	Number of phases	Nos	1	
6	Number of core in each CT	Nos	1	
7.	Frequency	Hz	50	
8.	Rated Voltage			
8.1	Nominal	kV	33	
8.2	Maximum	kV	36	
9.	Temperature rise above 45 deg C ambient at normal rated current	deg C		
10	Insulation level			
10.1	Impulse withstand voltage	kV	170	
10.2	Power frequency withstand voltage (1min rms)	kV	75	
11	Creepage distance	mm		
12	Short time thermal rating	kA	25	
13	Current ratings	A		
14	Rated VA burden	VA	50	
15	Accuracy class		5p20 for protection and 0.5 for metering	
16	Rated thermal VA burden	VA		
17	Over load factor	%	200	
18	Dimension	cu mm		
19	Weight	kg		

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
20	ISO 9001 holder	Yes/No	Yes	
21	ISO 9001 certificate submitted	Yes/No	Yes	
22	Type test certificate submitted	Yes/No	Yes	

Signed :
As Representative for :
Address :
Date :

TECHNICAL DATA SHEET - 6
(To be completed by the Tenderer)

POTENTIAL TRANSFORMER

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
1	Manufacturer and Country of Origin			
	Model No.			
2	Year of manufacturing experience	Years		
3	Applicable Standards		IEC	
4	Type		outdoor, oil immersed	
5	Number of phases	No	1	
6	Frequency	Hz	50	
7	Rated primary voltage			
7.1	Nominal	kV	$33\sqrt{3}$	
7.2	Maximum	kV	$36\sqrt{3}$	
8	Temperature rise above 45 deg C ambient at normal rated current			
8.1	with 1.1 times rated primary voltage continuously	deg C		
8.2	with 1.5 times rated voltage for 30 seconds	deg C		
9	Insulation levels			
9.1	Impulse withstand voltage (peak)	kV	170	
9.2	Power frequency withstand voltage (1min rms)	kV	75	
10	Creepage distance	mm	825	
11	Open circuit intermediate voltage	V		
12	Ratings			
12.1	Voltage ratio	kV	$33\sqrt{3}:0.11\sqrt{3}$	
12.2	Rated burden	VA	100	
12.3	Accuracy class		5p and 0.5	
12.4	Over voltage factor			
12.4.1	30 seconds		1.1	
12.4.2	Continuous		1.5	
12.5	Connection			
12.6	Secondary fuse			
	Manufacturer			
	Amp. Ratings	A		
12.7	By pass device for protection provided	Yes/No	Yes	
12.8	Knife switch and fuse on secondary provided	Yes/No	Yes	

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
13.	No of secondary windings	No	2	
14.	Dimension	M		
15.	Weight	kg		
16.	ISO 9001 holder	Yes/No	Yes	
17.	ISO 9001 certificate submitted	Yes/No	Yes	
18.	Type test certificate submitted	Yes/No	Yes	

Signed :
As Representative for :
Address :
Date :

TECHNICAL DATA SHEET - 7
(To be completed by the Tenderer)

LIGHTNING ARRESTOR

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
1	Manufacturer and Country of Origin			
	Model No.			
2	Year of manufacturing experience	Years		
3	Applicable Standards		IEC	
4	Type		outdoor, gapless, zincoxide	
5	Voltage rating of LA	kV	30	
6	Nominal Discharge Current	kA	10	
7	Surge counter with insulating base furnished	yes/no	yes	
8	Minimum power frequency spark over voltage	kV		
9	Maximum 1/50 impulse spark over voltage	kV		
10	Maximum front wave spark over voltage	kV		
11	Maximum switch surge spark over voltage	kV		
12	Number of section per pole			
13	Insulation level			
13.1	Impulse withstand voltage (peak)	kV	170	
13.2	Power frequency withstand voltage (1min rms)	kV	75	
14	Creepage distance	mm	825	
15	Earth terminal and accessories provided	Yes/No	Yes	
16	Surge counter	Yes/No	Yes	
17.	ISO 9001 holder	Yes/No	Yes	
18.	ISO 9001 certificate submitted	Yes/No	Yes	
19.	Type test certificate submitted	Yes/No	Yes	

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TECHNICAL DATA SHEET - 8
(To be completed by the Tenderer)

33kV CONTROL AND RELAY PANEL

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
1	Control and relay panel type			
1.1	Manufacturer and Country of origin			
1.2	Year of manufacturing experience	Years		
2	Control switches			
2.1	Manufacturer and Country of origin			
2.2	Type			
2.3	Current Rating	A		
2.4	Catalog Furnished	yes/no	yes	
3	Push Bottom			
3.1	Manufacturer and Country of origin			
3.2	Type			
3.3	Contact rating continuous	Amp		
	Making current	Amp		
	Breaking current	Amp		
3.4	Catalog Furnished	yes/no	yes	
4	Indicating Lamps			
4.1	Manufacturer			
4.2	Voltage ratings	V		
4.3	Wattage	W		
5	Indicating instruments			
5.1	Ammeter		digital	
	Manufacturer and Country of origin			
	Type			
	Current Range (300-200-100/5 Amp CT operated)	A		
	Accuracy Class		0.5	
	Scale			
	Type of scale			
	Range of indication (300-200-100/1 Amp CT operated)	A	0-100 0-200 0-300	
	Lineal/ non linear			
	Overloaded range	%	1.5	
	VA burden			
	Catalog furnished	yes/no	yes	
	Transducer operated	yes/no		
6	Voltmeter			
	Manufacturer and Country of origin			
	Type		static	
	Accuracy class		0.5	
	Scale			
	Range of indication	kV	0-36	
	Linear/non linear			
	Over scale range	%	1.1	
	VA burden			

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
	Catalog furnished	yes/no	yes	
	Transducer operated	yes/no	yes	
7	Apparent power meter (kVA)			
	Manufacturer and Country of origin			
	Type		digital	
	Rated voltage	kV	$33\sqrt{3}:0.11\sqrt{3}$	
	Rated current	A	300-200-100/5	
	Current range (Transducer operated)	mA		
	Accuracy class		0.5	
	Scale			
	Type of scale			
	Range of indication		0-10	
	Linear/non linear			
	VA burden			
	Current coil			
	Voltage coil			
	Catalog furnished	yes/no	yes	
	Transducer operated	yes/no	yes	
8	KWH Meter		NEA shall provide	
	Manufacturer and Country of origin			
	Type		TOD (static)	
	Applicable standard		IEC	
	Accuracy class		0.2	
	Import Export meter provided	yes/no	yes	
	Rated voltage	kV	$33\sqrt{3}:0.11\sqrt{3}$	
	Rated current	A	300-200-100/1	
	VA burden			
	Current coil			
	Voltage coil			
	Impulse contact provided 1pulse 100kW	yes/no	yes	
	Reverse rotation locking mechanism provided	yes/no	yes	
9	Power factor meter			
	Manufacturer and Country of origin			
	Type		digital	
	Accuracy class		0.5	
10	Annunciators			
	Manufacturer and Country of origin			
	Type			
	Manufacturer's type designation			
	Catalog furnished	yes/no	yes	
	Number of inputs (annunciator/event)			
	Number of active points	nos	24	
	Number of rows		4	
	Number of column		6	
	Type of mounting		Flush	
	Replacement of individual inscription plates and lamps from front panel possible	yes/no	yes	
	Sequence of operation as per specification	yes/no	yes	

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
11	Protective Relays			
11.1	Phase Over Current Relay			
	Manufacturer and Country of origin			
	Type		static Non directional	
	Manufacturer's type designation			
	Applicable standards		IEC	
	Triple pole or single pole		Single*3	
	Current setting range	% of rated current	20-200%	
	Operating time at 10 times current settings	msec	3	
	Reset time		ms	
	Characteristics		IDMT (Standard inverse)	
	Instantaneous unit provided	yes/no	yes	
	Current setting range	% of rated current	500-2000%	
	Operating range			
	NO Contacts			
	Insulation test as per IEC	yes/ no	yes	
	Indication			
	Hand reset flags provided	yes/no	yes	
	Light emitting diode provided	yes/no	yes	
	Auxiliary DC supply	V	110	
	Technical Literature submitted	yes/no	yes	
	Test Certificate submitted	yes/no	yes	
11.2	Earth fault relay			
	Manufacturer and Country of origin			
	Type		static/non directional	
	Manufacturer's type designation			
	Applicable standard		IEC	
	Triple pole or single pole		Single	
	Continuous overload capacity		xIn	
	Current setting range	% of rated current	10-80%	
	operating time at 10 times current setting	msec	3	
	Characteristics		IDMT (Standard inverse)	
	Instantaneous unit provided	yes/no	yes	
	Current setting range	% of rated current	500-2000%	
	Operating range			
	NO Contacts			
	Insulation test as per IEC	yes/ no	yes	
	Indication			
	Hand reset flags provided	yes/no	yes	
	Light emitting diode provided	yes/no	yes	
	Auxiliary DC supply	V	110	
	Technical Literature submitted	yes/no	yes	
	Test certificate submitted	yes/no	yes	
11.3	Directional Over current Relay		not required	
	Manufacturer and Country of origin			
	Type		static/ directional	
	Manufacturer's type designation			
	Applicable standard		IEC	
	Triple pole or single pole		Single*3	

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
	Current setting range	% of rated current	50-200%	
	operating time at 10 times current setting	sec	3	
	Reset time		ms	
	Characteristics		IDMT (Standard inverse)	
	Instantaneous unit provided	yes/no	yes	
	Current setting range	% of rated current	200-1600%	
	Operating range			
	Insulation test as per IEC	yes/ no	yes	
	Indication			
	Hand reset flags provided	yes/no	yes	
	Light emitting diode provided	yes/no	yes	
	Auxiliary DC supply	V	110	
	Technical Literature submitted	yes/no	yes	
	Test certificate submitted	yes/no	yes	
11.4	Directional Earth Fault Relay			
	Manufacturer and Country of origin			
	Type		static/ directional	
	Manufacturer's type designation			
	Applicable standard		IEC	
	Triple pole or single pole		Single	
	Continuous overload capacity	xIn		
	Current setting range	% of rated current	10-80%	
	operating time at 10 times current setting	sec	3	
	Characteristics		IDMT (Standard inverse)	
	Instantaneous unit provided	yes/no	yes	
	Current setting range	% of rated current	200-1600%	
	Operating range			
	Insulation test as per IEC	yes/ no	yes	
	Indication			
	Hand reset flags provided	yes/no	yes	
	Light emitting diode provided	yes/no	yes	
	Auxiliary DC supply	V	110	
	Technical Literature submitted	yes/no	yes	
	Test certificate submitted	yes/no	yes	
11.5	Differential Relay			
	Manufacturer and Country of origin			
	Standard reference			
	Type			
	Voltage rating	V	110	
	Type of Mounting	Flush		
	Operating time setting	ms	<30	
	Sensitivity setting		20-50%xIn	
	Bias setting			
	CT ratio Compensating range			
	Burden for Current Circuit	VA		
	DC Burden	VA		
	Tripping	A		
	Making Current	A		
	Closing load (At 110V DC)	A		
	Ambient Temperature Range	Deg C		
	Auxiliary DC supply	V	110	
	Technical Literature submitted	yes/no	yes	
	Test certificate submitted	yes/no	yes	

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
11.6	Auxiliary Tripping and Lockout Relay			
	Manufacturer and Country of origin			
	Type			
	Manufacturer's type designation			
	Applicable standard		IEC	
	Operating Time	ms	<15	
	Does the lockout relay reset by the manually operated or electrically operated reset device			
	Is the cut off contact provided to interrupt the operating coil	yes/no	yes	
	Contact rating at 125V DC	A		
	Auxiliary DC supply	V	110	
	Technical Literature submitted	yes/no	yes	
	Test certificate submitted	yes/no	yes	
11.7	Break Fail Lockout Relay, 86K			
	DC Voltage Rating	V	110	
	Nos of electrically separate NO and NC Contacts			
11.8	Break Failure Lockout Relay BF			
	DC Voltage Rating	V	110	
	Nos of electrically separate NO and NC Contacts			
	Technical Literature submitted	yes/no	yes	
	Test certificate submitted	yes/no	yes	
12	Construction of Control and Relay Panel			
	Type	Simplex		
	Manufacturer's type designation			
	Applicable Standard			
	Control panel furnished as per specification	yes/no	yes	
	Enclosure protection calss	IP	IP54	
	Thickness of sheet metal used			
	Front and rear portion	mm	>3	
	Side top and bottom cover	mm	>2	
	All instruments, meters, relays and control switches flush or semi flush type		flush	
	Ground Bus			
	Material		copper	
	Size		mm x mm	
	Internal Wiring			
	Type of Insulation			
	Voltage Grade of Wires	V	600	
	Cross Section of Wires	sq.mm	2.5 min	
	Current Circuit			
	Voltage and auxiliary circuit			
	Over all dimension of control board		cu mm	
	Shipping data			
	Size of large package		mm×mm×mm	
	Weight of heaviest package		kg	

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TECHNICAL DATA SHEET - 9
(To be completed by the Tenderer)

DISTRIBUTION BOARD

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
1	Construction of AC DB			
	Type		Simplex/Duplex	
	Manufacturer's Type designation			
	Applicable Standard			
	Control Panel furnished as per specification	yes/no	yes	
	Enclosure Protection Class	IP	IP54	
	Thickness of sheet metal used	mm	>2	
	All instruments, meters, relays and control switches flush or semi flush		Flush	
	Bus			
	Material		copper	
	Size	mm×mm		
	Rating	A	400A	
	Instruments/Equipments mounted			
	Voltmeter	V	0-120V	
	Ammeter	A	0-200A	
	Control switches			
	MCCB			
	Type		DP	
	Manufacturer			
	Current rating	A	400A	
	Internal wiring			
	Type of insulation			
	Voltage grade of wires	V	600	
	Cross section of wires		sq.mm	
	Current circuit			
	Voltage &auxiliary circuit			
	Number of feeders	Nos		
	MCB used	yes/no	yes	
	Type	SP/DP	SP/DP	
	Ratings	A		
	Overall Dimension	mm×mm×mm		
	Shipping data			
	Size of large package			
	Weight of the heaviest package	kg		
	Delivery of equipment in months following award of contract	months		
	Technical literature/ drawings submitted	yes/no	Yes	

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TECHNICAL DATA SHEET - 10
(To be completed by the Tenderer)

CONTROL CABLE

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
1	Manufacturer and country of origin			
2	Manufacturer's type designation			
3	Type			
4	Applicable Standards	IEC		
5	Voltage ratings			
	Suitable for max. system voltage	V	1000	
	Voltage grade of the cables	V	600	
	Rated voltage between each conductor and screen	V		
	Rated voltage between two conductors	V		
6	Conductor material		copper	
7	Conductor			
	Cross section of wires	sq.mm		
	Nos & dia of each core in cable			
	Overall jacket of thickness			
8	Insulating material	Polyethylene		
9	Overall jacket material	PVC		
10	Net weight of the cable	kg/m		
11	Standard drum length	m		
12	Continuous current at 45 deg C			
	in ground			
	in duct			
13	Electrical parameters			
	Resistance	ohm		
	Reactance	ohm		
14	Technical literature submitted	yes/no	yes	
15	Type test certificate submitted	yes/no	yes	
16	Delivery of equipment in months following award of contract	months		

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Address :
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TECHNICAL DATA SHEET - 11
(To be completed by the Tenderer)

LV POWER CABLE

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
1	Manufacturer and country of origin			
2	Manufacturer's type designation			
3	Type			
4	Applicable Standards		IEC	
5	Voltage ratings			
	Suitable for max. system voltage	V	1000	
	Voltage grade of the cables	V	600	
	Rated voltage between each conductor and screen	V		
	Type of system earthing		Solidly grounded	
6	Conductor material		copper	
	Cross section of wires	sq.mm		
	Nos & dia of wires of each conductor			
	Insulating material and thickness		Polyethylene	
	Overall jacket material/thickness		PVc	
	Overall cable diameter			
7	Continuous current			
	in ground	A		
	in duct	A		
8	Electrical parameters			
	Resistance	ohm		
	Reactance	ohm		
9	net weight of the cable	kg/m		
10	Technical literature submitted	yes/no	yes	
11	Type test certificate submitted	yes/no	yes	
12	Delivery of equipment in months following award of contract	months		

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TECHNICAL DATA SHEET - 12
(To be completed by the Tenderer)

HV XLPE POWER CABLE

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
1	Manufacturer and country of origin			
2	Manufacturer's type designation			
3	Type			
4	Applicable Standards		IEC	
5	Voltage ratings			
	Suitable for max. system voltage	kV	12	
	Rated voltage between each conductor and screen	kV	12	
	Type of system earthing		Solidly grounded	
6	Conductor material		aluminium	
	Cross section of wires	sq.mm		
	Nos & dia of wires of each conductor			
	Insulating material and thickness		XL Polyethylene	
	Overall jacket material/thickness		PVC	
	Overall cable diameter			
7	Continuous current	mm		
	in ground	A		
	in duct	A		
8	Electrical parameters			
	Resistance	ohm		
	Reactance	ohm		
9	net weight of the cable	kg/m		
10	Technical literature submitted	yes/no	yes	
11	Type test certificate submitted	yes/no	yes	
12	Delivery of equipment in months following award of contract	months		

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TECHNICAL DATA SHEET - 13
(To be completed by the Tenderer)

GROUNDING SYSTEM

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
1	Main ground grid conductor material		copper	
2	Main ground grid conductor size	sq.mm		
3	Depth of buried main ground conductor			
4	Material of riser		copper	
	Crosssection of riser conductor	sq.mm	100	
5	Type of joint above and below ground level			
6	Ground electrode			
	Material		copper clad steel	
	Diameter	mm	16	
	Length	m	as per IEEE80	
7	Fench grounding included			
8	Cross section of conductor rise for fench ground	sq.mm		
9	Fench seperately grounded by electrode	yes/no	yes	
10	Calculation for grounding grid length and conductor size furnished	yes/no	yes	
11	Earthing system designed for	ohm	<1	

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TECHNICAL DATA SHEET - 14
(To be completed by the Tenderer)

MISCELLANEOUS MATERIALS

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
A	Strain bus and fittings			
1	Manufacturer and country of origin			
2	Nominal sectional area			
3	Nos and Size of wires			
	Aluminum			
	Steel			
4	Overall diameter	mm×mm×mm		
	Steel core			
	Complete conductor			
5	Continuous current at 45 deg C	A		
6	Ultimate tensile strength			
7	Short circuit current 1 sec			
8	Resistance	ohm		
9	Weight	kg		
B	Fittings			
1	Manufacturer and country of origin			
2	Material			
C	Suspension and tension insulators			
1	Manufacturer and country of origin			
2	Manufacturer's type designation			
3	Applicable standard			
4	Size			
	Diameter	mm	254	
	Height	mm	146	
5	No of units per string	No	11	
6	Combined electrical and mechanical failing load	kg	12000	
7	Creepage distance per unit	mm	292	
8	Impulse withstand voltage	kV	120	
9	Dry power frequency withstand voltage	kV	78	
10	Wet power frequency withstand test	kv	45	
11	Puncture voltage	kV	120	
12	Technical literature submitted	yes/no	yes	
13	Type test certificate submitted	yes/no	yes	
D	Post insulator			
1	Manufacturer and country of origin			
2	Manufactures' type designation			
3	Applicable standard			
4	Rated system voltage	kV	132	
5	Maximum rated voltage	kV	145	
6	Unit size (Diameter)	mm		
7	Unit size (length)	mm		
8	Creepage distance	mm	>3300	
9	Insulation level			
	Impulse withstand voltage	kV	124	
	Power frequency withstand voltage (1	kv	42	

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
	min rms)			
10	Failing load (bending)	kg		
11	Failing load (torsion)	kg-m		
12	Technical literature submitted	yes/no	yes	
13	Type test certificate submitted	yes/no	yes	
E	ACSR Conductor			
1	Manufacturer and country of origin			
2	Manufacturer's type designation			
3	Applicable standard			
4	Unit size(dia x no of strands)			
5	Overall cross sectional area			
6	Technical literature submitted	yes/no	yes	
7	Type test certificate submitted	yes/no	yes	
F	Earth Wires			
1	Manufacturer and country of origin			
2	Manufacturer's type designation			
3	Applicable standard			
4	Unit size(dia x no of strands)			
5	Overall cross sectional area			
6	Technical literature submitted	yes/no	yes	
7	Type test certificate submitted	yes/no	yes	

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TECHNICAL DATA SHEET - 15
 (To be completed by the Tenderer)

WALL MOUNTED SPLIT TYPE AIR CONDITIONER

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
1	Manufacturer/Type			
2	Standard Reference			
3	Voltage ratings	V	230	
4	Frequency	Hz	50	
5	Power Consumption	kw		
6	Cooling capacity/Heating capacity	BTU/hr		
7	Compressor Type	Rotary/ recepccating		
8	Fan speed steps	3		
9	Air Swing	yes/no	yes	
10	Air filter make/type			
11	Refrigerant type	R410A		
12	mode of operation			

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TECHNICAL DATA SHEET - 16
(To be completed by the Tenderer)

12KV VACUUM CIRCUIT BREAKER

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
1	Manufacturer and country of origin			
2	Year of manufacturing experience			
3	Manufacturer's designation as per submitted catalogue			
4	Applicable standard	IEC		
5	Type	3 Phase , Indoor		
6	Rated Voltage			
6.1	Nominal	kV	11	
6.2	Maximum	kV	12	
7	Rated Current			
7.1	Continuous at 45 degree ambient			
	incomer	A	1200	
	outgoing	A	630	
	Trunking chamber	A	2000	
	Bulbar	A	2000	
	Bus bar	A	1200	
7.2	Short time for 1 sec at max. kV	kA	25	
	Momentary	kV		
8	Frequency	Hz	50	
9	Rated short circuit breaking current	kA		
10				
10.1	Peak	kA	63	
10.2	RMS Symmetrical	kA		
11	Interrupting time at 100% capacity			
11.1	Maximum Opening time	ms		
11.2	Total interrupting time	ms	60	
12	Closing time	ms		
13	Make time	ms	120	
14	Maximum capacitive current breaking capacity (rms)	A		
15	Insulation level			
15.1	Impulse withstand voltage (peak)	kV	75	
15.2	Power frequency withstand voltage	kV	28	

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
16	Vacuum chamber			
	Make time			
	Rating	A		
17	Operating mechanism			
17.1	Type	Spring Operated		
17.2	Operating voltage of closing and tripping coil	V DC	110	
17.3	Operating voltage range			
	Closing time	% of rated	85-110%	
	Tripping	voltage	70-110%	
17.4	Closing and tripping current	A		
17.5	Spring charging motor rating			
	Capacity	kW		
	Rated voltage	V	400	
	Frequency	Hz	50	
	Phase	No	3 Phase	
17.6	Time required by motor to charge the spring completely	sec		
17.7	Push bottom for local/ remote control	Yes/No	yes	
17.8	Selection switch for local/remote control	Yes/No	yes	
18	Current transformer			
	Nos of core (incoming and outgoing)		2 and 2	
	Ratio/class/burden		200-400/1A	
	and 300-600/1A			
	Metering		5P20,30VA	
	Protection		0.5,30VA	
	Differential			
18.2	For outgoing			
	Nos of core		2	
	Ratio/class/burden		100-200/1A	
	Metering		5P10,30VA	
	Protection		0.5,30VA	
19	Indicating Instruments			
19.1	Ammeter			
i	Manufacturer and country of origin			
ii	Type		digital	
iii	Current range (300-200-100/1 Amp CT operated)			
iv	Accuracy class		0.5	
v	Scale			
	Range of indication (300-200-100/1A CT operated)	A		
	Linear/Nonlinear			
	Overload range	%	1.5	
vi	VA Burden	VA	30	
	Is manufacturer ISO holder	yes/no	yes	
19.2	Voltmeter			
i	Manufacturer and country of origin			
ii	Type		digital	
iii	Accuracy class		0.5	
iv	Scale			

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
	Range of indication	kv	0-15	
v	VA Burden			
	Is manufacturer ISO holder	yes/no	yes	
19.3	Apparent Power meter			
i	Manufacturer and country of origin			
	Type			
	Rated voltage	kV	$11\sqrt{3}:0.11\sqrt{3}$	
	Rated Current	A	300-200-100/1	
	Accuracy class		0.5	
	Range of indication	MVA	0-15 or 10	
	VA burden			
	Current coil			
	Voltage coil	VA		
	Is manufacturer ISO holder	yes/no	yes	
19.4	KWh Meter			
i	Manufacturer and country of origin			
ii	Type		static 3-phase, 4 wire	
iii	Accuracy class		0.2/0.5	
iv	Rated voltage	kV	$11\sqrt{3}:0.11\sqrt{3}$	
v	Rated Current	A	300-200-100/1	
vi	VA burden			
	Current coil			
	Voltage coil	VA		
vii	Reverse rotation locking mechanism provided	Yes/No	yes	
	Is manufacturer ISO holder	Yes/No	yes	
19.5	Annunciators			
	Manufacturer and country of origin			
	Type			
	Number of active points	No	4	
	Type of mounting		Flush	
	Replacement of individual inscription plates and lamps from front panel possible	yes/no	yes	
	Sequence of operation as per specification	yes/no	yes	
20	Protective Relay			
20.1	Over current relay			
iv	Manufacturer and country of origin			
ii	Type		static Nondirectional	
iii	Manufacturer's type designation			
iv	Applicable standard			
v	No of poles		three	
vi	current setting range	% of rated current sec	20-200%	
vii	Operating time at 10 times current setting		3	
viii	Reset time	ms		
ix	Characteristics		IDMT (standard inverse)	
x	Instantaneous unit provided	Yes/No	yes	
	Current setting range	% of rated current		

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
	Operating range			
	NO Contacts			
xi	Insulation test according to IEC	yes/no	yes	
xii	Indication			
	Hand reset flags provided	yes/no	yes	
	Light emitting diode provided	yes/no	yes	
xiii	Auxiliary DC supply	V	110	
xiv	Technical literature provided	Yes/No	yes	
20.2	Earth fault relay			
i	Manufacturer and country of origin			
ii	Type		Static/ non directional	
iii	Applicable standard		IEC	
iv	Continuous overload capacity	xIn		
v	Current setting range	% of In sec	10-80%	
vi	Operating time at 10 times current setting		3	
vii	Characteristics		IDMT (standard inverse)	
viii	Instantaneous unit provided	Yes/No	yes	
	Current setting range	% of In	200-1600%	
	Operating range			
	NO Contacts			
ix	Insulation test according to IEC	Yes/No	yes	
x	Indication			
	Hand reset flags provided	yes/no	yes	
	Light emitting diode provided	yes/no	yes	
xi	Auxiliary DC supply	V	110	
xii	Is Manufacturer ISO 9001 holder?		yes	
xiii	Technical literature submitted		yes	
xiv	Type test certificate submitted		yes	
20.3	Auxiliary Tripping and Lockout Relay			
i	Manufacturer and country of origin			
ii	Type			
iii	Manufacturer's type designation			
iv	Applicable standard			
v	Operating time	ms	<15	
vi	Contact rating at 125V Dc	A		
21	Earthing switch			
	Type		Integrated	
	rating			
	interlocking	yes/no	yes	
22	Surge Arrestor			
	Type		Zno	
	Rating	kA	9kV, 10kA	
23	Space heater provided for cubicle		yes/rating	
24	Operating duty cycle		0-0.3sec-co-3min-co	
25	Number of possible operation without maintenance under:			

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
	Rated short circuit braking current	No	100	
	Rated normal current	No	10000	
26	Clearances			
26.1	Phase to phase	mm	127	
26.2	Phase to earth	mm	76.2	
27	Padlocking provision for cubicle	Yes/No	yes	
28	Total weight of the circuit breaker	kg		
29	Mechanical Dimension (LXWXH)	mm×mm×mm		
30	Delivery of equipment in months following award of contract (Allowing time for approval of drawing)			
31	Type test certificate submitted	yes/no	yes	
	Has manufacturer exported units	yes/no	yes	
	Technical literature submitted	yes/no	yes	

Signed :

As Representative for :

Address :

Date :

TECHNICAL DATA SHEET - 17
(To be completed by the Tenderer)

BATTERY AND BATTERY CHARGER

S.No.	Description	Unit	NEA Requirement	To be filled by Bidder
A	Battery			
1	Manufacturer			
2	Type of battery			
3	Number of Cells			
4	Voltage Rating	V	110	
5	Ten (10) hours rating at 5 deg. C	AH		
6	Ten (10) hours rating at standard temperature	AH/deg.C	240	
7	One (1) minute rating	A		
8	Sealed jar construction	Yes/No		
9	Type of Plates			
a.	Positive (Plants or tubular)			
b.	Negative			
10	Type of rack		Furnished	
11	Number of Rack section			
12	Recommended specific gravity of electrolyte at the end of full charge			
13	Float Charging Voltage	V		
14	Equalizing Charging voltage	V		
15	Boost Charging voltage	V		
16	Internal resistance of one cell	Ohms		
17	Short Circuit	A		
18	Float Charging current	A		
19	charging current of a fully discharged battery at 8 hour charging rate			
20	End Voltage of each cell	Volts		
21	Rack interconnection furnished?	Yes/No		
22	list of accessories			
B.	Charger			
1	Manufacturer			
2	Type of charger-constant voltage	Yes/No		
3	Number of charger			
4	Battery charger output rating	A		
5	5 10% excess capacity provided	Yes/No		
6	Battery charger current	A		
7	DC constant load considered	A		
8	time required to fully charge battery under equalizing/boost charging	Minutes/Minutes		
9	Range of DC voltage variation	kVA		
10	Maximum AC input	kVA		
11	Ripple	%		
12	Efficiency of charger at 100% output	%		
13	Voltage Regulation	%		
14	Delivery of equipment in months following award of contract (Allowing time for approval of Drawing)			

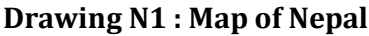
Signed :
 As Representative for :
 Address :
 Date :

Chapter 6

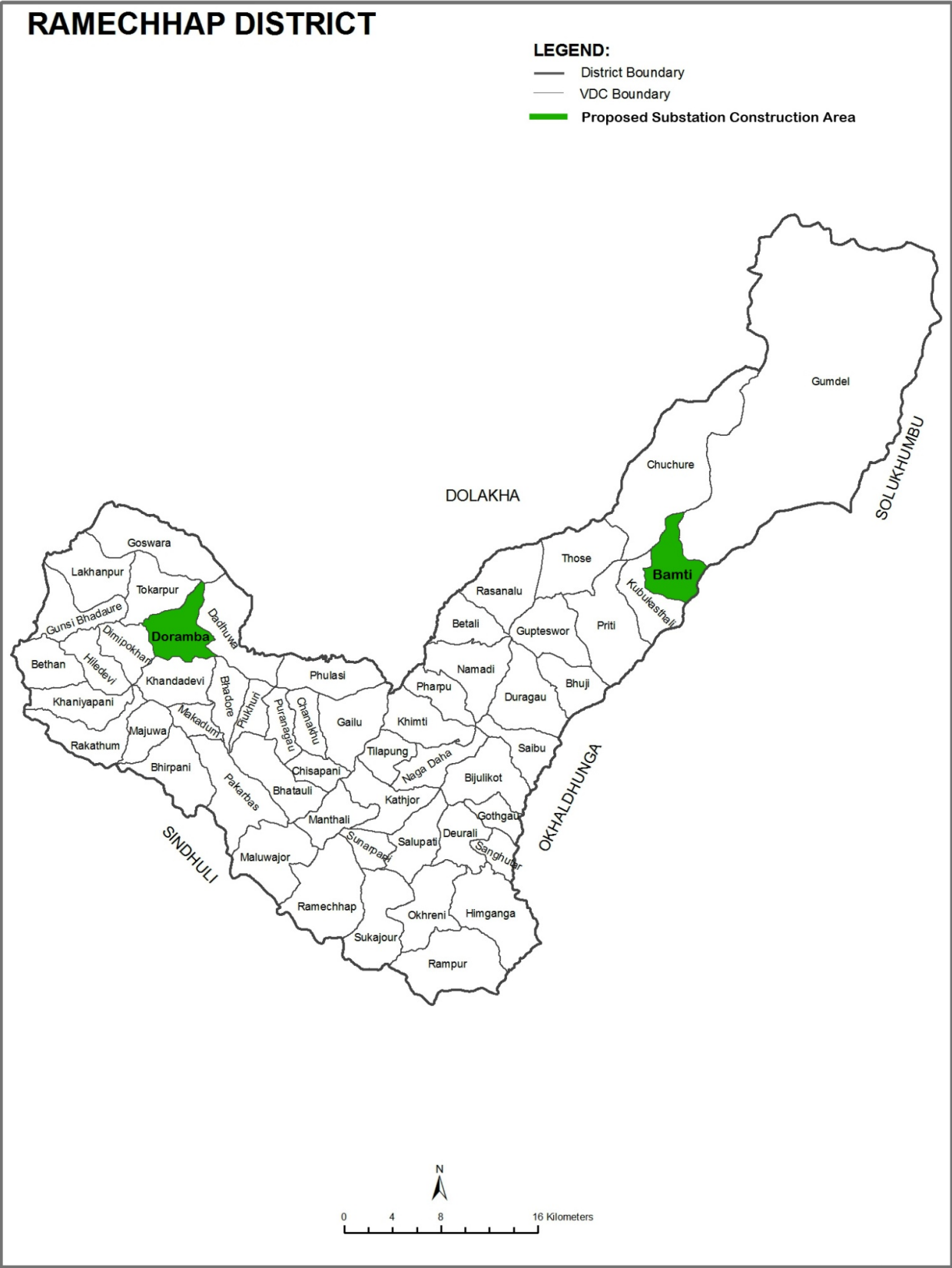
Drawings for Substations

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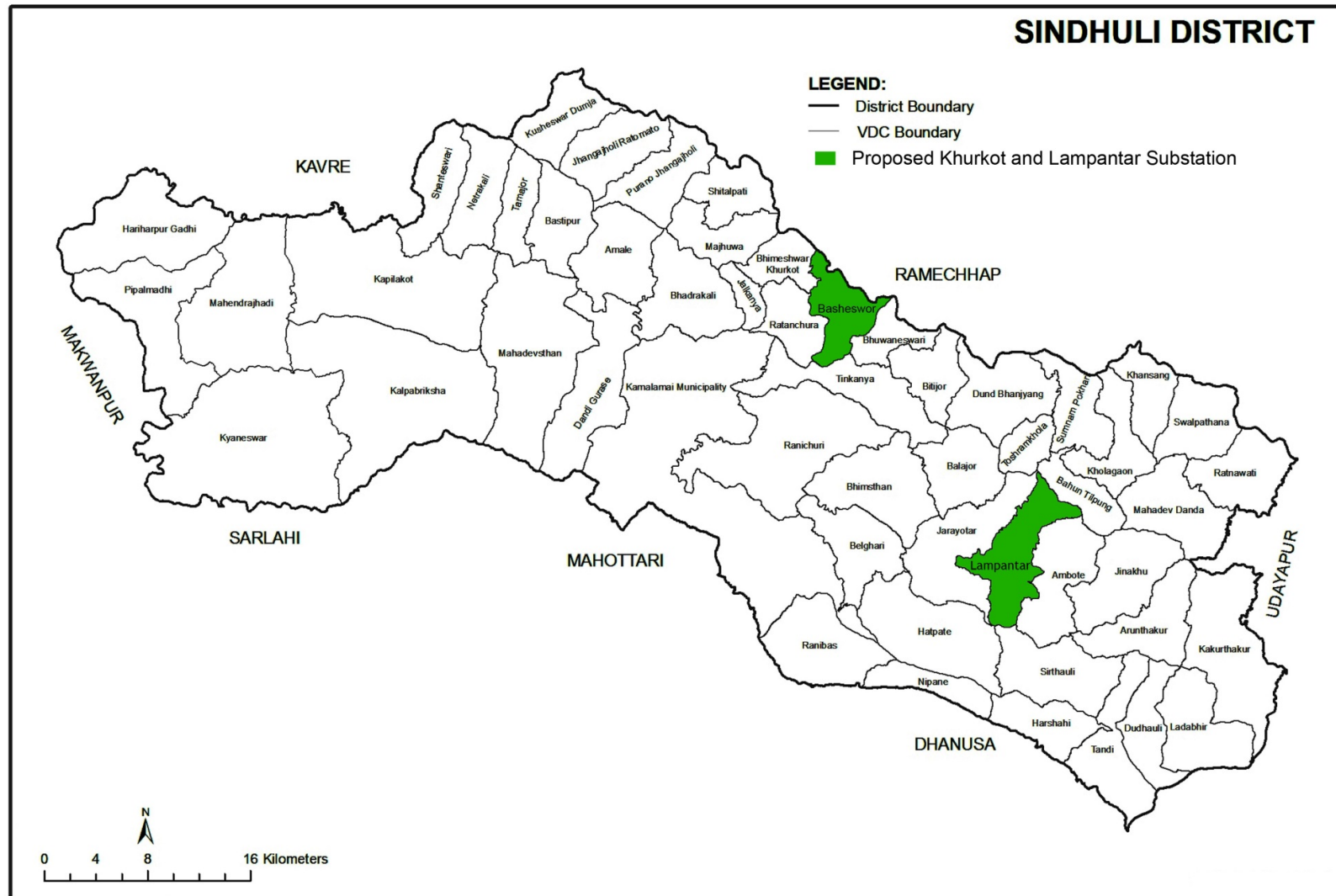
Drawing N1 : Map of Nepal
Drawing N2 : Map of Ramechhap District
Drawing N3 : Map of Ramechhap District
Drawing N4 : Map of Sindhuli District
Drawing N5 : Map of Gulmi District
Drawing N6 : Map of Kapilbastu District
Drawing SS-01 : Conceptual Drawing
Drawing SS-02 : Section-AA
Drawing SLD-01 : Single Line Diagram for 33/11kV 3 MVA Substations
Drawing SLD-02 : Single Line Diagram for 33/11kV 6/8 MVA Substations

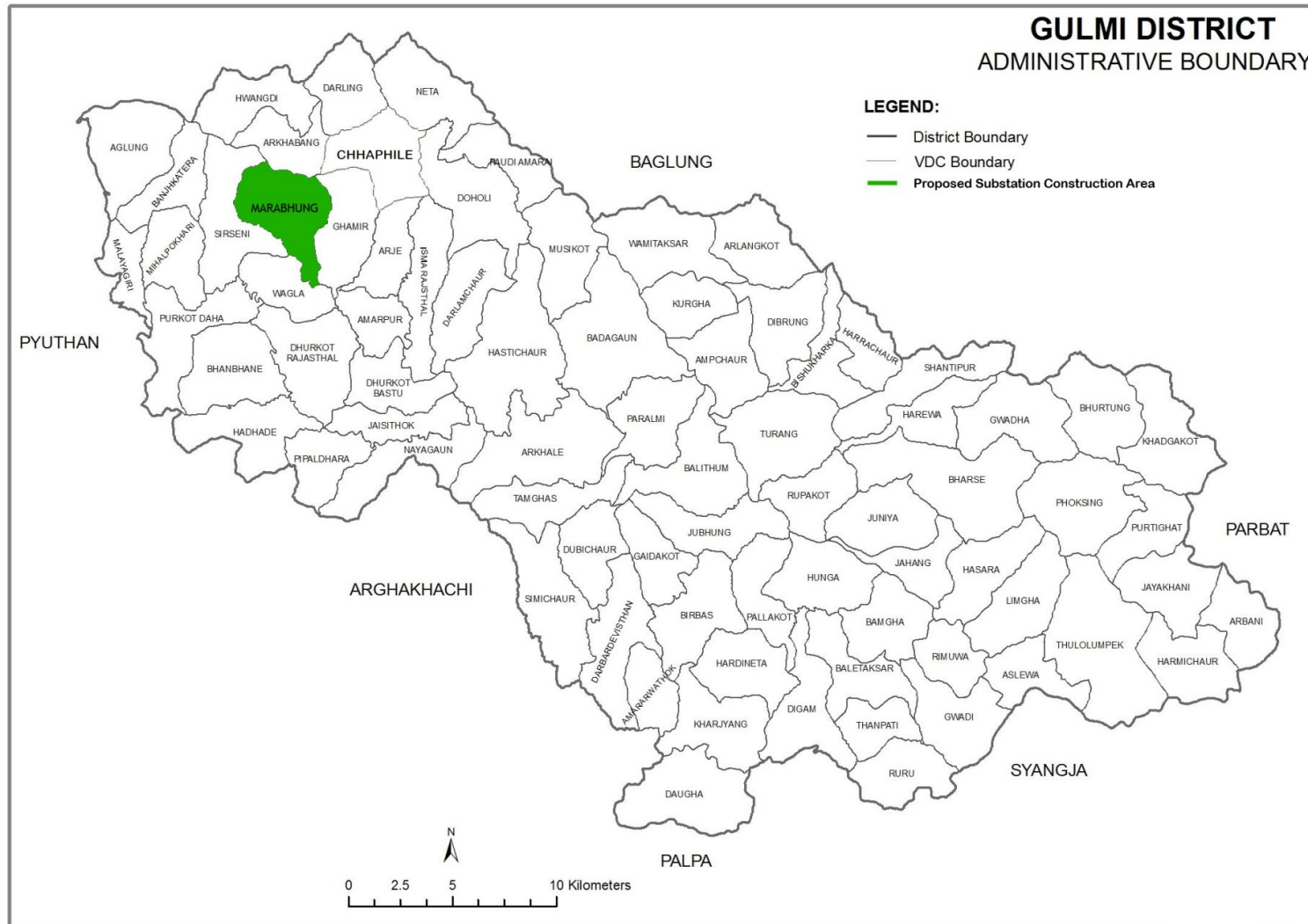






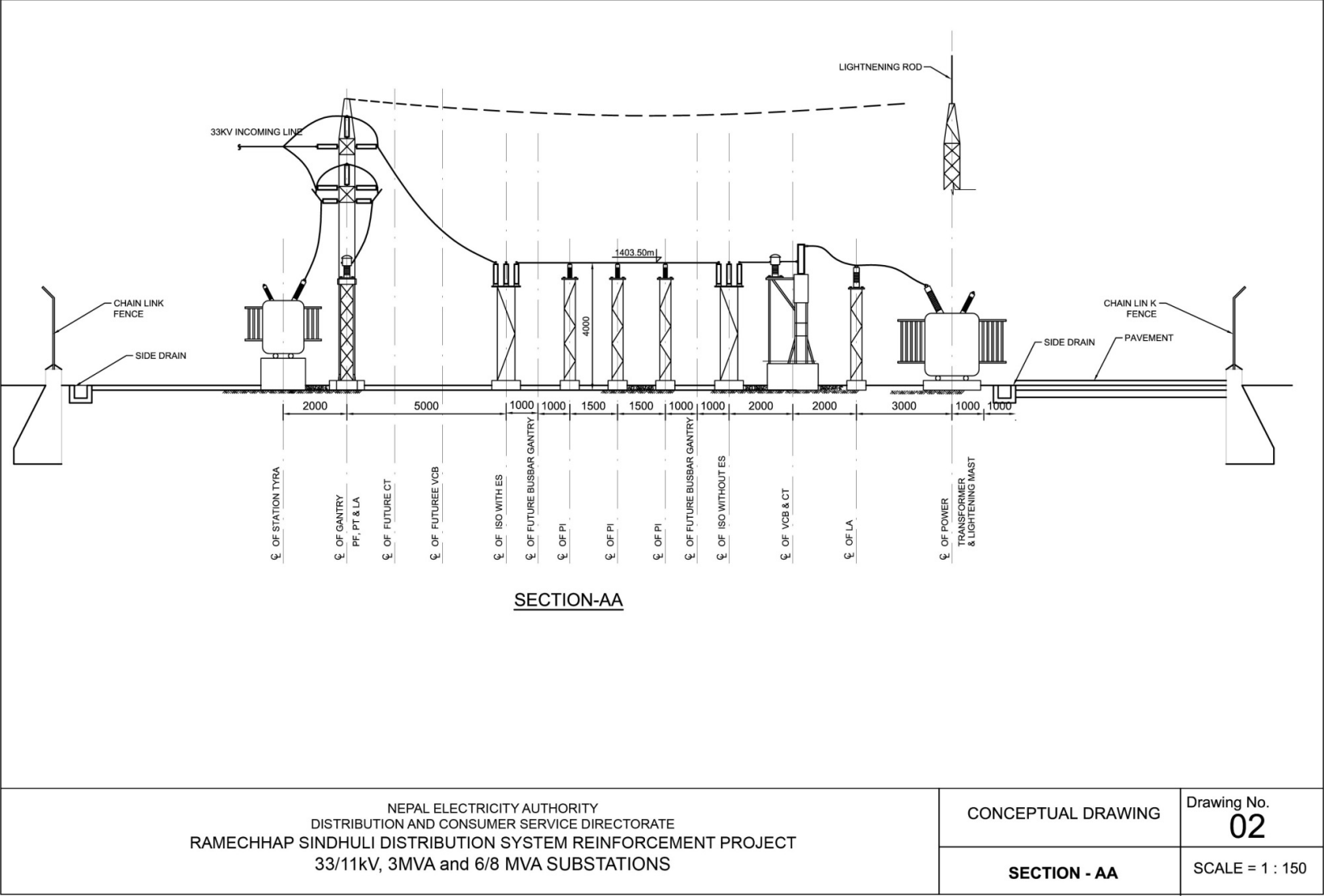
Drawing N3 : Map of Ramechhap District





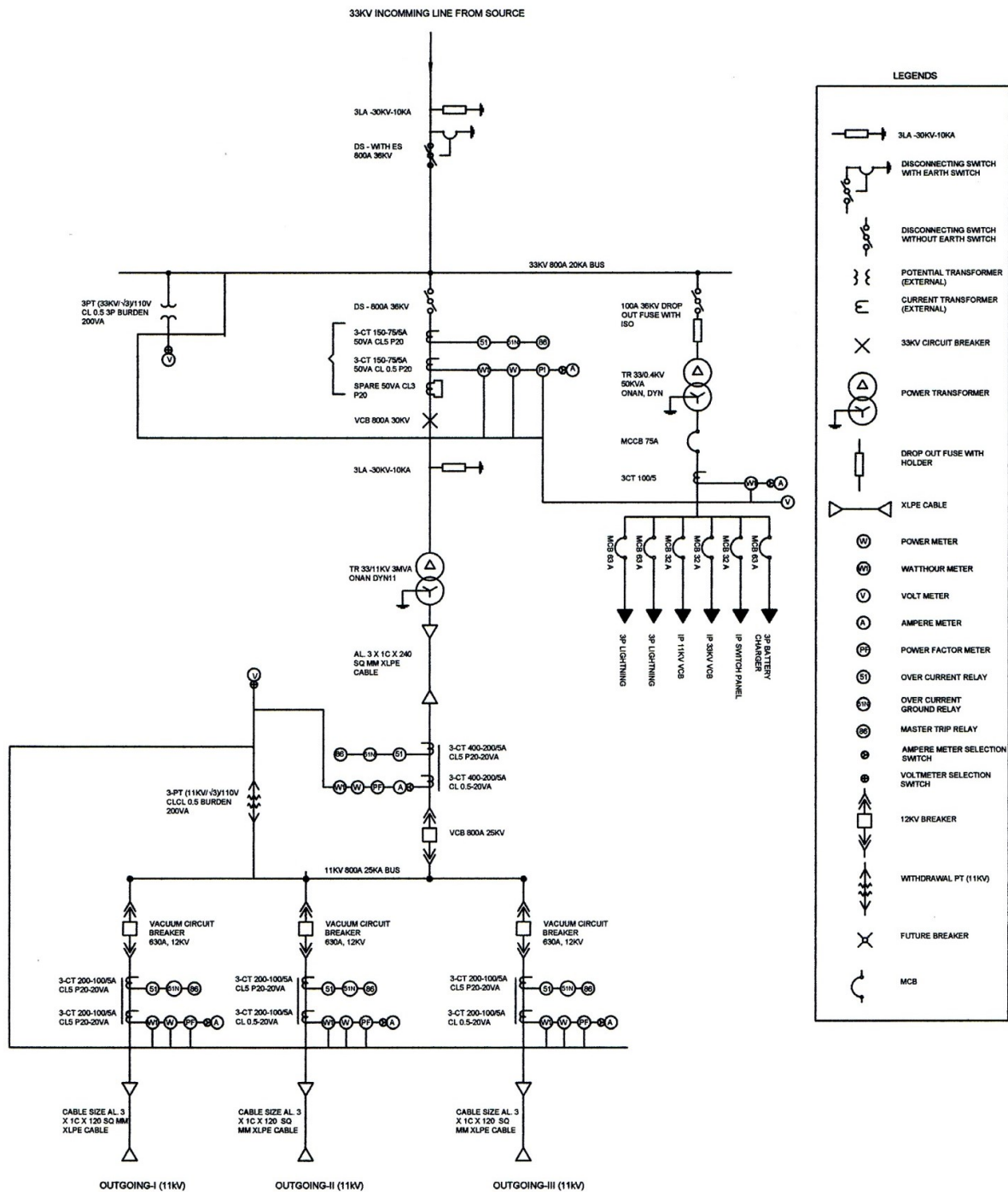
Drawing N5 : Map of Gulmi District





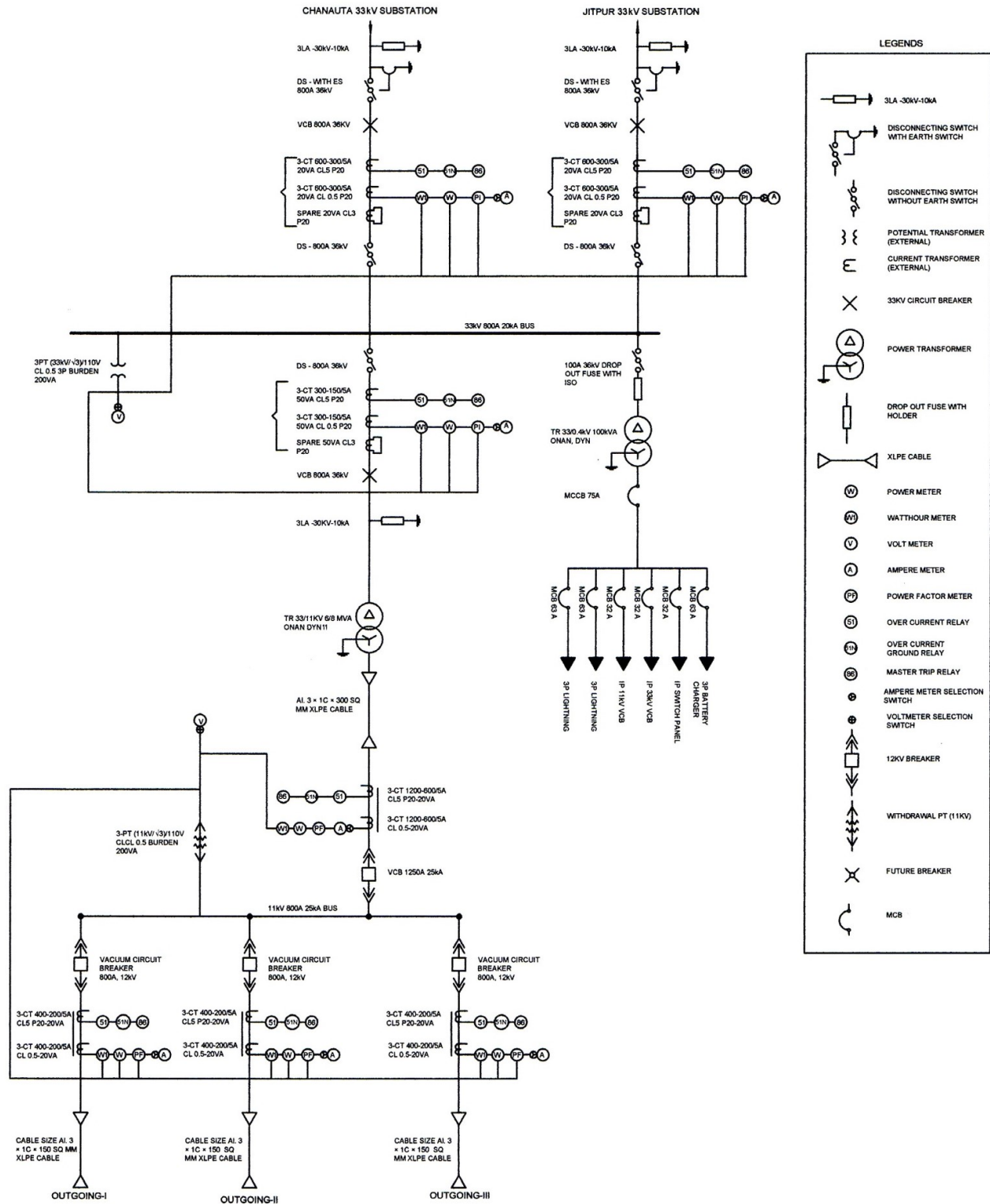
Drawing SS-02 : Section -AA

33/11kV 3MVA Substations



Drawing SLD-01 : Single Line Diagram for 33/11kV 3 MVA Substations

33/11kV 6/8 MVA SUBSTATION



Drawing SLD-02 : Single Line Diagram for 33/11kV 6/8 MVA Substations