

**Employer's Requirement
For**

**PROCUREMENT OF DESIGN, SUPPLY, ERECTION, TESTING AND COMMISSIONING OF
110KV,**

30 MVAR CAPACITOR BANK IN HAMESHA BAHAR SUBSTATION, NANGHARHAR

Da Afghanistan Breshna Sherkat (DABS)

Procurement of Design, Supply, Erection, Testing and Commissioning of 110KV, 30MVAR Capacitor Bank in 110KV Hamishabahr Substation in Nangarhar Province.

INVITATION FOR BID No.:

ISSUED ON:



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Acronyms

ACSR	Aluminium Conductor Steel Reinforcement
ADB	Asian development Bank
AFRM	Afghanistan Residence Mission
ANSI	American National Standard institute
AP	Angle Point
ASCE	American Society of Civil Engineers
ASTM	American Society of Testing Materials
BDS	Bid Data Sheet
BOQ	Bill of Quantity
BS	British Standard
Cct-km	Circuit Kilometer (Double Circuit, 3Phase, Twin Conductor Per Phase)
COF	Contract Forms
CPA	Conditions of Particular Application
Cu.m, m ³	Cubic Meters
DA	Double Circuit Tower Type – A (Suspension)
DABS	Da Afghanistan Breshna Sherkat
DB	Double Circuit Tower Type – B (Tension)
DC	Double Circuit Tower Type – C (Tension)
DCPT	Dynamic Cone Penetration Test
DD	Double Circuit Tower Type – D (Tension)
DDM/DDE	Double Circuit Tower Type –
DDM/DDE (Tension/Dead End)	
DDP	Delivery Duty Paid
DDU	Deliver Duty Unpaid
deg	Degree
DIN	Deutsches Institute für Normung e.V.
DS	Direct selection
ELC	Eligible countries
EQC	Evaluation and Qualification criteria
EXW	Ex factory, ex works or ex warehouse
FC	Foreign Currency
FIDIC	Federation Internationale des Ingenieurs Conseils (International Federation of Consulting Engineers)
FOB	Free on Board
G/m ²	Gram per Meters Square
GCC	General Conditions of Contract
HBSS	Hamesha Bahar Substation
ICC	International Chamber of Commerce
IEC	International Electro technical Commission
IEEE	Institute of Electrical and Electronics Engineers
IFB	Invitation for Bids
ISO	International Standards Organization
ITB	Instruction to Bidders

Kg	Kilogram
Kg/cm ²	Kilogram Centimeter Square
KN	Kilo Newton
KV	Kilo Volt
l.m, m	Linear Meters, Meters
L.S	Lump Sum
LARP	Land Acquisition and Resettlement Plan
LC	Local Currency
m/sec	Meter per Second
MEW	Ministry of Energy and Water
MOSS	Minimum Operating Safety standards
N	Newton
No.	Number
NoC	Negotiation of Contract
N/mm ²	Newton per Milimeter Square
OPGW	Optical Fiber Ground Wire
Owner	DABS
Owners Engineer	DABS Appointed/Selected Technical Representative(s)
PCC	Plain Cement Concrete
PCU	Project Coordination Unit
PDF	Proposal Forms
PDS	Proposal Data Sheet
PISU	Programme Implementation Support Unit
PMG	Permanent Magnet Generator
PMO	Project Management Office
RCC	Reinforced Cement Concrete
RFP	Request for Proposal
RoW	Right of Way
SCADA	Supervisory Control and Data Acquisition
SCC	Special Conditions of Contract
SMEC	Snowy Mountains Engineering Corporation
SPT	Standard Penetration Test
sq.m, m ²	Square Meters
sq.mm, mm ²	Square Milimeter
TIF	Telephone Influence Factor
Ton	Metric Ton
UN	United Nation
UNMACA	United Nations Mine Action Center, Afghanistan
UXO	Unexploded Ordinance
VDE	Verband Der Electrotechnik Elektronik Informationstechnik e.v

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1. PROJECT DETAILS

1.1 Project Overview

Da Afghanistan Breshna Sherkat (DABS, hereafter called the Employer) proposes to construct a new 110kV, 30MVAR Capacitor Bank Bay in the existing 110KV Hamishabahr substation, Nangarhar Province. The mentioned substation is fed from 110kV single circuit Transmission Line from the bus of NAGHLU HPP at a distance of around 88km. In addition to the Voltage Regulation by the Tap changers of transformers, it is proposed to install one set of 110kV, 30MVAR Capacitor Bank so that the capacitor should operate in steps of (1X10, 1x20 and 1x10+1x20) MVAR using VAR Control relays. In that case it can be used as per requirements. And it is feasible for optimum voltage control in the system. The functionality of capacitor should be such that it can be used in steps of 10, 20 and 30MVAR. The design should be as per IEC/Other Approved international standards.

1.2 Requirements of 110kV Capacitor Bank Bay

The Project is turnkey and the documents is concept design document. It includes design, erection, supply, installation, test and commissioning of all HV equipments including Protection system. And it also consists of DC Distribution system, LV distribution system all civil works for overall bay as per the requirement. Also if the contractor wish to visit the site to familiarize himself with the needs in the substation. They should inform the Employer officially and DABS will facilitate visiting the site.

The design, supply, erection, testing and commissioning of all equipment for the Capacitor Bank Bay is proposed in this project. The 110KV Group Operated Disconnects with earth switch, SF6 Circuit Breaker, Current Transformers, CVTs, Current Limiting Reactors, Surge arrestors, control & Relay panels, 30MVAR capacitor Bank including mounting racks, all Protective equipment, Protective relay Panel and control panel shall be supplied, erected, tested and commissioned.

The contractor has to design the Protection system for the Capacitor Bank and supply all required equipment to be erected with the Capacitor bank. All Equipments are to be selected as per design requirements matching the IEC and other accepted standards. Contractor shall provide and program all relay settings for all protective equipment supplied and get approval from the Employer and software shall be issued to the employer with license keys.

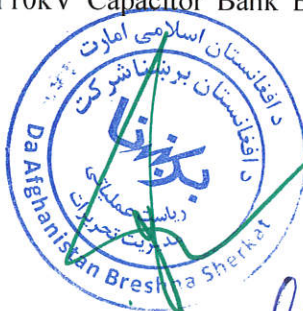
The Bill of materials provided are only indicative. Bidder can include any materials or items in the price schedules for the satisfactory function of the Capacitor Bank bay in the scope.

1.3 Completion of Project: All the materials shall be delivered well in time so that the project must be completed including testing and commissioning within 9 months from the date of signing of the contract agreement.

1.4 Project Guarantee: The Contractor is to guarantee the satisfactory working of the plant erected under the Contract for a period of 1231. From the date on which the Employer takes over the plant.

1.5 SCOPE OF WORK

1.5.1 The scope of work shall include design, supply, erection, installation, testing and commissioning of the 30MVAR capacitor Bank with all required equipment for the 110 KV Capacitor Bank Bay as per the Single Line Diagram, specifications and requirements of the bid documents so that the new capacitor Bay can be operated and maintained satisfactorily to the expectations of the owner. The project consists of supply of all materials and equipments on DDP site basis, including transportation & insurance and unloading at site, storage of materials and equipment, construction /erection, testing and commissioning of new 110kV Capacitor Bank Bay complete in all respects. The 110 kV bay equipments



Including the Capacitor Banks shall be installed out door and the Control and Protection Panel shall be installed indoor.

1.5.2 Site preparation for the new 110 KV Bay: Development of piece of Land with provision for construction.

1.5.3 supplying 110kV equipment such as circuit breaker, Group Operated Disconnect with Earth Switch, Bus post Insulators, Current Transformers (CT), surge arresters, CVTs, Current Limiting reactors, Capacitor Banks including mounting racks, Insulators and all Protective equipment for the Capacitor banks are included in the Scope.

1.5.4 Supplying all accessories and Hardware fittings required for connecting and forming the 30MVAR capacitor Bank.

1.5.5 Supplying G.I structures for mounting the equipment.

1.5.6 Erecting Structures on Foundations for all required equipment of Capacitor Bank

1.5.7 All jumper connections including suitable connectors and Hardware fittings

1.5.8 Marshalling Box for the new bay, erected on foundations (please see the Table for SPEC).

Marshalling Box

Insulation	1000Volt
Type	Outdoor
Degree of protection	IP 56
OCT Sec terminal	As per Substation design
AC Volt	400V
DC Volt	As per Substation design

1.5.9 Earth Mat extension including connections and nodal electrodes for all new Equipment and mounting structure including complete materials. The Earthing system of the Capacitor bank also will be included in the Scope.

1.5.10 Construction of Cable Ducts/ trenches with Cable supporting racks, cover slabs & Sump Pits, for laying control & power cables including complete required materials such as MS Sheet/Angle/GI perforated cable trays etc. (it is design build project)

1.5.11 Supply & laying of Control & Power cables in requisite Cable Ducts constructed for this purpose properly on trays & with Number Tags for identification of 1kV grade Power & Control cables along with complete accessories [cables offered shall be suitable for temperature conditions of site] for substation along with cable kits & cable supporting arrangements.



Sizing of power cables shall be selected keeping in view continuous current, voltage drop & short-circuit consideration of the system. Relevant calculations shall be submitted by contractor during detailed engineering for Employer's approval. In case higher sizes of cables are required as per calculation for sizing of power cables during detailed engineering, same shall be provided by the contractor without any additional cost to the Employer.

1.5.12 Shielding of Yard with its proper earthing including Earth Wire, Hardware clamps/fittings etc shall also be included in the scope if needed.

1.5.13 Cable trench must be suitably connected to the existing Trench and drainage system.

1.5.14 Chain link fence for switchyard shall be extended for the new Bay. The bidder must go to the site and add it. If needed

There should be a separate safety fence made of hot dip galvanize steel guy for the Capacitor Bank with a small gate with lock and Key. A containment area has to be provided to collect the spillage of Capacitor Insulation Fluid.

1.5.14 Switch Yard light must be extended for the new Bay.

1.5.15 Supply & Erection of (One No.3-Phase or 3 single phase which are technically reliable), 30 MVAR, 110kV Capacitor on suitable foundation blocks Cement Concrete & Reinforcement complete.

1.5.16 Associated equipment for the new bay erected on foundations.

1.5.17 supplying of control and Protection Panels with all required accessories.

1.5.18 providing the required spares essential for the Capacitor bank and associated fittings.

1.5.19 Providing Mandatory spares.

1.5.20 Testing and commissioning of the new Capacitor Bay.

1.5.21 Providing Operation & Maintenance Manuals and training at site to the Employer's Engineers.

1.5.22 AC and DC outlets if available in the existing Panels. If not new one has to be provided. Connecting of cables are included in the Scope.

1.5.23 any other Items of Equipment/Materials/Works which are not covered above but necessary for completion of yard.

1.6 Scope of Civil works

1.6.1 The civil works shall include but not limited to the works indicated in Section Civil Works & in Detailed Scope of Works.

Before proceeding with the construction work of the new 110 KV bay, Contractor shall survey the route of transportation and substation site and fully familiarize himself with the route of transportation, culverts, roads & rail bridges, loading & unloading facilities, site conditions and General arrangements & scheme etc. Though the Employer shall endeavor to provide the Information, it shall not be binding for the Employer to provide the same. The bidders are advised to visit the substation site and acquaint themselves with the topography, infrastructure and also the design philosophy. The bidder shall be fully responsible for providing all equipment,

Materials, system and services specified or otherwise which are required to complete the construction and successful commissioning, operation & maintenance of the substations in all respects. All materials required for the Civil and construction/installation work shall be supplied By the Contractor. The cement, steel and other needed material shall also be supplied by the Contractor.

1.6.2 The complete design (unless specified otherwise in specification elsewhere) and detailed engineering shall be done by the Contractor.

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

1.6.4 The minimum bay width for 110kV shall be 10_meters (minimum) and the minimum equipment interconnections shall be at 3 mtrs Center to center or it can be selected as per requisite IEC/IEEE standards. The short circuit forces and spacer span based on the phase to phase spacing and conductor span/configuration shall be calculated by the contractor and the short circuit values, spacer span indicated in Section-Switchyard Erection technical specifications shall not be applicable for the substations. The short circuit forces value applicable for equipment support structures shall also be calculated by the contractor. Design of the new Bay and its associated electrical & mechanical auxiliary systems includes preparation of single line diagrams and electrical layouts, electrical and physical clearance diagrams, design calculations for the bay and for Earth mat, control and protection schematics, wiring and termination schedules, civil designs (as applicable) and drawings, illumination and other relevant drawings & documents required for engineering of all facilities to be provided under this contract, are covered under the scope of the Contractor. If all the technical offers are the same as per Item number 2.2.4.the decision will be made by the financial division.

1.6.5 Any other items not specifically mentioned in the specification but which are required for erection, testing and commissioning and satisfactory operation of the Capacitor bank bay are deemed to be included in the scope of the specification unless specifically excluded.

1.6.6 The bidder shall maintain the overall dimensions, phase to earth clearance, phase to phase clearance, sectional clearances & bus heights, and shall confirm to the statutory electrical clearances required for the substation as per IEC Standards.

1.6.7 The C&R Panel shall be considered in the Control Room and any modification required accommodating it and the power and Control Cables shall be included in the Scope. Space considered for panels is in the planned existing Control room.

1.6.8 Complete Fire Fighting System for the new Bay including trolley/ wheel mounted, hand held fire extinguisher shall be included in the Scope.etc. the fire detection system shall be automatic and firefighting system shall be manual.

1.6.9 Complete drainage System including required materials for the new Bay if required.

1.6.10 Gravel spreading in the New Bay area.

1.6.11 Demolishing of approximately 4mx10m road. it should be reconstructed and it is included in the scope of work. (If required)

1.6.12 dismantling of 10 m long chain linked fencing may be required and reconstruction of the same is also included restricted by fence new area also.

1.6.13 Any Item of Equipment/Material/Work not covered above but necessary for complete successful operation of Bay.

1.6.14 Set of as Built Drawings

1.6.15 Construction Drawings

1.6.16 other items of works pertaining to scope of works

1.6.17 All design documents including calculations, drawings and other related materials.

The single line diagram (SLD) are enclosed in Annexure III. Based on the scope of work, SLD, and on the requirement in this documents and international standards, the bidder has to design, supply, erect, install, test and commission the new 110KV Capacitor Bank bay.

1.7 Coordination Activities

Contractor shall interface and coordinate with other parties to ensure proper connection of substations and transmission lines constructed independently. The interface point between substation work and transmission line work shall be at the first gantry in the substations and interface the busbar protection and SCADA system.

1.8 Code, Standards, Specifications

All material used, plant supplied and all workmanship and tests shall be in accordance with the latest editions of IEC and ISO Standards, or where International Standards are not applicable, with national standards such as ASA, ANSI, ASTM, BS or VDE + DIN, IEEE, ASCE. Where such standards and codes are national or relate to a particular country or region, other authoritative standards that ensure substantial equivalence to the standards and codes specified or in accordance with technical requirements of a Country where the site is located, will be acceptable. For any such standards which are not written in the English language, the Contractor shall make available copies of a certified English translation thereof. Where no standards exist, as in the case of patent or special materials, all such materials and workmanship shall be of the best quality and full details of the material and any quality control tests to which they may be subjected shall be submitted to the Engineer for approval.

The Contractor shall deliver (soft copy and hard copy) at his own cost, one complete set of the selected and approved international code standards, and specifications to the Employer / Engineer within 28 days after commencement of the works.

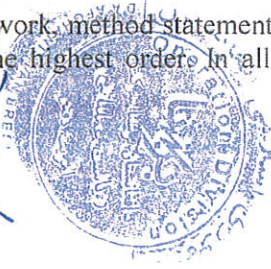

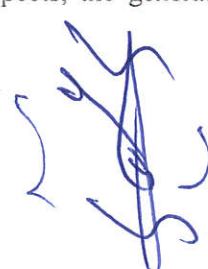

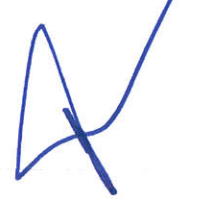
The set shall contain codes, standards and specifications as referred to in the technical specifications or approved alternatives. One set shall be kept at the Contractor's site office and shall be accessible to the Employer or his representatives during working hours.

1.9 Equipment and Materials

All equipment and materials to be incorporated in the works must be new, unused, and of the most recent or current models, and must incorporate all recent improvements in design and materials unless provided for otherwise in the Contract. Where applicable, all equipment and material shall be of design suitable for adverse climatic conditions as experienced on site in Afghanistan. All equipment and material shall be inspected and tested in full, to prove compliance with the requirements of the Specifications to the satisfaction of the Engineer.

1.10 Workmanship

All work, method statements of work and workmanship, whether fully specified herein or not, shall be of the highest order. In all respects, the generally accepted requirements and commonly recognized

good practice for first-class work of this nature are to be adhered to and the Contractor shall submit quality certificates for materials. Method statements shall be submitted for all works for review and approval before the work commences and shall be to the satisfaction and approval of the DABS Engineer.

1.11 Design and Engineering

The Contractor shall design, manufacture, supply, erect, construct, install, test and commission all equipment and Materials, items and components of the Works, and carry out all installation services and work necessary so that the Works described herein shall be satisfactory for their intended purpose.

The Contractor shall design the complete Works in accordance with the design criteria and specifications given in the Supply Requirements, and as shown in the Bid Drawings. All design carried out by the Contractor shall comply with these Specifications and shall take into account all requirements of the Facilities and technical requirements of Afghanistan. The Contractor shall optimize the design of each component of the Works in order to achieve the most economic design. The Contractor shall be entirely responsible for all design carried out by him.

The Contractor shall inform themselves fully of the actual dimensions, levels, etc., of any other existing or proposed structures before commencing the manufacture of parts dependent on such data. The design calculations for each member forming part of the system shall be based on the most unfavorable combination of all the loads which the said member or part is intended to support or assist in supporting either permanently or temporarily. All design shall be subject to the review and approval of the DABS Engineer.

Where appropriate design criteria/specifications are not indicated in the supply requirements or shown in the Bid Drawings, then the Contractor shall carry out the design work in accordance with generally accepted engineering design theories, principles and criteria, to the satisfaction of the DABS Engineer.

The Contractor shall provide the Employer with fully detailed design drawings, detailed design reports and design calculations relating to the Works. All design work shall be subject to the approval of the Employer, pursuant to the Conditions of Contract. Design drawings, design reports and design calculations shall be prepared and submitted in accordance with chapter Documentation of the General Requirements.

1.12 System Characteristics and Climatic Conditions.

All equipment and material shall be designed for efficient operation under Afghanistan's climatic conditions, which can be harsh with snow and ice in winter and hot and dusty conditions in the summer. The following system characteristics and climatic conditions data are provided for guidance in designing the equipment and related material:

Specified clearances shall be considered minimums. The supplied values are elevation dependent and have been provided for information only. The designer shall consider elevation and adjust clearances tendered and applied to equipment design.

Table 1.12 Plant Design Conditions

HV System	
Nominal Voltage (Un)	110KV
Highest System Voltage (Umax)	123KV
Design Voltage (Um)	110KV
Rated short time current	40kA/3sec
Earthing	Solidly Earthed

Insulation Coordination	IEC 60071-1
Rated lightning impulse withstand (peak)	550 KV
Rated 1 min power frequency withstand (KV rms)	230 KV
Phase-to-earth air clearance:	
Minimum	1200mm
Phase-to-Phase air clearance :	
Minimum	1300mm
Creepage distance outdoor +	31mm/Kv
Frequency	
Standard frequency	50Hz
Maximum continuous ac system frequency	52.5Hz
Minimum continuous ac system frequency	47.5Hz
Maximum short-term ac system frequency	52.5Hz (Max. duration 900 s)
Maximum rate of change of frequency (df/dt)	0.2Hz/s
Minimum short-term ac system frequency	47.5Hz (Max. duration 1800 s)
MV (20KV) Distribution System	
Nominal Voltage (Un)	20KV
Highest System Voltage (Umax)	24KV
Design Voltage (Um)	24KV
Standard Frequency	50Hz
Rated Short Time Current	25kA/1sec

Table 1.1.1 Plant Design Conditions continued MV (20KV) Distribution System

System Configuration	3 phase/3 wire
Earthing	Solidly earthed
Insulation Coordination	IEC 60071-1, -2
Rated Lightning Impulse Withstand (peak)	145KV
Rated 1 min Power Frequency Withstand	50KV

Minimum Phase-to-Earth Air Clearance	270mm
Creepage Distance Outdoor	31mm/KVPG
LV Distribution System	
Nominal Voltage (Un)	400/230V
Design Voltage (Um)	0.6/1KV
Voltage Variation	±7.5%
Standard Frequency	50Hz
Rated Short Time Current	12.5kA/1 sec
Earthing	Solidly earthed
Climatic and Geographic Conditions it should be as per site condition	
Seismic Factor for design Data not available	(Contractor to nominate value)
Altitude (Project Area only)	
Jalalabad	2060ft. or as per site condition

Dry Period	June to November(has to be checked at the site)
Rain Period	December to May(has to be checked at the site)
Average	40°C(has to be checked at the site)
Maximum	55°C(has to be checked at the site)
Minimum	-20°C(has to be checked at the site)
Humidity	
Average humidity	95%(has to be checked at the site)
Ground Resistivity of Soil:	
Average	2000 Ohm-m Single soil layer (To be verified at site).
Wind:	
Maximum Wind Velocity	41 m/s (148km/h) (has to be checked at the site)
Table 1.1.1 Climatic and Geographic Conditions continued	
Wind gust factor or maximum wind gust 1.5(has to be checked at the site)	Wind gust factor or maximum wind gust 1.5(has to be checked at the site)
Wind and Dust	Sand and dust storms in summer(has to be checked at the site)
Isokeraunic Level Thunderstorm	23 days/year(has to be checked at the site)

Solar radiation 1.2KWH/Sq. m /day

Design ice load of 20mm may be considered.

1.13 Language

The English language shall be used in all Contract documents and in all correspondence between the Contractor and the DABS Engineers, and between the Contractor and the Employer.

1.14 System of Units

In all correspondence, in all technical schedules and on all drawings, metric units of measurement, System International (SI) system of units, shall exclusively be used:

- Dimensions in meters and millimeters unless specified otherwise
- The unit of mass is the kilogram (kg)
- The unit of force is the Newton (N)
- Angular measurement shall be in degrees, with 90 degrees comprising one right angle

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1.15 Documentation

1.15.1 General

The sizes of all documents and drawings shall conform to the ISO standard, and be of size A1, A2, A3 or A4. Larger sizes than A1 shall be avoided. All documents in size A3 and A4 shall be bound in hard covers. The schematic diagrams, apparatus and cable lists shall have a size of A3 or A4. The Contractor shall submit the hard copy and soft copy of the all documents as per the specification and price schedule.

All drawings shall be prepared and submitted in the latest version of AutoCAD or a similar computer aided drafting software package. Scales to be used on the drawings shall be 1:10, 1:20, 1:40, 1:50 and multiples of this series.

Operational and warning labels in the Afghan language shall also be indicated.

The Contractor shall, during the project duration, maintain a List of Documentation to be updated whenever needed. The List of Documentation shall include the date of the original issue of each document submitted as well as the dates of every revision. The List of Documentation shall also include a time schedule for the submittal of the documentation.

1.15.2 Documentation for Design and Manufacture

During the design period, full documentation on all plant equipment shall be supplied to the DABS Engineer and to the Employer for review and approval. All drawings prepared by the Contractor shall be submitted in five (5) sets hard copy and two sets (2) of soft copy (CD) to the Employer for review and approval. All documentation shall have such information or instructions related to the drawings and the design as may be necessary.

Within twenty-eight (28) days after receiving such drawings, calculations, samples, patterns and models, one copy of each document will be returned to the Contractor, dated, signed and marked by the Engineer and, where necessary, with proposed corrections indicated.

Any delay arising out of failure by the Contractor to rectify the design, calculations, drawings, etc. in good time should not alter Contract completion date.

Drawings marked **RETURNED FOR CORRECTION** shall be corrected by the Contractor and sent to the DABS Engineer for further review.

When a drawing is marked **REVIEWED** or **REVIEWED AS AMENDED**, the Contractor will be allowed to use the drawing for manufacture and erection. The Contractor shall, however, make corrections according to the remarks given by the Employer, Engineer, expert and upon their approval, the Contractor could use the drawings. Manufacturing starting prior to receipt drawings marked **REVIEWED** or **REVIEWED AS AMENDED** is done at the Contractor's own responsibility.

The Engineer's approval does not however in any way relieve the Contractor of his full responsibility for the correctness of his documentation and the proper functioning, quality and compliance with the Specifications of all plant and equipment supplied by him.

The Engineer's approval shall not relieve the Contractor from full responsibility from mistakes or omissions therein or there from (including any resultant mistake or error in the Works) or for any discrepancy or deviation from the Technical Specification and other drawings.

Calculations, samples, patterns, models, etc., submitted to the Engineer for his review, shall be such as are called for herein or as may be necessary for proving compliance with the Contract.

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1.15.2. Participation of Employer's Staff in FATs

The Employer's staff or his representative has the right to witness all FATs carried out by Contractor or his Sub-supplier which should be requested by the contractor for all equipments that need to witness by employer as per IEC standard or other international standards. The Contractor must inform the Employer at least 4 weeks in advance when and where the FAT will be carried out and submit FAT procedures for comment and approval as per IEC Standards. and Contractor should provide all required accommodation (Visa, Tickets, traveling, hotel expenses,

Documentation, etc.) And Perdiem (according to first kick off meeting) for employer's staff while Attending the FAT.

The FAT expenses of each equipment has been considered in all substation equipments prices.

1.15.3 Documentation for installation

The Contract Price shall be deemed to include illustrated installation, operating, service and maintenance instructions for the Works, which shall be written in English. The installation, operation, service and maintenance manuals shall cover all aspects of the Works, including the civil works and structures, surface water drainage, sub-soil and under-structure drainage, etc., and all electrical equipment supplied. Hard copy and soft copy of the Method Statement with drawings/sketches shall be submitted for review and approval to Employer/Engineer for construction, erection, installation, etc. works.

The manuals shall include parts catalogues, and details of equipment installation, operation, maintenance and repair. If the manufacturer's standard bulletins are supplied, they shall be clearly marked to indicate the specifications applicable to the particular equipment that is supplied. Each manual shall include a full set of assembly drawings, including wiring diagrams, reduced to A3 size.

The manual shall also contain a detailed service program adapted for each plant for all equipment explaining what action shall be done on which equipment and when.

Prior to the installation period the Contractor shall distribute copies of the REVIEWED documents and such other particulars, to the Employer in four (4) sets and to the Engineer in one (1) set.

The Contractor shall submit in due time but not less than one month before commissioning, two copies of preliminary Operation and Maintenance Instructions and Service handbooks to the Engineer for review and approval, following the same procedure as for the drawings.

The approved documentation shall be distributed in five (5) sets to the Employer two months before the start of commissioning.

If any descriptive brochures forming part of this documentation shall be provided in English versions, complete translations shall be enclosed.

The documentation shall continuously be updated during the installation and test period by the Contractor. During the initial period of operation, before receipt of As-built documentation at the site, one copy of the updated erection documentation, instructions, etc., shall be kept at the site.

1.15.4 Commissioning and Completion Report

Prior to the issue of the Taking-Over Certificate, the Contractor shall submit to the Employer's Representative one original and six copies of a Commissioning and Completion Report for each Section of the Works. The Works, or, if applicable, the Section, shall not be considered to be completed for the purposes of taking-over until such Commissioning and Completion Reports have been submitted to the Employer's Representative.

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1.15.5 As-Built Documentation

General

Immediately after the Operational Acceptance of the Facilities, the Contractor shall update all final documents in accordance with the modifications made. When a document contains all Modifications, it shall be marked as-built.

As-built documentation shall be submitted to the Employer in four (4) sets and to the Engineer in one set, at the latest two months after Operational Acceptance of the Facilities.

For drawings, A3 size and larger, one of the sets issued to the Employer, shall be of reproducible transparent material (PVC). In addition, two soft copies, CD ROMS or similar computer storage media, shall be supplied for all As-Built drawings.

The supply of As-built documents shall comprise but not be limited to all AutoCAD drawings for construction and installation, calculations, instructions for operation, maintenance, repair and adjustment, apparatus lists, spare parts lists containing information needed for ordering for all equipment supplied under the Contract.

General Manuals

The following general manuals, covering the whole project, shall be delivered:

- A general description of the equipment in this contract
- Operating instructions, suitable for training of personnel
- General maintenance instructions, describing frequencies and methods for regular inspections, for planned maintenance and for regular part replacements. The instructions shall also include fault location guides.
- All other drawings or manuals that are not mentioned, but are deemed necessary for a safe and proper handling of the delivered equipment.
- The manuals shall include spare part lists and description of any special tools needed for service of the equipment.

System Design Documentation

The following documents shall be delivered:

- All layouts, construction and installation drawings
- All design, calculations, regarding civil, electrical and mechanical design data and computations
- Design Drawings, Sag and Tension Chart, tower schedule, tower spotting data, etc.

System Documentation

Documents for approval shall be delivered before the work is started but shall also be included in The as-built documentation as follows; in case of alterations agreed upon by all parties, new documents shall be issued:

- Type test certificates for important equipment and material: data specifications on other equipment
- Routine test certificates
- Data lists with Engineer required amendments incorporated. The contents of the lists shall correspond to the schedules of this document. Data lists will be regarded as binding for the manufacturer
- Dimension drawings. They shall be regarded as binding for the manufacturer and shall contain measures, weights and features of the equipment
- Detail drawings as required by the Engineer

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1.16 Progress Reports

Work plans, monthly programs, and reports shall be provided by the Contractor. At the end of each month, the Contractor shall submit suitable written progress reports to the Employer and Engineer with the progress of design, manufacture, delivery, transport, erection, etc. If the progress of the Works does not conform to the approved Program, the Contractor shall indicate these deviations, with substantiating reasons.

1.17 Manufacture

Before commencing any manufacture of the equipment and structures, the Contractor shall submit for the approval of the DABS Engineer, the drawings of the manufacturers of the equipment and structures. After such approval has been given, the manufacture shall be planned and performed according to the Specifications and to the satisfaction of the DABS Engineer.

The Engineer shall be afforded every opportunity to control and inspect the manufacture and testing of materials in the steelworks, rolling mills, foundries, factories etc., and their assembly in the workshops of the Contractor and his Subcontractors.

1.18 Site Regulations and Safety

The Employer and the Contractor shall establish Site regulations according to the General Conditions of Contract.

The Contractor shall provide appropriate training in handling plant and machinery to the workers and laborers before the commencement of work. All workers employed by the Contractor shall be insured against any accident.

1.19 Notices and Permits

The Contractor shall give the requisite notice and obtain any necessary approvals from the Government or Authorities. Authorities' Inspectors may be required in the case of excavations, trenching and (in particular) blasting operations; the Contractor shall pay for all permits required prior to and during the execution of the Contract, including those required for all temporary works.

1.20 Verification of Dimensions

Before work is commenced on any structural element required to be fabricated, or provided under this Contract, the Contractor shall verify by measurement on site, the relevant dimensions of all work previously completed.

1.21 Site to be Kept Tidy

Throughout the progress of the Works, the Contractor shall keep the site and all working areas in a tidy and workmanlike condition, and free from rubbish and waste materials. Other items, which are not required for use by the Contractor at the present time, shall be dispersed about the site in an orderly fashion, or shall be properly and securely stored.

The Contractor shall not mobilize and demobilize of any construction plant, materials, etc. from the site without the approval of the Employer or Engineer.

1.22 Site Supervisors

The Contractor shall provide the services of competent specialists to supervise the construction of the Works and erection / installation of Plant at the Site. The Contractor's Site Supervisors shall be given full responsibility and authority to negotiate and agree points arising out of the Works, in order that the Works may proceed with a minimum of delay. Directions and instructions given by the Employer or the Engineer to the Site Supervisors shall be interpreted as having been given to the Contractor.

1.23 Safety of Personnel

The maximum safety, consistent with good erection/installation practices shall be afforded to personnel directly engaged on this Contract, or to persons who, in the normal course of their occupation, find it necessary to utilize temporary works erected by the Contractor to access the working area.

Once any section of the Works or Plant has been energized, the Contractor shall establish a system for ensuring the safety of personnel and plant. While the Works, Plant are under the control of the Contractor, the Contractor shall be primarily responsible for the safety precautions. While the Works, Plant are under the control of the Employer, the Employer shall be primarily responsible for these precautions.

1.24 Packing and Transport Marking

All parts of the Plant shall be well packed and protected against loss or damage during the transport by sea and land and whilst in storage under adverse climatic conditions. All packing shall be performed in such a way that the plant will not be damaged by overturning of the packages or by weather. Dimensions of packages, crates, etc., shall be suitable for road transport. Instructions for handling shall be clearly marked on all parts, packages and crates.

All parts, packages and crates shall be adequately marked to enable identification. Each item contained in a package shall be clearly identified on the packing list by its description and part number and assembly drawing reference, and each item shall be marked or labeled to correspond with the packing list. The marking system to be used shall be as instructed by the Engineer.

All packages shall allow for easy removal and checking at site. Wherever necessary, proper arrangement for attaching slings for lifting shall be provided. All packages shall be clearly marked with signs showing 'up' and 'down' on the sides of boxes, and handling and unpacking instructions as considered necessary. Special precautions shall be taken to prevent rusting of steel and iron parts during transit by sea or storage on land.

The cost of all plant needed for the temporary fixing and supporting of the various parts of the Plant and the various packages to crane hooks, etc., during handling, transport and storage and the cost of load distribution beams, etc., where they form part of the packing or crates, shall be included in the Contract Price.

The Contractor shall be entirely responsible for all packing and any loss or damage shall be made good by the Contractor and, except where otherwise provided, at the Contractor's own expense.

Identification, reinforcement or upgrading of roads/bridges for access to the site and for transport of plant and materials shall be the responsibility of the Contractor. Any costs associated with identification, reinforcement and upgrading of roads and bridges shall be deemed to be included in the Contract Price.

1.25 Corrosion Protection and Painting

1.25.1 General

All parts of the Plant shall be protected against corrosion under service conditions. The protection shall also prevent corrosion during transport, storage and erection. Because of the high humidity at the Site, the protection shall be carried out at the Contractor's workshop.

Damage to the protection during transport, erection, etc., and erection joints, shall be repaired to the same quality as specified for the plant item.

1.25.2 Surface Protection

All steel and iron surfaces to be painted shall be prepared by means of sand or shot blasting or other approved methods. Before being blast-cleaned, the surfaces shall be cleaned of oil and grease. The surfaces shall be of clean metal and shall be dry and free from any foreign matter at the time of painting.

All surfaces to be painted shall be smooth, even and free from dirt, rubbish and shall be dry and protected from dampness; i.e., surfaces shall be free from anything that will adversely affect the adhesion or appearance of paint or galvanizing.

All defective concrete/cement plaster shall be cutout and trimmed, holes in internal plaster faces shall be made good with approved material. All dirt and powdery substrate shall be removed with slightly damp cloth.

All laitance shall be removed from concrete surfaces by wire brush or blasting. All holes, defects shall be filled and repaired by epoxy grouts. All dust and/or mill scale etc. shall - if necessary - be removed from new metal surfaces with a wire brush, chipping hammer or grinding. The surface of the metal work shall then be primed with an approved metal primer before application of the undercoat.

Pre-treatment of the galvanized surfaces includes etch-cleaning, sweep blasting (preferred) or emery paper used to clean and roughen the surface, remove any matter detrimental to the adhesion and to achieve a better anchor pattern.

Wood surfaces shall have all ironwork removed prior to the preparation of surfaces and re-fixed upon completion of the paint. All knots and resinous parts in wood surfaces shall be treated by two coats of shellac varnish. Cracks and holes shall be treated by one coat of primer and filled with approved filler.

1.25.3 Painting

The painting shall be carried out in an efficient and professional manner to the satisfaction of the Engineer. The quality and colors as well as the application of the paints shall be approved by the Engineer and the Contractor shall submit detailed information, samples and the Manufacturer's recommendations for the paints for approval.

Emulsion paints shall be used for internal cement plastering and internal fair-faced concrete of walls and ceilings. All emulsion paints shall be washable consisting of:

- One coat of Acrylic primer sealer
- Two coats of filler based on alkaline resistant polyvinyl-acetate
- Two coats of polyvinyl-acetate emulsion flat finish

Oil paints shall be used for wood surface and internal cement plastering and internal fair faced concrete in confined humid areas such as bathrooms, consisting of:

- One coat of Acrylic primer sealer
- Two coats of filler, based on alkaline resistant polyvinyl-acetate
- Two finish coats, based on alkyd resins

Varnishes shall be used for wood surfaces and shall be of one of the following types:

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- Polyurethane varnish
- Synthetic varnish of linseed oil alkyd resin

All un-galvanized external surfaces except nuts, bolts and washers which may be removed for maintenance purposes shall be painted at the manufacturer's works as follows:

- A primary coat of rust-inhibiting paint.
- Two coats of non-glossy oil and weather resisting paint, the second of which shall be applied on completion of work tests.
- One final coat of aluminum, oil and weather-resisting non-fading paint.

The total thickness of the above coatings shall be minimum 160 μm for outdoor surfaces and 120 μm for indoor surfaces.

Other paint systems:

- Epoxy paints for concrete shall be as per the specification.
- Oil resistant paints shall be epoxy paint resistant to all types of oil.

Paints for steel and galvanized surfaces are specified under "General Technical Requirements Mechanical".

Application of Paints (General)

All paint application shall be done in line with the paint manufacturer's instructions. Before applying any paint, all prepared surface shall be dry and clean. All priming paints shall be applied by brush except for etch primer which may be applied by brush or spray. Paints shall be applied

As evenly as possible to provide a smooth coating of uniform thickness. Damaged areas of priming coats or undercoats shall be made good before further coats of paints are applied. The Various coats of paint shall be distinguishable from each other by their shade.

The Contractor shall inform the Engineer in good time before starting to apply the next coat so that the Engineer shall have the opportunity of approving the previous coat. Painting systems shall not be carried out at temperature below 5°C or above 35°C. Trial coats shall be prepared at the request of the Engineer.

The Contractor shall, upon completion remove all paint where it has been spilled, splashed or spattered on surfaces including sanitary fixtures, glass, and hardware. It shall be removed without marring the surface finish of the item being cleaned.

1.25.4 Galvanizing

All ferrous parts shall be galvanized except where otherwise specified. The dry film thickness or galvanization thickness on steel shall be measured by means of a magnetic or electrical thickness gauge such as "Micro tester" or "Electrometer", and recorded in a tabulated form, indicating each layer of coat and the total dry film thickness. Contractor is responsible to provide such instrument without any charge to the Employer.

Galvanizing shall be applied, not less than 98% of which must be pure Zinc. The galvanizing procedure shall be started only after having finished all chipping, trimming, fitting and bending. Also, all drilling, punching, cutting and welding shall have been completed and all burrs removed.

All steel, including bolts, nuts and washers, shall be galvanized at the manufacturer's premises by means of hot dipping in accordance with internationally recognized standards such as ASTM A 239, or equivalent. The Zinc coat applied shall conform to ASTM A-123, minimum thickness grade

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85 and higher (see table 2, ASTM A 123-89a).

Galvanizing shall consist of a continuous coating to minimum weights (g/m^2) as follows:

Rolled steel exposed to the atmosphere	600g/m ²		
Rolled steel under the ground surface	1,500g/m ²		
Cast iron and malleable iron	600g/m ²		
Bolts, nuts and washers	375g/m ²		

The zinc coating shall meet the requirements according to BS 729, ASTM, A123, A153, A239 and A385, DIN 50961, 50976, 50978 or other equivalent methods and international standards. All steel shall be fully fabricated before galvanizing, no machine or shop work, boring, punching, etc., will be allowed after galvanizing.

1.26 Structural Steel and Cast Iron

Structural steel shall be made by the open-hearth basic oxygen or electrical furnace process.

In order to reduce the risk for material confusions, only two strength classes may be used. Suitable classes are low tensile steel (yield point 220 - 260N/mm²) and high tensile steel (yield point 300 - 350N/mm²).

Steel shall comply with the requirements of ASTM A143 and embrittlement tests shall be made in accordance with that specification.

If the Contractor intends to use more than one quality of steel, they will be required to take every precaution to the satisfaction of the Engineer, against any possible intermixing of different qualities during transport, storing, handling manufacture and installation.

Cast iron shall have a tensile strength of at least 140N/mm². It shall be made from the best grey pig and scrap iron, and shall be close-grained, tough and uniform in character.

Malleable iron shall be of the black hearth type with a tensile strength of not less than 330 N/mm².

1.27 Copper, Aluminum Alloys and Clad Steel

Copper and aluminum stranded conductor material shall meet the requirements of IEC Standards. The specification of proposed aluminum alloys shall be submitted for approval.

The preferred aluminum-clad steel to be supplied is Alum weld or substantially equivalent. The preferred copper-clad steel to be supplied is Copper weld or substantially equivalent.

1.28 Marking

A legible mark of origin shall be applied on all castings and forgings, particularly on conductor and overhead ground wire hardware, and on insulators and associated hardware. Insulators shall, in addition, be marked with the mechanical or electromechanical failing load or a corresponding code number.

Each separate member of the structure shall be marked indicating tower/pole type and number and the piece corresponding to the shop drawings. These marks shall be embossed into the steel before galvanizing, or concrete as part of the casting, in such a manner as to be plainly visible after manufacture.

1.29 Concrete Works

1.29. A General

In general, and except where otherwise specified, the Contractor shall supply all labor, materials and plant required for the concrete work and all tests thereon and shall:



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- Nominate the sources of materials, testing and mix design
- Mix, transport, place, compact, finish and cure all concrete
- Erect and dismantle all forms and formwork
- Produce and install all steel reinforcement
- Embed, as required, all items, whether supplied and erected directly or by other Contractors, in accordance with specifications and drawings.

The scope includes the design, engineering and construction including anti-termite treatment, plinth protection, DPC including sanitary, water supply, and electrification false ceiling etc.

(The below Not applicable)

of Control room building and. The building shall be of RCC framed structure of concrete of M25 (Min.) The contractor shall appoint a reputed architect (to be approved by Employer) for design of architecturally pleasing building and to incorporate local architecture.

The finishing schedule is given in subsequent clauses.

Flooring in various rooms of control room building shall be as for detailed schedules given in Table -1 given below:

12.8 Walls

Control room buildings shall be of RCC framed structure. All walls shall be non-load bearing walls. Min. thickness of external walls shall be 230 mm brick masonry with 1:3 cement sand mortar.

12.9 Plastering

All internal walls shall have minimum 12mm thick plaster on smooth side and 15mm thick plaster on rough side of brick wall with cement mortar 1:3 (1 cement: 6 sand). The ceiling shall have 6mm thick 1:4 cement sand plaster.

12.10 External Finishing

External plaster 18mm thick shall be of 1:3 cement sand plaster in two layers under layer 12mm thick and 6mm thick upper layer. External surface of the building shall be painted with Acrylic smooth exterior paint "TRUMP" of M/s Snowcap India Ltd or equivalent

12.11 ROOF

Sloping RCC cast in situ roof shall be provided for all buildings with false ceiling as mentioned in finish schedule. Store room may not be provided with false ceiling.

1.29.1 FALSECEILING

(Not applicable)

The control room and all other areas specified in internal finish schedule elsewhere shall have closed aluminum ceiling system comprising 84mm wide, 12.5mm deep panels of approved color with a recessed flange of 23.9mm roll formed out of 0.5mm thick aluminum alloy AA 5050 /5052/3003 achromatized and stove enameled on both sides, panels to be fixed on roll formed carriers 32mm wide 39mm deep out of minimum 0.9mm thick aluminum alloy strip with cut outs to hold panels in a module of 100mm minimum at maximum 1.6 m c/c carrier suspended from roof by 4mm diameter galvanized steel wire rod hangers with special height adjustment springs/clips made out of spring steel at maximum spacing of 1.5m c/c. The system is to be got approved by purchaser before installation.

1.29.2 DOORS AND WINDOWS

(Not applicable)

The details of doors and windows of the control room building shall be as per finish schedule Table-1 and relevant code. Rolling steel shutters and rolling steel grills shall be provided as per layout and requirement of buildings. Paints used in the work shall be of best quality specified in as per relevant code in Afghanistan.

1.29.3 PARTITION (Not applicable)

Partition made of anodized aluminum frame provided with 5.5 mm thick clear glass shall be supplied and installed between relay area and control room.

1.29. B plumbing & sanitation (Not applicable)



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a) PLUMBING & SANITATION. (Not applicable)

PVC pipe shall be used for external and internal sewer system conforming to international standards for external pipe and Sch-40 for internal pipe.

All Plumbing and sanitation, installation, design etc. must be as per international code like IPC
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(i) All plumbing and sanitation shall be executed to comply with the requirements of the appropriate bye-laws, rules and regulations of the Local Authority having jurisdiction over such matters. The Contractor shall arrange for all necessary formalities to be met in regard to inspection, testing, obtaining approval and giving notices etc.

(ii) Galvanized MS pipe of medium class conforming to relevant International standard shall be used for internal & external piping work for potable water supply.

(iii) Sand, CI pipes with lead joints conforming to relevant international standard shall be used for sanitary works above Ground level.

(iv) Each toilet shall have the following minimum fittings.

- Soil, waste and drain pipes, for underground works shall be stone ware for areas not subject to traffic load. Heavy duty cast iron pipes shall be used otherwise.

SPECIFICATION FOR ROADS AND CULVERTS

((Not applicable))

a) All roads shall be concrete road (rigid) pavement. Adequate turning space for vehicles shall be provided and bend radii shall be set accordingly. Road to the transformer shall be as short and straight as possible.

b) Relevant international standard shall be followed for construction of Roads.

c) Cross section of the road shall be as per drawings enclosed with the tender documents.

1.30.1 Cement

The type of cement to be used shall depend on the constructional circumstances and on the prevailing local conditions.

Ordinary Portland cement, ASTM C-Type I, may be used at places not exposed to chemical aggressiveness. Moderate sulphate resistant cement and highly sulphate resistant cement shall be used as per the recommendation of the soil investigation reports and written approval of Engineer and the Employer. No extra payment will be made to the Contractor for the use of sulphates resistant cement.

Cement shall be delivered to the site in bulk cement containers or in sealed bags clearly marked with the maker's name and shall be carefully stored in a waterproof shed with a raised floor or in a silo of approved design. Each consignment of cement shall be stored apart from earlier consignments and the cement shall be used in the order in which it is delivered.

The Contractor shall ensure that a certificate accompanies each consignment from the manufacturer certifying that the cement in that consignment is in accordance with the Specification. Weathered or congealed cement, or cement more than three (3) months old after production, shall not be permitted to be used unless otherwise approved by the Engineer after the quality test.

Cement shall be stored in a suitable weather-tight enclosure on a board platform raised off the ground. The enclosure should be such that free circulation of air around the bags of cement is kept to a minimum.



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Any cement that has become damp, caked or lumpy shall not be used. Concrete batching operations shall be organized so that cement that has been manufactured first is used first.

Each consignment of cement may, after delivery to the site and at the discretion of the Employer, be subjected to the whole of the tests and analyses required by the standard Specification.

The Employer may reject any cement as a result of any tests thereof, notwithstanding the manufacturer's certificate. The Contractor may also reject cement which has deteriorated owing to inadequate protection or other causes or in any other case where the cement is not to his satisfaction. The Contractor must remove all rejected cement from the site without delay and expenses for the Employer.

The Contractor shall arrange for these tests to be carried out at his own expense.

1.30.2 Aggregates

All aggregates to be used for the Works shall be crushed rock type complying with the requirements of BS 882 or equivalent in all respects and shall be subject to the tests laid down in BS 812 or equivalent. The Contractor shall furnish to the Engineer samples of both the proposed fine and the coarse aggregates, together with such full details as the Engineer may require. No aggregates may be used in the Works until approved by the Engineer.

During the work, the Engineer shall order such tests he may consider necessary on the aggregates; any aggregates found to have unsuitable characteristics at any time shall not be used in the Works and shall be removed from the Site. Aggregates are subject to the Employer's approval.

The various fractions of fine and coarse aggregates shall be stored separately and in such a manner as to avoid the admixture of dirt in the concrete. Aggregates shall be handled in such a way that separation is avoided.

Maximum size of aggregate used in concrete shall not be more than 20 mm. The combined aggregate shall be as coarse-grained and dense-graded as possible. Fine and coarse aggregates shall be stored so that they are kept clean and free from contamination and are not subjected to segregation. Where a clean hard surface is not available for the stockpiles, the bottom 150 mm of the aggregate piles that are in contact with the ground shall not be used.

1.30.3 Grading of Aggregates

The grading of the fine and coarse aggregates shall be such that when they are mixed in the proportions decided for each class of concrete, the grading of the combined aggregate shall be suitable for making dense concrete of appropriate workability, containing the proportions of cement and water prescribed.

The proportions of fine and coarse aggregates and the maximum size of the coarse aggregate to be used in each class of concrete shall be approved by the Engineer.

The Contractor shall be responsible for mixing the aggregates in the proportions approved by the Engineer for each class of concrete and each section of the work. He shall submit samples of the concrete material to the Engineer and the Employer well before starting any concrete work, and have test cubes made and tested from the aggregates and the cement which he intends to use. Concrete works must not begin until such samples and tests are to the Engineer's satisfaction.

Fine aggregate (sand) shall consist of clean material or manufactured sands and coarse aggregate shall consist of clean gravel, crushed gravel or crushed stone. Both the fine and coarse aggregates shall comply with ASTM C33. Sulphate and sulphide shall be in such quantities that the whole proportion, in Sulphur trioxide, be less than 1 percent of the mass. Prohibited aggregates include:

- Feldspathic or schistose rock

- Aggregates containing charcoals or their residues such as coke, ashes, clinkers, finders.

1.30.4 Water

The water to be used for mixing and curing of concrete shall at all times be kept clean and free from deleterious materials such as oil, acid, alkali, silt, etc. which effects to the cement, aggregate or the steel reinforcement. Water chemical analysis tests shall be carried out before commencement of foundation works.

1.30.5 Admixtures

No admixtures shall be used without written approval of Engineer and the suitability of admixtures must be proven in trial mixes in presence of representative of Employer. If required to improve the quality of concrete (workability, finish and water tightness), water reducing and set retarding agents and plasticizers shall be used in accordance with ASTM C-494. Under no circumstances shall calcium chloride or any admixtures containing calcium chloride be permitted in the concrete.

Manufacturer's recommendations and instructions concerning overdosing of additives shall be strictly observed and mixture containing chlorides shall not be used under any circumstance.

1.30.6 Concrete Mixing, Placing and Compaction, Protection and Curing

Mix Design

Full details of the components forming the concrete mix proposed to be used by the Contractor shall be submitted to the Engineer for assessment least one (1) month before any concreting Operations are commenced. Once the proposed mix has been approved by the Engineer, it shall not be varied by the Contractor unless the Engineer's prior approval has been obtained. No concreting shall be commenced in any portion of the work until the preparations and the Concrete mix design have been approved, and permission been granted by the Employer.

The required minimum concrete class is a C 25 as per BS standard. The mix design of the concrete has to be approved, and its suitability proven in trial mixes at site. In case of use of ready mixed concrete, trial mixes may be waived if an earlier proven mix design is used.

The concrete mix shall be designed and tested and their submission shall include the following information:

- Source, nature and grading of both the fine and coarse aggregates
- Type and supplier of the cement to be used
- Proportions by weight of both the fine and coarse aggregates
- Weight of cement per cubic meter of concrete
- Water-cement ratio by weight
- Estimated slump of the mix
- Arithmetic mean compression strength of the mix at 7 days and 28 days using cube compression test samples, plus the standard deviation of the test strengths and the number of cubes tested.

Any admixtures specified for inclusion in the concrete mixes or that the Contractor intends to use in his mixes (and they have had the prior approval of the Engineer) shall be included in these trial mixes. The ratio of the weight of fine aggregate (sand) to the total weight of aggregates shall be between 0.35 and 0.50. The minimum cement content shall be 350-400kg/m³ and the maximum water cement ratio by weight shall be 0.45.

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The Contractor shall allow for the cost of all such testing in his Tender as well as any further testing and additional reporting that the Employer/Engineer may require.

Mixing of Concrete

All concrete shall be mixed in power driven mixers, approved by the Engineer. If required in some locations (i.e., a mixing machine transportation problem), volume basis will be allowed as long as careful controls are maintained and written approval from the Engineer has been received. The concrete materials shall be accurately measured to ensure the production of uniform batches of concrete. The Contractor will be required to proportion the materials by weight at all times. If Required, the materials may be measured by volume and the proportions in each batch adjusted to suit whole bags of cement after getting written approval from the Engineer. Only unbroken bags of cement may be used. Bags of cement that have partially set, contain any lumps, or have become wet at any stage shall not be used.

Volume measurement shall be carried out using well-proportioned gauge boxes. Under no circumstances will the volumes be proportioned by shovels. The gauge boxes shall be loose-filled with the material being measured then struck off level with a straight edge then discharged into the mixer. The required volume of mixing water shall be adjusted to allow for the free moisture contained in the aggregates. Personnel in charge of the concrete mixing operations shall be trained and experienced in this method of concrete production.

The batch mixture shall be rotated at a speed recommended by the manufacturer and all concrete shall be mixed for a minimum of 1½ minutes from the time the last of the materials have been placed in the mixing drum. The mixing shall continue until the materials are thoroughly and uniformly mixed and the concrete is uniform in color and texture. The entire batch must be discharged from the mixer before recharging commences. Each batch of concrete shall have a similar appearance. The slump of the concrete shall normally be between 25mm and 50mm corresponding to a stiff, plastic consistency.

All plant for mixing shall be cleaned and free from all dirt and debris. All mechanical equipment (mixture, vibrator, etc.) and the stock of construction material (cement, aggregate and sand) shall be checked before starting a concrete pour to ascertain whether or not it is in good operation condition and sufficient in quantity for the foundation work. The Contractor shall always have at least two vibrators in operating condition at the location of the concrete placement.

In hot weather conditions, various means should be employed to lower the temperature of concrete as:

- Using cold water; the use of ice is to be limited to chill the mixing water, but no ice is to be used during batching.
- Avoiding the use of the hot cement
- Insulating water supply lines and tanks
- Cooling coarse aggregate
- Shading and/or cooling mixer drums
- Adequately watering of sub-grade, formwork and reinforcement
- Avoid concreting around midday
- The temperature of fresh concrete must in no case exceed +30°C

Placing and Compaction of Concrete

Concrete shall be conveyed from the mixer to molds by a method that prevents segregation or loss of the ingredients. It shall be placed as nearly as practicable in its final position to avoid segregation due to re-handling or flowing.

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The placement of concrete shall be at such a rate that the concrete is at all times plastic and flows smoothly, ensuring that the concrete in its final position shall be dense and homogeneous.

The placement of concrete in the molds shall be completed within ½ hour after the introduction of the mixing water to the cement and the aggregates in the concrete mixer. Batches in excess of 30 minutes of mixing the concrete shall be rejected and replaced by fresh concrete without any extra cost to the Employer. Each formwork shall be filled with concrete as a continuous operation. The written approval is required for construction (working) joints, if required.

Concrete shall be placed and compacted/vibrated in horizontal layers of not more than 300 mm thickness each and vibrators and other compacting equipment shall be to the satisfaction of the Engineer.

An appropriate method must be adopted by the Contractor to prevent separation of concrete when placing concrete in the foundations with a fall over 1 meter.

Protection and Curing

Cement-based repairs may require some initial protection, because rapid drying could halt the Hydration of the cement and lead to shrinkage cracking, de-lamination and weakness.

Careful curing is essential by covering with absorbent material that is kept damp, preferably covered in turn by polythene or similar sheets, which are sealed at the edges. Shading from the sun may be necessary. Importantly, alternate wetting and drying must be prevented because of the alternating stresses that it would cause.

If repairs are to be carried out during hot weather, it is advisable to shade the work from direct sunlight in order to prevent drying out of cement-based repairs or over-rapid stiffening of resin-based materials.

Requirements for curing large volume repairs are similar to those for new construction. Although they are less critical in this respect than thin patches, curing is important to a durable result. Normal curing methods are usable except that sprayed-on curing membranes are suitable if a surface coating is to be applied later.

During the initial stages of hardening, the concrete shall be protected from the direct rays of the sun and from drying winds. The formworks containing the hardened concrete shall not be disturbed or give external forces.

To ensure proper curing, all concrete shall be kept moist for a period of at least 10 days. Foundations shall not be backfilled before they have been cured and inspected. The foundations shall not be subjected to any loads in addition to those existing at the time of the placing of the foundation concrete until the curing period has elapsed. Curing compound membranes shall be applied uniformly by spray, leaving no pinholes or gaps, at a rate not to exceed 4.91kg/m²/liter. The curing compound shall be applied after finishing operations are completed and surface moisture has disappeared.

1.30.7 Ready-mixed Concrete

Ready-mixed concrete may be used in the Works, provided that adequate control is maintained of the supply, mixing, and placing of the concrete.

Concrete shall be placed and compacted in its final position within 90 minutes of the water being added to the mix. If the Bidder/Contractor proposes the use of pumps for the transporting and placing of concrete, he shall submit a detailed method statement. The Contractor shall ensure that pumping shocks shall not be transferred from the pipeline to the form-work, to previously laid concrete or to the structure. The initial discharge of any pumped concrete shall be discarded completely.

1.30.8 Steel Reinforcement

The steel reinforcement shall consist of hot rolled deformed bars conforming to the requirements of BS 4449, Grade 460 or its equivalents IEC standards. The specific number, type and location of ridges on the deformed bars shall be approved by the Engineer and the Employer.

The number, placing and fixing of bars shall be in accordance with the drawings and approved bar bending schedules, or otherwise, as directed by the Engineer.

All reinforcing bars shall be bent in accordance with the relevant standard. In particular, no reinforcement shall be heated. All reinforcement shall be rigidly fixed in position to the concrete cover specified by an approved means.

All chairs, tie-wires or other devices used to connect, support, secure or fasten reinforcement shall be provided as per the requirement and as directed by the Engineer.

All reinforcing bars shall be stored in a clean, dry place on platforms off the ground. Grease, oil, paint or any other substance that will affect the bond of the reinforcement shall not be allowed to come in contact with the bars. All such substances shall be cleaned off the reinforcement before it is placed for concreting.

All reinforcing bars shall have a protective cover of not less than 100 mm at the bottom of footings and on any surface of concrete that will be exposed to salt water and 50 mm for concrete exposed to weather or soil.

1.30.9 Formwork

The Contractor shall be entirely responsible for the design and construction of the formwork to be used for concreting.

The formwork shall have sufficient strength to withstand the pressure resulting from placement and vibration of the concrete, and shall be maintained rigidly in position.

All form-works shall be of such tight construction that slurry cannot flow out at the joints during pouring and compaction. If required, joints shall be sealed with foam rubber strips.

No concrete shall be placed until the Engineer or his representative has examined and approved the formwork.

1.30.10 Surface Finish

Unless otherwise shown on the drawings, all permanently visible concrete surfaces shall have a regular finish of uniform texture free from holes, pins and formwork.

Should any section of the concrete present a rough, uneven, honeycombed discolored or imperfect appearance when the shuttering is removed, it shall be chiseled to such a depth and refilled and properly refaced with such class of concrete as the Employer may direct.

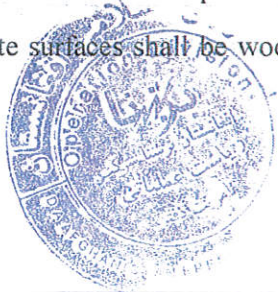
In the event of excessive porosity being discovered, the defective area shall be chiseled and made well as specified above, all at Contractor's cost. No plastering of such concrete areas will be permitted.

Concrete foundation edges above the ground level and 300mm below the ground level shall be beveled by inserting 25mm triangular edges in the formwork.

Concrete foundation tops shall be designed and finished to prevent the accumulation of water.

Concrete surfaces shall be wood float or steel trowel finished as specified on the Drawings or

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Instructed by the Engineer. All finishing works shall be carried out in accordance with the Relevant specification of British Standard and to the satisfaction of the Engineer.

All concrete foundations shall be treated with an asphaltic or equivalent coating in order to be acid-resistant. The surface to be covered must be perfectly clean. The coating shall be applied on the formed surface of the foundation with a layer at least 2mm thick.

The required protective painting of foundations shall not be executed till the end of the curing period to obtain a completely dry surface. Painting shall be done according to the specifications of the supplier.

1.30.11 Fixing of Steel Structures

Where shown on the drawings or as directed by the Engineer, steel items shall be embedded directly in correct positions in primary concrete. All brackets, anchor bolts and other steel items, for which recesses in concrete have been made, shall be fixed by secondary concrete after careful alignment to correct positions.

1.30.12 Testing of Concrete

The Contractor shall design and test concrete mixes, which have 28 days cubicle compressive strength of 28Mpa.

All testing of concrete shall be carried out in accordance with the requirements of BS 5328/IEC: Part 4 and BS 1881/IEC. During the placing of concrete for each section of the work and at such other times as directed by the Engineer and the Employer, quality certificates of all materials shall be submitted and 3 sets of test cubes, size 15cm x 15cm x 15cm, shall be taken, each set consisting of 6 cubes. From each set 3 cubes shall be tested after 7 days and the remaining 3 cubes after 28 days. The compressive strength of the cubes shall not be less than 25N/mm² after 28 days.

Consistency and bleeding test and such other preliminary tests as the Engineer may direct, shall be taken as often as directed by the Engineer or Employer.

No concrete of any type or class shall be used in the Works before the preliminary tests have shown specified compressive strength and workability.

All test cubes shall be well marked and cured as specified.

1.31 Maintenance Tools and Plant

The Contractor shall include and supply all tools and plant with latest calibration certifications that are required for the normal operation and maintenance of the equipment being supplied under the Contract. All tools and plant shall be subject to the inspections and/or tests on the functions specified in the Supply Requirements and guaranteed in the approved drawings.

Instruction manuals of tools and plant shall be submitted for approval in the same manner as the installation operation and maintenance manuals and when finally approved, one original and three copies shall be prepared and forwarded to the Employer.

Each tool and plant item shall be clearly marked with its size and/or purpose and shall be packed in the appropriate box with three (3) sets of an operation and maintenance instruction book. All nameplates, duty labels and instruction plates on tools and appliances shall be marked in English.

1.32 Auxiliary Electrical Supply

The Contractor shall be entirely responsible for providing auxiliary electricity supplies needed on Site for construction and commissioning.

1.33 Temporary Site Installation

The Contractor shall be entirely responsible for providing all temporary site installations of every kind that may be required for carrying out the works including the facilities concerning office, living accommodation, fenced storage areas, lockable sheds, installations for supply of industrial water, power and compressed air, etc. The Contractor shall plan all temporary site installations required for the works to the approval of the Engineer. After completion of the work, such temporary installations are to be removed and the site left clean.

All costs for the construction and/or supervision and the removal or handing over to the Employer of all temporary site installations shall be deemed to have been included in the price schedules.

1.34 Running Costs

The Contractor shall be entirely responsible for the running and maintenance costs throughout the period when the site works are being carried out, including all temporary site installation works.

The costs for running and maintaining the temporary site installations together with other running costs necessary for the satisfactory execution of the works shall be deemed to have been included in the price schedules.

1.35 Social Safeguards

The Contractor shall minimize the locations of transmission towers in agricultural and populated areas. Where routing of transmission towers across agricultural and populated areas is unavoidable, the tower locations shall be positioned to completely avoid houses, structures, and interference with social and cultural assets.

The Contractor's detailed line route design will be reviewed and approved by the Employer in consultation with any affected people, after verification of its land acquisition impacts.

1.36 Geotechnical Investigation (if required)

1.36.1 Scope of Work

The scope of work includes obtaining permits, licenses, obtaining underground utility clearances, performing soil borings, perform rock coring where appropriate, performing index, strength, and soil resistivity tests and providing the engineering report.

1.36.2 Definitions

ASTM – American Society of Testing and Materials specifications, latest revision.

Boring – Excavation four to eight inches in diameter made with a drill rig for the purposes of testing for engineering properties.

Drill Rig – A general term for portable machinery consisting of a derrick, power supply, draw works, hammer drop system, augers, drill-rod, bit, and other equipment necessary for geotechnical drilling and having the capability to advance borings to a depth of twenty-five meters and perform SPT, thin-walled (Shelby tube), and rock core sampling.

Contractor – the Company under contract to the Engineer or Employer to provide drilling, laboratory testing and other geotechnical engineering services for the project under the direction of its geotechnical engineer.

SPT – Standard Penetration Test, for driving a split-barrel sampler to obtain a representative soil sample and a measure of the penetration resistance of the soil as defined under ASTM D 1586.

USCS – Unified Soil Classification System

1.36.3 Right of Entry

The Employer or Engineer shall delineate the access and define the access restrictions to each boring location.

1.36.4 Environmental Protection

The Contractor shall comply with all applicable regulations pertaining to the protection and preservation of the environment. The Contractor shall get authorization from the Employer to clear any materials, or make any improvements whatsoever, to facilitate access to each boring.

The Contractor shall return the ground to as near original condition as possible and remove rubbish, unused materials, and other material belonging to him, or used under his direction during the performance of this work.

The Contractor shall avoid crossing, entering into, or working in any environmentally sensitive areas.

1.36.5 Responsibility for Damages

The Contractor shall exercise due care in driving and in the execution of the work, on public and private property. The Contractor shall be responsible for all excess damages to property incurred by Contractor.

1.36.6 Locating Underground Utilities

The Engineer shall indicate the boring locations. The Contractor shall coordinate with all underground utilities to locate and mark any underground utility in the vicinity of each boring location prior to initiating any drilling activities. Minor offsets, as approved by the Engineer, are acceptable to provide a safe working clearance for any utility, whether underground or overhead.

1.36.7 Equipment and Procedure

The field testing programs shall consist of drilling the borings as shown on the Boring Location Plan, and obtaining suitable soil samples for laboratory analysis. The field testing program shall

all be performed with a truck-mounted Drill Rig, under the direction of the geotechnical engineer. Field work shall include penetration testing, split barrel and /or thin-walled tube (Shelby tube) sampling, and rock coring where applicable. Penetration testing and split barrel sampling shall conform to ASTM D 1586 using a two-inch (2") O.D. sampler. Thin-walled tube sampling shall conform to ASTM D 1587. Rock coring shall conform to ASTM D 2113 using a 2 to 2-1/2 inch I.D. "N" series core barrel. Rock core samples shall be prepared and transported to the soil/geotechnical testing laboratory in accordance with ASTM procedure D 5079.

Soil Samples shall be sealed in air/water tight containers, handled carefully to avoid disturbance, and delivered promptly to the soil/geotechnical testing laboratory.

All drill pipes, drilling tools, auger, etc. shall be free of potentially contaminating materials (i.e. oil, grease, paint, microbes, etc.). The rig shall be free of leaks, which could contaminate the holes or site (i.e. hydraulic fluids, oil, gas, loose paint, etc.).

1.36.8 Test Borings & Field Work

A minimum of four (4) borings are to be performed at each SVC site. Borings shall be drilled to a minimum depth of six (6) meters for shallow foundations, eleven (11) meters for standard drilled piers, and fifteen (15) meters for dead end drilled piers. Soil samples shall be obtained at intervals of one and a half (1.5) meters or less to allow accurate logging of the soil nature, thickness and characteristics and to obtain material for geotechnical testing. Sampling shall include penetration testing, split barrel and /or thin-walled tube (Shelby tube) sampling, and rock coring where applicable. Rock sampling shall be obtained on a continuous basis.

1.36.9 Soil

The Contractor shall log the borings on a continuous basis during drilling. Soil shall be visually classified in the field using the USCS in general accordance with ASTM D 2488. A record of SPT blow counts shall be made. The following characteristics shall be noted in the sequence presented below for each soil type encountered:

- Soil Type Primary, Secondary (i.e. LEAN CLAY, sandy)
- Color Primary colors only
- Consistency/Density Using blow count
- Plasticity Visual observation
- Moisture Visual observation
- Grain Size Distribution Note the presence of boulders
- Any Other Features Such as mineralization, organics, odor, lack of bedding or structure, etc.

1.36.10 Rock

If rock is encountered during field sampling, the Contractor shall be required to obtain rock core samples. Continuous cores shall be obtained, labeled, and stored in appropriate core boxes. The logs shall indicate size and type of coring equipment (coring bit and barrel). Rock materials shall be described by the Contractor in the sequence described below and in accordance with standard geologic nomenclature, including:

- Rock Type
- Relative Hardness
- Density
- Texture
- Color
- Weathering
- Bedding
- Fractures, Joints, Bedding Planes, and Cavities (including any filling material and whether open or closed)

- Rock Quality Designation (RQD)
- Percent Recovery
- Start and Stop Time of Core Run
- Length of Core Run
- Other Descriptive Features (fossils, pits, crystals, etc.)

1.36.11 Groundwater

Observations of groundwater shall be recorded on the boring log(s) by the Contractor. Logs shall identify the depth, date and time at which water is first encountered the depth to water at the completion of drilling and the stabilized depth to water. The logs shall indicate any and all observed seepages within the boring. If free groundwater is not observed within the boring, it shall be noted. The presence of surface waters including drainage ditches, canals, rivers, and/or lakes in the immediate vicinity of the boring location shall be recorded. Any evidence of artesian water, perched water, or loss of drilling water shall be reported.

Upon completion of each boring to the required depth, the groundwater level shall be recorded. The groundwater level shall be recorded again after twenty-four (24) hours. The Contractor shall fill each boring hole after performing the required work. After being filled, each boring locations shall be marked with a wooden stake, which shall give the boring number. Boring holes shall be covered until filled.

1.36.12 Resistivity Testing

Field in-situ soil resistivity measurements shall be conducted at the Chimtala and Kandahar East Substations. The testing will be carried out using a high-impedance, earth resistivity meter and 18" stainless steel, non-polarizing electrodes (also known as "stakes" and "pins").

A total of two (2) test locations will be placed on site. The measurements will be conducted as outlined in Soil Resistivity Testing below:

Soil resistivity shall be measured using the "Wenner Four-Pin" Method in accordance with IEEE Standard 81, IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Ground System. In the Wenner method, measurements are conducted at three equal spacing with four probes in a line or traverse. The four probes are designated as an input current probe C1 as the first pin, two internal probes, P1 and P2 which is a measure of the voltage for each spacing and the Second outside pin is C2, the return current probe.

Measurements shall be conducted up to a largest probe spacing that is equivalent to the maximum dimension of the substation if possible. If the largest spacing is not possible due to problems with adequate area or obstructions that interfere with the measurements, then a spacing should be chosen as close as possible to a distance which can be achieved. For example, if the maximum dimension of the substation is 750 feet but due to space restrictions, three equal spacing of 750 feet are not possible, it is decided that a maximum spacing of 500 feet can be measured. Then this becomes the largest spacing.

The recommended probe spacing between one (1) and 200 feet are shown below. For probe spacing greater than 200 feet, the recommended incremental distances shall be fifty (50) feet up to 500 feet and 100 feet greater than 500 feet. 25, 2.5, 5.0, 7.5, 10, 15, 20, 25, 30, 40, 50, 60, 80, 100, 120, 140, 160, and 200 feet.

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After conducting a first measurement traverse as described in Step 2, a Second measurement should be performed perpendicular to the first traverse. The purpose of this second measurement is to make comparisons in the soil structure in two different directions within the area of the facilities. The second traverse should be conducted for the same probe spacing as the first traverse or as many as possible. In order to conduct the two perpendicular traverses, it is recommended that the potential probe designated as P1 is selected as the fixed probe for both traverses and the other probes are laid out from this pin. The perpendicular traverse would be performed with the three probes of the second traverse being laid out 90o from the first traverse at the P1 pin location.

The instrument selection is important for this measurement. The "Measuring Techniques" page identifies a Biddle Det2/2 which is a capable device for these measurements. If the measurements are to be conducted in high resistivity soils (such as the desert with dry sand or mountain terrain with a high concentration of rocks), or there is anticipation of large amount of 50 Hertz interference, another instrument may be required which is capable of transmitting a larger amount of power and is immune to the interference. This should be discussed with Engineer to determine which instrument is appropriate.

The measurement results shall be recorded in tabular form as illustrated in the table below. In order to determine the resistivity, for this table, it is necessary to calculate a conversion factor. The conversion factor is as follows:

$$I = 2 \times I \times R$$

Where "a" is the measurement spacing (in meters) and "R" is the measured resistance value.

Test Point	Probe Spacing Meters	Resistance	Reading	Resistivity (Ohm
1				
2				
3				
4				
etc.				

On the datasheet, additional information that should be recorded includes; the date and time of the measurement, the persons conducting the measurements, the instrument that was used, and the weather conditions. A sketch of the area and the layout of the test probes should also be provided (see below).

The apparent soil resistivity will be plotted against the probe spacing during the actual field measurements to detect anomalies in the readings. This will allow corrective action to be taken immediately during the field measurements and will enhance the confidence factor in the recorded data.

One of problems with measurement values where resistance is too high (this becomes apparent when the instrument indicates a high resistance value or the measurements indicate an unusually high

value abnormal from the trend in measurements).

This can be corrected by two possible methods (but not limited to these methods); adding salt water (which should be included as one of the items for the measurement trip) to each probe, or adding additional pins connected to the C2 current probe or the P2 potential probe.

This is done by connecting additional electrodes (pins) perpendicular to the existing C2 or P2 pin (where the resistance is high) until a satisfactory reading is obtained. Please confer with Engineer for additional information.

A sketch of the test layout, to include a North Arrow, and the test/site conditions will be recorded.

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All field testing shall be performed under the direction of the Contractor's registered geotechnical engineer. During field testing and sampling a continuous log shall be maintained as well as visually classifying the subsurface soil and/or rock. Logs shall show borehole and sample diameters and depths at which drillings or sampling methods or equipment change. Logs shall show total depth of penetration and sampling. The bottom of the hole shall be clearly identified on the log with notation "Bottom of Hole" or "Total Depth". Logs shall show drilling fluids, drilling equipment make and model, drilling method, date and time drilled, casing, any heaving conditions, loss of circulation, voids, or any other conditions observed during drilling.

Any special drilling or sampling problems shall be recorded on the logs, including resolutions. Any indications of contaminations (i.e. staining, odors, etc.) shall be noted.



1.36.14 Laboratory Testing Program/Procedure

All laboratory testing shall be performed in accordance with current applicable ASTM standards and procedures under the direction of the Contractor's registered geotechnical engineer. The laboratory shall have the general capability for soil and rock testing as indicated in ASTM D 3740, "Evaluation of Agencies Engaged in the Testing and/or Inspection of Soil and Rock as used in Engineering Design and Construction". Laboratory tests shall be made to provide data for the classification of the soil and rock encountered in the field and for the prediction of their engineering behavior when used as construction materials or for the support of the structures at the site. In general, the Contractor shall perform all of the laboratory tests that will be necessary to complete an engineering analysis performed by the registered geotechnical engineer.

Index Testing

Index testing including, but not limited to, dry density, moisture content, gradation shall be performed as directed by the Contractor's geotechnical engineer to adequately classify the soil in accordance with ASTM D 2487 and evaluated subsurface conditions.

Strength Testing

Strength testing shall be performed on undisturbed and/or relatively undisturbed soil samples to determine cohesion, angle of internal friction, shear strength, soil modulus parameter, and stress-strain modulus. Shear strength testing may include, but not be limited to, Triaxial Compression Tests UU, CD, or CU, direct shear, and/or consolidation testing. Uniaxial compression of rock specimens for determination of uniaxial strength and shear modulus shall be performed as directed by the Contractor's geotechnical engineer to complete the engineering analysis and develop foundation design criteria.

Supervision and Records

All laboratory testing shall be performed under the direction of the Contractor's registered geotechnical engineer. Records shall be maintained of when samples were received and when testing was performed to assure that in-situ moisture conditions are maintained prior to testing.

Deliverables

Copies of the laboratory test data and final results shall be submitted to the Contractor's geotechnical engineer for analyses and report.

1.36.15 Engineering Analyses and Report

Deliverables

Based on the results of the field work and laboratory testing, the Contractor will prepare a formal written report which provides recommendations for site development and foundation design as well as any applicable construction procedural recommendations. Said report shall be certified by the Contractor's registered geotechnical engineer certified in the state in which the work was performed and shall include, but not limited to, the following recommendations:

- Site plan showing boring locations
- Detailed log of borings including N values and ground water levels.
- Summary of laboratory test data, including but not limited to soil unit weight, in-situ moisture content, internal friction angle or cohesion, liquid limit, plastic limit and plasticity index.
- Discussion of surface and subsurface soil and groundwater conditions (if encountered)
- Recommendations for site preparation parameters

- Discussion shall be given to top soil stripping, cut and fill slopes, reuse as cut materials in fill, site drainage, structural fill material and compaction, shrink and swell factors.
- Recommendations for suitable foundation type(s)
- Recommended foundation design parameters including allowable soil bearing, anticipated settlement, active and passive soil pressures, coefficients of friction between soil and concrete foundations, and all necessary parameters to be used within a foundation design program
- Feasibility of excavation techniques
- Suitability of on-site soils for use as compacted backfill
- Geologic characteristics of the site relevant to proposed construction
- Seismological data for the area of the site

Soil resistivity in ohm-meters to be provided as a separate report

Two (2) copies of the geotechnical report and resistivity test results shall be submitted along with all associated boring logs and tabular data to Employer and Engineer.

1.37 SPECIAL TOOLS AND TACKLES

The bidder shall include in his proposal the deployment of all special tools and tackles required for erection, testing, commissioning and maintenance of equipment. In addition to this, the Contractor shall also furnish a list of special tools and tackles for the various equipment in a manner to be referred by the Employer during the operation of this equipment.

1.38. CONSTRUCTION POWER & WATER

The contractor shall make his own necessary arrangements for construction power at his own cost. However, he may avail metered power as per the availability in the DABS system.

The contractor shall also make his own arrangement for construction water supply at his cost and the Employer shall in no case be responsible for any delay in works because of non-availability of water and Electricity. However, the contractor can utilize the water in the existing substation compound for construction works as per the availability.

1.39. WARRANTY

The Contractor is to guarantee the efficient and satisfactory working of the plant erected under the Contract for a period of twelve (12) months from the date on which the Employer takes over the plant in accordance with the General Conditions of Contract.

1.40. SPECIFIC REQUIREMENTS

1.40.1 General

(a) The bidder shall be responsible for safety of human and equipment during the working.

It will be the responsibility of the Contractor to coordinate and obtain clearance from DABS, before starting activities. Any additional items, modification due to observation of such statutory authorities shall be provided by the Contractor at no extra cost to the Employer.

(b) All Isolators shall be local/remote motorized Center Break Double rotating type with provision for manual operation.

(c) All the equipment to be supplied for the new bay shall be suitable for operation under prescribed conditions.

(d) The DC control is 220V. All the equipment supplied must suit this voltage.

(e) The successful Bidder will be required to maintain sufficient qualified and experienced personnel at the site to provide hands on training to employer's personnel in the O&M practices as followed internationally.

(g) Lighting System

The bidder shall provide light fittings for the New Bay in order to have sufficient lighting for the Equipment of the Bay.

(h) Laying of Power Cables

Cables shall be generally laid in accordance with IS 1255-1983 (Code of practice for installation and maintenance of power cables up to and including 33kV rating) or any other applicable international standards. Depth of laying shall be 1.2 meter (minimum) or as per Standard in cases of power cables buried directly in the ground. The metal sheath/ armor of cable shall be efficiently earthed at both ends. Sand bedding, back fills, warning tapes, cable protection corners (bricks) etc shall be provided en-route for all circuits as per Section-Switchyard Erection.

(h) Training of Employer's Personnel

The contractor shall organize and conduct complete and through on the job training program (to be conducted in English language) providing necessary training material, at no extra cost to the Employer. However, the traveling and living expenses of owner's personnel, if any, shall be borne by Employer.

The duration of the training shall be as follows:

Operation, maintenance and commissioning aspect for 2 (two) persons at site as per following

Control and protection: 3 days

1.40.2 Specific Requirement for Civil Works

a. Execution of Works

b. The civil works shall include all necessary supply of equipment and materials, design, construction, excavating, Backfilling, filling etc. to complete a functioning substation. The civil works shall include the following main parts: (if required)

- Forming of the site to ensure correct surface drainage.
- Leveling and compacting of bay area.
- Gravelling of the complete bay area.
- Install drainage system for the new bay area.
- Excavation and backfilling as required.
- Construct fences and gates for the Capacitor Bank (if required).
- Construct concrete foundation for all apparatus.

- Construct steel structures and apparatus supports as required.

c) Leveling of Site (if required)

Any soft soil or other material unsatisfactory for the leveling work shall be excavated and removed from the Site. After the bulk excavation and the filling and compacting works have been carried out, the Contractor shall remove any remaining high spots and fill in any depressions so that before the commencement of any construction work, the whole of the area has been leveled to the requisite ground level to the satisfaction of the Employer.

d) Setting Out

Before any excavation or filling work begins, the Contractor shall set out accurately all excavation and filling lines according to the drawings and shall satisfy himself as to the correctness of all site levels shown on the drawings. During the work, the Contractor shall ensure that the excavation and filling follow the said lines and the Contractor shall set out as necessarily as the works precede, profiles and other markers for leveling purposes and he shall be in agreement with the Employer about the levels of the said profiles and markers.

e) Excavation

The Contractor shall excavate the ground to the lengths and widths and exact depths as indicated on the drawings required for the construction of the works. In cases where the bearing capacity of the subsoil under foundations or roads is insufficient, the excavation shall be continued to such greater depth as may be necessary. Based on the existing ground water level, the foundations shall not be deeper than necessary. All excavation may be carried out mechanically, but the final shaping and trimming of the sub-grade below foundations, etc. shall be done by hand. The Contractor shall handle and remove as necessary all water from a whatsoever source which may come into the excavations and he shall provide, maintain, and remove on completion all planking, strutting, shoring or piling required to support the sides of the excavation.

The Contractor shall report all cases of unsuitable or weak ground to the Employer and shall follow the instructions given by the Project Manager during the excavation works. If due to negligence or mistakes on the part of the Contractor any excavations be taken to a level lower than that shown on the drawings or stated in the specification or required for the works, the Contractor shall at his own cost fill in the voids so formed to the proper level with approved fill material well compacted or, if necessary, under foundations and the like with approved blinding concrete.

f) Filling and Compacting

Filling of areas and around foundations and backfilling of trenches shall be executed in such a way and to such extra depths as will ensure that final surface after settlement and compacting conforms to the specified levels. All filling material shall be free from cinders, ashes, refuse vegetation or organic material, boulders and other unsuitable material.

All fill material shall be well compacted by mechanical means until a high degree of compacting is obtained. The filling material shall be placed in even layers of a depth not greater than 0.4 m and each layer shall be thoroughly compacted. A suitable power-driven roller of at least 5 tons weight, making at least 10 passes for each layer shall be used. For backfilling of narrow and steep sections, the thickness of each layer shall be maximum 150 mm, each layer being compacted to required density by using a



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vibrating plate compactor. Filling and compacting around any pipes, cables or ducts shall be done by hand using selected materials for a depth of at least 0.5 m above such pipes, cables or ducts.

The Employer's instructions regarding the addition of water to improve compacting of fill must be adhered to. For fill under roads and foundations every effort shall be made to compact the fill material at its optimum moisture content for compacting. In any case, the dry density of the compacted soil shall not be less than 95% of the maximum density according to ASSHTO T180.

The switchyard area shall be surfaced with a minimum of 50 mm of 12mm aggregate and over that 50mm layer of 20mm aggregate.

g) Leveling

Depending on the ground socket level, leveling to the surroundings might be needed. The slope of such shall be between 1:100 and 1:50.

h) Disposal of Surplus

The Contractor shall remove from the Site all surplus soil or other excavated material not required or not suitable as fill material. Such material shall be transported to spoil dumps located as agreed upon with the Employer.

i) Drainage (if required)

The Contractor shall install an adequate drainage system for the new substation area. Building down pipes shall be connected to the drainage system. Open ditches are not allowed within the substation area. The drainage system shall be designed for the relevant local climatic conditions.

j) Fences and Gates (if required)

The Contractor shall design, furnish and install a chain link fence and gates around the whole Capacitor Bank area. The chain link shall have a mesh width of maximum 50mm² and each wire shall have a minimum failure load of 2,000 N. Straight line posts shall have a minimum bending failure load, applied horizontally on the top, in the most unfavorable direction, of 600N.

Top and bottom tension wires shall have a minimum failure load of 5,000N. In case of 2.5m or higher chain link, the top wire shall be substituted by a top rail. Barbed wires shall have a minimum failure load of 3,000N.

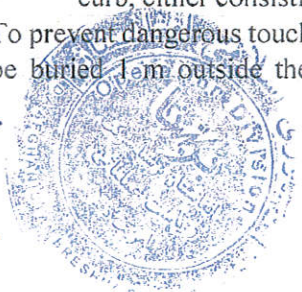
There shall be one gate of size made of the same Chain link mesh of width not less than 1.8 meter with pad lock and key. Fence posts and gates shall be set in concrete foundations of adequate strength.

Straight line posts shall have a spacing not exceeding 3m. Guyed tension posts shall be inserted each 50m along straight lines. End and corner posts shall be adequately braced. Straight line posts shall have 800mm – 1,000mm deep foundations, either a 6-inch concrete tube filled with concrete, or a directly cast foundation, at least 200mm wide. Foundations for corner or end posts shall extend minimum 1,000mm below surface and consist of either a filled 9-inch concrete pipe, or be a directly cast foundation, at least 300mm wide. The main gate shall be designed with a reinforced concrete foundation connecting both posts.

The space between the bottom of the chain link and the ground surface shall be filled in by a concrete curb, either consisting of prefabricated slabs or cast at site.

To prevent dangerous touch voltage, a 35mm² copper wire or the size after appropriate calculations shall be buried 1m outside the fence and 0.5m deep. Connections between the fence and the encircling

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earth wire shall be made each 3m. The encircling earth wire shall be connected to the station grounding grid.

In case of an insulated (plastic coated) fence, the encircling earth wire may be omitted. Only gateposts will be connected to the station grounding grid. The top and bottom wires (or top rails) will be divided in 50m sections fully insulated from each other.

k) Construction of cable trench along with covers, sump pits and road crossings

General guideline for concreting below 5-degree temperature shall be as per international standards. Also the procedure for cold weather concreting shall generally be as per recommended international standard. The detailed procedure taking into account specific site and environmental/climatic conditions shall be submitted by the contractor for review / approval of Employer's Project Manager

Design and drawing for all contractor engineered items shall be developed by the contractor and submitted for approval of Employer.

Bricks of 50kg per sq.cm. Compressive Strength shall be used. However, Contractor can propose use of fly ash based bricks/ hollow concrete blocks or solid concrete blocks to suit the availability at site.

l) All the structure shall be designed as equivalent to Earthquake zone IV in accordance with relevant international standard.

m) All items of works shall be executed in accordance with BS standard or any other equivalent international Standard.

For all RCC items concrete mix used shall be 1:1.5:3 (Cement: 1.5 coarse sand: 3 stone aggregate of appropriate sizes.

n) All marshalling boxes and equipment junction boxes located outdoor shall be installed on appropriate height of 500mm from ground level.

1.41 MATERIAL AND FINISHES

In choosing materials and their finishes, due regard is to be given to the desert conditions under which equipment is to work.

1.41.1 Materials

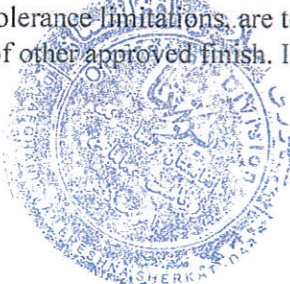
a) Metal

Iron and steel are generally to be painted or galvanized as appropriate in accordance with this Specification. Indoor parts may alternatively have chromium or copper-nickel plated or other approved protective finish. Small iron and steel parts (other than rustless steel) of all instruments and electrical equipment, the cores of electromagnets and the metal parts of relays and mechanisms are to be treated in an approved manner to prevent rusting. Cores etc., which are built up of laminations or cannot for any other reason be anti-rust treated, are to have all exposed parts thoroughly cleaned and heavily enameled, lacquered or compounded.

b) Screw, nuts, springs, pivots, etc.

The use of iron and steel is to be avoided in instruments and electrical relays wherever possible. Steel screws, when used, are to be zinc, cadmium or chromium plated, or when plating is not possible owing to tolerance limitations, are to be of corrosion-resisting steel. All wood screws are to be dull nickel brass or of other approved finish. Instrument screws (except those forming part of a magnetic circuit) are to be

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of brass or bronze. Springs are to be of non-rusting material, e.g. phosphor-bronze or nickel silver, as far as possible.

c) Fabrics, cork, paper etc.

Fabrics, cork, paper and similar materials, which are not subsequently to be protected by impregnation, are to be adequately treated with an approved fungicide. Sleaving and fabrics treated with linseed oil or linseed varnishes are not to be used. d) The use of wood in equipment is to be avoided as far as possible. When used, woodwork is to be thoroughly seasoned teak or other approved wood which is resistant to fungal decay and is to be free from shakes and warp, sap and wane, knots, faults and other blemishes. All woodwork is to be suitably treated to protect it against the ingress of moisture and from the growth of fungus and termite attack, unless it is naturally resistant to those causes of deterioration. All joints in woodwork are to be dovetailed or tongued and pinned as far as possible. Metal fittings where used are to be of non-ferrous material.

d) Rubber

Neoprene and similar synthetic compounds, not subject to deterioration due to the climatic conditions, are to be used for gaskets, sealing rings, diaphragms, etc., instead of the standard rubber based material.

1.41.2 Finishes a) Painting

All ferrous metalwork other than on the transmission towers and outdoor switch yard structures is to be provided with an effective vapor sealing paint finish, applied in accordance with the best trade practice. Before painting or filling with oil or compound, all un-galvanized parts shall be completely clean and free from rust, scale and grease and all external rough metal surfaces on casting shall be filled. The paint system is to be in accordance with best practice for hot and humid locations and this paint system shall be fully described in the Bid. Paint is not to be applied before tanks and chambers have passed any required pressure or vacuum tests. Internal surfaces of tanks and chambers which are to contain oil are to be treated with an approved oil resisting finish. All external surfaces shall receive a minimum of three coats of paint. The primary coat shall be applied immediately after cleaning. The second coat shall be of oil and weather resisting nature and of a shade of color easily distinguishable from the primary.

b) Non Ferrous Parts and Bright Steel Parts

All exposed metal liable to corrosion is to be appropriately protected by coating with an approved anti rusting composition. Other non-ferrous parts shall be adequately protected against corrosion during shipment or in service.

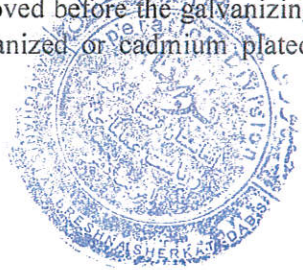
After erection these parts shall be cleaned with an approved solvent and polished bright where required.

c) Galvanizing

Galvanizing shall be applied by the hot dipped process generally in accordance with ASTM A 123-73 and shall consist of a thickness of zinc coating equivalent to not less than 0.610 kg/square meter of surface. The zinc coating shall be smooth, clean and of uniform thickness and free from defects. The preparation for galvanizing and the galvanizing itself shall not adversely affect the mechanical properties of the coated material.

All drilling, punching, cutting and bending and welding of parts shall be completed and all burrs shall be removed before the galvanizing process is applied. Surfaces which are in contact with oil shall not be galvanized or cadmium plated. All steel wires shall be galvanized by an approved process before

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stranding. The zinc shall be smooth, clean, of uniform thickness and free from defects and shall withstand the tests set out in IEC standard or such other standard as may be approved. If any galvanized part is found to be imperfect, it is to be replaced. The whole of the expense involved in the replacement of the imperfect part is to be borne by the Contractor.

The Contractor shall provide an instrument for checking galvanizing thickness, eg. Elcometer, or otherwise agree with the Engineer an approved method of testing galvanizing on Site. If, in the opinion of the Engineer, the extent of damage found on Site to a galvanized part appears capable of repair, the Contractor may, after receiving such agreement, attempt to effect such repair by approved methods. The agreement to attempt repair shall not bind the Employer/Engineer to accept the repaired part when it is re-offered for inspection. In the event that it is found that galvanized parts are subject to the formation of white rust during shipment or storage on Site, the Employer/Engineer shall either : i) approve a system of scrubbing and protective painting to be applied on Site if, in his opinion, this is expedient or ii) forthwith order that the affected parts be condemned and that all future shipments receive, before dispatch from the Works, special dip or spray treatment to individual members to his approval without extra charge to the Purchaser. Either of the above measures shall not be held as a cause for failure to meet the Completion Dates.

1.41.3 Nuts and Bolts

Nuts and Bolts for incorporation in the plant are preferably to conform to Metric Coarse. Other sizes or threads are permitted for threaded parts not to be disturbed in normal use or maintenance.

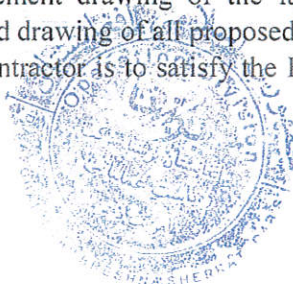
Nuts and bolts for pressure parts are to be of the best quality bright steel, machined on the shank and under the head nut. Fitted bolts are to be a driving fit in the reamed holes they occupy, are to have the screwed portion of a diameter such that it will not be damaged in driving and are to be marked in a conspicuous position to ensure correct assembly at Site. On outdoor equipment all bolts, nuts and washers shall be of non-rusting material where they are in contact with non-ferrous parts in fittings and elsewhere where specifically required by the Employer / Engineer. Stud holes in those parts of the plant which are subjected to heat in use are to be adequately vented. All washers are to be included under this Contract, including locking devices and anti-vibration arrangements, which are to be subject to the approval of the Employer / Engineer. Taper washers are to be fitted where necessary. Where there is risk of corrosion, bolts and studs are to be finished flush with the surface of the nuts. The Contractor shall allow for the supply of surplus bolts, nuts and washers in excess of the exact amount measured to allow for shortages due to loss, misappropriation, etc.

1.41.4 Casting

All castings are to be as free from blowholes, flaws, and cracks as is practicable. No welding, filling or plugging of defective parts is to be done under any circumstances. All cast-iron is to be of close-grained quality approved by the Employer / Engineer.

1.41.5 Welding

In all cases where fabrication welds are liable to be highly stressed, such as may be the case in parts subjected to reversals or stresses in operation, the Contractor is to supply the Engineer with a general arrangement drawing of the fabrication and, at a later date but before fabrication commences, a detailed drawing of all proposed weld preparations on the fabrication. Before such welding commences the Contractor is to satisfy the Employer / Engineer that welders or welding operators are qualified in



accordance with the requirements of the appropriate section of BS 4872, Part I or such other standard as may be approved. The Contractor may be required to submit evidence of the welders abilities. After scrutinizing the general arrangement and welding detail drawings the Engineer will inform the Contractor of the stages at which inspection will be required.

It shall be the Contractor's responsibility to notify the Engineer when one or more of the inspection stages will be reached and no further work is to be carried out until the specified stage has passed the Engineer's inspection. In addition to the above, the Employer / Engineer reserves the right to visit the Contractor's Works at any reasonable time during fabrication of the items of plant and to familiarize himself with the progress made and the quality of the work to date. In the event of the Contractor wishing to make an alteration to any part of the weld preparation, he is first to submit to the Engineer a copy of the revised drawing showing the amended preparation in detail and to wait confirmation of its acceptance or non-acceptance.

1.41.6 Labels

All equipment shall be provided with labels or name plates, giving any identifying name, type or serial number, together with information regarding the rating, nominal voltage and current and the like under which the item of plant in question has been designed to operate. The labels shall be permanently attached in a conspicuous position. The English language is to be used, except on nameplates and labels associated with operation or maintenance of the plant which shall be in the Afghanistan language to the approval of the Employer / Engineer. Such nameplates or labels are not to be of corrodible or hygroscopic material with lettering of contrasting color. Items of plant, such as valves, which are subject to handling, are to be provided with an engraved chromium plated brass nameplate or label with engraving filled with enamel.

1.41.7 Packing and Shipping

Any items liable to be damaged in transit shall be effectively protected and securely fixed in their cases. All lifts of over 2 tons shall be marked to show where slings should be placed. All cases shall be clearly identified giving particulars of manufacturer's name and type of equipment. All identification marks on the outside of cases are to be waterproof and permanent and as shown in drawing. All materials used in packing are to comply with the relevant Afghanistan regulations. Adequate protection and precautions are to be taken to exclude termites or other vermin, noxious insects, larvae or fungus from the packing materials or plant. All contents are to be clearly marked for easy identification against the packing list. The Contractor shall be required to suitably protect all steelwork before shipment to prevent corrosion and/or damage to galvanized surfaces by white rust. All accessory items shall be shipped with the equipment. Boxes and crates containing accessory items shall be marked so they are identified with the main equipment. The contents of box and crate shall be indicated by marking on the exterior. Packing cases where used shall be strongly constructed and in no case is timber less than 25 mm in thickness to be used. The contents of packing cases shall be securely bolted or fastened in position with struts or cross battens. Cross battens supporting weight in any direction shall not rely for their support on nails or screws driven lengthwise into the grain of the wood, but shall be supported by cleats secured from the inside. Particular attention shall be given to strutting before packing cases are fastened down. Cases shall be up-ended after packing to prove that there is no movement of the contents. Timber wedges or chocks shall be firmly fastened in place to prevent their displacement when the timber shrinks.

All machined parts must be thoroughly greased & amply protected against rust forming and other corrosive elements. Where practicable, items such as electric motors, switch and control gear, instruments

and panels, machine components, etc., are to be cocooned or covered in polyethylene sheeting, sealed at the joints and the enclosure provided internally with an approved desiccator.

1.41.8 Subcontracted Plant and Materials

Where subcontracted plant and materials orders are let, triplicate copies of all such orders are to be submitted to the Employer/Engineer for approval at the time of placing. Copies of the orders shall be clearly marked with the Contract title and shall carry a statement to the effect that inspection of plant and materials may be required by the Employer/Engineer. The Contractor shall also provide the Engineer's representative on site with names and details of local subcontracts.

The Engineer reserves the right to withdraw his consent to local subcontract arrangements if such are considered unsuitable, but consent will not be unreasonably withheld.

1.41.9 Inspection and Testing

a) General

In accordance with the General Conditions of Contract the whole of the plant and equipment provided under the Contract will be subject to inspection and testing by the Employer/ Engineer during manufacture, erection and on completion. The approval of the Employer/ Engineer of the results of any such inspection or tests shall not prejudice the right of the Employer to reject the plant if it fails to comply with the Specification when erected or to fulfill the purpose for which it was supplied. The cost of tests including the provision of the necessary test equipment at the manufacturer's works, shall be deemed to be included in the Contract price.

b) Subcontractors

To facilitate inspection of bought out materials and plants, the Contractor shall submit three copies of all sub-orders placed by him, together with one copy of any drawings referred to in the sub-orders unless otherwise agreed. For the purpose of this clause, inter-works orders shall be treated as sub- orders. All sub-orders must include a statement advising sub- contractors that the items being ordered are subject to inspection and testing by the Employer/ Engineer.

c) Site Tests

The site test shall be carried out by Contractor's, witnessed and approved by Employer.

1.41.10 Design and Manufacture

The design and manufacture of all equipment specified herein shall be such as to give long and continuous service with high economy and low maintenance costs and to ensure the continuity of electricity supply under all operating conditions. All materials used shall be of the best quality and of a class most suitable for the operating conditions, and shall withstand normal working conditions without deterioration. All equipment is to operate without undue vibration and with the least possible amount of noise. All equipment and accessories offered shall be of well proven design. The detailed design shall be such as to facilitate inspection, cleaning and repairs and permit simplicity of operation and maintenance. All workmanship is to be of the highest class throughout and the design dimensions and materials of all parts are to be such that the stress to which they are subjected shall not render them liable to distortion or damage under the most severe conditions encountered in service. No repairs of defective parts will be permitted under any circumstances. All similar equipment and accessories offered shall be identical to one another as regards their design materials and workmanship. Corresponding parts shall be interchangeable wherever possible throughout the Contract Works and be such as to facilitate the fitting or replacement parts.

1.41.11 Particulars and shipment clearance

Bidders shall furnish full technical information and set out all particulars required in the Schedules. Drawings of all components shall be provided together with the equipment type and reference number to ensure their identification. Before approval for shipment will be issued by the Engineer, the manufacturer will be required to supply type test certificates and individual certificates for all goods supplied to testify that the goods comply with the applicable standards. If the tests proved unsatisfactorily, approval for shipment will not be issued.

1.41.12 Pad Locks

When required by the specification, non-ferrous pad locks with different key changes and two keys for each lock and a master key for each station, shall be provided.

Cabinets for the accommodation of padlocks and keys, whilst not in use, shall be provided and shall be suitably labeled so that keys will be readily identifiable. In the event that it is found that galvanized parts are subject to the formation of white rust during shipment or storage on Site, the Employer / Engineer shall either: a) Approve a system of scrubbing and protection painting to be applied on Site if, in his opinion, this is expedient or b) forthwith order that the affected parts be condemned and that all future shipments receive, before dispatch from the Works, special dip or spray treatment to individual members to his approval without extra charge to the Employer.

1.41.13 Pipe Supports

The whole of the pipe work and accessories included in this Contract shall be supported and mounted in an approved manner. All necessary saddles, structural steelwork, foundation bolts, fixing bolts and all other attachments shall be supplied. All pipe supports and attachments are to be designed for compatibility with any particular building and foundation requirements. The number and positions of all intermediate flexible supports between anchor points shall be determined by the weights to be carried and by the steelwork available for the purpose and are to be subject to the approval of the Employer / Engineer.

1.41.14 Valves

Valves shall be arranged so that the hand wheel moves in a clockwise direction to close the valve. The face of each hand wheel is to be clearly marked with the words "open" and "shut" and be provided with an arrow to indicate direction for opening and shutting. As far as possible valves shall not to be fitted in an inverted position. It is to be possible to remove and replace, or recondition in site, the seats and to remove the gates. Valves of 50 mm nominal bore and over are to be provided with valve position indicators showing the amount by which the valve is open or closed in relation to its full travel. All valve hand wheels are to be fitted with nameplates complying with specification. Suitable means are to be provided to protect the operating mechanisms of all valves against mechanical damage and dust or dirt. Adequate provision is to be made for the lubrication of the mechanism and guides and this is preferably to be of the pressure type. Valves which are normally required to be locked in the open or closed position are to be provided with a non-detachable locking arrangement. Precautions are to be taken to prevent corrosion of the valve spindles in contact with the gland packing.

1.41.15 Oil Level Indicators

Unless otherwise approved, oil level indicators of approved design shall be fitted to all oil containers other than hermetically sealed items. The indicators shall show the level at all temperatures likely to be

experienced in service, and shall be marked with the normal level at 20°C clearly visible from normal access levels and shall be easily dismantled for cleaning.

1.41.16 Pressure Gauges

All pressure gauges shall be fitted with stop cocks immediately adjacent to each gauge and all pressure gauge piping shall be fitted with an isolating valve at each point of connection to main system. Where pressure gauges are mounted on panels, the stop cocks shall be suitable for the connection of a test gauge. The finish of all pressure gauges shall be chromium plated. Where a difference in level exists between the situation of the gauge and the point at which pressure is to be measured, appropriate compensation shall be made in the dial reading and the dial must be marked with the amount of compensation applied. Where the compensation would amount to 2 per cent or less of the total movement indicated under normal conditions, it may be ignored. All pressure gauges where practicable shall be mounted on panels in locations approved by the DABS/Engineer. Stop cocks of gauges must be readily accessible. All pressure gauges shall be clearly identified by means of separate labels of approved type and lettering. All high pressure gauge piping is to be of rustless steel but other pressure gauge piping may be of copper tube or other material approved by the Employer / Engineer.

1.41.17 Thermometer Pockets

Thermometer pockets and instrument connections of an approved pattern are to be fitted in such positions as may be determined to suit the operation and testing of the plant to the approval of the Employer / Engineer. A thermometer pocket is to be fitted adjacent to each point of connection for distant remote temperature indication unless specifically stated to the contrary. Where necessary, the pocket shall be of approved alloy material suitable for the required service.

1.41.18 Instruments

All indicating and recording instruments shall be of the flush mounted pattern with dust and moisture proof cases complying with IEC 60068. Unless otherwise specified, all indicating instruments shall have a 150mm or 140mm rectangular case. Instrument dials in general should be white with black markings and should preferably be reversible where double scale instruments are specified. Scales shall be of such material that no peeling or discoloration will take place with ages. The movements of all electrically actuated instruments shall be of the dead beat type.

Unless otherwise specified, circular chart recorders shall be arranged for one complete revolution every 24 hours and roll chart recorders shall move approximately 25 mm per hour, and the actuating mechanism shall be spring driven with automatic rewinding by means of a synchronous motor. Where two or more quantities are recorded on the same chart, they shall be distinguished by the use of distinctive color not liable to fade. Recording instruments shall be fitted with glass windows so that the pen contact point on the chart and a length of chart on which the record has already been made are clearly visible. Indicating scales shall be provided to enable the charts to be read without removing them from the recorders. Charts and inks sufficient for two years continuous working on each recorder shall be supplied under the Contract. Wherever possible, instruments shall be provided with a readily accessible zero adjustment. Electrical Instruments and Meters All electrical instruments and meters are to comply with IEC 60051-1 and IEC 62271-203 or equivalent national standards respectively and, unless otherwise specified, shall be of industrial grade accuracy. Three-phase power measuring instruments shall be of the three-phase unbalanced load pattern wherever the current and voltage references permit. Maximum demand indicators shall have a demand interval of 30 minutes. Where precision grade metering is specified meters are to be calibrated to precision grade accuracy and allowance is to be made for the errors of current and voltage transformers with which they are to work and whose accuracy class is to

be Class 0.2, 0.5 and 1.0 respectively. Where commercial grade metering is specified the meters shall be calibrated to commercial grade accuracy. Unless otherwise stated, meters shall be single directional and fitted where required with suitable devices for the transmission of impulses to a summator. Var-hour meters shall be complete with phase shifting transformers as necessary. Front of panel test terminal blocks shall be provided for all meters. Summation meters are to be equipped where required with suitable contacts for the retransmission of impulses to a print-to-meter. **Instruments and meters other than electrical** Major scale markings, should be clearly differentiated from minor marks and pointers should taper evenly to the width of the minor scale marks. The normal working range should be between 50 and 75 per cent of the full movement of the pointer.

1.41.19 Electrical Insulation

All insulating materials shall be suitably finished so as to prevent deterioration of their qualities under the specified working conditions. Plastics, elastomers, resin-bonded laminates and inorganic materials shall be of suitable quality selected from the grades or types in the appropriate IEC Standard. All cut or machined surfaces and edges of resin-bonded laminates shall be cleaned and then sealed with an approved varnish as soon as possible after cutting.

Wherever practicable, instrument, apparatus and machine coil windings, including wire wound resistors, with the exception of those immersed in oil or compound, shall be thoroughly dried in a vacuum or other approved means and are then to be immediately impregnated through to the core with an insulating varnish complying with BS.2778. The coils are to be covered with impregnated cotton or other suitable synthetic material. The impregnated coils are finally to be covered with an impervious enveloping varnish. Encapsulation of windings is preferred.

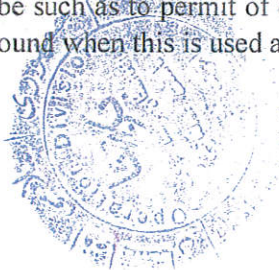
1.41.20 Earthing Connection

All necessary studs, connectors and earth bars shall be provided to permit the connection of each switchboard, motor or other electrical equipment supplied under the Contract to the substation general earthing system. The provisions for earthing shall be such that no reliance is to be placed on the conductivity of metal to metal joints without the use of special connectors.

1.41.21 Electric Motors

All motors shall be Universal Type, in accordance with IEC: 60072 and, unless otherwise specified, shall be of the totally enclosed fan cooled type, suitable for continuous operation and direct on-line starting. Main conductor and slot insulation shall be non-hygroscopic and in accordance with Classes B or E of IEC 60085. Motors to be located out of doors shall be entirely suitable for operation under the climatic conditions at Site. Motors shall be capable of operating continuously at rated output at any frequency between 48 and 51 cycles per second and at any voltage within 6 percent of the nominal value. Motors shall be designed to operate for a period of not less than 5 minutes at a voltage of 25 percent below the nominal value and at normal frequency without injurious overheating. If required by the Employer / Engineer, the Contractor is to demonstrate that the motors comply with this requirement. The starting current at full voltage is not to exceed six times the rated full load current. All bearings shall be fitted with oil or grease lubricators complying with specification. Vertical shaft motors shall have approved thrust bearings. The ends of motor windings shall be brought out to terminal boxes and the arrangement shall be such as to permit of easy changing over of any two phase leads without disturbing the sealing compound when this is used at cable terminations. All terminals shall be of the stud type of adequate

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size for the particular duty, marked in accordance with an approved standard and enclosed in a weatherproof box. All terminal boxes shall be fitted with an approved sealing chamber, conduit entry or adaptor plate, as required, together with the necessary fittings to suit the type of cable specified.

1.41.22 Starters and Contactors

Where starters shall be provided under this Contract, each motor shall be equipped with two or three pole control gear as appropriate and suitable, unless otherwise specified, for direct starting by the switching of full line voltage on to a standing motor. All starters should preferably be supplied by one manufacturer. Contactors are to be of robust design and are to comply with IEC. They shall operate without undue noise or vibration. Contactors shall be mounted in ventilated metal cubicles. Unless otherwise approved, the metal surfaces of the cubicle walls adjacent to the contactors shall be protected by fire-proof insulating material. Where two or more contactors are contained in the same cubicle, they shall be separated by barriers of fire-proof insulating material. The cubicles shall be complete with all locks, cable sealing boxes, busbars, internal wiring, terminal boards and accessories. All bare copper connection shall be taped and all secondary wiring is to be so arranged and protected as to prevent its being damaged by arcing. Starters shall be of the electrically held-in type with integral "start" and "stop" push buttons mounted externally on the door, with integral interlocked isolators. Where required, auxiliary switches shall be included for the operation of "red" and "green" indicating lights on remote instrument panels. All a.c. contactor coils shall be connected between phases for 400 volt working. All motor contactors and their associated apparatus must be designed to operate for a period of not less than 5 minutes at a voltage of 25% below the nominal value and at normal frequency without injurious overheating. For circuits controlling motors of 15 kW and over, transformer operated overload and phase failure relays are to be provided. These shall be of approved type and be operated by saturating type current transformers. For circuits controlling motors of less than 15 kW, thermal overload trips will be accepted.

1.41.23 Control, Switches and Push Buttons

a) General:

Control switches for electrically operated circuit breakers and motor operated isolators shall be of discrepancy type and arranged to operate clockwise when closing the circuit breakers and anti-clockwise when opening them. They shall be designed to prevent accidental operation. Operation of switches of the discrepancy type shall be effected by two independent movements.

Alternatively, control switches for circuit breakers only may have pistol grip handles.

Switches for other apparatus shall be operated by shrouded push buttons or have handles of a type other than that used for circuit breakers.

Control, reversing, selector and test switches are to be mounted, constructed and wired so as to facilitate the maintenance of contracts without the necessity for disconnecting wiring.

Where necessary control switches shall be capable of being locked in appropriate positions but control switches for circuit breakers and for motor operated setting devices shall be of the nonlocking type with spring return to the "neutral" position.

All push buttons shall be of the non-retaining type made of non-hygroscopic materials, non-swelling and fitted to avoid any possibility of sticking.

The contacts of all switches and push buttons shall be strong and have a positive wiping action when operated.

Control switches for use in direct control schemes shall be rated for the substation battery voltage and in any case not lower than 220 volts.

All control switches shall be provided with labels to give clear indication as to the direction of each operation, for example, "open", "close", "raise", "lower", etc.

ii) Electrical Control Locations

Equipment may be electrically controlled from a number of different control points as specified in the appropriate sections of this Specification. The control positions shall be designated as follows:

b) Local Control

Located adjacent to the item of plant to facilitate maintenance, inspection and emergency operation.

c. Remote Control

Located at a substation control room where specified items of plant are monitored and controlled by direct wire connection.

d) Supervisory Control

Located at a Load Dispatch Centre where principal items of plant are remotely controlled via a tele control system.

e) Indicating Lamps and Fittings

Indicating lamps fitted into the facial of switch and instrument cubicles or panels shall be adequately ventilated. Lamps shall be easily removed and replaced from the front of the panel by manual means not requiring the use of extractors.

The bezel of metal or other approved material holding the lamp glass shall be easily removable from the body of the fitting so as to permit access to the lamp and lamp glass. The lamps shall be clear and must fit into an accepted standard form of lamp holder. The rated lamp voltage should be 25 percent in excess of the auxiliary supply voltage, whether a.c. or d.c. Alternatively, low voltage lamps with series resistors will be acceptable. The lamp glasses shall be in standard colors, red, green, blue, white and amber. The color shall be in the glass and the different colored glasses shall be interchangeable. Transparent synthetic materials may be used instead of glass, provided such materials have fast colors and are completely suitable for use in desert climates. Spare lamps shall be supplied as 300% of the number and size of each type used with a minimum of

12.

f) Auxiliary Switches

Where appropriate, each item of plant shall be equipped with all necessary auxiliary switches, contactors and mechanisms for indication, protection, metering, control, interlocking, supervisory and other services. All auxiliary switches, including spares, and Contractors as well as the associated coil connections and inter-connections between auxiliary switches, shall be wired up to a terminal board on the fixed portion of the plant, whether they are in use or not in the first instance. All auxiliary switches and mechanisms shall be mounted in approved accessible positions clear of the operating mechanisms and shall be protected in an approved manner, and if outdoors, housed in a substantial weatherproof enclosure. Where adjustable linkages are provided to facilitate the timing of the auxiliary switches with respect to the main equipment, approved locking devices shall be fitted. The contacts of all auxiliary

switches shall be robust and have a positive wiping action when closing, and where necessary, discharge resistors shall be provided to prevent arcing when breaking inductive circuits. Banks of auxiliary switches and associated terminal boards shall be arranged to facilitate extension when required.

g) Anti-Condensation Heaters and Ventilators

Any major items of electrical equipment which are liable to suffer from internal condensation due to atmospheric or load variations shall be fitted with heating devices suitable for electrical operation at 220/230 volts a.c, 50 Hz. single phase of sufficient capacity to raise the internal ambient temperature by 5°C. A suitable thermostat shall be included in the heater circuit. The electrical apparatus so protected shall be designed so that the maximum permitted rise in temperature is not exceeded if the heaters are energized while the apparatus is in operation. Where fitted, a suitable terminal box and control switch, with indicating lamp, shall be provided and mounted in an accessible position. All such equipment, whether fitted with a heating device or not, shall be provided with adequate ventilation, screened to prevent entry of vermin, suitable drainage and to be free from pockets in which moisture can collect.

1.41.24 Oil

The oil shall comply with the requirements of IEC 60296. Where other types of filling media are used in current transformer chambers and other parts of the equipment, they shall be of an approved type.

1.41.25 Electricity Supplies for Auxiliary Plant

The electricity supplies available for auxiliary plant will normally be:

- i) 400V 3-phase 50 Hz 4-wire for power
- ii) 230V single phase 50 Hz for lighting and indication.
- iii) 220V d.c. for essential indication controls, protection, alarms and circuit breaker closing and tripping supplies.

The equipment provided under this Contract is to be capable of operating reliably at voltages down to 80% of the normal voltage except where otherwise specified.

1.41.26 System Identification

System identification of AC circuit shall be as follows:

Phase 1 R – Red

Phase 2 Y – Yellow

Phase 3 B – Blue

Neutral – Black

Grounding - Green with yellow stripes.

Wire colors for small wiring shall be as follows:

Colors of Wire Circuit Particulars

Red - Red-phase connections in current and voltage transformer circuit only.

Yellow - Yellow-phase connections in current and voltage transformer circuit only.

- Blue - Blue-phase connection in current and voltage transformer circuit only.
- Green - Connection to earth. With yellow stripes
- Black - A.C. neutral connections, earthed or unearthed, connected to the secondary circuit of current and voltage transformers. Any other AC connection other than those above and color connection in a.c./d.c. circuit.
- Grey - Connection in d.c. circuit.

1.41.27 Oil or Compound Filled Chambers

All joints of fabricated oil or compound filled chambers, other than those which have to be broken, shall be welded and care shall be taken to ensure that the chambers are oil-tight. Defective welded joints are not to be caulked but may be rewelded subject to the written approval of the Engineer. Suitable provision shall be made for the expansion of the filling medium in all oil or compound filled chambers and the chambers shall be designed to avoid the trapping of air or gases during the filling process. Design shall permit the temperature of any chamber which shall be compound filled to be raised such that the compound does not solidify during the filling process. All wiring in the vicinity of oil-filled chambers shall be insulated with oil-resisting insulation of approved quality.

1.41.28 Lubrication

The Contract is to include for the supply of flushing oil for each lubrication system when the item of plant is ready for preliminary tests and the first filling of approved lubricants for the commercial operation of the plant.

A schedule of the oils and other lubricants recommended for all components of the Contract Works shall be submitted to the Engineer for approval. The number of different types of lubricants shall be kept to a minimum. Copies of this schedule shall be included in both the draft and final copies of the operating and maintenance instructions. In the case of grease lubricated roller type bearings for electric motors a lithium based grease is preferred.

Where lubrication is effected by means of grease, preference will be given to a pressure-gun system with a separate nipple to each point. Where necessary for accessibility, the nipple shall be placed at the end of extension piping, and, when a number of such points can be grouped conveniently, the nipples shall be brought to a battery plate mounted in a convenient position. Nipples shall be of the hexagon headed type complying with BS.1486 Part 1 table 1 type 11B. Where special greases shall be used and where high temperatures are encountered, then 'button' nipples in accordance with BS.1486 are preferably to be used.

The Contractor is to supply at least one grease gun equipment for each type of nipple provided. Where more than one special grease is required, a grease gun for each special type shall be supplied and permanently labeled.

1.41.29 Internal Cleaning of Pipes

The Contractor shall be responsible for ensuring that the internal surface of all pipe lines is thoroughly cleaned both during erection and before the pipe line is placed in commission. The procedure adopted by the Contractor is to include the following:

- i) Through cleaning of all internal surfaces prior to erection to remove accumulations of dirt, rust, scale etc., and welding slag due to site welding before erection

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- ii) Through cleaning of all pipe work after erection by blowing thorough to atmosphere to ensure that no extraneous matter is left in the system. The Contractor is to provide all necessary facilities for carrying out these requirement.

1.41.20 Conditions of Operation

Except where otherwise specified in this contract all materials and equipment shall be suitable for operation at the guaranteed maximum sustained rating throughout all seasons of the year. The highest operating voltage will be 123kv.

1.41.30 Climate Condition

In choosing materials and their finish, due regard shall be given to the climate conditions under which equipment have to work, and the recommendations under which equipment is to work.

1.41.31 Reliability

All materials and equipment shall be designed for operation on systems where continuity of supply is the prime consideration. They shall also be satisfactory in operation under the atmospheric and climatic conditions prevailing at the site and under such variations of current, voltage and frequency as may be met under fault and surge conditions on the system.

1.41.32 Type Approval

All materials and equipment shall have satisfactorily passed type approval test equal to those required in accordance with the equivalent standards. The Contractor shall certify that the materials and equipment offered will be identical in all essential particulars in respect of design, materials and workmanship with the materials and equipment for which type approval certificates are submitted.

1.41.33 Compression Glands for Solid Dielectric, Power and Multicore Control Cables

Compression type glands with armor and bonding clamps for the termination of all solid dielectric multicore cables shall be designed to secure the armor wires to provide electrical continuity between the armor and threaded fixing component of the gland and to provide watertight seals between the cable outer sheath and gland and between the inner sheath and threaded fixing component.

1.41.34 Terminal Boards

All terminals shall be mounted in accessible positions. Adjacent terminals shall be adequately spaced to each other and to the incoming cable gland plate. Separate studs shall be provided on each terminal strip for the cores of incoming and outgoing cables including all spare cores.

Acceptable types of terminal are:

- i) Screw or stud type used with crimped ring type termination Screws and studs shall be of not less than size M6 but stainless steel and bronze down to size M5 may be used provided that the current carrying capacity is adequate. All studs shall be provided with nuts, washers and lock washers.
- ii) Insertion clamp type whereby the standard conductor or crimped termination is clamped between plates by a screw having a suitable locking device. Terminal entries shall be shrouded such that no current carrying metal is exposed. Tapped holes are to have not less than three full threads. Screws shall be of plated steel, stainless steel or phosphor bronze and size M3 or M4.

Terminal assemblies are preferably to be of the unit form suitable for mounting collectively on a standard assembly rail, secured from the front and giving the required number of ways plus ten percent spare with a minimum of three.

400/230V circuit terminals shall be segregated from other terminals and shall be fitted with non-flammable plastic covers to prevent contact with any live parts. They are to have warning labels, with red lettering, mounted thereon in a conspicuous position.

All connections shall be made at the front of the terminal boards and no live metal shall be exposed at the back.

1.41.35 Miniature Circuit Breakers, Fuses and Links

Facilities shall be provided for protection and isolation of circuits associated with protection, control and instruments. They shall be of approved type and grouped, as far as possible, according to their functions. They shall be clearly labeled, both on the panels and the associated wiring diagrams. Facilities shall be provided to enable the control circuits for any circuit breaker to be individually isolated for maintenance purposes. Facilities for protection and isolation of control and tripping circuits are preferably to be mounted on the outside of control panels. All fuses are to incorporate HRC cartridges to IEC 60269. Miniature circuit breakers are to comply with BS.3871 Part 1 or other relevant standard. Spare fuses shall be supplied as 100% of the number and size of each type used, with a minimum of 6 (six).

2. TECHNICAL SPECIFICATIONS

2.1 Steel Structures

1. General

Steel structures shall be provided under this Contract for supporting the insulators, switchgear, overhead conductors, bus bars, earth wires, and other equipment and fittings generally as shown on the drawings, and have to be designed and erected according to the relevant international recognized standards.

Drawings of the Bidder's design are to be submitted with the bid.

The structures shall include all necessary access ladders to give access to the various levels of the high-level equipment and shall incorporate all necessary screens to comply with the requirements of insulation levels and minimum clearances.

Step, ladders, handrails, guards and other facilities shall be provided on the inside of the columns near the junction of the beam and column, to facilitate safe inspection and maintenance for the structures. Step bolts are not acceptable for the steel structures.

The design and arrangement of supporting structures shall be subject to approval by the Owner/Engineer. The structures shall be rigid and self-bracing against all dead, wind, pull-off and other applied loads. Wherever such an arrangement can be adopted, structures shall be braced by horizontal beams at intermediate or high level to provide an integrated framework. At or near ground level, all uprights shall be provided with holding down bolts provided under this Contract.

The rigidity of the structures shall be such that the alignment of the apparatus which they carry shall not be disturbed by the loads to which the structures are subjected.

Busbar dead end structures shall be designed so as to be suitable for future Busbar extension.

2. Design

All structures shall be designed so that no failure or permanent distortion shall occur when tested with applied forces equal to 2.5 times the maximum simultaneous working loads.

The maximum allowable stresses in tensile members shall be such as to give a factor of safety of not less than 2.5 on the elastic limit strength.

Contractor should design the steel structure considering the applied conductor tension and sag for the condition, that at the highest operating temperature of conductor (i.e 90°C for ACSR and AAC) the maximum sag of conductor is 3 percent.

Bolts and nuts shall be fitted with spring washers. Taper washers are to be added where necessary. Threads of bolts shall be spun galvanized and the threads of nuts shall be greased. The diameter of bolts and nuts which are mechanically stressed shall not be less than 12 mm and shall have metric screw threads. Nuts and heads of all bolts shall be of the hexagonal type. Minimum quality of for bolt shall be in accordance to the respective standards (5.6 of DIN 267).

Bolt holes are not to be more than 1.5 mm 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.

3. Deformation – Deflection Conditions

Under permanent loads and with normal wind but with no short-circuit and no earthquake, deformations are never higher than the following values:

- Beam:

Vertically: 1/200 of the span

Horizontally: 1/200 of the span

- Column: 1/150 of the height in both directions measured at the level of the horizontal axis of the beam.

4. Material

Material for steel members and plates of towers shall be of the type and grade most suitable for the application intended and shall conform to the latest applicable standard, specifications and recommended practices of the industry. The quality of steel to be used for the fabrication on the towers shall at least correspond to SS400 and SS540 according to JIS G 3101. The steel to be used shall be of a quality that will not have its physical properties changed or become embrittled by hot dip galvanizing.

All material shall be tested at the steel mill in accordance with applicable specification and standards under which they are manufactured. The contractor shall apply all certified mill tests. Test shall be conducted in accordance with ASTM A370. The test to be conducted shall include, but are not limited to uniformity of galvanizing coating, mechanical and chemical properties of all steel and additional embitterment testing on high strength steel.

High tensile steel, when stores in the fabricators stockyard prior to fabrication and galvanizing, shall be marked continuously throughout its length with a light blue water paint line. In addition, the grade number of the steel shall be painted on and ringed round with paint.

The steel shall be free from blisters, scale and other defects.

Main members and bracings of lattice structures shall be not less than 6 mm and 5 mm thick respectively.

5. Construction

The compression members of steel structures shall consist of rolled steel sections and the tension members of rolled steel sections or flats.

All members shall be stamped or marked for erection purposes as specified.

All members shall be stamped or marked in an approved manner with numbers and/or letters corresponding to number and/or letter on the drawings or material lists. Drawings and material lists shall be submitted to the Engineer for approval. The erection marks if stamped, shall be stamped before galvanizing and shall be clearly visible after galvanizing.

Pockets and depressions likely to hold water shall be avoided and all parts of the structures shall be properly drained.

Where overhead transmission lines are terminated at the substation structures, landing plates welded to the structures shall be provided for reception of the transmission line insulator fittings and earth wire clamps.

Special care shall be taken not to injure the skin on galvanized or special treated surface during erection. Care shall be taken to prevent or remove any white rust, streaks or foreign matter deposited on galvanized surfaces during storing or transport or after erection.

Approved means shall be provided for fixing and bonding copper conductors to the steel work at sufficient points to obtain efficient earthing. Earth connection shall be made to a vertical face, clear of the ground. Foundation bolts shall not be used for their attachment.

To facilitate inspection and maintenance the structures shall be provided with steps, ladders, handrails, screens, guards and other facilities. Step bolts are not acceptable for substations structures

6. Workmanship

All members shall be cut to jig and holes shall be drilled or punched to jig. All parts shall be carefully cut and holes accurately located so that when the members are in position the holes can be accurately aligned before being bolted up. Drifting or reaming of holes will not be permitted. All burrs shall be removed before galvanizing.

The drilling, punching, cutting, bending and welding of all fabricated steelwork shall be carried out before galvanizing and shall be such as to prevent possibility of irregularity occurring which might cause any difficulties in the erection of steel structures on the site.

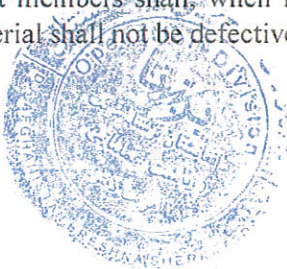
Except where specified to the contrary, all iron and steel used in the construction of the work shall be galvanized.

Galvanizing shall be applied by the hot dip process for all parts according with ASTM A-123, A-143 and A-153 shall be applied by the hot dip process and shall consist of a suitable thickness of zinc coating of not less than 610 grams of a zinc per square meter of surface.

The zinc coating shall be smooth, clean and of uniform thickness and free from defects. The preparation for galvanizing itself shall not adversely affect the mechanical properties of the coated materials.

Built members shall, when finished, be true and free from all kinks, twists and open joints, and the material shall not be defective or strained in any way.

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Steel gauges of the stud type shall be provided to enable the Engineer to carry out such checking of members as he may consider necessary.

7. Other Materials

(1) General

All construction materials such as conduit, steel angles, steel channels, steel plate, bolts, nuts and other related items required for operation shall be provided without extra charge and shall comply with the highest grade requirements of relevant standards.

(2) Lighting fixtures

(a) High pressure mercury vapor Lamp 230 V, 250 W, 50 Hz, Single phase to be mounted on the Steel structure with adequate fittings.

(b) Daylight switch (photoelectric automatic switching) 230 V, 6 A, 50 Hz, single phase.

(c) Emergency lighting, 230 V, 20 W x 2, fluorescent lamp, to be connected to inverter circuit

(d) Power distribution box. Outdoor use for housing of (b) and required number of switches/wiring, to be fixed on a steel structure column. The Contractor shall submit to the Employer design drawing of item (d) for approval. Road and fence outside perimeter lighting fittings mounted on suitable columns shall be supplied and erected to give a general level of illumination of 5 luxes. Special attention shall be given to access and building gates.

(3) Number Plate and Danger Plate for connection Line tower to Switchyard The number plate indicates tower number, phases and earthing resistance, and the danger plate is used for calling caution. Both the number and the danger plates shall be fixed to the tower with bolts.

The number plate and danger plate shall be supplied by the Contractor in a finished form, together with zinc coated steel bolts and nuts of 10 mm in a diameter for fixing these to the tower member. The bolt holes on tower member for fixing these plates will be instructed by the Engineer when returning the approval drawings of tower. The Contractor shall provide one (1) number plate and two (2) danger plates each for a tower.

8. Tests

The following tests shall be carried out before shipment according to ASTM A370

(a) Mechanical strength of materials

(b) Galvanizing test

(c) Shop assembly

2.2 Circuit Breakers

1. Codes and Standards

Circuit - breakers shall conform to the following standards as to material, design and tests, except as modified in this specification:

IEC 60060-1, High-Voltage Test Techniques – Part 1: General Definitions and test requirements.

IEC 60376: Specification of technical grade Sulphur Hexafluoride (SF6) for use in electrical equipment.

IEC 60815-1: Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 1: Definitions, information and general principles

IEC 60815-2: Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 2: Ceramics and glass insulators for a.c. systems

IEC 62155: Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1000 V.

IEC 62271-1: High Voltage Switchgear and Control gear. Part 1: Common Specifications.

IEC 62271-100: High Voltage Switchgear and Control gear. Part 100: High Voltage Alternating Current Circuit Breaker.

IEC 62271-300: High Voltage Switchgear and Control gear. Part 300: Seismic Qualification of Alternating Current Circuit Breaker

IEC 62371: Characteristics of hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1000 V.

Circuit breakers for feeders shall have auto reclosing with facility for making it operative/inoperative. They shall also have Synchronizing Check facility.

2. General

The circuit-breakers shall be of the SF6, outdoor, 3-pole single-break type.

The manufacturer shall guarantee the maximum value of over-voltage as high as 1.5 p.u. without restrikes.

Circuit-breakers shall be capable of interrupting their circuits for the duty cycle specified. They shall be substantially in the same mechanical and electrical condition at the termination as at the beginning of the specified duty cycle, shall have not emitted flame, oil or given other indications of failure.

Circuit-breakers shall be capable of interrupting their rated interrupting current within the specified time after the tripping coil has been energized. The breaking time shall not be more than 60 milliseconds. **The circuit breakers shall be capable of withstanding short circuit current 40 KA for 3 seconds.**

The line circuit-breakers shall be suitable for single and three phase multiple rapid auto-reclosing (0.3s). The bus-coupler and transformer circuit-breakers shall not be equipped with automatic

Reclosing and shall be mechanically linked to avoid any single-phase operation.

All circuit-breakers shall be able to perform an O – CO switching cycle when the auxiliary voltage is lost.

The rupturing capacity of the circuit-breakers after unsuccessful auto-reclosing should not fall below the minimum required rated breaking capacity.

The main high-voltage current carrying parts shall be able to carry the rated current continuously and the temperature rise of the main high-voltage current carrying parts, auxiliary circuits and devices shall be limited as specified in IEC 62271, however, the reference ambient- temperature shall be maximum 55 degrees Celsius.

Full contact and current carrying capacity shall be maintained during reasonable over-travel and under travel of the mechanism.

All main high-voltage current carrying parts and supporting insulators shall be capable to withstand successfully without damage or injurious distortion the specified short-circuit currents for the time duration specified.

The circuit-breakers shall be designed on the buffer principle i.e. the complete installation shall employ the single-pressure principle or an equivalent design.

The contacts shall be of self-wiping and self-cleaning type.

All circuit breakers shall be of the trip-free type. Care must be taken to prevent any pumping. Should the breaker either fail to latch or should it trip during closing, due to malfunction of the protective relays, adequate measures to prevent pumping shall be taken.

The circuit breakers shall be suitable for satisfactory open and close mechanical operations in accordance with IEC 62271-100.

The circuit-breaker shall be equipped with a temperature balanced remote and local SF6 gas monitoring system with two stages, indicating early the necessity of replenishing and blocking the breaker on the excessive pressure drop. SF6 gas density monitors shall be installed on each pole. All devices required for fail-safe operation during condition of low gas pressure shall be provided.

Replenishing of gas shall be possible while the circuit breaker is in service.

All circuit breakers shall be designed for closing and tripping by remote and local electrical controls. Local electrical control shall be from the outdoor control cubicle by means of a local "CLOSE" - "TRIP" control switch. The control location shall be selected by a "LOCAL"-"REMOTE" transfer switch provided within the outdoor control cubicle. The "LOCAL" operation shall be possible only during breaker maintenance, when the associated disconnecting switches are open. When the switch is under local control, this shall be indicated in the control room.

Each pole shall have a mechanical position indicator. The device shall be labelled "ON" and "OFF" and shall be clearly visible.

Operation of the breaker shall be actuated by two independent tripping coils and one closing coil. The trip circuits shall be duplicated and automatically supervised.

All electrically operated closing devices shall be suitable for operation at voltages between 85% and

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110% of the nominal control voltage.

The tripping devices shall be suitable for operation at voltages between 70% and 110% of the nominal control voltage.

Circuit breakers shall be equipped for phase discrepancy detection.

All circuit breakers shall have a sufficient number of auxiliary contacts, which shall be capable of carrying at least 10A continuously and be easily convertible from normally-open to normally-closed or vice-versa for annunciation locally and to the control room and for all necessary interlocks.

Breaker tripping must be indicated by a switch-discrepancy contact, made up of two signaling contacts. All contacts even if not used shall be wired up to the terminal blocks ready for connection to external equipment.

All circuit-breakers of the same rating and service shall be physically and functionally interchangeable.

For refilling purposes, portable SF6 gas bottles including all required accessories shall be furnished. The circuit breakers shall have auto reclosing facility which can be made operative and inoperative with selector switches.

3. Rating

The rating of circuit breakers shall comply with Technical Particular and Guarantee (TPG).

Circuit-breakers shall meet the Transient Recovery Voltage requirements specified in IEC 62271 Standard (representation by four parameters) for the rated short circuit conditions.

Rated line-charging breaking current and rated cable-charging breaking currents shall be as specified in IEC 62271 Standard.

4. Insulating medium

Circuit-breakers shall be of the SF6 single-pressure type.

Circuit-breakers shall be provided with means to ensure that moisture content, arc products and contaminants are retained and filtered to prevent loss of dielectric or internal condensation on insulating medium.

The nominal operating pressure of the SF6 insulating gas shall be as low as is compatible with the requirements for electrical insulation and space limitations to ensure there is no chance of the gas liquefying at the lowest ambient temperature.

5. Spring Charged Operating Mechanism

Circuit breaker operating mechanisms shall be the spring- spring type. The operating mechanism type offered shall have accumulated failure-free references at a sufficient number of circuit breakers and for at least three years in operation under similar climatic conditions. The Bidder shall give the reason for his choice.



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The circuit-breaker's operating mechanism shall be capable of storing energy to perform at least three complete closing and power closing mechanisms shall be recharged automatically for Further operation of as soon as the circuit breaker has completed the closing operation.

The design of the closing mechanism shall be such that the circuit-breaker cannot be operated inadvertently due to external shock forces resulting from short-circuit, circuit-breaker operation, vibration or any other causes.

A manually operated emergency tripping device per pole shall be provided as part of the mechanism. The emergency tripping device shall be protected against accidental operation and capable of tripping the circuit-breaker during a complete loss of the AC and DC auxiliary supply.

The circuit-breaker shall be provided with indicators or targets for each operating mechanism. They shall be located so that the position of the poles, whether open or closed can easily be determined. The mechanism shall be trip free as defined in IEC Standard.

The motor device for drive mechanism shall be operated at 220 V DC.

If a circuit-breaker closing mechanism is not fully recharged for further operation within a predetermined time after a closing cycle, the mechanism shall be locked out and alarm initiated.

Each part of the operating mechanisms shall be of substantial construction utilizing such materials as stainless steel, brass or gunmetal where necessary to prevent sticking due to rust or corrosion.

If not maintenance-free the maintenance period of the driving mechanism must not be shorter than that of the circuit breaker itself.

The spring mechanism shall be fully charged before it can be released to close the circuit-breaker. It shall not be possible for the breaker to close whilst the spring is being charged.

The mechanism shall be provided with means for charging the spring by hand. This operation may be carried out with the doors of the cubicle opened. During this process no electrical or mechanical operation of the mechanism shall endanger the operator, or damage the equipment.

A mechanical indicating device shall be provided to indicate the state of charge of spring and shall also be visible with the doors of the cubicle closed.

An alarm shall be provided at the local control panel and in the control room to indicate a spring failing to be charged a pre-set time after circuit-breaker closing.

The spring mechanism shall be fitted with a manual release, preferably by a local push button shrouded to avoid inadvertent operation.

Means shall be provided for discharging the spring when the circuit-breaker is in the open position without the circuit-breaker attempting to close.

6. Operating Cubicle

The cubicle enclosing the operating mechanism shall accommodate the auxiliary contacts, the shunt tripping coils for "ON" and "OFF" operation, the terminal block and control device for electrical or mechanical local operation of the circuit-breaker.

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Cubicles shall be of rigid, hot dip galvanized, preferably folded but alternatively formed on a framework of standard rolled steel sections and shall include any supporting steelwork necessary for mounting on the circuit breaker.

The cubicle shall be vermin proof, weatherproof and well ventilated through louvers comprising a brass gauze screen attached to a frame and secured to inside of the cubicle. Divisions between compartments within the cubicle shall be perforated to assist air circulation.

Doors shall be rigid and fitted with waterproof sealing material suitable for the climatic conditions specified and with proper locking devices.

Access door or panels shall be glazed where necessary to enable instruments to be viewed without opening the cubicle. The arrangement of equipment within the cubicle shall be such that access for maintenance or removal of any item shall be possible with the minimum disturbance of associated apparatus.

A copper earth Busbar shall be provided with tapped holes and screws and shall be connected to the earthing system.

A heating element for 230 V AC must be installed to avoid moisture in the circuit breaker cubicle. The heating element shall be temperature controlled, however a by-pass switch shall enable continuous heating.

Interior lighting operated from a door switch shall be provided within each cubicle assembly. Lamps shall be 230 V with bayonet base.

A 230 V AC, 10 A single-phase standard power outlet along with its approved fuse to fit standard prong-plug shall be installed inside each cubicle assembly.

An approved schematic diagram of the local control system of the circuit breaker, identifying the various components within the cubicle and on the circuit breaker and referring to the appropriate drawings and maintenance instructions, shall be affixed to the inside of the cubicle access door. The diagram shall be marked on durable non-fading material suitable for the specified site conditions.

7. Wiring

All wires shall be identified at both ends according to the interconnection diagrams.

Wiring between terminals of various devices shall be point-to-point, no splicing or "T" connection shall be allowed.

All internal wiring shall be neatly trunked in wiring troughs.

All groups of bundled conductors to hinged doors and panels shall use extra flexible wire arranged so that a twisting rather than a bending motion is imparted to the moving conductor bundle.

Terminal blocks shall be arranged with sufficient space for easy connections of incoming cables. Parallel rows of terminal blocks shall be spaced at least 15 cm apart. At least 20% spare terminals shall be provided in each block. Terminal studs and wires shall be numbered or otherwise marked in accordance with applicable schematic and wiring diagrams.

The DC power supply to the circuit-breaker tripping coils and the control circuit wiring shall be provided with shielded cables, like type NYCY, and all other measures of protection shall be taken in order to minimize the hazard of damage to these cables and subsequent failing of control voltage.

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Auxiliary circuits shall be capable of carrying at least 10 A continuously.

8. Installation Supervision

During erection, test and commissioning at site, the manufacturer's expert engineer shall supervise the work.

9. Testing

Type test certificates for the specified equipment shall be issued by an approved internationally acknowledged, reputable, independent testing laboratory.

9.1. Type Tests

The circuit-breaker type offered shall have passed the type tests in accordance with IEC 62271-100.

9.2. Routine Tests

Circuit-breakers 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 62271-100.

10. Accessories

The following items shall be provided for the circuit breaker:

- a. Name plate.
- b. Position indicating signal lamp.
- c. 10-stage auxiliary switch for position indication and interlocking.
- d. Counter to record the number of operation.
- e. Primary terminal connectors.
- f. Grounding terminal(s).
- g. Supporting structure with anchor bolts and nuts.
- h. SF6 gas for first filling.
- i. SF6 gas leakage detector.
- j. Mounting bolts and nuts.
- k. Primary terminal connecting clamps, connectors, jumpers and necessary material for connection to conductors (Busbar) and other equipment.
- l. Other necessary accessories, even if specified elsewhere in the Bid Documents or not expressly specified but required for a continuous reliable operation.

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2.3 Disconnecting and Earthing Switches

1. Codes and Standards

Disconnecting and earthing switches shall comply with the requirements of the following standards, except as modified in this specification:

IEC 60060-1: High-Voltage Test Techniques –
Part 1: General Definitions and test requirements.

IEC 60815-1: Selection and dimensioning of high-voltage insulators intended for use in polluted conditions

Part 1: Definitions, information and general principles.

IEC 60815-2: Selection and dimensioning of high-voltage insulators intended for use in polluted conditions

Part 2: Ceramics and glass insulators for a.c. systems.

IEC 62155: Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1000 V.

IEC 62271-1: High Voltage Switchgear and Control gear.

Part 1: Common Specifications.

IEC 62271-102: High Voltage Switchgear and Control gear.

Part 02: Alternating Current Disconnectors and Earthing Switches.

IEC 62371: Characteristics of hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1000 V.

2. General

All Isolators shall be Local/Remote motorized center break double post rotating type with provision for manual operation.

One three-phase disconnecting-switch shall consist of three units of single-phase disconnecting switches. They shall be completed with supporting steelwork and installed to permit easy maintenance and shall be so located that the minimum safety clearances are always maintained.

The single-phase Disconnectors shall be mounted on three separate steel supports but operated three-phase by a common motor-operated mechanism. The Disconnector poles must be so coupled as to ensure synchronism of the switching motions under all conditions.

All contact arms shall be in positive continuous control throughout the entire cycle of and in angular synchronization during the closing and opening operation. The Disconnectors shall be of the slow acting type.

Disconnectors shall be designed for the specified rated currents. The contacts shall carry their rated load currents without overheating or welding. They shall be suitable for off-load isolation at the maximum permissible continuous operating voltage.

Full contact and current carrying capacity shall be maintained during reasonable over travel and under travel of the mechanism.

All main high-voltage current carrying parts and the supporting insulators shall be capable to withstand successfully without damage or injurious distortion, the short-circuit current for the time duration specified.

The use of stranded wire connections bridging the movable links are not allowed. Main contacts shall be of the high pressure line type and arcing contacts, if provided, shall be subjected to the DABS/Engineer's approval.

Service conditions require that the Disconnectors shall remain alive and in continuous service for periods of up to two years in the climatic conditions specified, even without operation or maintenance.

The Disconnecting Switches shall be suitable for at least 200000 operating cycles, satisfactory open and close mechanical operations in accordance with class M1 IEC 62271-102.

All line Disconnectors shall be fitted with approved three-phase line earthing switches.

The line Disconnectors shall be interlocked also with their associated earthing switch in such a manner as to allow the Disconnectors to be closed only if the earthing switch is open and to allow the earthing switch to be closed only if the Disconnector is open.

The earthing switch, when in the closed position, shall be capable of carrying the rated short time current for the specified time duration without the contacts burning or welding. The position of the earthing switch shall be indicated by a reliable indicating device.

In order to prevent the possibility of making or breaking load current, Busbar Disconnectors, line Disconnectors and transformer Disconnectors shall be interlocked with the circuit-breaker of the respective bay so that the Disconnectors can be closed or opened only if the circuit-breaker is open.

Disconnectors and earthing switches shall have the sufficient number of auxiliary contacts for the control circuits, which shall easily be convertible from normally closed to normally-open and vice-versa.

3. Rating

The rating of Disconnectors shall comply with the Technical Particular Guarantee.

4. Operating Mechanism

Each Disconnector and earthing switch shall be three-phase group-operated, by a DC motor-driven mechanism.

Disconnector operating mechanisms shall be of robust construction, carefully fitted to ensure free action and shall be unaffected by the climatic conditions at site. Mechanisms shall be as simple as possible and comprise a minimum of bearing and wearing parts. Approved grease lubricating devices shall be fitted to all principal bearings.

Each rotating insulator rod shall be provided with weatherproof type, sealed, ball or roller bearing.

All pin, sert screw and washers shall be of non-corroding material.

Operating rods shall be equipped with weatherproof ball or roller bearings or with brass bearings in order to avoid corrosion.

Mechanisms shall be designed to be readily operated by one man and shall be provided with interlock and auxiliary switches as specified.

Manual operation shall be possible on all Disconnectors and earthing switches from switches located approximately 1 meter above ground. The force to open or close a single-pole or three-pole switch manually shall not exceed 15 kg on a crank not over 1.5 m in length.

The mechanism shall be housed in a weatherproofed enclosure complete with auxiliary switches, terminal blocks, heaters, cable gland plates, cable glands, etc.

All steel and malleable iron parts including the supporting steelwork shall be galvanized as specified.

5. Interlocking Facilities

Disconnectors and earthing switches shall be provided with an interlocking system which ensures safe operation of the equipment under all service conditions.

Interlocks shall be effective at the point where hand-power is applied so that stresses cannot be transferred to parts remote from that point.

All electrical interlocks shall so function as to interrupt the operating supply, and an approved system of interlocks shall be provided which shall cover the emergency hand operation of apparatus which is normally power operated. Failure of supply (or its restoration after an outage) or of connections to any electrical interlocks shall not produce or permit faulty operation.

Electrical bolt interlocks shall be energized only when the operating handle of the mechanism is brought to the working position. Visible indication shall be provided to show whether the mechanism is locked or free. Approved means, normally inaccessible shall be provided whereby the bolt can be operated in the emergency of a failure of interlock supplies.

Disconnectors shall be so interlocked that they cannot be operated unless the associated circuit breaker is open.

The interlocking facilities shall allow for the on-load transfer of feeder circuits from one Busbar to the other Busbar system, i.e. both Busbar Disconnectors could be closed when the bus coupler is closed.

6. Locking Facilities

Locking facilities shall be provided on each Disconnector.

Provision shall be made at that part of the mechanism where the operating power is applied and not to remote or ancillary linkages.

7. Testing

7.1. Type Tests

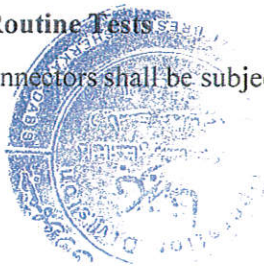
The disconnecting and earthing switch types offered shall have passed the type tests in accordance with IEC Standard.

Type test certificates for the specified equipment shall be issued by an approved internationally acknowledged, reputable, independent testing laboratory.

7.2. Routine Tests

Disconnectors shall be subject to routine tests according to IEC 62271-102.

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8. Accessories

The following items shall be provided for each disconnecting and earthing switch:

- a. Name plate.
- b. Primary terminals
- c. Supporting structure with anchor bolts and nuts.
- d. Primary terminals connecting clamps, connectors, and other necessary material for connection to conductors, Busbar and other equipment.
- e. Other necessary accessories even if specified elsewhere in the Bid Documents or not expressly specified but required for a continuous reliable operation.

2.4 Current Transformers

1. Codes and Standards

Current transformers shall conform to the following standards as to material, design and tests:

IEC 60296: Fluids for electro technical applications – Unused mineral insulating oils for transformers and switchgears.

IEC 60815-1: Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 1: Definitions, information and general principles

IEC 60815-2: Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 2: Ceramics and glass insulators for a.c. systems

IEC 61869-1: Instrument Transformers - Part 1: General requirements for instrument transformers.

IEC 61869-2: Instrument Transformers - Part 2: Additional requirements for current transformers

IEC 62155: Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1000 V.

IEC 62271-1: High Voltage Switchgear and Control gear. Part 1: Common Specifications.

IEC 62371: Characteristics of hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1000 V

2. General

CT ratios, number of cores, burden rating etc. shall be selected by the contractor depending on the design and shall take the approval of the Employer prior to procurement.

The current transformers shall be outdoor, single-phase, vertically mounted, free standing, oil immersed type, low reactance inverted type, single or multi-turn primary and shall be hermetically sealed.

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Each current transformer shall be impregnated and filled with oil of grade as specified in IEC 60296. Oil level indicators shall be provided. Oil volume shall be compensated by using a corrosion-proof metallic bellow.

Current transformers shall be designed for base mounting. The secondary leads shall terminate in a weatherproof junction-box (IP54) mounted on the current transformer base and the secondary leads size shall not be smaller than 4 sq mm.

Primary winding conductors shall have the capacity of the nominal continuous current and short-time current not less than that of the associated switchgears for a duration of one second.

Except where stated in data sheets all current transformers shall have a maximum continuous primary current rating not less than the primary current rating of the bay in which they will be installed.

Star connection and earthing of the current transformer's neutral shall be performed only once for the three-phase group and located at the corresponding outdoor control cubicle.

The secondary windings shall consist of enameled insulated wire and each current transformer secondary winding circuit shall be earthed at only one point. The secondary terminals must never be opened.

Current transformers shall be supplied with the number of cores for metering and protections as specified in the Technical Particular and Guarantee (TPG).

The cores shall be constructed of the highest quality, non-aging, cold-rolled, grain oriented steel especially suitable for the purpose. The steel shall be in thin laminations and each sheet shall have an insulating surface treatment or coating resistant to the action of hot oil.

Magnetization and core-loss curves shall be provided for each type and rating of current transformers.

The magnetization characteristic shall be submitted to the DABS for approval.

If the Bidder wishes to provide current transformer ratios differing from those specified, he shall first obtain approval in writing from the DABS for each specific instance.

Current transformers for balanced protective schemes including neutral current transformers where appropriate, shall have identical turns ratio and shall have their magnetization characteristic matched to each other.

The neutral current transformers, if any, shall be of the totally enclosed bushing type, complete with suitable mounting, cable box for secondary connections, etc.

Minimum knee point output voltage of current transformer for distance protection shall be:

$$V_k > I_f (1 + X/R) \times (Z_r + R_{ct} + 2R_l),$$

where I_f is the maximum fault current in secondary term, X/R the primary system ratio, Z_r the relay burden impedance, R_{ct} the current transformer's internal resistance in secondary terms, R_l the lead resistance from current transformer to relay. The lowest ratio of current transformer shall be used for determining I_f in secondary term.

Current transformers provided for protective gear purposes shall have over-current and saturation factors not less than those corresponding to the design short circuit level of the system. The output of each current transformer shall be not less than that specified and the Bidder shall ensure that the capacity

of the current transformers provided is adequate for operation of the associated protective devices and instruments.

The Bidder shall provide details of their method of calculating the outputs of the current transformers for each type of protection specified and shall submit calculations for all the current transformers for approval to the DABS.

Separate cables shall be laid from each individual protection core up to the control and protection cubicle. The screen of the cable connecting the current transformers to the outdoor control cubicle and further to the control and relay cubicle shall firmly be connected at both ends to the substation earthing system.

If double ratio secondary windings are specified, a label shall be provided at the secondary terminals of the current transformer indicating clearly the connection required for either ratio. These connections and the ratio in use shall be shown on the appropriate schematic and connection diagrams.

Where multi-ratios are specified current transformers with multiple windings are offered, it shall be possible to select either ratio for each winding without alteration to the number of primary turns.

Provision for lifting component parts or the complete assembly as required for inspection, handling and erection at site of the current transformer shall be provided. The following facilities shall be provided:

- a. Easily visible means of determining from ground the level of oil within the current transformers
- b. Oil drain cock and sampling device.
- c. Earthing terminal of adequate dimensions.

3. Rating

Rating of the current transformers shall comply with Technical Particular and Guarantee (TPG).

4. Testing

4.1. Type Test

The current transformers offered shall have passed the type tests in accordance with IEC 61869-1.

Type test certificates for the specified equipment shall be issued by an approved internationally acknowledged, reputable, independent testing laboratory.

4.2. Routine Test

Current transformers shall be subjected to routine tests as per IEC 61869-1.

5. Accessories

The following accessories shall be provided with each current transformer:

- a. Name plate
- b. Primary terminals
- c. Earthing terminal
- d. Primary winding protective device

- e. Weatherproof secondary terminal box
- f. Lifting lug
- g. Supporting structure with anchor bolts and nuts
- h. Mounting bolts
- i. Oil level indicator
- j. Drain and sampling plugs
- k. Oil filling plugs
- l. Oil adjusting unit (if necessary)
- m. Pressure relief device
- n. Cable conduit
- o. Weatherproof secondary terminal box for each 3-current transformers
- p. Primary terminal connection clamps, connectors, jumpers and other necessary material for connection to conductors (Busbar) and other equipment.
- q. Other necessary accessories, even if specified elsewhere in the Tender Document or not expressly specified but required for a continuous reliable operation.

2.5 Voltage Transformers

1. Codes and Standards

Unless otherwise stated, voltage transformer shall comply with the following:

IEC 60270: High Voltage Test Techniques – Partial Discharge Measurements.

IEC 60296: Fluids for electro technical applications – Unused mineral insulating oils for transformers and switchgears.

IEC 60358-1: Coupling Capacitors and Capacitor Dividers – Part 1: General rules.

IEC 60481: Coupling Devices for Power Line Carrier Systems.

IEC 60815: Guide for the selection of insulators in respect of polluted conditions.

IEC 60815-1: Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 1: Definitions, information and general principles.

IEC 60815-2: Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 2: Ceramics and glass insulators for a.c. systems.

IEC 61869-1: Instrument Transformers - Part 1: General requirements for instrument transformers.

IEC 61869-5: Instrument Transformers - Part 5: Additional requirements for capacitive voltage transformers.

IEC 62155: Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1000 V.

IEC 62371: Characteristics of hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1000 V

2. General The voltage transformers shall be of the outdoor, single-phase, vertically mounted, capacitor type.

The design of capacitor voltage transformers shall be such that the accuracy shall not be affected by the presence of pollution on the external surface of the insulation.

Voltage transformers shall be suitable for use as line couplers for the operation of carrier accelerated tripping and communication systems. The material of insulators of voltage transformers shall be porcelain or silicon rubber.

Voltage transformers specified to carry line traps at the top, shall be designed and dimensioned accordingly.

Capacitor voltage transformers shall also be suitable for use as couplers for high frequency live line pulse fault-locators and measurements.

Secondary fuses shall be provided on each voltage transformer, located such that they are accessible while the primary is alive and shall be provided with labels indicating their function and their phase colors.

The voltage transformer secondary circuit shall be earthed at only one point by a separate earth link situated at each voltage transformer.

A fast damping device shall be provided at each voltage transformer in order to damp transient and Ferro resonant oscillations.

The capacitor unit shall be hermetically sealed.

A bushing shall be provided to enable a high-frequency signal to be coupled to the capacitor unit.

The bushing shall be fully protected against rain and vermin by a sealed weatherproof terminal box (IP54).

The capacitive voltage transformer's terminal box shall:

- a. has a provision for connection with a line matching unit.
- b. has an earthing-switch capable of being operated from ground level. It shall preferably include facility to enable the capacitor coupling unit to be earthed via the drain coil whilst simultaneously isolating the carrier equipment for test purposes.
- c. has a surge arrester connected between the coupling capacitor and earth to protect the matching unit, drain coil, etc.



3.1. Construction

All material and workmanship throughout shall be of best quality and in accordance with modern practices. The design shall be such that installation replacement and general maintenance may be undertaken with a minimum of time and expense. The Capacitor Voltage Transformer shall consist of a Capacitor Divider and an electromagnetic unit (Intermediate Voltage Transformer) connected between the Intermediate terminal and the earth terminal of the capacitor divider unit for providing the secondary output. The capacitive divider shall be made up of one or more coupling capacitors, each containing a large number of series connected capacitor elements impregnated with synthetic oil.

3.2. Coupling Capacitors

Coupling capacitors shall be equipped with corrosion-proof metallic bellows to accommodate the variations in oil volume due to variation of temperature.

The capacitor electrodes shall be made from aluminum foil. The dielectric shall consist of high quality paper separating layers of polypropylene film impregnated with synthetic oil. Appropriate clamping of capacitor stacks should be demonstrated by the manufacturer to ensure long term stability of the divider.

The capacitor divider unit shall offer negligible capacitance variation with temperature and shall have optimum stability of ratio for different ambient temperatures.

The stack capacitance at rated power frequency shall not differ from the nominal nameplate value by more than - 5% or +10%. After dielectric tests the capacitance at rated power frequency shall not differ from that measured prior to dielectric tests by less than the equivalent of one capacitor element.

3.3. Electromagnetic Unit

The electromagnetic unit shall consist of an Intermediate Voltage transformer a device for suppression of Ferro resonance oscillations and a compensating reactor to ensure correct phase and ratio relationship between primary and secondary voltages. These shall be housed in a corrosion resistance base housing which is filled with mineral oil. A drain screw, oil filling screw and oil level indicator shall also be provided. The intermediate transformer shall operate at low magnetic flux. If ground switch for the intermediate transformer is provided, it shall be lockable in "open" position.

The intermediate transformer shall be provided with an electrostatic earth screen between the primary and secondary windings to reduce inter winding capacitance. The screen shall be solidly connected to the tank of the CVT.

The base housing may be constructed of corrosion resistant die cast aluminum, galvanized steel or painted steel.

A high frequency power line carrier terminal shall be provided (in between the earth terminal of capacitive divider unit and earth) for connection of carrier communication and metering apparatus.

4. Accuracy Requirements

Accuracy Class 0.2 for metering and class 3P for protection shall be considered. The voltage ratio and the burden rating shall be selected by the contractor depending on the design and shall take the approval of the Employer prior to procurement.

The measuring and protective accuracy clauses specified in the schedule of technical particular and guarantee shall be met without having to make adjustment for changes of power factor, burden or voltage.

The ratio of the voltage transformers shall not be affected by changes in ambient temperature.

The standard reference range of frequency shall be from 99 to 101% of rated frequency for accuracy classes for measurement and from 96 to 102% for accuracy class for protection. The ratio error and phase displacement shall remain within accuracy limits as required by IEC 61869-5.

The voltage error and phase displacement at rated frequency at any voltage between 80% and 120% of rated voltage and with burdens of between 25% and 100% of rated burden, at power factor of a 0.8 lagging, shall not exceed the prescribed value for measuring accuracy class.

The voltage error and phase displacement at rated frequency at 5% rated voltage and at rated voltage multiplied by rated voltage factor with burdens as between 25% and 100% of rated burden at a power factor of 0.8 lagging, shall not exceed the prescribed value for protective accuracy class. At 2% of rated voltage the limit of error and phase displacement with burdens between 25% and 100% of rated burden at a power factor of 0.8 lagging will be not more than twice as high as that prescribed for the accuracy class.

5. Effects of Transients

5.1. Transient Response

The transient response of the Capacitor Voltage Transformer shall be such that on the application of a short circuit to the primary and earth terminal the secondary output voltage shall fall to a value less than 10% of the peak value before short circuit in less than one cycle of rated frequency.

5.2. Ferro resonance Suppression Performance

When a Capacitor Voltage Transformer supplied at 120% of rated voltage and with substantially zero burden has its secondary terminal short circuited and the short circuit is suddenly removed, the peak of the secondary voltage shall revert to a value which does not differ from its nominal value by more than 10% after 10 cycles of rated frequency.

All CVT's shall be tested on a Routine Test with a minimum of 10 secondary short circuit operations to ensure conformance with this requirement. Secondary waveforms shall be included in the test report.

5.3. Short Circuit Characteristics

Capacitor Voltage Transformer shall be capable of withstanding for one second the mechanical and thermal stresses resulting from short circuit on secondary terminal with maximum rated voltage maintenance on primary terminal.

6. Secondary Terminal Boxes

The secondary terminals of the Capacitor Voltage Transformer shall be brought out into a weatherproof terminal box attached to the transformer tank. Mini circuit breakers of suitable rating shall be connected to the polarity end of each secondary winding for protection of the CVT.

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Note: Mini circuit breakers can be omitted provided the CVT when energized to 120% of rated voltage withstands without damage a secondary short circuit applied on each secondary winding separately for a minimum duration of one hour.

7. Bushings

Bushings shall be made of silicon rubber or wet process porcelain which shall be homogeneous free from laminations, cavities or other physical flaws and shall be well verified tough and impervious to moisture. Bushing shall have a glaze of brown color.

Bushings shall be made of alternating sheds and shall possess good self-cleaning properties. Minimum inclination of top shed shall be greater than 5° as per IEC Standard.

8. Tests

8.1. Type Tests

The type tests shall be performed in accordance with IEC 61869-5.

Type test certificates for the specified equipment shall be issued by an approved internationally acknowledged, reputable, independent testing laboratory.

1) Short Time Withstand Current Test

2) Dielectric Tests as follows:

a) Dry Lightning Impulse Test This test shall be performed at the level specified in IEC 61869-5 for Dry Lightning Impulse Test.

b) Wet Power Frequency Voltage Test

c) Partial Discharge Test Partial Discharge Test is not required for completed Capacitor Voltage Transformer. However, evidence shall be produced by the manufacturer showing that the insulator bushings have passed the Partial Discharge test.

3) Test for Accuracy

4) Temperature Rise Test on complete CVT unit

5) Ferro resonance Test on complete CVT unit

6) Transient Response Test

7) Insulation Endurance Test

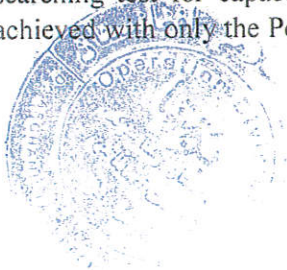
8.2. Routine Tests

8.2.1 On the capacitor divider:

a) Capacitance and dissipation factor measurement before and after power frequency withstand voltage (dry) test.

b) Dry Impulse Test of each capacitor section (This test is required in order to provide a more searching test for capacitor element flaws on a routine basis [all units] than would otherwise be achieved with only the Power Frequency Withstand and Partial Discharge Tests). The test may be

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performed on individual capacitor sections only, at the rated lightning impulse level multiplied by a factor equal to the percentage of the unit's power frequency voltage tap which is borne by the individual capacitor section under test.

c) Power frequency withstand voltage (dry) test.

d) Partial discharge measurement according to IEC standard (for Bushing) .

8.2.2 On the electromagnetic unit:

a) Induced potential test on the primary circuit

b) Applied potential test on the secondary circuit

8.2.3 On the complete CVT:

a) Accuracy tests

b) Polarity check

9. Rating

The rating of the Voltage Transformers shall comply with Technical Particular and Guarantee (TPG).

10. Accessories

The following accessories shall be provided with each capacitive voltage transformer:

a. Name plate.

b. Primary terminal.

c. Secondary terminal box.

d. Earthing terminal.

e. Lifting lug.

f. Cable conduit.

g. Supporting structure with anchor bolts and nuts.

h. Carrier earth switch.

i. Carrier surge arrester.

j. Weatherproof secondary terminal box.

k. Primary terminal connection clamps, connectors, jumpers and other necessary material for connection to conductors (Busbar) and other equipment.

l. Other necessary accessories, even if specified elsewhere in the Bid Documents or not expressly specified but required for a continuous reliable operation.

2.6 Surge Arresters

1. Standards

Surge arresters shall comply with IEC and/or all other equivalent or better relevant standards:

IEC 60137: Insulating bushings for alternating voltages above 1000 V.

IEC 61463: Bushing - Seismic qualification.

IEC 62271-300: High-voltage switchgear and control gear. Part 2: Seismic qualification for rated voltages of 72.5 kV and above.

IEC 60099-3: Surge Arresters. Part 3: Artificial pollution testing of surge arresters.

IEC 60099-4: Surge Arresters. Part 4: Metal-oxide surge arresters without gaps for a.c. systems.

IEC 60099-5: Surge Arresters. Part 5: Selection and application recommendations.

IEC 60270: High Voltage Test Techniques – Partial Discharge Measurements.

2. Operational Conditions

The surge arresters shall be designed to ensure satisfactory operation under the atmospheric conditions prevailing at site, and under such sudden variation of voltage as may be met with under working conditions of the system.

3. General Requirements

4.1. Design and Manufacturing Requirements

Surge arresters shall be outdoor, vertically mounted, self-standing type on supporting base or structures.

These surge arresters shall be metal-oxide type, gapless discharge devices, having non-linear characteristic, explosion proof, heavy duty, Station Class and shall be hermetically sealed to ensure a permanently reliable performance, irrespective of the surrounding atmosphere.

Surge arresters shall consist of zinc-oxide disc stacks housed inside the sealed insulator body.

The insulator body housing the active parts of the arrester shall be of silicon rubber or porcelain with alternating size in order to attain a low sensitivity to pollution and fitted with proper grading rings. The color shall be brown.

The surge arresters shall be capable of diverting the impulse voltage caused by lightning strikes and over voltage due to switching and temporary power frequency over voltages, and shall be designed for a nominal discharge-current as specified at the rated high voltage.

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

The surge arresters shall be capable of withstanding Continuous Operating Voltages (C.O.V) as stated at the Technical Particular and Guarantee (TPG).

The reference current of the arresters shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltages. In case of overloading, a pressure-relief device must discharge the dangerous pressure.

Internal components shall be designed to minimize internal corona and also to ensure minimal capacitive-coupling with any conducting layer of pollutant on the outside of the porcelain housing.

Each surge arresters shall be provided with high voltage terminals suitable to connect aluminum connectors and earth terminals shall be of tinned copper suitable to connect copper connectors.

The construction of surge arresters shall ensure proof against ageing and shall be of the maintenance free type.

5.2. Surge Counter and Leakage Current Meter

One surge-counter and leakage current meter shall be provided for each phase. The surge-counter shall be of the electromechanical type and designed for continuous service, operated by the discharge current passed by the surge arrester.

The leakage current meters shall be provided for installation in the earth connection of surge arresters and shall be designed for continuous service, suitable leakage current monitor on each pole of the arresters and measure leakage currents. The internal parts shall be fully weatherproofed with a transparent cover to provide on unobstructed view of the milli-ammeter. The reading of surge-counter and leakage current meter shall be visible through an inspection glass panel. Internal parts shall be hermetically sealed in a weather-proof housing and shall allow the recording device to be read without exposing the internal parts to the atmosphere.

The surge-counter and leakage current meter shall be connected in the main earth lead from the arrester in such a manner that the direction of the earth lead is not changed or its surge impedance materially altered. Earthing surge arrester should be separated from the mesh grounding system of substation. Bolted links shall be provided so that the surge-counter and leakage current meter may be short-circuited and removed without taking the arrester out of service.

6. Rating

Rating of the surge arrester shall comply with Technical Particular and Guarantee (TPG).

7. Performance

7.1. Operating duty

The surge arrester shall interrupt the follow-current after each of ten applications of an 8/20 microsecond impulse current having the peak value equal to the nominal discharge current of the arrester, while the arrester is connected to a power supply at the rated voltage, the interval between successive impulse current applications being about 60 seconds and the polarity of the impulse current being positive for five applications and negative for five applications.

7.2. Durability

No puncture or no external flashover of the arrester shall occur at the nominal discharge current, and the performance of the arrester shall not be deteriorated for a long time of service even if exposed to successive operations.

8. Tests

8.1. Type tests

Type test certificates for the specified equipment shall be issued by an approved internationally acknowledged, reputable, independent testing laboratory.

8.2. Routine tests

Before delivery surge arresters shall be subjected routine tests made by the manufacturer in accordance with IEC 60099-4.

Failure of a test specimen to comply with any one of the requirements of this standard shall rejected.

9. Accessories

Each surge arrester shall be supplied complete with the following accessories:

- a. Name plate.
- b. Pressure-relief device.
- c. Two primary terminals, one for connection to the power line and the other for connection to earth insulating base.
- d. Surge-counter and leakage current meter.
- e. Porcelain or composite Insulator base.
- f. Supporting structure with anchor bolts and nuts.
- g. Primary terminal connection clamps, connectors, jumpers and other necessary material for connection to conductors and other equipment.
- h. Bolted links shall be provided so that the surge counter and leakage current meter may be short circuited and removed without taking the arrester out of service.
- i. Other necessary accessories, even, if specified elsewhere in the Tender Documents or not expressly specified but required for a continuous reliable operation.

2.7 Glass or Ceramic Insulators

1.0 General

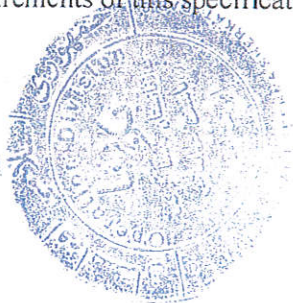
1.1 Work Included

This specification covers the requirements for design, manufacturing, testing, packing, furnishing and delivery of insulators to be used for 132/20 kV Substation: cap and pin type.

1.2 Quality Standards

1.2.1 General

The supplier and/or manufacturer shall control the quality of items (and services) to meet the requirements of this specification, applicable codes, standards and other applicable documents.



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IEC 60071-1: Insulation co-ordination – Part 1: Definitions, principles and rules.

IEC 60120: Dimensions of ball and socket couplings of string insulator units. IEC

60305: Characteristics of string insulator units of the cap and pin type.

IEC 60372: Locking devices for ball and socket couplings of string insulator units - Dimensions and tests.

IEC 60383-1: Insulators for overhead lines with a nominal voltage above 1000 V, Part 1: Glass or ceramic insulator units for a.c. systems - Definitions, test methods and acceptance criteria.

IEC 60383-2: Insulators for overhead lines with a nominal voltage above 1000 V, Part 2: Insulator strings and insulator sets for a.c. systems - Definitions, test methods and acceptance criteria.

IEC 60815-1: Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 1: Definitions, information and general principles.

IEC 60815-2: Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 2: Ceramics and glass insulators for a.c. systems.

IEC 61211: Insulators of ceramic material or glass for overhead lines with a nominal voltage greater than 1000 V – Impulse puncture testing in air

IEC/TR 61467: AC power arc tests for insulator sets

1.3 Site Conditions

Pollution Level: 1. Heavy (according to condition of location)

1.4 Submittals

1.4.1 Language

All documents are to be in the English language.

1.4.2 Documents to be submitted with the Bid

Each bidder shall submit with its bid the following documents, data and information in addition to any other information called for elsewhere in the Bidding Documents to enable DABS to fully evaluate the proposal of the Bidder.

Type Test Certificates

Type test certificates or type test reports shall be supplied in the bidding documents for the Following major equipment items:

110kV capacitor units

110kV Circuit Breakers

110kV Motorized Disconnect Switch

110 Surge Arrestor

110 Instruments transformer (CT, CVT)



Control and protection panels Main Relays
Other relays Panels
AC Panels
DC Panels

And it has to be mentioned that vendors list for mentioned equipments has to be submitted along with other documents for evaluation. So that after the contracts there should not be any confusion and misunderstandings.

1.4.3 Document to be submitted after Award of Contract

- a. Confirmation of data provided in the Bid.
- b. Technical particulars.
- c. Outline drawings of insulator units.
- d. Type test certificates of insulators to be supplied.
- e. Inspection Quality and Testing Procedure.
- f. Quality control procedure.

1.5 Testing and Inspection

The following tests shall be carried out in order to determine whether the materials and equipment comply with this Specification.



Not less than three-week notice of all tests shall be given to DABS. As many tests as in the opinion of DABS are possible shall be arranged together. Four copies of the records of all tests shall be furnished to DABS. All instruments shall be approved and shall, if required by DABS, be calibrated by an approved authority.

With the exception of the manufacturer's routine and sample tests waive all type tests may, at the option of DABS, providing satisfactory previous type testing records, issued by an approved internationally acknowledged reputable independent testing laboratory, are available and are approved by the Engineer.

The cost of tests shall be deemed included in the Contract Price.

Testing shall be in accordance with the relevant clauses of the standards as mentioned in this Specification with the additions stated in below:

1.5.1 Type Tests of Insulator Units(Not Applicable)

The type tests are as follows:

- a. Verification of the dimensions.
- b. Dry lightning impulse withstand voltage test.
- c. Wet power-frequency withstand voltage test.
- d. Electro-mechanical failing load test or mechanical failing load test
- e. Thermal-mechanical performance test.
- f. Residual strength test.
- g. Impulse puncture testing in air

1.5.2 Routine Tests of Insulator Units(Not Applicable)

Routine tests of insulator units shall be carried out in accordance with IEC 60383-1.

1.5.3 Sample Tests of Insulator Units(Not Applicable)

Sample tests shall be carried out in accordance with IEC 60383-1.

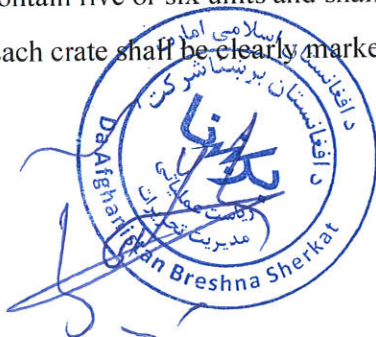
1.5.4 Type Tests of Complete Insulator Sets(Not Applicable)

- a. Dry lightning impulse withstand voltage test, according to IEC 60383-2.
- b. Wet power-frequency withstand voltage test, according to IEC 60383-2.
- c. AC power arc test, according to IEC 61467.

1.6 Packing, Marking and Delivery(Not Applicable)

The insulators shall be packed in wire bound wooden crates. The packing shall be suitable for transport by sea, rail and road, as separate crates or pelletized. It is preferred that each separate crate contain five or six units and shall contain only insulator units of the same type.

Each crate shall be clearly marked with the following information:



- a. Contents.
- b. Quantity.
- c. Net weight and gross weight.
- d. Name of DABS and name of the Bidder.
- e. Contract number.
- f. Project name.
- g. Destination.
- h. Any other identification required by DABS.

2.0 Specific Requirements

2.1 Type of Insulators

The insulator units shall be of the cap and pin type and shall be of aluminous ceramic or toughened glass;

2.2 Materials, Design and Quality

2.2.1 Ceramic

Where ceramic insulators are used, they shall be made of the highest grade, dense, homogeneous, wet-process ceramic. The ceramic shall be free from warping, roughness, cracks, blisters, laminations, projecting points, foreign matter and other defects, except those within the limits of standard accepted practice.

2.2.2 Glass

Where glass insulators are used, they shall be made of the highest grade, dense, homogeneous, toughened glass possessing uniform mechanical and electrical strength and long life service. The glass shall be free from warping, roughness, cracks, blisters, laminations, projecting points, foreign matter and other defects, except those within the limits of standard accepted practice.

2.2.3 Cap and pin insulators

Cap and pin insulators shall comply with IEC 60305 and shall be provided with ball and socket couplings in accordance with IEC 60120 and split-pin type locking devices for the insulator units themselves, in accordance with IEC 60372.

The caps shall be made of good commercial grade malleable cast iron or ductile/cast iron and shall be hot dip galvanized after all necessary marking. The cap shall be truly circular, with the inner and outer surface concentric, and shall be free from cracks, shrinks, air holes, burrs, and rough edges to minimized field concentrations and radio disturbances.

The insulator pins shall be made of forged carbon steel or high tension steel and free from cracks and air-holes. Pins shall be provided with zinc anti-corrosion sleeve and the materials of the sleeve shall be pure zinc with the purity not less than 99.7 per cent. Total fused area of the interface should be more than 80 per cent of the total interfacial area between the zinc sleeve and the pin.

The metal of cap and pin insulators shall be hot-dip galvanized in accordance with ASTM A 153 or equivalent and shall consist of a coating of at least.



- for iron and steel castings and forgings:

610 g/m² for all samples, with 500 g/m² on any individual sample;

- for bolt, nuts and washers:

375 g/m² for all samples, with 300 g/m² on any individual sample;

The zinc coating shall be smooth, clean, free from defects, and of uniform thickness, satisfying the prescribed test procedure.

The locking devices shall be of austenitic stainless steel or phosphor bronze. Locking device shall be so formed that when set and under any conditions there shall be no risk of the locking device being displaced accidentally and that nothing but extreme deformation of the locking device shall allow separation of the insulator units. Locking device design shall be such as to allow easy removal or replacement of the insulator units under live line conditions. Locking devices when in position shall be independent of rotation, and the efficiency of the locking shall be independent of the degree of opening applied to the locking device after insertion.

2.2.4 Glaze

All ceramic surfaces exposed to the weather shall be glazed with reasonably uniform brown color. The glaze shall be smooth, hard, dense, and properly fitted to the ceramic and shall be unaffected by the weather, ozone, nitric acid, nitric oxides, alkali, dust, or sudden change in temperature within the atmospheric range.

2.2.5 Cementing

Extra high quality cement shall be used for cementing the insulator body to the cap and pin. The cement shall have minimum expansion to avoid thermal stress between joints. Cement thicknesses shall be as small and even as possible, and proper care shall be taken to correctly center and locate the individual parts during cementing.

2.3 Marking

Each insulator shall be legibly and indelibly marked with the manufacturer's name or trade mark, the year of manufacture, a mark indicating the minimum failing load and such other mark as may be approved to assist in the representative selection of batches for the purposes of testing. For ceramic insulators these marks shall be printed, not impressed, and shall be applied before firing and shall be clearly legible after firing the glazing.

For glass insulators these marks may be applied by sand blasting. If these indications are stamped on the insulator socket, they shall not affect the quality of galvanization.

2.4 Coordination with Manufacturer of Fittings

It is the Bidder's responsibility that a close and constant liaison be maintained between the manufacturer of insulators and the manufacturer of fittings so that all component parts of an insulator assembly are perfectly adapted to one another.



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2.5 Conductors and Hardware

1. Codes and Standards

Conductors for Bus bar and all electrical connections in the outdoor substation bays shall be in accordance with IEC 61089 or equivalent international standards in respect of current rating and material analysis.

Type of conductor shall be Hard Drawn Aluminum or Aluminum Alloy (AAC) or Thermal Aluminum Conductor (TAL) or ACSR. Size of Busbar conductor and current rating shall be calculated by the Bidder to meet the substation requirements. Busbars shall be strung in continuous conductor lengths for each span.

Conductors and connectors provided for extending existing connections at each substation shall be identical with the existing equipment except where otherwise specified.

2. General

Materials used for Busbars and bay conductors 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.

Busbars shall be arranged so that they may be readily extended in length with a minimum of disturbance to existing equipment.

All necessary clamps and connectors for connections between the Busbars, bay conductors and equipment for the complete scope of work shall be provided under this Contract.

Clamps and connectors shall be of an approved type, preferably type tested. Connections dependent upon site welding techniques will not be permitted.

Busbars and bay conductors shall be so arranged and supported that under no circumstances, including short circuit conditions, can the clearances between live metal and earth or earthed metal work or between conductors be less than the specified distances.

When 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 clamps shall be of approved types and shall be as light as possible. Those for the Busbar conductor shall 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 per cent of the ultimate strength of the conductor.

Clamps and fittings made of steel or malleable iron shall be galvanized.

The Bidder shall supply all Bus bars, jumpers, necessary connectors and clamps for connection between the bus bars and all apparatus/equipment even if not specifically mentioned in the tender

Specification, bill of Quantities and drawings, but necessary for the proper completion of the work.



Carpin

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2.9 CONTROL AND RELAY PANEL

1.1. The contractor has to provide Control and protection Panel which will suit the spare space available in the existing control room. 4.5-meter-long spare space is available in the control room, covered with MS plate.

2.MOUNTING

- 3.1. All equipment on and in panels shall be mounted and completely wired to the terminal blocks ready for external connections. The equipment on front of panel shall be mounted flush.
- 3.2. Equipment shall be mounted such that removal and replacement can be accomplished individually without interruption of service to adjacent devices and are readily accessible without use of special tools. Terminal marking on the equipment shall be clearly visible.
- 3.3. Cut outs if any, provided for future mounting of equipment shall be properly blanked off with blanking plate.
- 3.4. The center lines of switches, push buttons and indicating lamps shall be not less than 750mm from the bottom of the panel. The center lines of relays, meters and recorders shall be not less than 450mm from the bottom of the panel
- 3.5. The center lines of switches, push buttons and indicating lamps shall be matched to give a neat and uniform appearance. Likewise, the top lines of all meters, relays and recorders etc. shall be matched.
- 3.6. No equipment shall be mounted on the doors.

4. PANEL INTERNAL WIRING

- 4.1. Panels shall be supplied complete with interconnecting wiring provided between all electrical devices mounted and wired in the panels and between the devices and terminal blocks for the devices to be connected to equipment outside the panels. When panels are arranged to be located adjacent to each other all inter panel wiring and connections between the panels shall be furnished and the wiring shall be carried out internally
- 4.2. All wiring shall be carried out with 650V grade, single core, stranded copper conductor wires with PVC insulation. The minimum size of the multi-stranded copper conductor used for internal wiring shall be as follows:

All circuits except current transformer circuits and voltage transfer circuits meant for energy metering - one 1.5mm sq. per lead.

All current transformer circuits one 2.5 sq.mm lead.

Voltage transformer circuit (for energy meters): Two 2.5 mm sq. per lead.

- 4.3. All internal wiring shall be securely supported, neatly arranged, readily accessible and connected to equipment terminals and terminal blocks. Wiring gutters & troughs shall be used for this purpose.
- 4.4. Auxiliary bus wiring for AC and DC supplies, voltage transformer circuits, annunciation circuits and other common services shall be provided near the top of the panels running throughout the entire length of the panels.
- 4.5. Wire termination shall be made with solderless crimping type and tinned copper lugs, which firmly grip the conductor. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wire and shall not fall off when

the wire is disconnected from terminal blocks. All wires directly connected to trip circuit breaker or device shall be distinguished by the addition of red colored unlettered ferrule.

4.6. Longitudinal troughs extending throughout the full length of the panel shall be preferred for inter panel wiring. Inter-connections to adjacent panel shall be brought out to a separate set of terminal blocks located near the slots of holes meant for taking the inter-connecting wires.

4.7 Contractor shall be solely responsible for the completeness and correctness of the internal wiring and for the proper functioning of the connected equipment.

5. TERMINAL BLOCKS

5.1. All internal wiring to be connected to external equipment shall terminate on terminal blocks. Terminal blocks shall be 650 V grade and have 10 Amps. Continuous rating, molded piece, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts. Markings on the terminal blocks shall correspond to wire number and terminal numbers on the wiring diagrams. All terminal blocks shall have shrouding with transparent unbreakable material.

5.2. Disconnecting type terminal blocks for current transformer and voltage transformer secondary leads shall be provided. Also current transformer secondary leads shall be provided with short circuiting and earthing facilities.

5.3. At least 20% spare terminals shall be provided on each panel and these spare terminals shall be uniformly distributed on all terminal blocks.

5.4. Unless otherwise specified, terminal blocks shall be suitable for connecting the following conductors of external cable on each side

All CT & PT circuits: minimum of two of 2.5mm Sq. copper.

AC/DC Power Supply Circuits: One of 6mm Sq. copper

All other circuits: minimum of one of 2.5mm Sq. Copper.

5.5. There shall be a minimum clearance of 250mm between the first row of terminal blocks and the associated cable gland plate or panel side wall. Also the clearance between two rows of terminal blocks edges shall be minimum of 150mm.

5.6. Arrangement of the terminal block assemblies and the wiring channel within the enclosure shall be such that a row of terminal blocks is run in parallel and close proximity along each side of the wiring-duct to provide for convenient attachment of internal panel wiring. The side of the terminal block opposite the wiring duct shall be reserved for the Owner's external cable connections. All adjacent terminal blocks shall also share this field wiring corridor. All wiring shall be provided with adequate support inside the panels to hold them firmly and to enable free and flexible termination without causing strain on terminals.

5.7. All necessary cable terminating accessories such as gland plates, supporting clamps & brackets, wiring troughs and gutters etc. (except glands & lugs) for external cables shall be included the scope of supply.

6. PAINTING

6.1. All sheet steel work shall be phosphated in accordance with the relevant international standard "Code of practice for phosphating iron and steel".

6.2. Oil, grease, dirt and swarf shall be thoroughly removed by emulsion cleaning

6.3. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water rinsing with a slightly alkaline hot water and drying.

6.4. After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying.

- 6.5. The phosphate coating shall be sealed with application of two coats of ready mixed, stoved type zinc chromate primer. The first coat may be "flash dried" while the second coat shall be stoved.
- 6.6. After application of the primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after inspection of first coat of painting. The exterior color of paint shall be of a slightly different shade to enable inspection of the painting.
- 6.7. A small quantity of finished paint shall be supplied for minor touching up required at site after installation of the panels.
- 6.8. In case the bidder proposes to follow any other established painting procedure like electrostatic painting, the procedure shall be submitted for MEW's review and approval.

7. MIMIC DIAGRAM

- 7.1. Colored mimic diagram and symbols showing the exact representation of the system shall be provided in the front of control panels.
- 7.2. Mimic diagram shall be made preferably of anodized aluminum or plastic of approved fast color material, which shall be screwed on to the panel and can be easily cleaned. Painted overlaid mimic is also acceptable. The mimic bus shall be 2mm thick. The width of the mimic bus shall be 10mm for bus bars and 7mm for other connections.
- 7.3. Mimic bus color will be decided by the DABS and shall be furnished to the successful Bidder during Engineering.

8. NAME PLATES AND MARKINGS

- 8.1. All equipment mounted on front and rear side as well as equipment mounted inside the panels shall be provided with individual name plates with equipment designation engraved. Also on the top of each panel on front as well as rear side, large and bold nameplates shall be provided for circuit/feeder designation.
- 8.2. All front mounted equipment shall also be provided at the rear with individual name plates engraved with tag numbers corresponding to the one shown in the panel internal wiring to facilitate easy tracing of the wiring.
- 8.3. Each instrument and meter shall be prominently marked with the quantity measured e.g. KV, A, MW, etc. All relays and other devices shall be clearly marked with manufacturer's name, manufacturer's type, serial number and electrical rating data.
- 8.4. Name Plates shall be made of non-rusting metal. Name plates shall be black with white engraving lettering.
- 8.5. Each switch shall bear clear inscription identifying its function e.g. 'BREAKER' '52A', 'SYNCHRONISING' etc. Similar inscription shall also be provided on each device whose function is no other-wise identified. If any switch device does not bear this inscription, separate name plate giving its function shall be provided for it. Switch shall also have clear inscription for each position indication e.g. "Trip- Neutral-Close", "ON-OFF", "R-Y-B-OFF" etc.
- 8.6. All the panels shall be provided with name plate mounted inside the panel.

MISCELLANEOUS ACCESSORIES

- 9.1. **Plug Point:** 230V, Single phase 50Hz, AC socket with switch suitable to accept 5 Amps and 15 Amps pin round standard Indian plug, shall be provided in the interior of each cubicle with ON- OFF switch.
- 9.2. **Interior Lighting:** Each panel shall be provided with a fluorescent lighting fixture rated for 230

Volts, single phase, 50 Hz supply for the interior illumination of the panel controlled by the respective panel door switch. Adequate lighting shall also be provided for the corridor in Duplex panels.

9.3. **Switches and Fuses:** Each panel shall be provided with necessary arrangements for receiving, distributing and isolating of DC and AC supplies for various control, signaling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with miniature circuit breakers (MCB). Selection of the main and sub-circuit MCB rating shall be such as to ensure selective clearance of sub-circuit faults. MCBs shall conform to IEC 60947. Each MCB shall be provided with one potential free contact and the same shall be wired for annunciation purpose. However, voltage transformer circuits for relaying and metering shall be protected by fuses. All fuses shall be HRC cartridge type conforming to relevant international standard mounted on plug-in type fuse bases. Fuse carrier base as well as MCBs shall have imprints of the fuse 'rating' and 'voltage'.

9.4. **Space Heater:** Each panel shall be provided with a space heater rated for 230V, single phase, 50 Hz Ac supply for the internal heating of the panel to prevent condensation of moisture. The fittings shall be complete with switch unit.

10. EARTHING

10.1. All panels shall be equipped with an earth bus securely fixed. Location of earth bus shall ensure no radiation interference for earth systems under various switching conditions of isolators and breakers. The material and the sizes of the bus bar shall be at least 25 X 6 sq.mm perforated copper with threaded holes at a gap of 50mm with a provision of bolts and nuts for connection with cable armors and mounted equipment etc. for effective earthing. When several panels are mounted adjoining each other, the earth bus shall be made continuous and necessary connectors and clamps for this purpose shall be included in the scope of supply of Contractor. Provision shall be made for extending the earth bus bars to future adjoining panels on either side.

10.2. Provision shall be made on each bus bar of the end panels for connecting Substation earthing grid. Necessary terminal clamps and connectors for this purpose shall be included in the scope of supply of Contractor.

10.3. All metallic cases of relays, instruments and other panel mounted equipment including gland plate, shall be connected to the earth bus by copper wires of size not less than 2.5 sq. mm. The color code of earthing wires shall be green.

10.4. Looping of earth connections which would result in loss of earth connection to other devices when the loop is broken, shall not be permitted. However, looping of earth connections between equipment to provide alternative paths to earth bus shall be provided.

10.5. VT and CT secondary neutral or common lead shall be earthed at one place only at the terminal blocks where they enter the panel. Such earthing shall be made through links so that earthing may be removed from one group without disturbing continuity of earthing system for other groups.

11. INDICATING INSTRUMENTS, RECORDERS & TRANSDUCERS

11.1.1 All instruments, meters, recorders and transducers shall be enclosed in dust proof, moisture resistant, black finished cases and shall be suitable for tropical use. All Megawatt, Megavar, Bus voltage and frequency indicating instruments shall be provided with individual transducers and these shall be calibrated along with transducers to read directly the primary quantities. They shall be accurately

adjusted and calibrated at works and shall have means of calibration check and adjustment at site. The supplier shall submit calibration certificates at the time of delivery. However, no separate transducers are envisaged for digital bus voltmeters and digital frequency meters and the indicating meters provided in the synchronizing equipment.

Indicating Instruments

Unless otherwise specified, all electrical indicating instruments shall be of digital type suitable for flush mounting.

11.1.2 Instruments shall have 4-digit display; display height being not less than 25 mm

11.1.3. Digital voltage and frequency meters shall be of class: 0.5 and shall have digital display of 5 and 4 digits respectively, with display size, not less than 25mm (height).

11.2 Transducers

11.2.1. Transducers (for use with Indicating Instruments and Telemetry/Data Communication application) shall in general conform to IEC: 688-1

11.2.2 The transducers shall be suitable for measurement of active power, reactive power, voltage, current and frequency in three phase four wire unbalanced system.

11.2.3 The input to the transducers will be from sub-station current & potential transformers. The output shall be in Milli-Ampere D.C. proportional to the input & it shall be possible to feed the output current directly to the telemetry terminal or indicating instruments.

11.2.4 The transducer characteristic shall be linear throughout the measuring range.

11.2.5 The transducer output shall be load independent.

11.2.6 The input & output of the transducer shall be galvanically isolated.

11.2.7 The transducer shall derive its auxiliary supply from the quantity to be measured without need for any external auxiliary supply.

11.2.8 Each transducer shall be housed in a separate compact case and have suitable terminals for inputs & outputs.

11.2.9 The transducers shall be suitably protected against transient high peaks of voltage & current.

11.2.10 The transducer shall withstand indefinitely without damage and work satisfactorily at 120% of the rated voltage and 120% of the rated input current as applicable.

11.2.11 The voltage, frequency & current transducers shall have an output of 0-10mA and the active & reactive power transducer shall have an output of 10-0-10mA.

11.2.12. The response time of the transducers shall be less than 1 second.

11.2.13. The accuracy class of transducers shall be 1.0 or better for voltage/current transducer, 0.5 or better for watt/VAR transducer and 0.2 or better for frequency transducer.

11.2.14. The transducers shall have a low AC ripple on output less than 1%. 11.2.15. The transducers shall be suitable for load resistance of 1000-1500 11.2.16. The transducer shall have dual output.

11.2.15 MW, KWh, KVARh meters with data access facilities and pulse output, class 0.2 shall also be mounted.

12. ANNUNCIATION SYSTEM

12.1. Alarm annunciation system shall be provided in the control board by means of visual and audible alarm in order to draw the attention of the operator to the abnormal operating conditions or the

operation of some protective devices. The annunciation equipment shall be suitable for operation on the voltages specified in this specification.

12.2. The visual annunciation shall be provided by annunciation facia, mounted flush on the top of the control panels.

12.3. The annunciation facia shall be provided with translucent plastic window for alarm point with approximate size of 35mm x 50mm. The facia plates shall be engraved in black lettering with respective inscriptions. Alarm inscriptions shall be engraved on each window in not more than three lines and size of the lettering shall not be less than 5 mm.

12.4. Each annunciation window shall be provided with two white lamps in parallel to provide safety against lamp failure. Long life lamps shall be used. The transparency of cover plates and wattage of the lamps provided in the facia windows shall be adequate to ensure clear visibility of the inscriptions in the control room having high illumination intensity (350 Lux), from the location of the operator's desk.

12.5 All Trip facia shall have red color and all Non-trip facia shall have white color.

12.6. The audible annunciation shall be provided by Buzzer/ Hooter /Bell having different sounds and shall be used as follows.

Sl. NO	Alarm Instrument	Function
	Hooter	Alarm Annunciation
	Bell	Annunciation DC failure
	Buzzer	AC supply failure

12.7 Sequence of operation of the annunciator shall be as follows

Sl. NO	Alarm Condition	Fault Contact	Visual Annunciation	Audible Annunciation
	Normal	Open	OFF	
	Abnormal	Close	Flashing	ON
	Accept Push Button			
D	RESET	Open	Off	OFF
	Pressed			
E	Lamp Test Push Button	Open	Steady On	OFF
	Pressed			

12.8. Audible annunciation for the failure of DC supply to the annunciation system shall be provided and this annunciation shall operate on 230 Volts AC supply on failure of the DC to the annunciation system for more than 2 or 3 seconds (Adjustable setting), a bell shall sound. A separate push button shall be provided for the cancellation of this audible alarm alone but the facia window shall remain steadily lighted till the supply to annunciation system is restored.

12.9. A separate voltage check relay shall be provided to monitor the failure of supply (230V AC) to the scheme mentioned in Clause above. If the failure of supply exists for more than 2 to 3 seconds, this relay shall initiate visual and audible annunciation. Visual and audible annunciation for

the failure of AC supply to the annunciation system shall be provided and this annunciation shall operate on Annunciation DC and buzzer shall sound.

12.10. The annunciation system described above shall meet the following additional requirements:

- a) The annunciation system shall be capable of catering to at least 20 simultaneous signals at a time.
- b) One set of the following push buttons shall be provided on each control panel:
 - Reset push button for annunciation system.
 - Accept push button for annunciation system.
 - Lamp test push button for testing the facia windows
- c) One set of the following items shall be provided common for all the control panel (not applicable for extension of substation):
 - Flasher relay for annunciation system.
 - Push button for Flasher test.
 - Three Push buttons for test of all audible alarm systems
- d) These testing circuits shall be so connected that while testing is being done it shall not prevent the registering of any new annunciation that may land during the test
- e) The annunciation shall be repetitive type and shall be capable of registering the fleeting signal. Minimum duration of the fleeting signal registered by the system shall be 15 milli seconds.

- f) In case of static annunciator scheme, special precaution shall be taken to ensure that spurious alarm condition does not appear due to influence of external electromagnetic/ electrostatic interference on the annunciator wiring and switching disturbances from the neighboring circuits within the panels and the static annunciator shall meet the high voltage susceptibility test , impulse voltage with stand test , high frequency disturbance test- class III and fast transient disturbance test -level III as per IEC 60255.

12.11. The annunciation system to be supplied for existing sub-stations shall be engineered as an extension to the existing scheme.

13. SWITCHES

13.1. Control and instrument switches shall be rotary operated type with escutcheon plates clearly marked to show operating position and circuit designation plates and suitable for flush mounting with only switch front plate and operating handle projecting out.

13.2. The selection of operating handles for the different types of switches shall be as follows:

Sl. No.	Switch	Type of Handle
	Breaker, Isolator Control Switches	Pistol grip, black
	Selector switches	Oval or knob, black
	Instrument switches	Round, knurled, black

13.3. The control switch of breaker and isolator shall be of spring return to neutral type. The switch shall have spring return from close and trip positions to "after close" and "after trip" positions respectively.

13.4. Instrument selection switches shall be of maintained contact (stay put) type. Ammeter selection switches shall have make-before-break type contacts so as to prevent open circuiting of CT secondary when changing the position of the switch. Voltmeter transfer switches for AC shall be suitable for reading all line-to-line and line-to-neutral voltages for non-effectively earthed systems and for reading all line to line voltages for effectively earthed systems.

13.5. Lockable type of switches which can be locked in particular positions shall be provided when specified. The key locks shall be fitted on the operating handles.

13.6. The contacts of all switches shall preferably open and close with snap action to minimize arcing. Contacts of switches shall be spring assisted and contact faces shall be with rivets of pure silver or silver alloy. Springs shall not be used as current carrying parts

13.7. The contact combination and their operation shall be such as to give completeness to the interlock and function of the scheme.

13.8. The contact rating of the switches shall be as follows:

SR.No	Description	Contact rating in Amps		230V AC
		220 V DC	48V DC	
	Make and carry Continuously	10	10	10
	Make and carry for 0.5 sec.	30	30	30
	Break for			
	Load	20	3	10

14. INDICATING LAMPS

14.1. Indicating lamps shall be of cluster LED type suitable for panel mounting with rear terminal connections. Lamps shall be provided with series connected resistors preferably built in the lamp assembly. Lamps shall have translucent lamp covers to diffuse lights colored red, green, amber, clear white or as specified. The lamp cover shall be preferably of screwed type, unbreakable and molded from heat resisting material.

14.2. The lamps shall be provided with suitable resistors.

14.3. Lamps and lenses shall be interchangeable and easily replaceable from the front of the panel. Tools, if required for replacing the bulbs and lenses shall also be included in the scope of the supply.

14.4. The indicating lamps with resistors shall withstand 120% of rated voltage on a continuous basis.

15. RELAYS

15.1. All relays shall conform to the requirements of IEC-60255 or other applicable standards. Relays shall be suitable for flush or semi-flush mounting on the front with connections from the rear.

- 15.2. All protective relays shall be in draw out or plug-in type/modular cases with proper testing facilities. Necessary test plugs/test handles shall be supplied loose and shall be included in contractor's scope of supply.
- 15.3. All AC operated relays shall be suitable for operation at 50 Hz. AC Voltage operated relays shall be suitable for 220 Volts VT secondary and current operated relays for 1 amp CT secondary. All DC operated relays and timers shall be designed for the DC voltage specified, and shall operate satisfactorily between 80% and 110% of rated voltage. Voltage operated relays shall have adequate thermal capacity for continuous operation.
- 15.4. The protective relays shall be suitable for efficient and reliable operation of the protection scheme described in the specification. Necessary auxiliary relays and timers required for interlocking schemes for multiplying of contacts suiting contact duties of protective relays and monitoring of control supplies and circuits, lockout relay monitoring circuits etc. also required for the complete protection schemes described in the specification shall be provided. All protective relays shall be provided with at least two pairs of potential free isolated output contacts. Auxiliary relays and timers shall have pairs of contacts as required to complete the scheme; contacts shall be silver faced with spring action. Relay case shall have adequate number of terminals for making potential free external connections to the relay coils and contacts, including spare contacts.
- 15.5. All protective relays, auxiliary relays and timers except the lock out relays and interlocking relays specified shall be provided with self-reset type contacts. All protective relays and timers shall be provided with externally hand reset positive action operation indicators with inscription. All protective relays which do not have built-in hand-reset operation indicators shall have additional auxiliary relays with operating indicators (Flag relays) for this purpose. Similarly, separate operating indicator (auxiliary relays) shall also be provided in the trip circuits of protections located outside the board such as Buchholtz relays, oil and winding temperature protection, sudden pressure devices, fire protection etc.
- 15.6. Timers shall be of solid state type. Pneumatic timers are not acceptable. Short time delays in terms of milliseconds may be obtained by using copper slugs on auxiliary relays. In such case it shall be ensured that the continuous rating of the relay is not affected. Time delay in terms of milliseconds obtained by the external capacitor resistor combination is not preferred and shall be avoided to the extent possible.
- 15.7. No control relay which shall trip the power circuit breaker when the relay is de-energized shall be employed in the circuits.
- 15.8. Provision shall be made for easy isolation of trip circuits of each relay for the purpose of testing and maintenance.
- 15.9. Auxiliary seal-in-units provided on the protective relays shall preferably be of shunt reinforcement type. If series relays are used the following shall be strictly ensured:
- (a) The operating time of the series seal-in-unit shall be sufficiently shorter than that of the trip coil or trip relay in series with which it operates to ensure definite operation of the flag indicator of the relay.
 - (b) Seal-in-unit shall obtain adequate current for operation when one or more relays operate simultaneously.
 - (c) Impedance of the seal-in-unit shall be small enough to permit satisfactory operation of the trip coil on trip relays when the D.C. Supply Voltage is minimum.
- 15.10. All protective relays and alarm relays shall be provided with one extra isolated pair of contacts wired to terminals exclusively for future use.
- 15.11. The setting ranges of the relays offered, if different from the ones specified shall also be acceptable if they meet the functional requirements.
- 15.12. Any alternative/additional protections or relays considered necessary for

Providing complete effective and reliable protection shall also be offered separately. The acceptance of this alternative/ additional equipment shall lie with the DABS.

15.13. The bidder shall include in his bid a list of installations where the relays quoted have been in satisfactory operation.

15.14. All relays and their drawings shall have phase indications as R-Red, Y-yellow, and B-blue.

15.15. Wherever numerical relays are used, the scope shall include the following:

- a) Necessary software and hardware to up/down load the data to/from the relay from/to the personal computer installed in the substation. However, the supply of PC is not covered under this clause.
- b) The relay shall have suitable communication facility for connectivity to SCADA. The relay shall be capable of supporting IEC 61850 protocol.

16. Capacitor Bank Protection

16.1. The bidder has to design the relay protection system for the capacitor bank supply and install all on the relay panel.

16.2. The maximum fault current could be as high as but the minimum fault current could be as low as 20% of rated current of CT secondary. The starting & measuring relays characteristics should be satisfactory under these extremely varying conditions.

16.3. The protective relays shall be suitable for use with capacitor voltage transformers having non-electronic damping and transient response as per IEC.

17.0 The control panel shall have provision to give alarm when system voltage goes below the set value at which the Capacitor bank is intended to be Switch On. There must be provision to change the set value. Automatic Switching ON of the Capacitor Bank is not required.

18. TRIP CIRCUIT SUPERVISION RELAY

The relay shall be capable of monitoring the healthiness of each 'phase' trip-coil and associated circuit of circuit breaker during 'ON' and 'OFF' conditions.

The relay shall have adequate contacts for providing connection to alarm and event logger.

The relay shall have time delay on drop-off of not less than 200 milli seconds and be provided with operation indications for each phase.

19. DC SUPPLY SUPERVISION RELAY

The relay shall be capable of monitoring the failure of D.C. supply to which, it is connected.

It shall have adequate potential free contacts to meet the scheme requirement.

The relay shall have a 'time delay on drop-off' of not less than 100 milli seconds and be provided with operation indicator/flag.

20. TYPE TESTS

The reports for following type tests shall be submitted by the bidder for the Protective relays.

Insulation tests as per IEC 60255-5

High frequency disturbance test as per IEC 60255-4 (Appendix -E) –Class III (not applicable for electromechanical relays)

Fast transient test as per IEC 1000-4, Level III (not applicable for Electromechanical relays)

d) Relay characteristics, performance and accuracy test as per IEC 60255

Steady state Characteristics and operating time



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Dynamic Characteristics and operating time for distance protection relays and current differential protection relays

For Disturbance recorder and Event logger only performance tests are intended under this item.

Tests for thermal and mechanical requirements as per IEC 60255-6

Tests for rated burden as per IEC 60255-6

Contact performance test as per IEC 60255-0-20 (not applicable for Event logger, Distance to fault locator and Disturbance recorder)

21. CONFIGURATION OF C&R PANELS

The following is the general criteria for the selection of the equipments to be provided in each type of panel.

CONTROL PANEL

Various types of control panels shall consist of the following

	Voltmeter with Selector switch	1 sets.
Sl.No	ITEM	Qty.
	Mimic Diagram to represent SLD	1 Lot
	Ammeter with Selector switch	1 sets.
	KVAR meter	1 set
	Isolator Control switch	1 set
	CB Control switch	1 set
	Red indicating lamp	1 No.
	Amber indicating lamp	1 set
	Green indicating lamp	1 No.
	White indicating lamp	1 No.
	Annunciation windows with associated annunciation relays	12 Nos.
	Push button for alarm	
	Circuit Name Plates	1 No.
	(Accept/reset/lamp test)	

Note:

- 1) The range of analog ammeter shall be suiting the Capacitor Bank current.
- 2) The range of analog voltmeter shall be from 0-150 kV for 110 kV.
- 3) The C&R panels shall be installed and wired with all the protection and supervision relays as required based on the requirements of the bay and standard.

26. ERECTION AND MAINTENANCE TOOLS

All special testing equipment required for the installation and maintenance of the apparatus, instruments devices shall be furnished in relevant schedule.

27. TROPICALISATION

Control room will be normally air-cooled/air- conditioned. All equipment shall however be suitable for installation in a monsoon area having cold, humid climate and dry and dusty seasons with ambient conditions specified in the specification. All control wiring, equipment and accessories shall be protected against fungus growth, condensation, vermin and other harmful effects due to cold environment.

2.10 POWER AND CONTROL CABLES

1.1 TECHNICAL REQUIREMENTS

1.1.1 General

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

- 1.1.2. They shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating conditions. The XLPE /PVC insulated L.T. power cables of sizes 240 sq. mm. and above shall withstand without damage a 3- phase fault current of at least 45 kA for at least 0.12 second, with an initial peak of 105 kA in one of the phases. The armor for these power cables shall be capable of carrying 45 kA for at least 0.12 seconds without exceeding the maximum allowable temperature of PVC outer sheath.
- 1.1.3. The XLPE insulated cables shall be capable of withstanding a conductor temperature of 250°C during a short circuit without any damage. The PVC insulated cables shall be capable of withstanding a conductor temperature of 160°C during a short circuit.
- 1.1.4. The Copper wires used for manufacturing the cables shall be true circular in shape before stranding and shall be uniformly good quality, free from defects.
- 1.1.5. The fillers and inner sheath shall be of non-hygroscopic, fire retardant material, shall be softer than insulation and outer sheath shall be suitable for the operating temperature of the cable.
- 1.1.6. Progressive sequential marking of the length of cable in meters at every one meter shall be provided on the outer sheath of all cables.
- 1.1.7. Strip wire armoring method (a) mentioned in relevant international standard shall not be accepted for any of the cables. For control cables only round wire armoring shall be used.
- 1.1.8. The cables shall have outer sheath of a material with an oxygen index of not less than 29 and a temperature index of not less than 250°C.
- 1.1.9. All the cables shall pass fire resistance test as per relevant international standard
- 1.1.10. The normal current rating of all PVC insulated cables shall be as per relevant international standard.
- 1.1.11. Repaired cables shall not be accepted.
- 1.1.12. Allowable tolerance on the overall diameter of the cables shall be plus or minus 2 mm.

1.2.1. XLPE Power Cables

The XLPE insulated cables shall be of FR type, C1 category conforming to relevant international standard and its amendments read along with this specification. The conductor shall be stranded Copper circular/sector shaped and compacted. In multicore cables, the core shall be identified by red, yellow, blue and black colored strips or coloring of insulation. A distinct inner sheath shall be provided in all multicore cables. For XLPE cables, the inner sheath shall be of extruded PVC to type ST-2 of relevant international standard. When armoring is specified for single core cables, the same shall consist of aluminum wires/strips. The outer sheath shall be extruded PVC to Type ST-2 of relevant international standard for all XLPE cables.

1.2.2. PVC Power Cables

The PVC (70°C) insulated 1100V grade power cables shall be of FR type, C1 category, conforming to relevant international standard and its amendments, read along with this specification and shall be suitable for a steady conductor temperature of 70° C. The conductor shall be stranded Copper. The Insulation shall be extruded PVC to type-A of relevant international standard. A distinct inner sheath shall be provided in all multicore cables. For multicore armored cables, the inner sheath shall be of extruded PVC. The outer sheath shall be extruded PVC to Type ST-1 of relevant international standard for all cables.

1.3. PVC Control Cables

1.3.1. The (0.6-1) kV grade control cables shall be of FR type C1 category conforming to relevant international standard and its amendments, read along with this specification. The conductor shall be stranded copper. The insulation shall be extruded PVC to type A of relevant international standard. A distinct inner sheath shall be provided in all cables whether armored or not. The over sheath shall be extruded PVC to type ST-1 of relevant international standard and shall be grey in color except where specifically advised by the Owner to be black.

1.3.2. Cores shall be identified as per relevant international standard for the cables up to five (5) cores and for cables with more than five (5) cores the identification of cores shall be done by printing legible Arabic Numerals on all cores as per clause 10.3 of relevant international standard.

1.4 HT CABLE FOR AUXILIARY POWER SUPPLY

1.4.1 (a) The HT cable of 1C shall be, XLPE insulated, armored cable conforming to relevant international standard and IEC 60502-2 1998. Terminating accessories shall conform to IEC 61442 1997/IEC 60502-4 1998.

(b) The HT cable of shall be, XLPE insulated, armored cable conforming to relevant international standard and IEC 60502-2 1998. Terminating accessories shall conform to IEC 61442 1997/IEC 60502-4 1998.

1.4.2. The construction of XLPE insulated, armored HT cable shall be generally conforming to relevant international standard. Terminating accessories shall conform to IEC 60840 1999.

1.5 CABLE DRUMS

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

1.5.2. Standard lengths for each size of power and control cables shall be 500/1000 meters. The cable length per drum shall be subject to a tolerance of plus or minus 5% of the standard drum length. The owner shall have the option of rejecting cable drums with shorter lengths. However, the total quantity of cables after taking into consideration of all cable drums for each size shall be within the tolerance of $\pm 2\%$.

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

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

1.5.5. Each drum shall carry the manufacturer's name, the purchaser's name, address and contract number and type, size and length of the cable, net and gross weight stenciled on both sides of drum. A tag

containing the same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.

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

1.6 TYPE TESTS

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

The type tests on cables shall be conducted on each type and size of cables offered.

1.6.1. Following type tests as per relevant international standard including its amendments and additional type tests shall be carried out on 1.1 kV grade XLPE insulated cables:

- a) Tests on conductor
 - i) Annealing test (for Copper)
 - ii) Tensile test (for Copper)
 - iii) Wrapping test (for Copper)
 - iv) Resistance test
- b) Test for armoring wires/strips
- c) Test for thickness of insulation and sheath
- d) Physical tests for insulation
 - i) Tensile strength and elongation at break
 - ii) Ageing in air oven
 - iii) Hot set test
 - iv) Shrinkage test
- e) Physical tests for outer sheath
 - i) Tensile strength and elongation at break
 - ii) Ageing in air oven
 - iii) Loss of mass in air oven
 - iv) Shrinkage test
 - v) Hot deformation
 - vi) Heat shock test
 - vii) Thermal stability
- f) Insulation resistance (volume resistivity test)
- g) High voltage test
- h) Flammability test
- i) Oxygen index and temperature index test on outer sheath
- j) Short time current test on power cables of sizes 240 sq.mm and above.
 - On conductor(s).
 - On armors.

1.6.2 Following type tests as per relevant international standard including its amendments and additional type tests shall be carried out on 1.1 kV grade PVC insulated cables:

- a) Tests on conductor
 - a. Annealing test (for Copper)
 - b. Tensile test (for Copper)
 - c. Wrapping test (for Copper)
 - d. Conductor Resistance test
- b) Test for armoring wires/strips

- c) Test for thickness of insulation and sheath
- d) Physical tests for insulation and outer sheath
- i) Tensile strength and elongation at break
- ii) Ageing in air oven
- iii) Shrinkage test
- iv) Hot deformation
- v) Loss of mass
- vi) Heat shock test
- vii) Thermal stability
- e) Insulation resistance
- f) High voltage test
- g) Flammability test
- h) Oxygen index and temperature index test on outer sheath
- i) Short time current test on power cables of sizes 240 sq.mm and above. i) On conductor(s).
- ii) On armors.

1.6.3 Following type tests as per relevant international standard including its amendments and additional type tests shall be carried out on XLPE insulated HT cable up to 33kV earthed system:

- a) Tests on conductor
 - i) Annealing test (for Copper)
 - ii) Tensile test (for Copper)
 - iii) Wrapping test (for Copper)
 - iv) Resistance test
- b) Test for armoring wires/strips
- c) Test for thickness of insulation and sheath
- d) Physical tests for insulation
- e) Physical tests for outer sheath
- f) Partial discharge test
- g) Bending test
- h) Dielectric power factor test
- i) Heating cycle test
- j) Impulse withstand test
- k) High voltage test
- l) Oxygen index and temperature index test on outer sheath

1.6.3 Contractor shall submit type test reports for which test conducted once are acceptable (i.e. The requirement of test conducted within last ten years shall not be applicable) for the following:

1.6.4 Load cycle test followed by P.D. measurement as per international standard

1.6.5 Terminating/jointing accessories as per IEC 60840:1999

- a) Partial discharge test at ambient temperature;
- b) Heating cycle voltage test

- c) Partial discharge tests
 - At ambient temperature
 - At high temperature

d) Impulse voltage test followed by power frequency test of outer protection for buried joints

e) Test of outer protection for buried joints

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2.11. CAPACITOR BANK SYSTEM

Technical Specifications for 30MVAR, 110 KV capacitor Bank

1. International Standards

IEC 60871-1: Shunt capacitors for a.c. power systems having a rated voltage above 1000 V,
Part 1: General performance, testing and rating - safety requirements - Guide for installation and operation,

IEC 60871-2: Shunt capacitors for a.c. power systems having a rated voltage above 1000 V,
Part 2: Endurance testing, (including Amendment 1 of 1991).

IEC 60871-3: Shunt capacitors for a.c. power systems having a rated voltage above 1000V,
Part 3 Protection of shunt capacitors and shunt capacitor banks.

IEEE Std 693: Recommended Practices for Seismic Design of Substation. NEMA CP-1:
Shunt capacitors.

2. Definitions

Shunt Capacitor Bank: A device with a combination of capacitor units connected in parallel and series connections that are connected between live potential and ground to provide reactive support.

Capacitor Unit: Collection of capacitor elements connected in parallel and series arrangements fitted inside a metal enclosure and vacuum sealed with an insulation fluid. Internal connections made to a bushing situated on the outside of the unit enclosure.

3. general

- a) The filter capacitor installation shall be designed and manufactured to provide reliable operation for a period of not less than 25 years with minimum maintenance. under service conditions as specified in the AB schedules and RAM requirements.
- b) The shunt capacitor equipment shall be manufactured under strict quality control using the highest quality of material and workmanship.
- c) **Vermin proofing:** All plant and material shall be designed and constructed to prevent inadvertent contact by snakes, rodents, cats, birds and other wildlife with energized plant or material or areas where damage may be inflicted to the plant. Anti-bird nesting devices shall be used. How this is delivered must be clearly described in the Contractors tender submission.
- d) Fire retardant material shall be used in the shunt capacitor installation.

4. Equipment and Work Supplied by the Contractor

4.1. The equipment components to be supplied by the Contractor for the complete capacitor installations shall include but not be limited to:

The Current Limiting reactors with their supporting insulators and pedestals;

Damping Resistors;

Capacitors as per IEC 60871 - 1 and IEC 60076- 6.

Type Testing of Capacitor Units,

Damping Resistors and Reactors;

2.11. CAPACITOR BANK SYSTEM

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Type Testing of Capacitor Units,

Damping Resistors and Reactors;

Supporting frame insulators with Creepage distance calculated at Um;

Bus work;

All necessary connections (electrical and mechanical);

Steel supporting racks;

Capacitance meter(s);

Safety earthing numbering and connection points;

All equipment required for the protective system of the Capacitor Bank as per the Design.

Insulated cable for neutral point earthing; Capacitor lifting device

Special tools;

Neutral cable connections to common rail including copper connection bar to steel pedestals;

Safety Earthing kit;

All necessary connections (electrical and mechanical);

Spares.

4.2 The work and services to be supplied by the Contractor complete.

filter capacitor Supply shall include but not be limited to:

Documentation;

Commissioning reports

Maintenance Manuals;

Training;

Reliability, Availability and Maintainability (RAM) program, studies and guarantees;

Seismic studies and analysis Quality assurance; Inspection and Test Plans Maintenance Requirements;

And Maintenance

Manufacture Tests Installation Monitor and report Commissioning bay

4.3 The Contractor shall supply drawings detailing positioning and size of all bolts, equipment, total weight of capacitor supporting racks including the assembled equipment. Any special clearance requirements for fitting the bolts and fixing nuts, locknuts and washers shall be detailed on the drawing.

4.4 All HV insulation to be a minimum of 31 mm/kV.

4.5 The Contractor shall be responsible for engineering, equipment design, manufacture, inspection and testing, supply, transport to site, unloading from transport at site, erection and field acceptance testing of all equipment supplied, commissioning, coating and painting works and ensuring that the equipment supplied complies with this specification including the RAM monitoring and reporting.

4.6 Safety Earthing Kit

The Contractor is to supply one safety earthing kit to earth each capacitor bank installation. The safety earthing kit to be according to Transmission standard and safety earthing procedure and shall include the following minimum equipment to safely earth all three phases for each installation:

- a) Lightweight induction earth tails with bottom and top connectors to make all the necessary connections for earthing all three phases including the neutral point earthing;
- b) One link stick with adapter head;
- c) One pair of insulated gloves;
- d) Container(s) to house all the safety earthing gear;
- e) Safety earthing studs/balls fitted to accommodate all the safety earthing connection points
- f) Safety earthing points, numbering and labelling.

5 Erection and Regulations

- a) The Contractor shall provide an experienced and competent erection engineer to supervise the erection work on site.
- b) Erection shall include moving from the off-loading position or storage, lifting, handling and positioning onto the supporting platform.
- c) All necessary staging, lifting tackle and tools shall be provided as part of the contract and these items shall be removed from site on completion of erection.
- d) The contract work, working conditions and safety shall be subject to the safety Practices.
- e) Should any erection work be undertaken on or near the Employer's installations which are already in service, the Contractor's work and the Contractor's personnel shall comply with the Permit to work system.

6 Maintenance during guarantee period

- a) The Contractor shall be responsible for all maintenance and repair work on equipment supplied by him, during the guarantee period (defects liability period 12 months from commissioning).
- b) At least one (1) month before the shunt capacitor is commissioned, the Contractor shall submit for approval, the name, qualification, experience and factory training of the engineer or technician who will be available locally for any repair or maintenance work during the guarantee period and during commissioning and during the RAM period.
- d) The Contractor shall supply at his own expense maintenance personnel, all tools, equipment, material and replacement units, that will be required to complete any maintenance or repair work during the guarantee and RAM period.

7 Maintenance after Guarantee Period

The Contractor shall provide Maintenance Schedules for the shunt capacitor equipment. The Maintenance Schedules and manuals explaining the requirements shall contain information on:

- a) The periodic replacement or refurbishment of individual components in order to maintain the bank's availability and reliability at the required level.
- b) The outage periods required for the routine maintenance of each apparatus to comply with RAM requirements.

- c) The manpower required to carry out the maintenance of each equipment or part of it.
- d) The design service life of each device. e) Spares required

8 Maintenance and Safety Training

The Contractor, with the assistance of his equipment suppliers shall conduct a training class of the Employer's maintenance/technical personnel at site. The duration of the training class is anticipated to be 1 to 2 days with 10 Employer participants. The training class shall be aimed at properly familiarizing the personnel with the shunt capacitor bank and the designers theory.

The maintenance training shall include, but not be limited to:

- a) Normal maintenance methods;
- b) Condition monitoring;
- c) Repairs and replacement
- d) Diagnostic procedures;
- e) Equipment calibration;
- f) Re-energization;
- g) Safety Practices;
- h) Demonstration of using the capacitor lifting device;
- i) Special tests.
- j) Compilation of cold commissioning procedure

9. Maintenance Instruments

9.1 General

A device for lifting, removing and replacing the capacitor units shall be supplied by the Contractor. The design of the lifting device shall be such that it can be safely operated in the shunt capacitor area by one person with associated bays in the high voltage yard still in service.

9.2 Capacitance Meters

One set of portable instruments for testing capacitor units shall be supplied to be used on both installations.

A set of instruments shall consist of (2) two capacitance meters. One meter to be of the hand held type and the second shall be a bridge injection type.

Both meters may be of the digital type with the following features:

- a) The meters shall be built into a small, robust, portable panel with a lid and carry handle.
- b) The meters shall be accurate to two decimal points.
- c) The meters shall be designed so that the capacitance of individual capacitor units belonging to a parallel group or a series string in the bank may be tested without opening any connection in the bank. The current rating and the testing range of the instrument shall permit the capacitance of the

largest group of parallel or series string of capacitor units to be measured without the instrument being overloaded.

- d) Details of the testing instruments shall be submitted for the Project Manager's approval at the time of tendering.

10 Capacitor Units Design Requirements

10.1 General

- a) Each capacitor phase shall consist of equal series capacitor groups/strings and shall be provided with its own supporting galvanized steel structures and all necessary insulators.
- b) The number of capacitor series groups shall be such that the voltage drop across the individual capacitors shall not exceed the rated capacitor voltage.
- c) The capacitor installation shall be of open rack construction, and shall be naturally air-cooled.
- d) Vemim proofing to be provided to eliminate the possibility of insulation flash over from occurring as a result of vermin contact

10.2 Capacitor Units

The capacitor units shall be designed, manufactured and tested in accordance with IEC 60871.

10.2.1 Rating Requirements

The kVAR and voltage ratings of capacitor units, and hence the number of these units to be connected in series and parallel, shall be chosen to meet the ratings specified for the bank as a whole. In addition, the arrangement and ratings of series/parallel units shall ensure that when a unit fails it does not cause a voltage rise in excess of 5% across healthy units for which they will be rated (IEC), while applying the rated current and voltage to the bank.

10.2.2 Overvoltage capability

Capacitor units shall be capable of repeated operation in the bank under the following conditions during the expected 30-year life of the bank:

- a) Maximum r.m.s. power frequency voltages based on the bank voltage ratings

1,00 p.u. – Continuous as per IEC

1,10 p.u. – 12 h in a 24 h period

1,15 p.u. – 30 min in a 24 h period

1,20 p.u. – 5 min, 200 times

1,30 p.u. – 1 min, 200 times

1,5 p.u. – 5 seconds

1,75 p.u. – 1 second

- b) In addition to the normal load requirements and over voltages associated with fault currents the capacitors shall be capable of withstanding the over voltages associated with the presence of system harmonics in the local system.

- c) The capacitor filter bank installations will be switched daily by the user. A minimum of at least 4 switching in operations per day and 4 switch out operations per day will occur. The installation will be designed to handle this switching requirement for the overall expected life of the installation.

10.2.3 Losses

The losses of each capacitor unit including losses due to the internal discharge resistors, including internal connections shall not be more than 0,1 watts per kVAR when measured at rated voltage, rated frequency and at 20 C ambient temperature.

10.2.4 Reactance Tolerance

The reactance tolerance for each unit shall not exceed 5 % over the ambient temperature range -20 C to +55°C. The reactance tolerance for the whole segment and bank shall be as specified in IEC 60871.

10.2.5 Capacitance unit Discharge resistors

Capacitor units shall be fitted with an internally mounted discharge resistor, which will reduce the residual voltage to 50 V or less within 5 min after the capacitor bank is de-energised.

10.2.6 Container and bushings

- a) Only stainless steel containers with a suitable protective coating and a light grey finish will be acceptable to the *Project Manager*. When filled with insulating fluid and sealed, no bubbles shall remain trapped in the container. The container shall be fitted with brackets suitable for mounting on the supporting frames. The full dimensions of the container and its overall height including bushings, the thickness of the stainless steel and the details of the brackets and their positions shall be supplied as specified. The clamping arrangement and its material shall be detailed and any limitations in the compatibility with copper or aluminum conductors shall be pointed out and determined.
- b) The bushing flange shall not be welded or soldered to the containers. The use of alternative attachment methods shall be stated in the tender as a deviation from this specification and shall be subject to approval by the Employer
- c) Earthing studs to be supplied on the individual capacitor unit studs for the purpose of safety earthing of shunt/filter capacitor banks. The earthing studs shall be made out of copper. This is required to accommodate the earthing of each capacitor unit on both connection points. Alternative

10.2.7 Insulation Fluid

The capacitor insulating fluid used shall be biodegradable and nontoxic. In the event of accidental spillage, the biological concentration and effect on the environment shall be minimal. Polychlorinated biphenyls (askarels) are not acceptable as insulating media. All characteristics of the fluid to be used shall be submitted.

10.2.8 Balancing

10.2.9 rating and Configuration

The shunt capacitor bank shall comprise individual capacitor units connected in series/parallel groups, supporting frames for the capacitor units, post insulators between frames, damping/filter reactors, and the necessary interconnections to provide a bank of the type and rating specified in the Schedules. Creepage distance and

vermin proofing requirements to be included in the design as per specified requirements. The continuous three-phase output at nominal transmission system voltage shall be as specified.

10.2.9 Capacitor bank voltage and maximum over voltage duration in p.u of maximum transmission system voltage

type	bank voltage rating in p.u. of specified nominal transmission voltage	maximum overvoltage duration	observation
Power Frequency	1,00	Continuous	Highest average value during any period of capacitor energization. For energization periods less than 24 h exceptions apply in accordance with the values below.
Power Frequency	1,10	12h continuous in every 24h	System voltage regulation and fluctuations
Power Frequency	1,15	30min continuous in every 24h	System voltage regulation and fluctuations
Power Frequency	1,20	5min x200 times (life time)	Voltage rise at light load
Power Frequency	1,30	1minx200times (lifetime)	
Power	1,50	5 seconds	

The shunt capacitor bank and each capacitor unit shall be capable of continuous operation at up to 135% of the rated r.m.s. current including fundamental and harmonic currents. Depending on the actual capacitance value, which may be at a maximum of 1,15 C_N, the maximum current can reach 1,5 C_N.

10.2.10 Technical Data for 30MVAR Capacitor Bank and accessories

DESCRIPTION	SCHEDULE A
1) Number of new 3-phase banks required	1
2) Substation	Hamishabahr substation, Jalalabad
3) Nominal transmission system voltage (U _N) kV (rms)	110kV
Highest System voltage	123
Basic Insulation Level	550-650
4) 3-phase output at nominal transmission system voltage (MVAR)	30 MVAR
6) IEC pollution classification	31 mm/kV
Discharging duration to drop the Voltage to 50Volts, after switching Off	5 minutes
Resistance of Discharge Resistors	To be Specified

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DESCRIPTION	UNIT	SCHEDULE A
Total capacitance per phase per bank	μ F	To be specified
Ratio between min and max capacitances between any two line terminals		<1.08% To be specified
e) Bank connection		Single grounded Star
c) discharge Resistance		Specify
l) Number of Bushings in One capacitor		One
Fuses for Capacitor units		External fuses required
Basic Insulation Level KV		550-650
Capacitor Unit's Body		Stainless steel
Thickness of body		To be Specified
Capacitor Unit mounting		To specify Vertical OR Horizontal
The KVAR of each capacitor Unit		To be Specified as per design
The weight of Each Unit		To be Specified as per design
Number of series groups		To be Specified as per design
Number of Parallel Units		To be Specified as per design
Number of Blocks		To be Specified as per design
Number of installed units in a Block		To be Specified as per design
Protective Equipment		To be Specified as per design
The insulation Fluid		To be Specified
Inrush current on switching		To be Specified
Dimensions of capacitor Unit		To be Specified
Continuous Current rating of Current limiting reactor		To be Specified
Continuous Current rating of the Capacitor Bank		To be Specified
Type of Reactor		Air Core

DESCRIPTION	
Q) Frequency (f) (Hz)	50
Minimum system frequency (Hz)	47.5
Maximum system frequency (Hz)	52.5
Maximum guaranteed performance (Hz)	50.5
Minimum guaranteed performance (Hz)	49
d) Number of phases	3
e) System effectively earthed	Yes

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3. DRAWINGS

The following set of As Built Drawings shall be furnished. The contractor shall submit drawings and get approval from the owner before issuing the drawings 'FOR CONSTRUCTION'

Switchyards structural Layout & Lay-out Plans as under:

1. New Bay Structural Layout & Lay-out Plan for 110 kV Switch Yard
2. Foundation Blocks for all the, columns, Equipment, Cable-Ducts with proper slopes, Drains, Marshaling Boxes, Parapet for Chain-Link Mesh Fencing, Illumination Tower/Poles & other infrastructures, Fire-Fighting Equipment complete with associated infrastructures, Earthing Pits/ Mat, Electrodes for LAs/Trans. etc.

For all the above mentioned foundation Blocks (including Main/Sub Main/Tee off Cable Ducts), along with layout, foundation design & sectional details shall also be furnished.

Equipment foundation Blocks (CTs, LAs, CVTs, CBs, Disconnects) on 110 kV.

Foundation Block for Capacitor bank.

The drainage system for out-flow of rains water.

Main/Sub- Main/Tee- off for cable Ducts for equipment and Power transformer units.

Illumination Tower/Poles their foundation Blocks.

Fire-Fighting Equipment Structures & their foundations, if any

For all the above mentioned foundation Blocks (including Main/Sub Main/Tee off Cable Ducts), along with Layout, foundation design & sectional details shall also be furnished.

3. Electrical Connection & sectional Drawings for a. 110 kV new bay.

4. The following set of Drawings-AC/DC Wiring Drawings, Guaranteed Technical Particulars (GTP), and Type test reports etc. in respect of 110 kV

a). The Set of Detailed AC Schematics & DC Wiring Drawings for C&R Panels in respect of the new Bay including the following:

a.	AC/DC Wiring Drawings
b.	Guaranteed Technical Particulars
c.	GA drawings.
d.	Type test reports

d). AC/DC Wiring Diagram/Arrangement of Aux. Contacts etc. for Breakers/ Motorized Isolator along with Erection/O&M Manual or Literature including the following:

a.	AC/DC Wiring Diagram
b.	Guaranteed Technical Particulars
c.	GA drawings.
d.	Type test reports

e). Detailed Drawings for other Equipments such as, for Capacitor banks & its protective devices, CTs, CVTs, Current Limiting Reactors and Terminals & other details, along with O&M Manual/Literature including the following:

a.	AC/DC Wiring Diagram
b.	Guaranteed Technical Particulars
c.	GA drawings.
d.	Type test reports

f). Detailed Drawings for Hardware Fittings/Clamps/Connectors etc. Literature including the following:

a.	Guaranteed Technical Particulars
b.	GA drawings.
c.	Type test reports

g). Detailed Drawings for Post Insulator & Tension/Suspension Disc insulator along with Literature including the following:

a.		Guaranteed Technical Particulars
b.		GA drawings.
c.		Type test reports

h). Detailed Drawings for Surge Arrestors along with Literature including the following:

a.		Guaranteed Technical Particulars
b.		GA drawings.
c.		Type test reports

5. Earth Mat Design & Drawings.



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4. Project management and Bill of Materials

1. The quantities required shall be worked out by the bidder as per the SLD and international standards, in case of variation at the time of detailed engineering actual quantities shall be payable as per quoted prices. The details of materials and quantities furnished in Price schedules are only tentative.
2. The quantities of items like power and control cables, Earth mat material, firefighting system, station lighting system and other installation items are considered as lot and the bidder is required to assess the quantities of these items based on Diagrams and scope
3. Wherever, the name of any equipment required to complete the job has not been indicated, the same should be indicated by the bidder along with the requirement of its quantity and the rate. No price will be paid for the items for which unit rates are not indicated in the above schedule, but will have to be supplied by the contractor to commission the substation satisfactorily.
4. The associated civil works for items under installation should be included in the erection price itself wherever not asked separately in schedule in the schedule for erection.
5. The final bill of material shall be prepared and submitted by the contractor during detailed engineering stage and take the approval from the Engineer in charge for the items for which unit rates have been indicated in above schedules
6. For additional items, if any as per the design of the bidder, the bidder shall use additional sheets for the same.
7. For spares & maintenances equipment the bidder is not required to quote the erection charges.
8. Expenses for excavations for foundations shall be included in cost of foundations.
9. The contractor shall conduct survey and take initial and final levels before and after levelling of the land for substation construction area. The Contractor will take timely approval from the employer for the Initial and Final Levels.
10. The Project Management shall include the Planning and scheduling of detailed activities, manpower, procurement of materials, construction tools & equipment, Quality Plan, Safety & Security, Project progress monitoring etc. In order to complete the Project within 9 months from the date of contract agreement. The contractor shall prepare the time schedule of all activities, Safety & Security Plan, Quality plan and get the approval from the Engineer in charge and also submit the weekly progress report for all activities using bar chart. Any shortfall in meeting the scheduled target shall be reviewed weekly and be rescheduled to overcome the same. If the employer feels that the contractor will not be able to make up the shortfalls, the employer will have all rights to make up the shortfalls by arranging other contractors to carry out the full or part of activities at the risk and cost of the contractor to whom the Project is originally awarded.
11. The Price for the project is tentative and it has been given from the projects that DABS has done contract in previous years.



BOQ for Prices (Schedules of Rates) for procurement of Design, Supply, Erection, Testing, and Commissioning of 110 KV/30 MVAR Capacitor Bank in Hamesha Bahar Substation - Nangarhar

Schedule No. 1: Plant (including mandatory spares)

Sr. No	Description	Unit	Qty. to be supplied	Rate/ Unit (AFN)	Total Amount (AFN)	Oragin (Country)
A	Design and supply of Main equipment					
1	110 KV, 30MVAR Capacitor Bank including, Current Limiting reactors, protective equipment mounting structures and accessories as per design. and also its responsibility of contractor to interfacing the new bay with existing SCADA and busbar protection if the existing busbar protection and Local SCADA be able to interface otherwise it can be able to interface with existing busbar and SCADA in the future.	set	1			
2	110KV,1250A,SF-6 Breaker including support structures , suitable connectors and anchor bolts	set	1			
3	110 KV,1250A Isolator With (1)E/Switch including support structures, suitable connectors and anchor bolts	set	1			
4	110 KV,1250A Isolator With two(2),E/Switch including Support structures, suitable connectors and anchor bolts.	set	1			
5	110KV Surge Arrestor with support structures, suitable connectors and anchor bolts	No	3			
6	110KV Post Insulator with support structures, suitable connectors and anchor bolts	No	3			
7	110KV CTs for Capacitor Bank Bay with support structures, suitable connectors and anchor bolts As per given specifications and the ratio is given as concept the contractor have to considered base on design and busbar protection.	No	3			



8	110KV CVT for Capacitor bank bay with support structures, suitable connectors and anchor bolts as per given specifications	No	3			
9	Control Panel for Capacitor Banks 110kV as per Standard specifications.	set	1			
10	Protection Panel for Capacitor Bank (Protection including backup Protection and Breaker Failure as per Design requirements).	set	1			
11	Marshalling kiosks for Capacitor bank bay	No	1			
12	CT test terminal block	set	1			
13	400V-AC distribution panel as standard specifications. for the AC system will Used from existing system to the new AC Panel.	No	1			
14	220V-DC distribution panel as standard specifications and the DC system will used from existing DC system to the New DC Panel	No	1			
15	<ul style="list-style-type: none"> •Capacitor bank Bay Power & Control cabling and Metering System. •Power MV, LV AC cables shall be of XLPE Copper conductor of different size. •Control cabling shall be of 3.5core, 2.5mm² and 4mm² Cable terminations for Control and Power cables and all other accessories required.	lump Sum	1			
16	Galvanized Steel structures, Gantries, columns and supports with connecting clamps and terminations as per standards for the equipment including associated accessories such as bolted type suspension and tension strings assemblies, Clamps, bolts, nuts, washers, busbar conductors, jumpers, Perforated trays and miscellaneous hardware as applicable according to standards and requirements for successful Commissioning.	Lot	1			



17	Supplying 45/50 Lit capacity Portable foam type fire extinguisher complete with initial charge, hose pipe and all accessories and fittings, trolley	No	2			
18	Supplying 22.5 kg capacity Portable Carbon dioxide Fire extinguisher complete with initial charge, hose pipe and all accessories and fittings, trolley etc.	No	5			
19	Supplying of 11kg capacity portable carbon dioxide fire extinguisher complete with initial charge , hose pipe and all accessories and fittings trolley	No	2			
20	Supplying of 5kg capacity portable dry chemical powder type fire extinguisher complete with initial charge , hose pipe and all accessories and fittings for wall mounting	No	2			
21	Supplying of suitable light fittings and emergency DC Lights for the Capacitor bank bay as per approved Drawings and specifications including all Poles, brackets, controls, junction boxes, power outlets etc. complete.	Lot	1			
B	Mandatory spares					
1	For Capacitor Bank system					
1.1	5% of all components used in forming the Capacitor Bank including capacitor Units(minimum quantity for any item shall be one)and also every thing is required to complete and energize the the project to complete.	Lot	1			
2	For 110KV SF6 Circuit Breaker					
2.1	Breaker pole complete with column, interrupter and operating mechanism and without support structure	set	2			
2.2	SF6 Gas for filling 3-poles	Lot	1			
2.3	SF6 Gas filling Equipment	set	1			
2.4	Rubber gaskets, 'O' rings and seals (complete replacement for one pole)	set	1			
2.5	Trip coils	No.	5			
2.6	Closing coils	No.	5			



2.7	Molecular filter for SF6 gas	Sets	1			
2.8	Density/Pressure monitor for SF6 circuit	No.	1			
2.9	Relays, Power contactors, switch fuse units, limit switches, push buttons, timers & MCB etc. for one CB	set	1			
2.1	Support Insulator Stack	Set	3			
2.11	Aux. contact assembly	Set	2			
2.12	All types of coupling for SF6 gas	Set	2			
3	For equipment of the new Bay					
3.1	Copper contact fingers for female & male contacts for 110 KV isolators	set	3			
3.2	110 KV Surge Arrestor	No.	2			
3.3	110 KV CVTs	No.	2			
3.4	110 KV CTs for the bay	No.	2			
3.5	Current limiting Reactor for Capacitor Bank	No	2			
Total of schedule no.1 Plant including mandatory spares (Carried over to schedule 4)						

Schedule No. 2. Design Services and Project Management					
Sr. No	Description	Unit	Qty. to be supplied	Rate/ Unit (AFN)	Total Amount (AFN)
A	Design and supply of Main equipment				
1	Design of Capacitor bank bay including electrical and mechanical with all Protective system and all other required design including drawings as per Standard	Lot	1		
B	Project Management				
1	Project Quality plan	Lot	1		



2	Project planning schedules & Progress Reporting	Lot	1		
3	Project Insurance	Lot	1		
4	Project Safety and security arrangements	Lot	1		
5	On-Site Training of Operation & Maintenance Staff	Lot	1		
6	On-Site training during construction and commissioning	Lot	1		
7	General Arrangement Drawings	Lot	1		
8	Site Civil Design Drawings	Lot	1		
9	3 Line AC Drawings with CTs, CVTs, meters, Protective Relays etc.	Lot	1		
10	Control Circuits & Wiring Drawings	Lot	1		
11	Coordination Study & Relay Settings Instructions	Lot	1		
12	General Construction Drawings	Lot	1		
13	Cable schedule	Lot	1		
14	As Built Drawings	Lot	1		
15	Maintenance Manual And Completion Report	Lot	1		
16	Witnessing of Factory Acceptance Tests (FAT) and Perdiem for engineers doing test.and etc wich is required for completion up to testing and commissioning.	Lot	1		
	Total of Schedule No. 2 (Carried over to schedule 4)				

Schedule No. 3. Installation Services

Sr. No	Description	Unit	Qty. to be supplied	Rate/ Unit (AFN)	Total Amount (AFN)
A	Main equipment erection including all materials, labor, consumables and connecting them to the earthing system				



1	Erection of 110KV, 30 MVAR Capacitor Bank including, Current limiting reactors, protective equipment, mounting structures and accessories etc. complete	No.	1		
2	Erection of 110KV SF-6 Breakers with support Structure	No.	1		
3	Erection of 110KV Isolator with E/Switch including support structures	Set	2		
4	Erection of 110KV Surge Arrestor with support Structure	No.	3		
5	Erection of 110KV Post Insulator with support Structure	No.	3		
6	Erection of 110KV CTs for the 30MVAR capacitor Bank with support structure	No.	3		
7	Erection of 110KV CVT with support structure	No.	3		
8	Control Panel for Capacitor Banks 110KV as per Standard specifications.	Set	1		
9	Protection Panel for Capacitor Bank (Protection Including backup Protection and Breaker Failure as per design requirements).	Set	1		
10	Erection of Marshalling kiosks	No.	1		
11	Laying, glanding, terminating and connecting Copper Control and Power Cable of various types including cost of all accessories and labor	Lot	1		
12	Supply and Installation of Firefighting system for capacitor bank bay.	Lot	1		
13	Installing, testing & commissioning of Light fittings and DC emergency for the new Capacitor Bank as per approved drawings and specifications including all Poles, brackets, controls switches, junction boxes , power outlets etc. complete	Lot	1		
14	Lightening protection supply, design, erection test and Commissioning for the bay	Lot	1		
15	Installation of Earth mat including excavation, cutting, bending laying in position in horizontal and vertical arrangements, including connecting the risers to Structures etc. complete with all consumables, bolts, nuts, washers, connectors etc. Complete for new capacitor bay as per requirements. (If required after site visit).	Lot	1		
B	Items for associated civil works				
16	Soil investigation testing for the location of Capacitor Bank Erection.	Lot	1		
17	Site preparation				
18	excavation, concreting, cement, reinforcement Steel, form work, grouting, underpinning, watering, curing etc. Complete for foundation of support	Lot	1		



	structures as per approved design.				
19	Leveling, compacting, separating the gravel and doing the fencing works in new areas of bay After the foundation and earth works. (except the areas of roads, equipment foundations and cable trenches) and fence around capacitor yards with equipments and installation	Lot	1		
D	CABLE TRANCHES				
	Construction of cable trenches and cable tray for required depth pre-cast RCC covers, including supply of labor, material, cement, reinforcement steel, steel angles, flats and providing PCC below cable trenches as per Electrical layout and technical specification including providing cable supports, supplying of Cover slabs and placing in position.				
20	For 110 KV new bay	Lot	1		
E	Testing & commissioning of the New Capacitor Bank Bay	Lot	1		
F	MISCELLENOUS				
21	Supplying, stacking of required quantities of 12mm nominal size broken stone in trapezium formation of measurable sizes as per the direction of the engineer in charge, taking the measurement by the engineer in charge and the contractor, uniformly spreading over the levelled & compacted area of the switchyard with the 12mm nominal size broken stone from the measured stacks for a thickness of 50mm as the project is design build so this should be considered as per Civil deign	lump sum	1		
22	Supplying, stacking of required quantities of 20mm nominal size broken stone in trapezium formation of measurable sizes as per the direction of the engineer in charge, taking the measurement by the engineer in charge and the contractor, uniformly Spreading the 20 mm nominal size broken stone from the measured stacks uniformly for a thickness of 50mm in the switch yard over the area spread already with 12 mm nominal size broken stone. as the project is design build so this should be considered as per Civil deign	Lump sum	1		
23	Designing, Supplying and fixing chain link fencing including gates for the new Capacitor Bank as per and technical specification and Bid document requirements international Specifications and approved drawings including supply of all materials and all civil works etc. complete	Lot	1		
	Total for schedule 3 for installation services (carried over to schedule no. 4)				-

Schedule No. 4. Grand Summary

Schedule	Description	Total Price	
		Foreign(USD)	Local (AFN)



1	Total of schedule No.1 Plant (including mandatory spares)		
2	Total of Schedule No. 2 Design Services and Project Management		
3	Total of schedule No.3 Installation Services		
TOTAL PRICE			
D	Contingency (10%)		
GRAND Total			
	Name of Bidder Signature & Stamp of Bidder		
<p>Note:</p> <p>1. The items listed above is for design, supply, erection, testing and commissioning.</p> <p>2. The contractor must do complete project as Design-build, Detail design, Supply, erection, installation, testing & Commissioning (Turnkey).</p> <p>3. The bidder is requested to review the BOQ and specification prepared by DABS and the bidder should visit the site. If any item or anything else needed for the bay including test and commissioning is missing, the bidder must include the price of it on its offer for the items given in Lot and Lump sum in the BOQ.</p>			

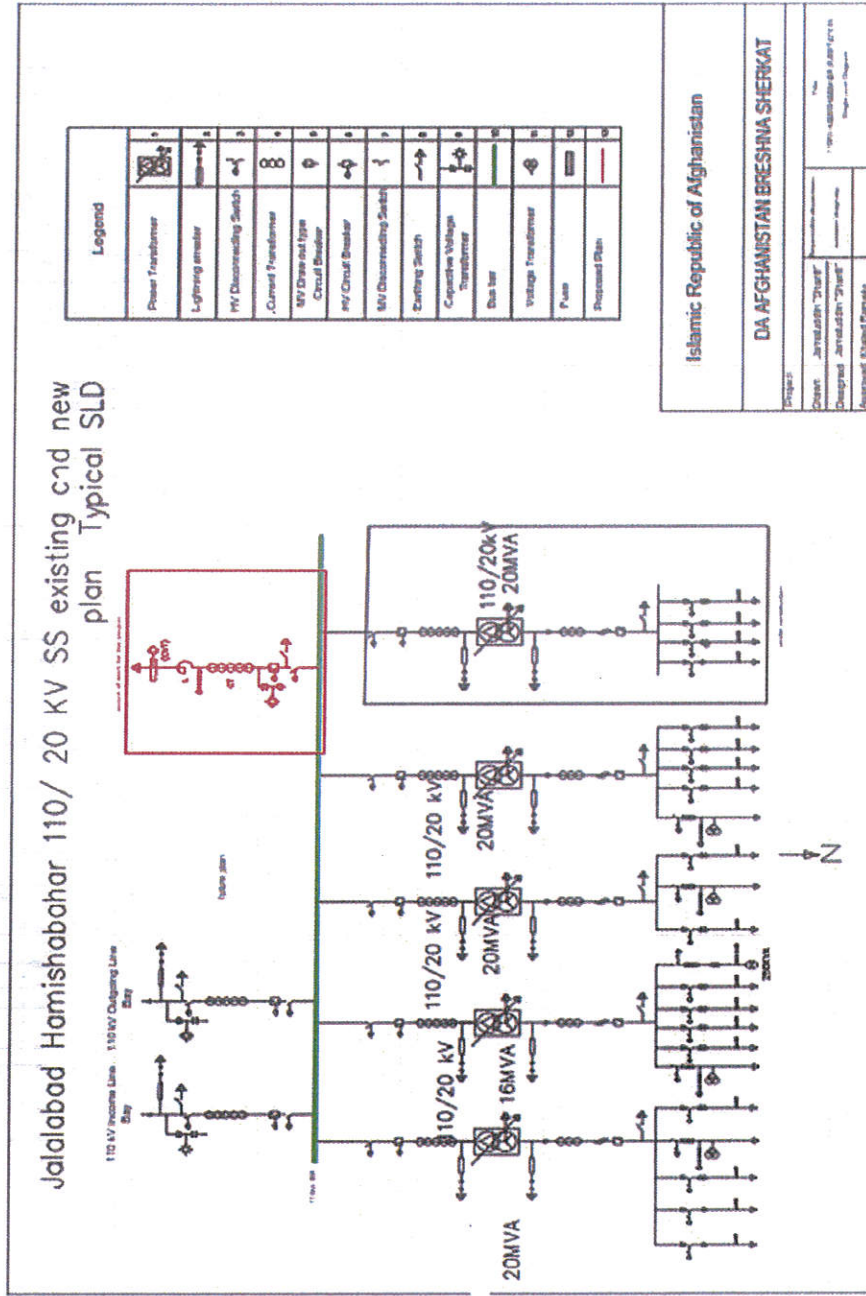
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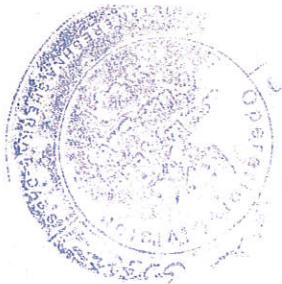
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6. TECHNICAL DATASHEETS

123 kV SF6 Circuit Breaker

Description	Unit	Required	Offered
Country of origin	-	To be Specified	
Manufacturer	-	To be Specified	
Design	-	Outdoor	
Insulation	-	SF ₆	
Type	-	To be Specified	
Standard	-	IEC 62271-100	
Rated normal current	A	1250	
Rated operating sequence		O-0.3sec-CO-3min-CO	
Rated break time	Cycle	3	
Highest system Voltage	kV _{rms}	123	
Rated frequency	Hz	50	
Making current	kAp	100	
Ambient temperature	°C	-20/55	
Average ambient temperature	°C	40	
Altitude Max.	Ft	2060	
Lightning impulse withstand level	kV Peak	550-650	
Power frequency withstand, dry	kV rms	230	
Power frequency withstand, wet	kV rms	230	
Rated short circuit current	kA	40	
Rated duration of short circuit withstand	Sec	3	
Rated total breaking time	Ms	60 or less	
Type of arc quenching medium	Gas	SF ₆	
Type of stored energy medium	Technology	Motor spring	
Voltage for operation device	VDC	220	



Technical Data for 123 kV Disconnect Switch

Description	Minimum Requirements		Data offered by Bidder
	Unit	Data	
110 kV Disconnect Switch:			
Manufacturer		Bidder to provide	
Manufacturer's model/type		Bidder to provide	
Rated maximum voltage	kV	123	
Rated service voltage	kV	110	
Rated frequency	Hz	50	
Disconnect switch construction:			
- Type of operation		Horizontal	
- Type of break		Center rotating type	
No. of poles		3	
Rated short-time current, 3 sec.	kA	40	
Rated supply voltage for operating Mechanism	Vdc	110	
Rated lightning impulse withstand voltage			
- to earth and between poles	kV	550	
- across open pole	kV	630	
Rated 1 min. power-frequency withstand Voltage			
- to earth and between poles	kV	230	
- across open pole	kV	265	
Rated current- bus & transformer bay	A	1250	
Rated peak withstand current	kA	100	
Rated mechanical endurance		M2	
Type of operating mechanism			
- Disconnect switch		Motorized/manual	
No. and type of auxiliary contacts			
- Disconnect switch		Bidder to provide	
Auxiliary contact rating	A	Bidder to provide	
Degree of protection for control box/marshaling kiosk		IP54	
Post type insulator:			
- Material		Porcelain	
- Color		Brown	
- Creepage distance	mm	> 3075	
- Cantilever strength	kN	Bidder to provide	
- Torsion strength	kN	Bidder to provide	
Applicable Standards:			
- Disconnect switches	IEC	62271-102	
- HV switches for 52kV and above	IEC	60265-2	
- Post type insulators	IEC	60168	
- Characteristics of post insulators	IEC	60273	
- Degree of protection for enclosure	IEC	60529	



Technical Data for 123 kV Current Transformer

Description	Minimum Requirements		Data offered by Bidder
	Unit	Data	
110 kV Current Transformer :			
Manufacturer		Bidder to provide	
Manufacturer's model		Bidder to provide	
Rated maximum voltage	kV	123	
Rated service voltage	kV	110	
Rated frequency	Hz	50	
Type		Outdoor	
No. of phase		1	
Construction		Free-standing	
Type of insulation		Oil	
Basic insulation level	kV	550-650	
Power frequency withstand voltage			
- Dry, 1-minute	kV	230	
- Wet, 10 seconds	kV	230	
Rated primary current:			
- Transformer	A	as per requirement	
Rated secondary current	A	1	
Continuous thermal current rating factor		1	
Rated short-time thermal current rating	kA	40	
Rated peak withstand current	kA	100	
Short-time thermal current duration	sec	1	
Rated dynamic current	kA	100	
No. of core		5	
Rated burden, metering/protection	VA	Bidder to provide	
Accuracy class, metering/protection		0.2/PX	
Degree of protection of secondary box		IP54	
Insulator housing:			
- Voltage rating	kV	123	
- Material		Porcelain	
- Color		Brown glaze	
- Creepage distance	mm	>3075	
- Cantilever strength	kN	By the bidder	
Applicable standards:			
- Current transformers	IEC	60044-1 & 60044-6	
- Insulator bushing	IEC	62155	
- Degree of enclosure protection	IEC	60529	
- Mineral insulating oil	IEC	60296	

Technical Data for 123 kV Capacitor Voltage Transformer

Description	Minimum Requirements		Data offered by Bidder
	Unit	Data	
132 kV Capacitor Voltage Transformer:			
Manufacturer		Bidder to provide	
Manufacturer's model		Bidder to provide	
Rated primary voltage	kV	110/√3	
Rated secondary voltage	V	110/√3	
Rated frequency	Hz	50	
Type		Outdoor	
Rated voltage factor		1.5	
Lightning impulse withstand voltage	kV	550-650	
Power frequency withstand voltage	kV	230	
Maximum PD level of capacitor voltage divider	pC	10	
No. of phases		1	
No. of core		2	
Accuracy class:			
Core 1		0.2 + 3P	
Core 2		0.2 + 3P	
Rated secondary burden			
- Metering	VA	By bidder based on calculated burden and reference standard	
- Protection	VA		
- Maximum simultaneous burden	VA		
Continuous thermal burden	VA	By bidder	
Degree of protection for secondary box		IP54	
Insulator housing:			
- Voltage rating	kV	123	
- Material		Porcelain	
- Color		Brown, glaze	
- Creepage distance	mm	≥ 6125	
- Cantilever strength	kN	By the bidder	
Applicable standards			
- Capacitor voltage transformer	IEC	60044-5	
- HV porcelain bushing	IEC	62155	
- Degree of protection of enclosure	IEC	60529	
- Insulating oil	IEC	60296 & 60867	

123 kV Surge Arrestors

Description	Unit	Required	Offered
Country of origin	-	To be Specified	
Manufacturer	-	To be Specified	
Design	-	ZnO, Gapless	
Standard	-	IEC: 60099-4	
Highest system Voltage (Um)	kV rms	123	
Normal discharge current	kA	10	
Rated frequency	Hz	50	
Maximum Continuous Operating Voltage (Uc)	kV	94	

Technical Data for 123kV Post Type Insulator

Description	Minimum Requirements		Data offered by Bidder
	Unit	Data	
123 kV Post Type Insulators:			
Manufacturer		Bidder to provide	
Manufacturer model/catalogue no.		Bidder to provide	
Application		Outdoor	
Type		Solid core	
Stack assembly		Tapered or uniform	
Insulator material:			
- Insulator shell		Porcelain	
- Insulator glaze		Standard	
- Color		Brown glaze	
Electrical ratings:			
- Nominal system voltage	kV	123	
- Basic impulse withstand voltage	kV	550-650	
- Power-frequency withstand, wet	kV	275	
- Creepage distance	mm	≥ 3075	
- RIV Data (Low frequency test voltage & Maximum RIV @1MHz)	kVrms μV	146 < 500	
Mechanical characteristics:			
- Overall height	mm	By the bidder	
- Cantilever strength	kN	10	
- Tensile strength	kN	By the bidder	By the bidder
- Compression strength	kN	By the bidder	By the bidder
- Torsional strength	kN.m	By the bidder	By the bidder
- Largest shed diameter	mm	By the bidder	
- Weight	kg		
Applicable standards:			
- Tests on post type insulators	IEC	60168	
- Characteristics of post insulators	IEC	60273	

Technical Data for Low Voltage AC Sub-Distribution Panel

Description	Minimum Requirements		Data offered by Bidder
	Unit	Data	
LV AC Sub-Distribution Panels			
Sub-distribution & lighting panels:			
- Busbar rated current	A	Bidder to provide	
- Busbar Material			
- Rated current, miniature circuit breakers	A	Bidder to provide	
- Auto transfer switching scheme		Bidder to provide	
- Voltmeters/ammeters/switches		Bidder to provide	
- Dry type lighting transformer (as needed)		Bidder to provide	
- U/V relay		Bidder to provide	
- Heaters & panel lighting		Bidder to provide	
- Dimensions, length/height/depth:		Bidder to provide	
• sub-distribution panel	mm	Bidder to provide	
• lighting panel	mm	Bidder to provide	
- Weight, sub-distribution/lighting panel	kg	Bidder to provide	

Applicable standards:	IEC	60364
	IEC	60439
	VDE	0100

Technical Data for LV DC Sub-Distribution Panels

Description	Minimum Requirements		Data offered by Bidder
	Unit	Data	
DC Sub-Distribution Panels			
Sub-distribution & lighting panels:			
- Busbar rated current	A	Bidder to provide	
- Busbar Material		Bidder to provide	
- Rated current, molded case circuit breakers	A	Bidder to provide	
- Rated current, miniature circuit breakers	A	Bidder to provide	
- Auto transfer switching scheme		Bidder to provide	
- Voltmeters/ammeters/switches		Bidder to provide	
- Heaters & panel lighting		Bidder to provide	
- Dimensions, length/height/depth:		Bidder to provide	
• sub-distribution panel	mm	Bidder to provide	
• emergency lighting panel	mm	Bidder to provide	
- Weight, sub-distribution/lighting panel	kg	Bidder to provide	
Applicable standards:	IEC	60364	
	IEC	60439	
	VDE	0100	

Technical Data for LV Cables

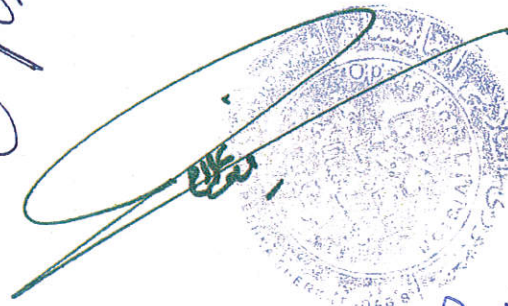
Description	Minimum Requirements		Data offered by Bidder
	Unit	Data	
0.6/1 kV LV Cables			
Manufacturer		Bidder to provide	
Type		Bidder to provide	
Conductor material		Copper	
Insulation material		PVC/XLPE	
Nominal cross-section & no. of cores:			
- LV power cable	mm ²	Bidder to provide for	
- control cable	mm ²	all cables	
Nominal voltage	kV	0.6/1	
Service voltage	V	400/230	
Frequency	Hz	50	
DC resistance of conductor at 20°C	Ω/km	Bidder to specify for each cable	
Working capacitance	μF/km	Bidder to provide	
Maximum continuous working voltage	kV	1.2	
Power frequency withstand voltage	kV	10	
Impulse withstand voltage (peak)	kV	20	
Charging current:			
- On air	A	Bidder to provide	
- In earth	A	Bidder to provide	
Maximum permissible short-circuit current (1s)	kA	Bidder to provide	/

External diameter of each cable	mm	Bidder to provide	
Minimum permissible bending radius	cm	Bidder to provide	
Weight of each cable size	kg/km	Bidder to provide	
Maximum permissible temperature	°C	90	

Technical Data for Lighting and Power Installation

Description	Minimum Requirements		Data offered by Bidder
	Unit	Data	
Lighting and Power Installation			
Outdoor Lighting Fixture:			
Manufacturer		Bidder to provide	
Type		Bidder to provide	
Outdoor high-pressure mercury	W	400	
Luminosity	Lm	20,000	
Service life	Hours	16,000	
Degree of protection		IP65	
Emergency Lighting:			
Manufacturer		Bidder to provide	
Type		Bidder to provide	
Rated service voltage	VDC	220	
Lighting density	Lux	50	
Power and Protection Sockets:			
Manufacturer		Bidder to provide	
Type		Bidder to provide	
Installation mode:			
- power socket combination		Metal casing	
- domestic sockets		Surface	
Degree of protection		IP65	

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Load Flow Study Report

For Capacitor Placement In Hamishabahr Substation

For the Purpose of Voltage Improvement

Prepared By: Eng. Jamaluddin Sharifi

Reviewed By: Eng. Khalid Ramaky

Checked By: Eng. ghafar Shokoori

Approved By Eng. Nangialai Miakhail And Eng. Naser Ahmadi

Dept.: Substation Design Department -COO

Project overview

Hamishababar substation is feed from Naghlu HPP Bus through 110kv single circuit Transmission line.it is having four power transformer with the capacity of (1x16+3x20) MVA.and one outgoing 110kv line to mehtarlam substation laghman Province.

The data required is collected from hamishababar substation in corporation with Nangharhar Breshna Office.

The Source for the study is chosen Naghlu HPP which has the capacity of 4x25MW power generation. As data is collected from Hamishababar Substation. Due to that it is considered As a load.

Scope of Work

The Scope of work is to study the substation from voltage drop perspective and losses. And also the main purpose of Study is the improvement of Voltage in Hamishababar bus.

The load flow shows the voltage in hamishababar 110kv bus is poor. for the purpose of Voltage Improvement 30MVAR Capacitor is added to the bus.

The data recorded in hamishababar substation is available in first six month of 1398 which is received from nangharhar Breshna. And the study is based on that.

The study is done considering NAGLU HPP as a source. Also the study is done on the monthly peak load of reactive power and its corresponding Active power.

Input Data

Incoming Line from Naghlu to Hamishabahar Substation

Month	year	Qmx (MVAR)	Qmn (MVAR)	P @ Qmx (MW)	P @ Qmn (MW)	Vmx (KV)	Vmn (KV)
حمل		9.7	1.1	33.3	21	110	100
ثور		12.7	6.4	46	28	106	98
جوزا	1398	14	7.3	48.6	30.8	102	96
سرطان		22.1	14.9	54	45	94	80
اسد		21.3	13.8	55	41	97	85
سنبه		21	11.8	54	39	98	85

Power Transformer 1, 16MVA, 110/20, YNyn0d11, %Z=10.58

Month	year	Qmx (MVAR)	Qmn (MVAR)	P @ Qmx (MW)	P @ Qmn (MW)	Vmx (KV)	Vmn (KV)
Hamal		1.5	0.6	4.6	1.4	20.30	17.4
ثور		2.8	1	7	2.2	20.1	17
جوزا	1398	3.6	1	9.6	3.4	19.8	16.2
سرطان		3.9	0.6	10.2	2.3	20.5	16.8
اسد		3.8	2.2	10.2	6.2	18.2	14
سنبه		3.4	2.2	9.6	5.1	18.1	14.1

Power Transformer 2,200VA,110/20,Dyn1,%Z=9.15

Month	year	Qmx (MVAR)	Qmn (MVAR)	P @ Qmx (MW)	P @ Qmn (MW)	Vmx (KV)	Vmn (KV)
حمل		2.4	1.2	15	8.4	20	17
ثور		2.8	1.3	14.7	5.3	18.2	15
جوزا	1398	2.3	1	15.2	5.1	18.2	15
سرطان		2.4	0.9	15.8	5.6	18.6	16.1
اسد		4	0.8	16.8	6	18	15.2
سنبله		4.8	0.5	14.5	8.3	17.5	14.4

Power transformer 3,20MVA,110/20,Dyn1,%Z=9.15

Month	year	Qmx (MVAR)	Qmn (MVAR)	P @ Qmx (MW)	P @ Qmn (MW)	Vmx (KV)	Vmn (KV)
حمل		6.6	3.1	14.2	9.9	20.2	17
ثور		2.6	0.6	9.4	4.1	19.8	17.3
جوزا	1398	2	0.8	10.8	3.9	19.5	16.3
سرطان		5	2.7	14.2	9.9	17.8	14.1
اسد		4.7	2.9	14.6	8.4	18	15
سنبله		4.5	2	14	9.7	18.9	16.2

Power transform 4,20MVA, 110/20, Dyn1, %Z=9.15

Month	year	Qmx (MVAR)	Qmn (MVAR)	P @ Qmx (MW)	P @ Qmn (MW)	Vmx (KV)	Vmn (KV)
حمل		2	1	8.6	3.2	19	17.1
ثور		3.2	1.4	8.9	3.1	19.6	17.1
جوزا	1398	4	0.5	13.9	4.2	19.4	16.8
سرطان		3.8	0.8	13.7	4	19.6	16.4
اسد		3.9	0.9	14	4.2	19.7	16
سنبه		4.5	1	13.6	4.2	19.6	16.2

110kv Outgoing Line From HB SS To Mehtarlam SS which is recorded from hamishababahr substation and in the study it is considered as a Lump load.

Month	year	Qmx (MVAR)	Qmn (MVAR)	P @ Qmx (MW)	P @ Qmn (MW)	Vmx (KV)	Vmn (KV)
حمل		1	0.4	6.4	1.2	110	100
ثور		1.2	0.4	5	1.3	106	98
جوزا	1398	1	0.2	7.4	2.6	102	96
سرطان		2	0.8	7.4	3.2	94	80
اسد		2	0.8	7.9	3.1	97	85
سنبه		2	0.1	7.4	3	98	85



Naghlu HPP

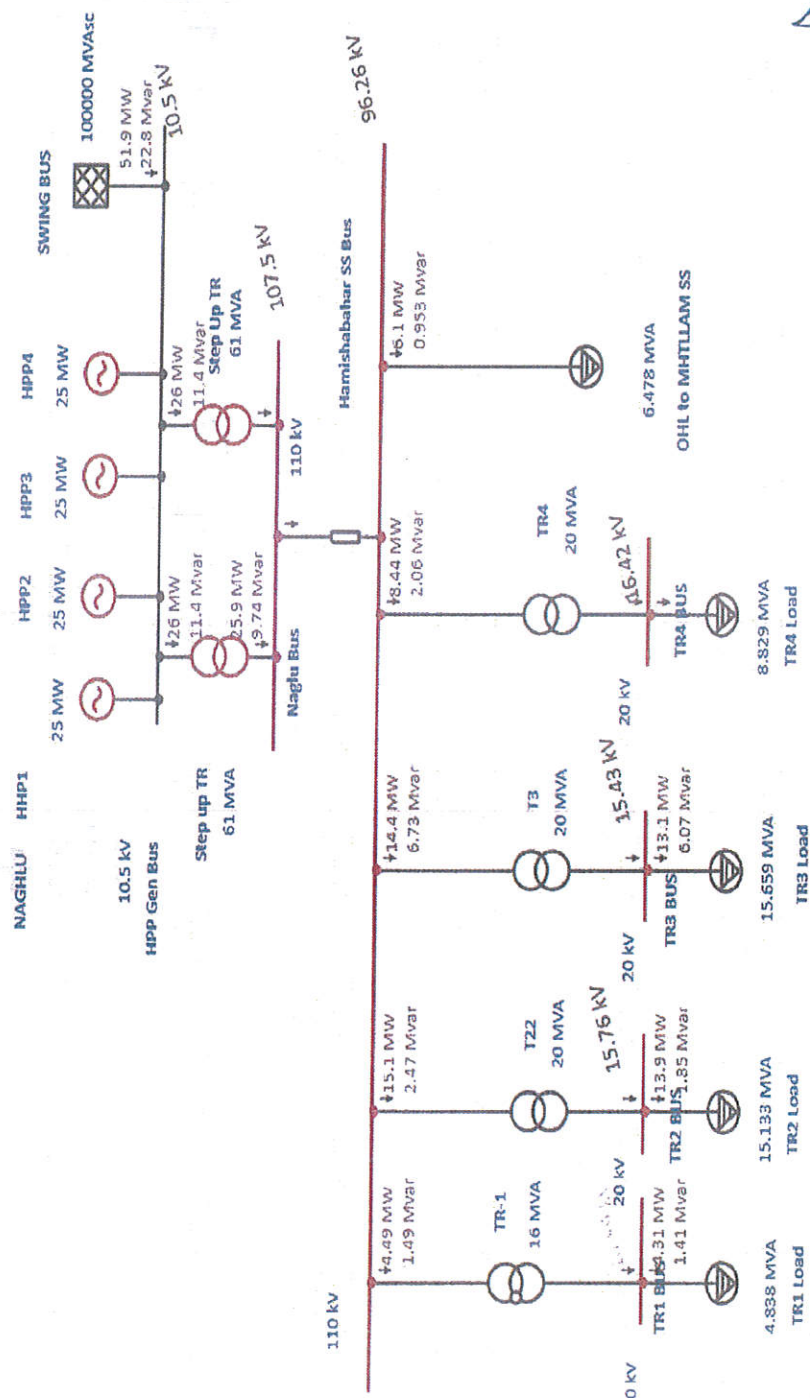
The source for the study is Naghlu HPP. There are four HPP generator with the capacity of 25MW and the power factor of 0.85. The Z for the generators were not available so it has been selected typical. The Transmission Line selected between Naghlu and hamishabahar substation is 110kv triangular structure in shape with cross sectional area of 300mm² and OPGW with C.S.A of 120mm². The voltage range is considered between 95 and 100% for Proposed Value of Capacitor.

Data recorded in hamishabahar Substation is for the 6 months from Hamal to Sunbula of 1398. We study it in 6 scenarios considering each month as a scenario. The software used for the study is ETAP 19.5.

Scenario 1
Hamal

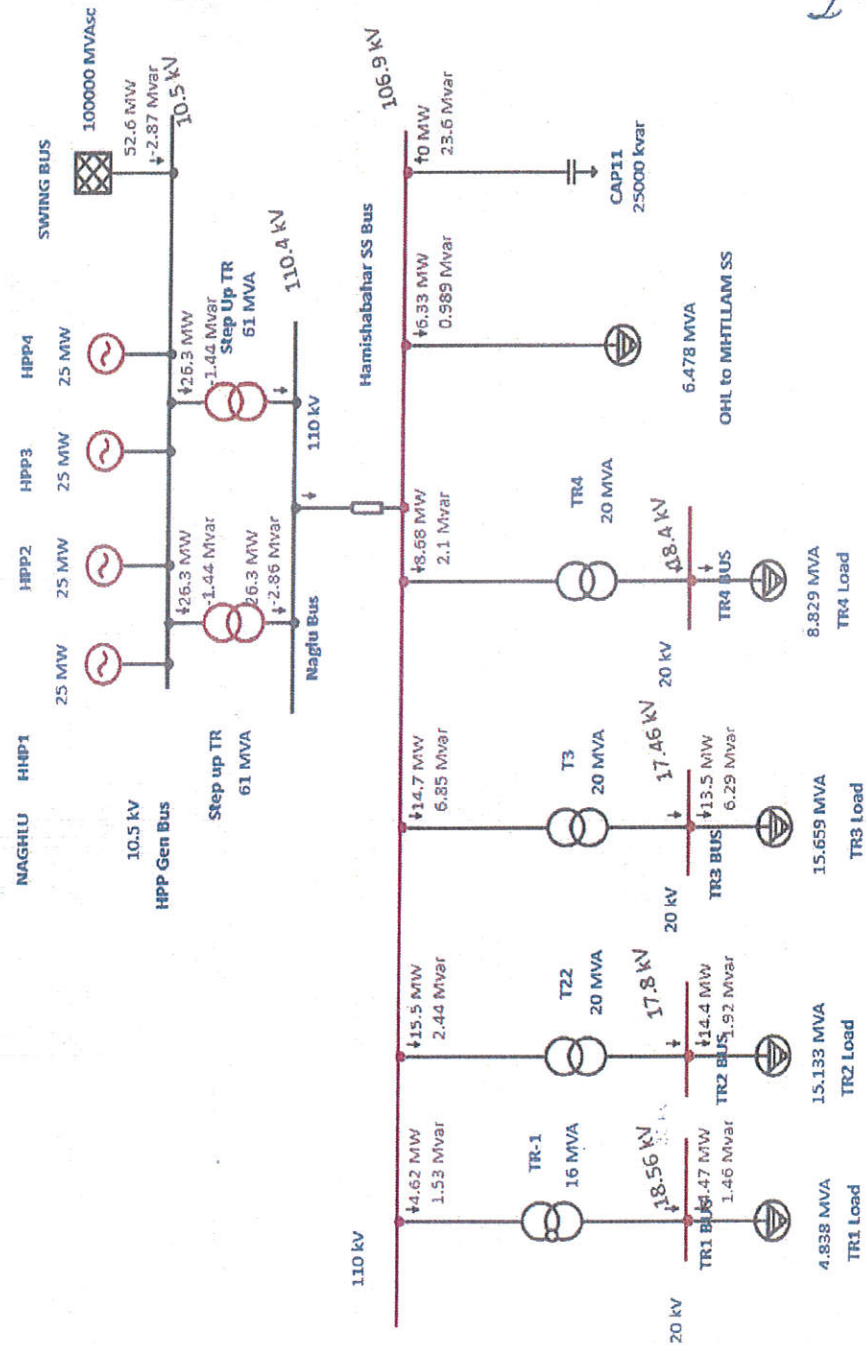
Load Flow result is Given in below Table And SLD.

HB Bus Voltage	Naghlu Bus Voltage	T1 Voltage	T2 Voltage	T3 Voltage	T4 Voltage
96.26	107.5	16.59	15.76	15.43	16.42



HB Bus Voltage	Naghlu Bus Voltage	T1 Voltage	T2 Voltage	T3 Voltage	T4 Voltage	Proposed Value of C
----------------	--------------------	------------	------------	------------	------------	---------------------

	KV	MVAR
106.9	110.4	17.8
	18.56	17.46
		18.4
		25

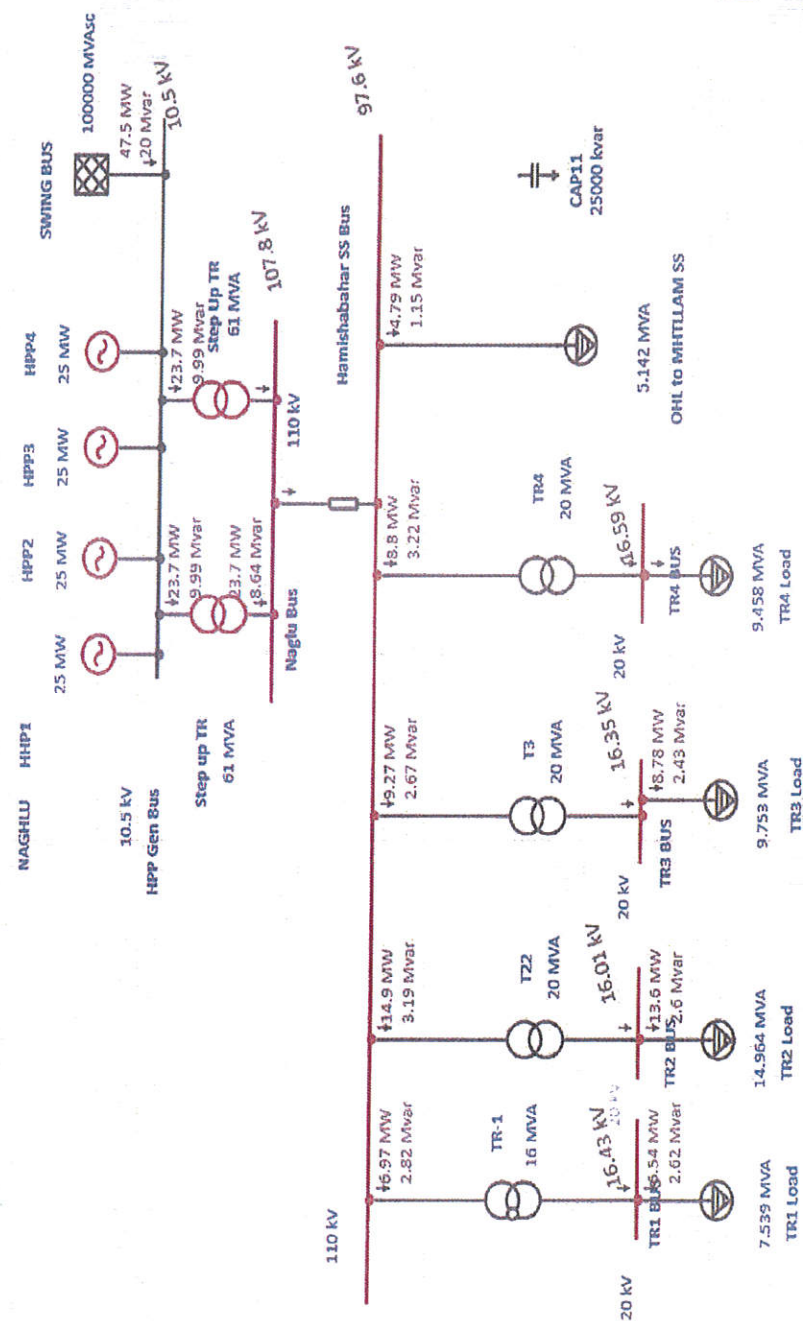


Scenario 2 Sawr

Load Flow result is Given in below Table and SLD.

HB Bus Voltage	Naghlu Bus Voltage	T1 Voltage	T2 Voltage	T3 Voltage	T4 Voltage
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97.6	107.8	16.43	16.01	16.35	16.59
KV					



~~May~~



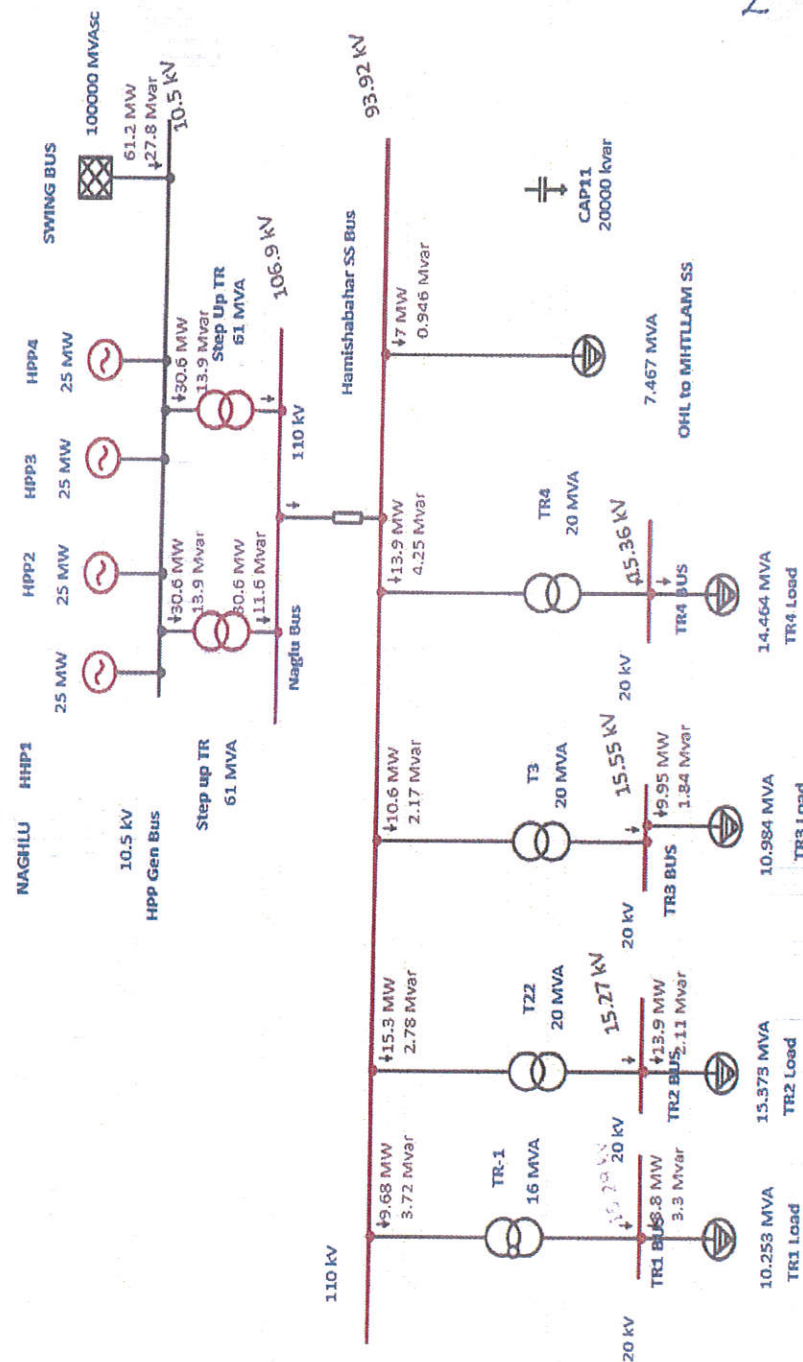
Scenario 3
jawza

Load Flow result is Given in below Table and SLD.

HB Bus Voltage	Naghu Bus Voltage	T1 Voltage	T2 Voltage	T3 Voltage	T4 Voltage
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KV

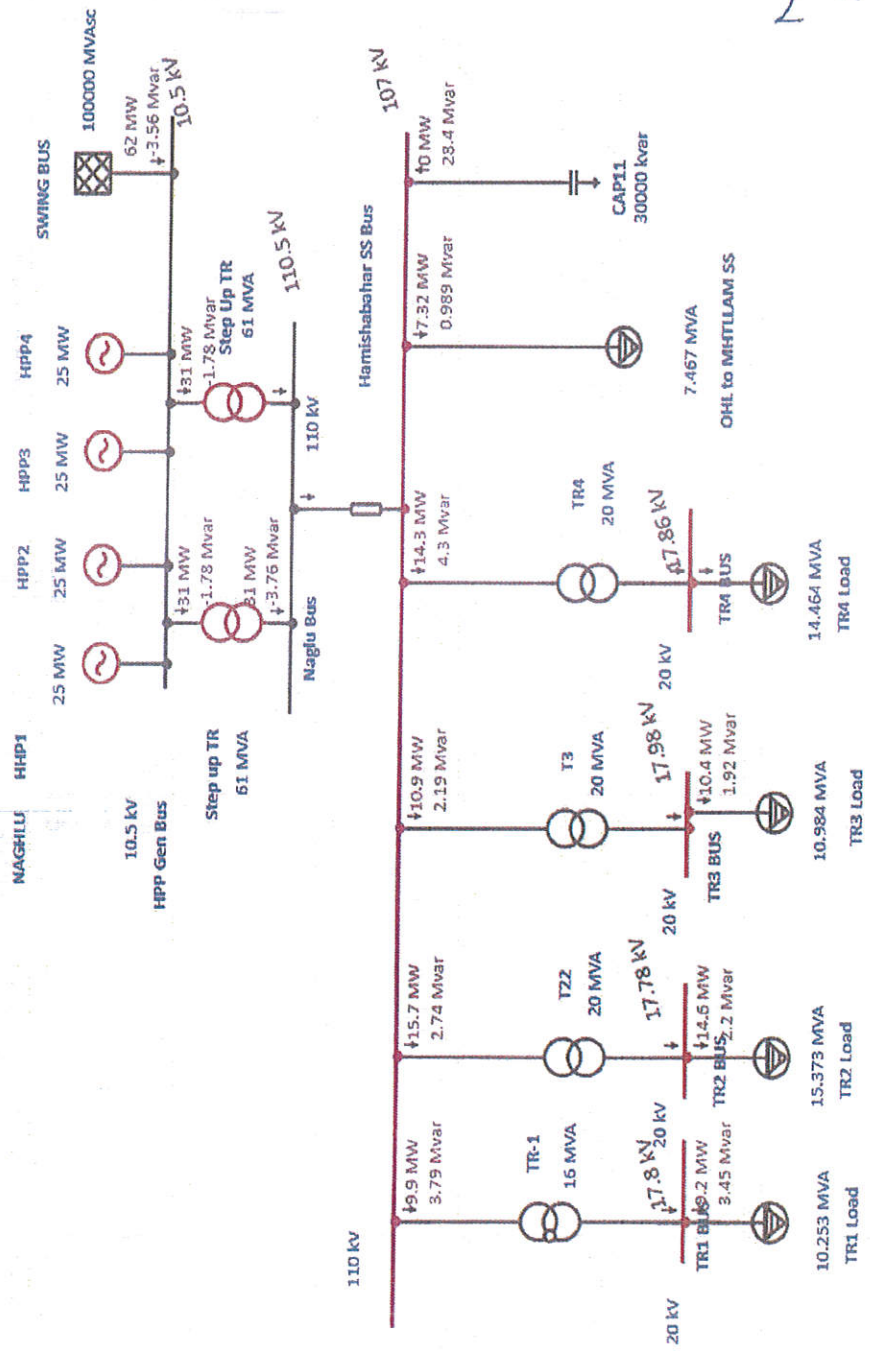
	106.9	15.29	15.27	15.55	15.36
93.92					



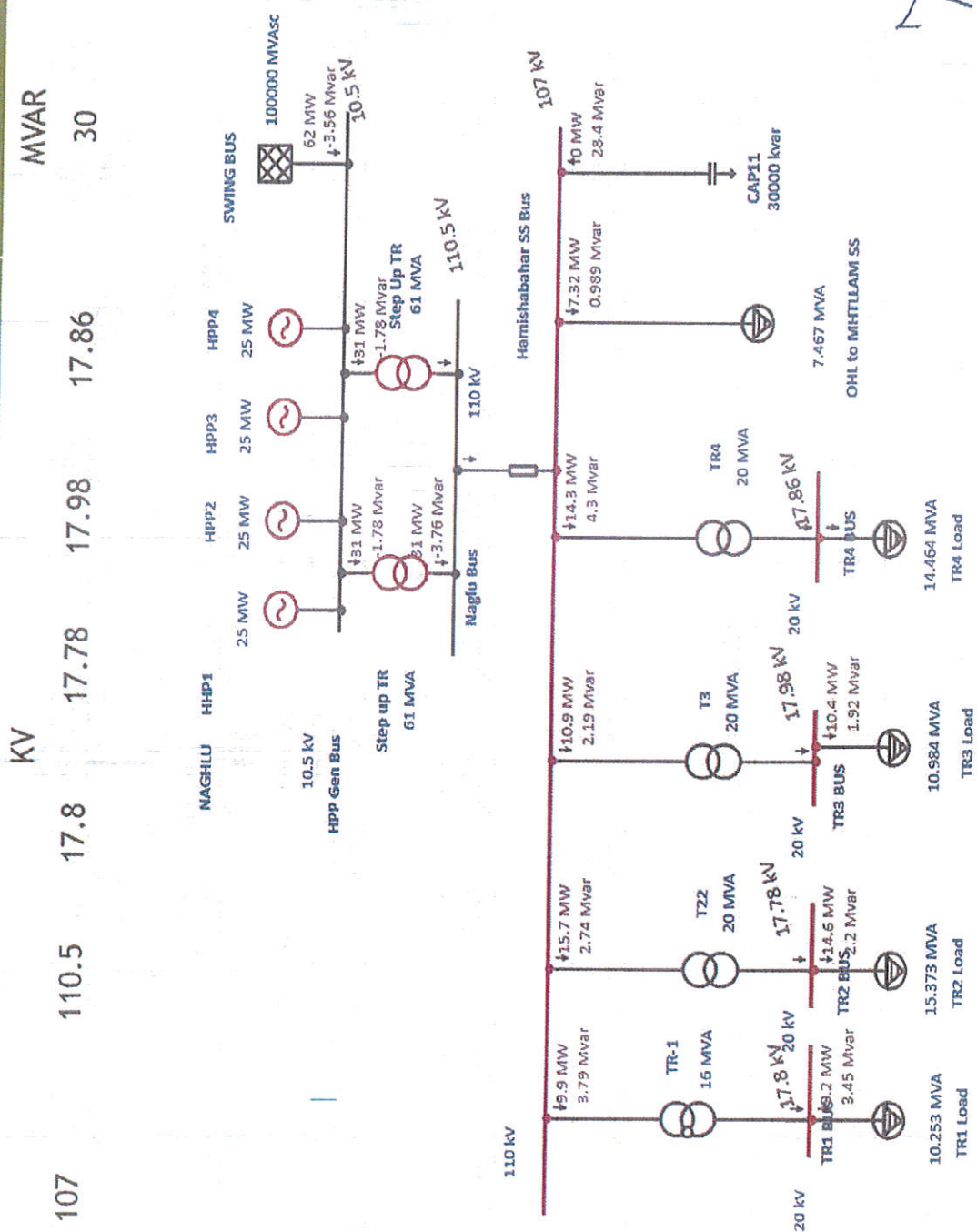
Proposed Value of Capacitor

HB Bus Voltage	Naghlu Bus Voltage	T1 Voltage	T2 Voltage	T3 Voltage	T4 Voltage	Proposed Value of C
----------------	--------------------	------------	------------	------------	------------	---------------------

KV	107	110.5	17.8	17.78	17.98	17.86	MVAR
							30



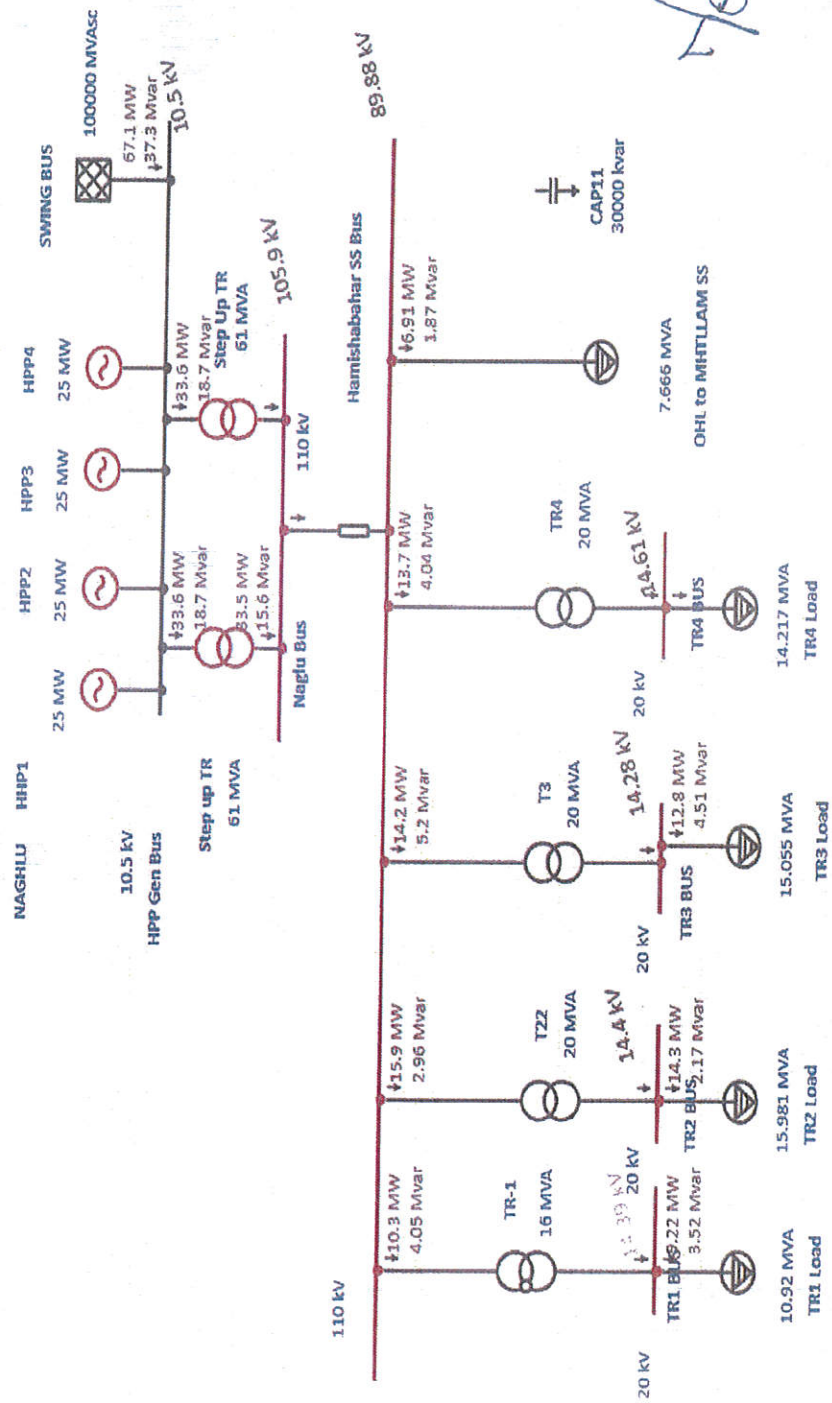
HB Bus Voltage	Naghu Bus Voltage	T1 Voltage	T2 Voltage	T3 Voltage	T4 Voltage	Proposed Value of C
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Scenario 4
Saratán

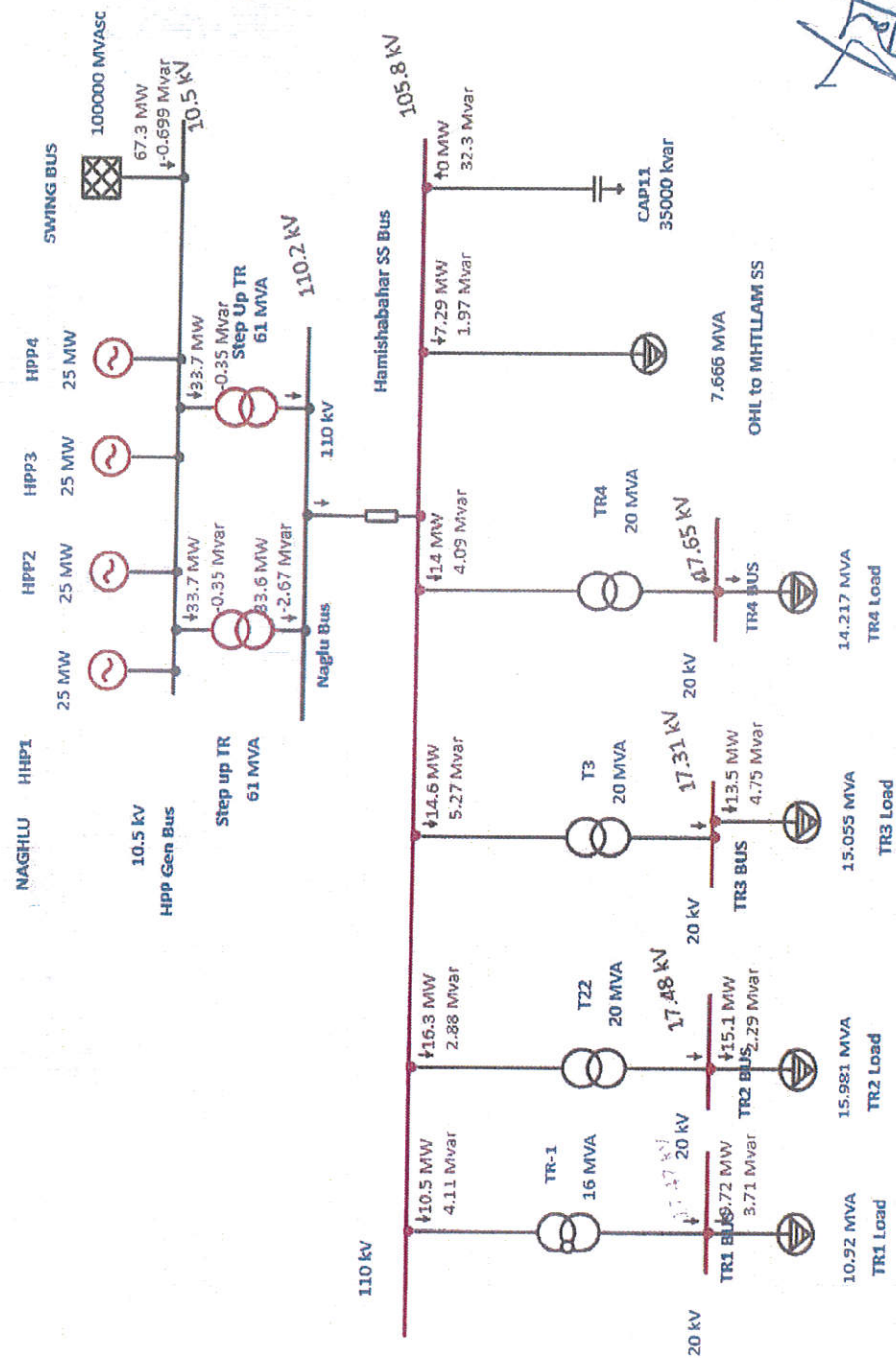
Load Flow result is Given in below Table and SLD.

HB Bus Voltage	Naghlu Bus Voltage	T1 Voltage	T2 Voltage	T3 Voltage	T4 Voltage
89.88	105.9	14.39	14.4	14.28	14.61



HB Bus Voltage	Naglu Bus Voltage	T1 Voltage	T2 Voltage	T3 Voltage	T4 Voltage	Proposed Value of C
----------------	-------------------	------------	------------	------------	------------	---------------------

	KV	MVAR
105.8	17.47	17.65
110.2	17.48	35

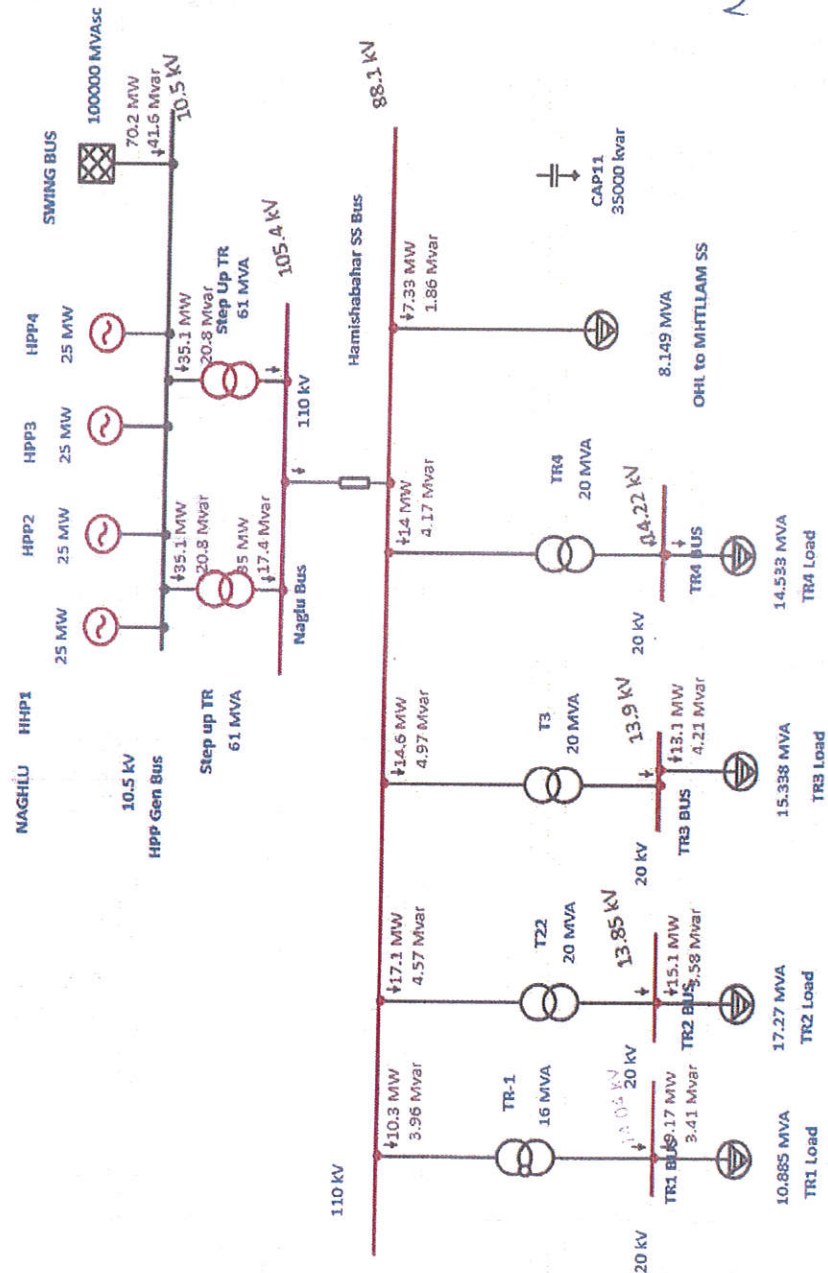


Scenario 5 Asad

Load Flow result is Given in below Table and SLD.

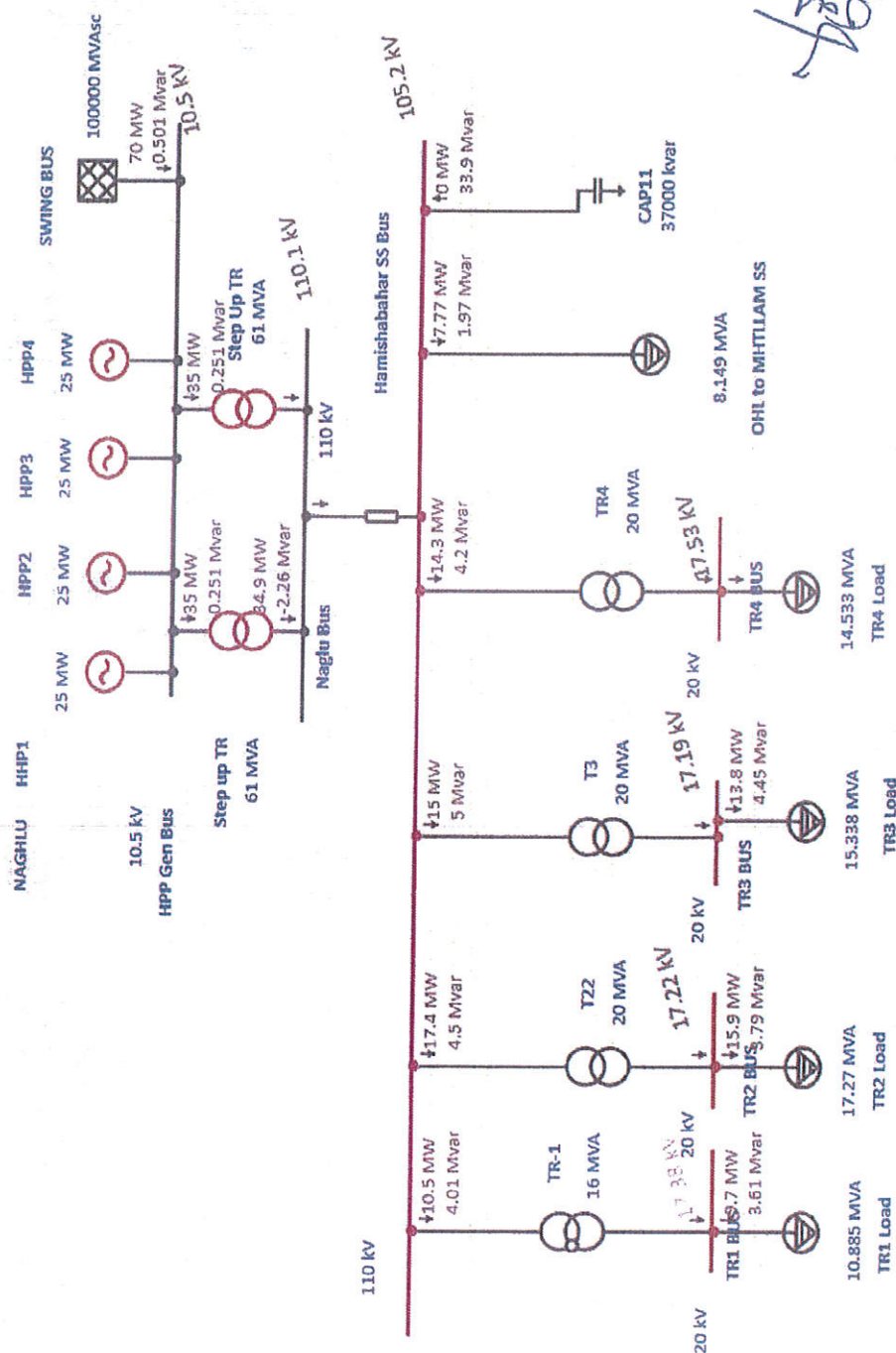
HB Bus Voltage	Naghlu Bus Voltage	T1 Voltage	T2 Voltage	T3 Voltage	T4 Voltage
----------------	--------------------	------------	------------	------------	------------

88.1	105.4	14.04	13.85	13.9	14.22
KV					



HB Bus Voltage	Naghu Bus Voltage	T1 Voltage	T2 Voltage	T3 Voltage	T4 Voltage	Proposed Value of C
----------------	-------------------	------------	------------	------------	------------	---------------------

	KV			MVAR
105.2	110.1	17.38	17.22	17.53
				37



Scenario 3
Sunbula

Load Flow result is Given in below Table and SLD.

HB Bus Voltage	Naghlu Bus Voltage	T1 Voltage	T2 Voltage	T3 Voltage	T4 Voltage
----------------	--------------------	------------	------------	------------	------------

KV

89.62

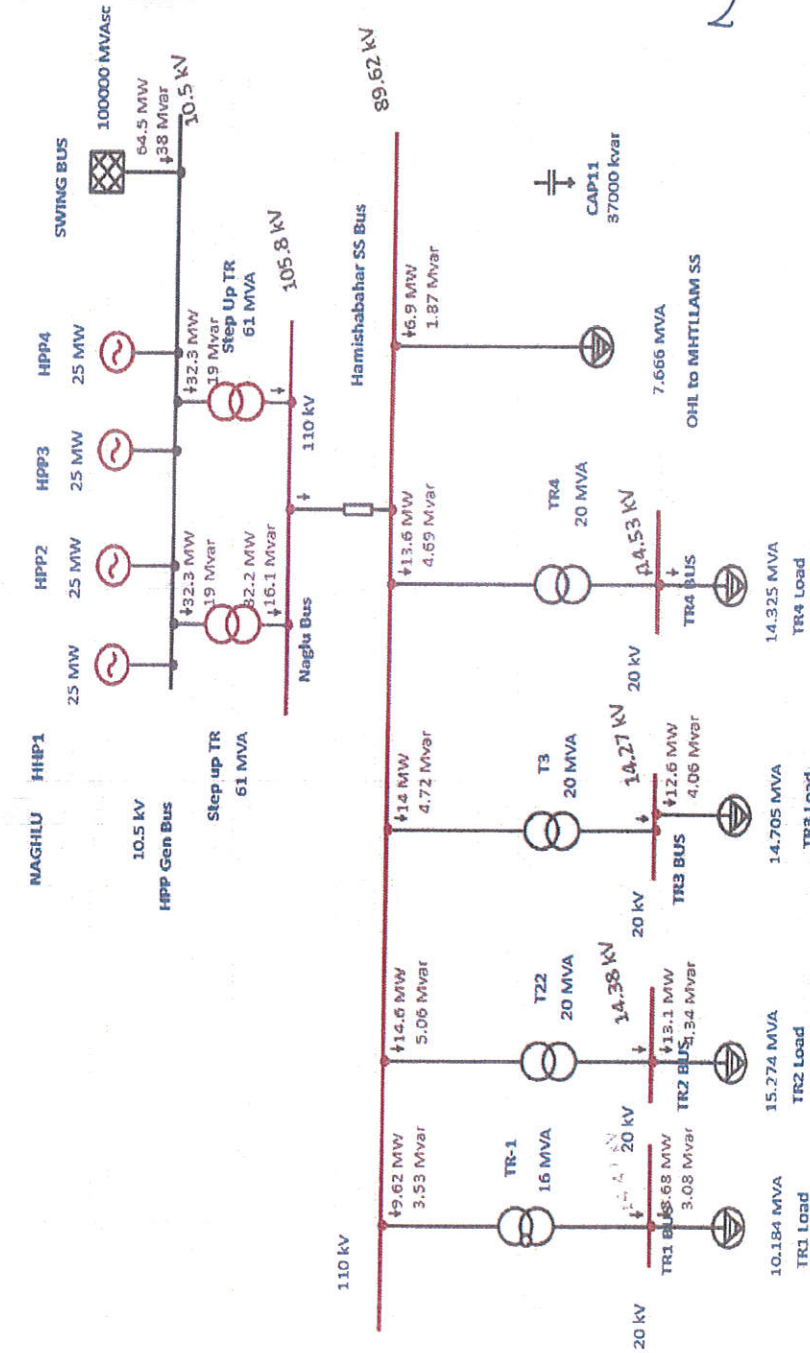
105.8

14.47

14.38

14.27

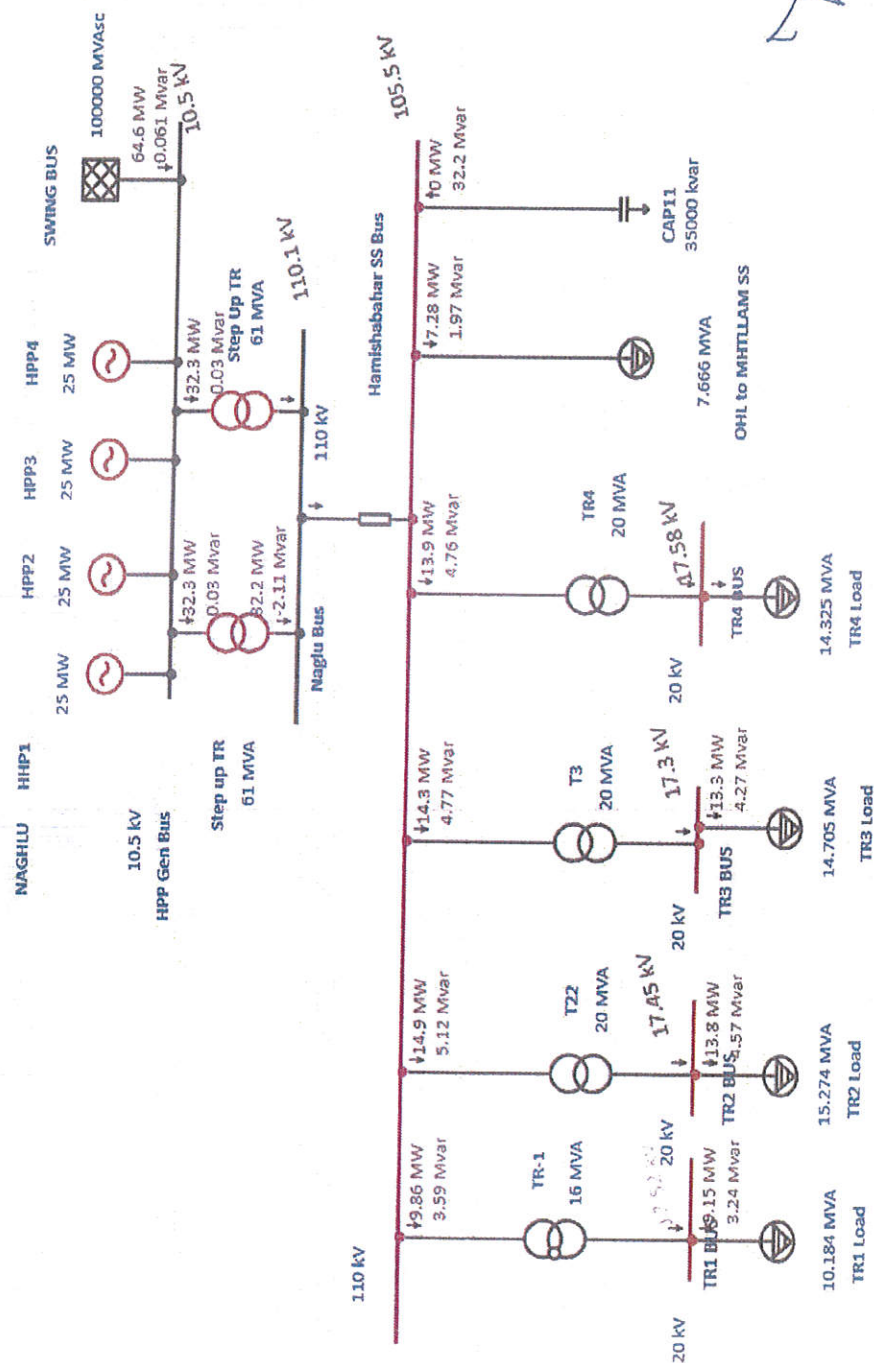
14.53



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	KV			MVAR
105.5	110.1	17.52	17.45	17.58
				35



Results and Conclusions

As we did study it for six months from Ham-Sun 1398 The result shows that the lowest 110kv voltage available in the substation is in asad month which is 88.1kV. And the Proposed capacitor Value for improving the voltage considering the Average of six months is calculated 30.33Mvar. which the appropriate selected value for the purpose is 30Mvar. and it improves the substation bus voltage to 105kV and beyond

Prepared By: Jamaluddin Sharifi

Checked by: Khalid Ramaky

Reviewed by: Ghafar Shokoori

Approved by: Nangialai Miakhail

Approved By: Mohammad Nasir Ahmadi

For informations

