ODISHA POWER TRANSMISSION CORPORATION LIMITED

(A Govt. Of Odisha Undertaking)

Regd. Office, Janpath, Bhubaneswar -751022

Website of OPTCL "www.optcl.co.in"

Engineering, Supply, Erection, Testing , Commissioning and Connectivity of the existing 33kV & 11kV UG Cabling System with the upcoming 132/33kV GIS GRID & 33/11kV GIS PSS in JANPATH of BTCD Area in Bhubaneswar in the state of Odisha On Turnkey Contract Basis

TENDER DOCUMENT NO: Sr.GM-CPC-E-TENDER-SCRIPS-UG CABLING JANPATH-06/2023-24

TECHNICAL SPECIFICATION

VOLUME-II (PART-A)

For further details, please visit the Official
Website of OPTCL **"www.optcl.co.in"** &
E-Tender Portal of OPTCL **"www.tenderwizard.com/OPTCL**"

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CHAPTER-E1
SCOPE OF WORK

1. SCOPE

The scope includes Engineering, Supply, Erection, Testing and commissioning of 33kV and 11kV UG Cabling Systems.

i. **33 kV UG Cabling Systems- 34.75 Km**

ii. **11 kV UG Cabling Systems- 10.18 Km**

iii. Supply, Installation, testing & commissioning of different sizes of 33kV & 11kV HT XLPE cable as per the price schedule.

iv. Supply, Installation, testing & commissioning of different sizes of 33 kV outdoor termination kits & jointing kit suitable for 33 KV XLPE cables as indicated in the price schedule.

v. Supply, Installation, testing & commissioning of different sizes of 11kV outdoor termination kits & jointing kit suitable for 11 KV XLPE cables as indicated in the price schedule.

vi. Supply, Installation, testing & commissioning of Optic Cable along with PLB Duct, Straight Through Connector & FO End Connector.

vii. Supply, installation, testing ,commissioning of 33kv DP structure, Isolator, SA, Hardware fitting.

viii. Supply, installation, testing ,commissioning of 33kv DP structure, Isolator, SA.

ix. Supply, installation, testing ,commissioning of Earthing conductor, Earthing device & accessories.

x. Construction of Boundary wall, earth mat & earth pits, provision of water to the earth pits, fencing (if required), Concrete roads inside the sub-station, RCC drains, Main & other gates, Garden & watering arrangement for the same, Street Lighting cum Lightning pole, Switchyard illumination, switch yard building illumination, oil sump pit for the transformers, and all other civil works etc. as per specification.

xi. The dismantling works if any involved shall also be done as per the direction of the Engineer- in-Charge. Dismantling shall be done by the contractor at his own cost.

xii. The scope is on the basis of a single/JV Bidder's responsibility,

completely covering supply and erection of all the equipment specified under the Specifications including other services. It will include the following:

xiii. Providing Engineering drawings related to foundation details, structural details of Substation work.

xiv. Providing Equipment data, Operational manual.

xv. Preparation of Cable Schedule (in shape of a booklet) for the Owner's approval.

xvi. Packing and transportation from the manufacturer's works to the site.

xvii. Loading, unloading and transportation as required.

xviii. Receipt, storage, preservation and conservation of equipment at the site including insurance.

xix. Erection, testing and commissioning of all the equipment.

xx. Performance and Guarantee tests on completion of commissioning.

xxi. The scope of work shall also include all work incidentals for successful operation and commissioning and handing over of works whether specifically mentioned or not. In general, works are to be carried out by the Contractor in accordance with the stipulations in Conditions of Contract.

CHAPTER-E2
33kV GIS PANEL

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TECHNICAL SPECIFICATIONS FOR 33kV GIS PANEL

1.0 SCOPE

This specification covers the technical requirements of design, manufacture, testing at manufacturer's works, packing, forwarding of 33kV Gas Insulated Indoor switchgear complete with all accessories for trouble free and efficient performance including supervision of installation and commissioning of SF6 gas-insulated vacuum circuit breaker switchgear and associated equipment. The GIS Panel should have in built surge Arrester.

2.0 STANDARDS

Sl. No.	Item	Standard
1	Switchgear	IEC 62271-200 / EN 62271-200 IEC 60694 / EN 60694
2	Switchgear behavior in the event of internal faults	IEC 62271-200 / EN 62271-200
3	Three-position disconnector and disconnector	IEC 62271-102 / EN 62271-102
4	Bus bar earthing switch	IEC 62271-102 / EN 62271-102
5	Circuit-breaker Current	IEC62271-100/EN 62271-100
6	transformer Voltage	IEC 60044-1 / EN 60044-1 IEC 60044-2 / EN 60044-2
7	transformer Voltage detectionsystems	IEC 61243-5
8	Protection against accidental contact, foreign Objects and waterInstallation	IEC 60529 / EN 60529 HD 637 S1

3.0 DESIGN CRITERIA

3.1 Operating Condition

a) Operating Conditions according to:- IEC 60694 / EN 60694

b) Temperature of ambient air Maximum value: 50 °C

3.2 Rated Normal Current

The rated normal currents of components are stated in the Technical data and shall be valid for design ambient temperature of 50° C.

3.3 Internal Arc Fault

a) Classifications to IEC 62271-200
b) Partition class- PM
c) Internal arc classification - AFLR (Authorized person access permitted from Front, Lateral & Rear side) for the panels with no rear access required.

3.0 Insulating Gas

a) Insulating gas Type Sulphur hexafluoride (SF6)
b) Design pressure at 20 °C For 36 kV Class - 0.05 MPa

4.0 TECHNICAL DATA

4.1 Bus Rating:- 33kV GIS, 25kA for 3s, Single Bus Bar 1250A @ max.50°C to 35°Caverage 24h.

4.2 Required Technical Parameter:

Bus bar System	Common bus bar
Electrical Data	
Rated voltage	36kV
Rated operating voltage	33kV
Rated frequency	50
Rated power-frequency withstand voltage	70kV
Rated lightning impulse withstand voltage	170kV
Rated short-time withstand current	25kA
Rated short-circuit duration	3s
Rated Dynamic Short Circuit current	62.5kAp
Rated operating current bus bar	1250A
Degree of Protection	
Main circuits	IP65
Drives	IP 3X
Cable connection compartment	IP 3X
Low voltage cabinet	IP 4X
Auxiliary Voltage	
Control	48V DC
Motor	220V AC
Protection system	48V DC
Remote control	48V DC

Socket/lighting/heating	230V AC
IAC Classification acc. to IEC 62271-200	
Classification IAC	AFL
Internal arc	25 kA 1 s
Dimensions	
Cubicle width max.	800mm
Cubicle depth maximum	2000mm
Cubicle height max.	2500mm
Properties	
Pressure relief duct	Not Required
SF6 pressure control	IDIS
Voltage Indication System	IVIS
Control panel	mechanical
Mech. Operation	Closed door Operation

5.0 DESIGN FEATURES OF SF6 GAS INSULATED SWITCHGEAR

5.1 General Description

The SF6 gas insulated switchgear shall be type-tested and of pre-fabricated metal construction. The offered Indoor GIS shall have VCB, Three Position Disconnecting Switch and Bus Bars enclosed in SF6 Gas. Single panels, each built up from a modular range of separate functional units, can be combined to produce the specified switchgear configuration. The modular units comprise:-

A) Standard basic module:

Incorporating the vacuum circuit-breaker

B) Floor-pan module, flange-mounted to the lower part of the basic module,with:

i) A wide range of cable connection options, appliance couplers for outer cone-type cable connection systems.

ii) Current transformers (toroidal type)

C) Cable compartment:

A metal-enclosed, air insulated clad compartment, with

i) Cable support for single and multiple cable installation

ii) Sufficient space for installation of current

Circuit-breaker and three-position switch drives are to be designed with mechanical interrogation interlocks and shall include all necessary auxiliary devices (auxiliary switches, releases etc.)

The three-position disconnecting switch (ON-OFF-EARTH) is to be designed with separate manual and/or motorized drives for the disconnector and earth switch functions.

All switching device drives shall be located outside of the gas compartments, for easy access. Under normal operating conditions for indoor switchgear units in accordance with IEC 50594 and when complying with the specified number of operations, no maintenance is required.

5.2 Functional Compartment

a) Circuit-breaker compartment – Gas insulated
b) Bus bar compartment – Gas insulated.
c) Gas compartments shall be segregated from each other and the panels shall also be physically segregated from each other. Unified (continuous) bus-barcompartment is not acceptable.
d) Each gas compartment shall be internal arc tested. In the event of an internal arc the plasma shall be carried through a duct outside the switchgear room.
e) Cable compartment shall also be internal arc tested. In the event of an internal arc the plasma shall be carried through a rear duct outside the switchgear room. Release of plasma in the cable basement is not acceptable.
f) Panel to panel connection shall be fully enclosed and shall not remain open. Gas handling shall not be required during coupling of panels or during future extension of switchboard.
g) Cable connection/transformer clad compartment are to be equipped with individual pressure relief devices - Air Insulated

5.3 Switchgear Operator Interfaces Requirements

a) A standard mechanical user interface, ergonomically Positioned at a convenient height**. It must be visible directly without opening of doors etc.**

b) The user interface comprises all the mechanical, panel related interfaces and continuous interrogating interlocks.

c) All the basic mechanical ON/OFF of CB, Isolator & earth switch operation, manual spring charge of CB must be possible without opening the door to ensure the operator safety.

d) Mechanical mimic directly linked to mechanism should be provided at the panel front door.

e) The basic switchgear unit is to be designed for suitable free- standing installation within a switch room.

f) The Interlocking shall be as per IEC.

5.4 Functional Intuitive Operator Interface Design

The SF6 Gas insulated switchgear shall be characterized especially by the followingoperating features:-

a) Ergonomic operability
b) Logical operation
c) Logical function states
d) Good visual communication of the overall function and operating states
e) Optimum operator guidance
f) All operations can be performed optionally via a motor-operated mechanism

The mechanical control panel is located at an optimum height for operation and arranged in a recessed position on the switchgear front. Thus, the operating area is clearly visible while no control elements protrude from the switchgear front. The position of the individual elements has been selected according to their function, i.e. according to their allocation to the corresponding device functions.

The elements which form part of a switching device, such as position indicators, crank ports or mechanical push buttons, are visually linked by a specific pattern and integrated in a mimic diagram. Mechanical operation is performed the same way as with the habitual operation with stationary switching devices. Separate control elements and mechanical switch position indicators are available for the following functions:

- Circuit breaker ON – OFF
- Disconnector ON - OFF- EARTH

5.5 Bus Bar / Panel Connections

The gas-insulated bus bar sections of the single panels shall be connected via single pole solid insulated connection elements which allows for easy exchange of a cubicle without SF6 works. Bus bar connection to be designed in such a way that no adjacent panels must be moved or opened for exchange of a panel.

Bus bar couplings between adjacent panels should be designed with a minimized quantity of electrical sealing joints.

5.6 Gas Compartment Technology

A Temperature Compensated Gas Monitoring Device shall be provided on the offered GIS to constantly monitor the Gas Pressure inside the Gas Compartment.

By design there should be no need for gas works during the whole time on site, not even for exchanging a center panel or extending the switchgear at later stage, e.g. no gas handling shall be necessary during the anticipated service life of the switchgear, under normal operating conditions. (The gas filled compartments are to be designed to be maintenance-free and hermetically sealed pressure systems in accordance with IEC 62271-200)

The switchgear panels shall be filled with gas and checked for leakage in the factory. For a proper recycling/emergency replacement, a gas valve in gas compartment has to be provided. In addition, the standard tools for filling the SF6 Gas also have to be provided.

Disconnector & VCB shall be encapsulated in GIS, However Busbar may be Solid Insulated (Touch Proof).

5.7 Installation Facility

The panels are to be delivered to site as factory assembled and routine tested units. After linking the panels (or panel assemblies) by the bus bar connection system and connection of the power and control cables the system should be ready for operation. No gas filling is required at site during bus bar connection & installation.

6.0 CIRCUIT BREAKER

The three pole vacuum circuit breaker with its maintenance-free vacuum interrupters is installed horizontally in the gas compartment.

The CB shall be spring operated, motor charged, and manually released spring closing mechanism with three pole simultaneous operations. The speed of closing operation shall be independent of the hand-operating lever. The indicating device shall be **mechanical type directly linked to the mechanism & shall show the OPEN and CLOSE position of breaker visible from front of the cubicle.** The spring charging time of the motor shall not exceed **20sec** in case of Vacuum Circuit Breaker. The "TRIP" and "CLOSE" coils shall be of reliable design and low consumption.

The Breakers shall be capable of Making & Breaking the short time current in accordance with the requirement of IEC 62271-100 and latest amendment thereof. The continuous current rating of breaker shall not be less than 1250 A for outgoing feeders and incomer feeders. **Ratings are IN-Panel at 50 Deg C designs ambient.**

Comprehensive interlocking system to prevent any dangerous or inadvertent operation shall be provided. Two stage gas **density** alarm and lockout system with local and remote indication shall be provided.

Emergency **mechanical trip push button on each CB shall be provided on panelfront & shall be accessible.**
Spring charge indication is to be provided.
The vacuum circuit breakers are to be equipped with:

a) Spring-stored-energy operating mechanism with motor, auto-reclosing
b) Mechanical OPEN and CLOSE push buttons
c) 1 closing solenoid
d) 2 shunt release
e) Operating cycle counter
f) Auxiliary switch with at least 6NO + 6NC
g) Auxiliary switch for "spring charged" signal

The circuit-breaker has to control at least **10,000 Make-Break cycles (One operating cycle of making & breaking) operations at rated current or 100 breaking operations at rated short-circuit** breaking current without maintenance. The mechanical life of the vacuum interrupter has to comprise at least **20,000** operating cycles.

The operating mechanism must be maintenance-free without time limit up to 10,000 operating cycles.

7.0 ISOLATORS AND EARTHING SWITCHES

Isolators or isolators combined with earth switches (3 position switches) shall be manual operated. In cases of emergency, manual operation must be possible.

The Earthing position for all 3 phases must be visible via a mechanical position indicator (MIMIC) directly connected to the drive shaft on panel front Fascia.

The mechanical operation of isolator/3 position disconnector switch must be possible with door closed for operator safety.

8.0 INSTRUMENT TRANSFORMERS

Only conventional inductive voltage and current transformers according to IEC 60044-1 and IEC 60044-2 or electronic current and voltage transformers to IEC 60044-7 and IEC60044-8 or a combination of both are acceptable. Current & voltage Sensors are not acceptable.

8.1 Current Transformers

The current transformers shall be Toroidal type current transformers. The Current Transformers shall be located outside the Gas Compartment.

The transformer ratio, the accuracy class and the performance load to be selectedto suit the application requirements.

Transformer Feeder Variant

a) Toroidal type Current Transformer
b) CT Primary Current: 600-300 A
c) CT Secondary Current: 1-1-1A
d) Core 1: Cl-0.2s / 15 VA
e) Core 2:CL-PS, Vk:500V , Iex <30mA @Vk/2
f) Core 3:CL-PS, Vk:500V , Iex <30mA @Vk/2

Incomer Feeder Variant

a) Toroidal type Current Transformer
b) CT Primary Current: 800-400 A
c) CT Secondary Current: 1-1A
d) Core 1: Cl-0.2s / 15 VA
e) Core2: Cl-PS

(CT burden shall be provided as per relay and metering requirement and bidder to substantiate this with suitable calculations during detail engineering with CT/ VT burden calculation)

9.0 MECHANICAL SAFETY INTERLOCKING FEATURES

Internal mechanical interlocks of the panel should have:-

a) With the circuit-breaker closed, the interrogation slide is locked for the disconnector and the earth switch. (Restriction to the insertion of Hand Crank forDisconnector-Earth Switch when CB is ON)

b) The interrogation slide always releases one insertion opening only (disconnector or earth switch), or both of them are locked. (To ensure thateither Disconnector- or Earth Switch operating at a time)

c) The crank for the disconnector and earth switch can only be removed in its appropriate end position.

d) When the crank on the disconnector or earth switch is still in place, or whenthe interrogation slide is open, the following components are locked:
   - ON push button of circuit breaker
   - ON pulse is interrupted

9.1 PROTECTION & CONTROL SYSTEM

Relay Make: Schnieder (Micom Series), ABB (RE.. Series), Siemens (7SJ/7SR Series).

Following functions shall be available in the Protection Relay:-

10.0 Incomer & Outgoing Feeders protection (Numerical Relay (IEC-61850): BCPU having dual port facility)

a) Over current instantaneous (50)
b) Over current IDMT (51)

c) Earth fault instantaneous (50N)
d) Earth fault IDMT (51N)
e) Directional Earth fault IDMT (67N)
f) Directional over Current IDMT (67)
g) Auto Reclosure – 4 Shots
h) Under & over voltage protection
i) Frequency related protection
j) LBB protection
k) BCPU shall have adequate nos. of BI & BO and transducers to suit the siterequirement for adopting the PRP based SCADA.

10.1 Bus PT (IVT)

33kV Bus PT (IVT) shall be housed in a separate Panel and it shall be air insulated. Voltage protection (Bus VTs shall be Part of Feeder Protection relay).

a) Overvoltage (59)
b) Under voltage (27)
c) Frequency Relay (81 O/U)

10.2 Outgoing Feeder (Transformer)

(I) Back-up protection: (Numerical Relay (IEC-61850): BCPU having dual portfacility)

a) Over current instantaneous (50)
b) Over current IDMT (51)
c) Earth fault instantaneous (50N)
d) Earth fault IDMT (51N)
e) Directional Earth fault IDMT (67N)
f) Directional over Current IDMT (67)
g) Auto Reclosure – 4 Shots
h) Under & over voltage protection
i) Frequency related protection
j) LBB protection

BCPU shall have adequate nos. of BI & BO and transducers to suit the siterequirement for adopting the PRP based SCADA.

(II) Numerical Differential protection Relay having dual port facility (For TransformerFeeders) in addition to the above.

a)Differential protection for transformer (87T)

k) Harmonic restraint features

l) Over fluxing features

m) Shall have adequate nos. of BI & BO

10.3 Other protections and related functions SCADA compatibility (Part of NumericalRelay)

l) Lock-out (86) relays

m) Trip circuit supervision (95) relays

10.4 Other protections and related functions (Part of Numerical Relay)

The protection relays shall have communication protocol on IEC 61850 Protocol.

11.0 SURGE ARRESTERS

Suitable 33 kV GIS surge arrestors in the incoming & outgoing feeders are to be provided. The specifications and characteristics of the surge arresters shall be finalized during detailed engineering.

12.0 LOW VOLTAGE PANELS

The accessories and auxiliary equipment required for the correct functioning of each circuit element shall be installed in conveniently located mechanism cabinet or could be an integral part of the circuit element.

General Requirements

12.1 Individual local control panels/Cabinets/Cubicles for each circuit shall be supplied as a part of this contract to facilitate local control of circuit breakers, isolators and earth switches. These panels shall also house the various relays, timers, etc. to realize various interlocks as per PURCHASER's requirement among circuit breakers, isolators and earth switches. The contacts, signals and conditions originating form/going to the gas insulated switchgear, associated auxiliary and monitoring equipment shall be wired up to the local control panel, for PURCHASER's further use.

12.2 Completely separate and isolated circuit shall be used for switchgear control, tripping, alarms and auxiliary devices. CLOSE and TRIP circuits shall be kept isolated to their final mechanical or electrical actuators. Trip circuits shall be

individually and permanently monitored for continuity.

Each auxiliary control circuit shall be monitored and shall be protected by a two poleminiature circuit breaker with auxiliary contacts.

12.3 Constructional Features

i) All panels shall be totally enclosed rigid sheet steel structures. All doors, removable covers and plates shall be gasketed all around with neoprene gaskets. All accessible live connections shall be shrouded and it shall be possible to change individual fuses, switches, MCBs without danger of contact with live metal.

ii) A ground bar for terminating the ground wires of shielded control cables shall be located near the cable entrance location.

iii) A receptacle rated 240V, 16A, AC 1 phase, 2 wire shall be installed in each panel in addition to a light point with door switch and one 6 pin, 240V AC, 5/15A socket outlet.

iv) Adequate safety precautions shall be taken to avoid accidental contact with 240Vpotential. The following precautions shall be observed:

a) All live parts shall be completely shielded using a halogen free fire retardantinsulating material.

b) 600V terminal blocks shall have removable covers and wiring shall be separated from other potentials.

c) A clear and legible warning notice carrying wording "DANGER 33KV" shall be located on the enclosure door.

12.4 All control equipment shall be suitable for operating in an ambient temperaturevarying between +10 deg. C and +50 deg.C.

12.5 Cabinet doors shall have provision for padlocking. Door shall be constructed such that they do not seize in the event of an internal fire.

12.6 Clearance shall be as per Manufacturer's type tested design following IEC Norms.

12.7 Adequate interior cabling space and suitable removable cable gland plate shall be provided. Necessary number of cable glands including cable glands

for cables from control room to GIS shall be supplied and fitted on to this gland plate. Cable glands shall be screwed-on type and made of brass. The cable entry shall be from bottom only.

12.8 All the hardware required for fixing the panel shall be in BIDDER's scope.

12.9 Terminal blocks for terminating all control, indication and monitoring wiring from the associated circuit element shall be installed in each cabinet. All terminal blocks shall be identified with marking strips. The conductor size range which the terminals can accommodate shall be clearly shown on the BIDDERS drawings. The terminal blocks used for cable connections shall be disconnecting type. All terminal blocks shall be covered by acrylic covers.

12.10 Disconnecting type terminal links shall be provided for current transformer circuits.

12.11 Switches/ MCBs

a) Switches/MCBs shall be hand operated, air break, heavy duty, quick make, quick break type conforming to applicable IEC standards.
b) It shall be the responsibility of the VENDOR to fully coordinate the overload and short circuit tripping of the MCBs with the downstream MCBs/fuses providesatisfactory discrimination.
c) A single throw isolating switches for complete isolation of the DC control circuits shall be provided.

12.12 Control & Auxiliary Power Supply

a) All control equipment shall be suitable for operation on specified DC voltage system.
b) In case two systems are working on two different battery potentials, say A and B, both A and B potentials shall not be connected to the contacts of same relay. However, it is permissible to use, for example, the relay coil on A andthe contacts on B battery. Dissimilar potentials shall not occur on contacts of same relay.
c) DC & AC power supply shall be done in a manner which will enable isolationof individual equipment. Common supply bus will be formed in the cubicle and then power supply shall be distributed into individual

equipment through MCCBs.

d) Separate circuits with switches, fuses etc of adequate rating shall be provided for control of space heater, lighting and power receptacle etc. These shall be on 240V, 1 phase AC supply.

12.13 Relays

a) Relays for various control, monitoring and blocking functions of a particular circuit element shall be installed in associated local control panel. Protective relays shall be subject to transient tests and shall be approved by the PURCHASER. All relay shall have dust covers. Please refer Section C3 for detailed specifications of BCUs and BCPUs.

b) Necessary auxiliary relays for alarm, time-delay relays, voltage relays as required for control and protection shall be mounted inside the local control panel. Voltage relays shall have sufficient thermal capacity for continuous energisation, using external resistors, if necessary.

c) Auxiliary relays shall be rated to operate satisfactorily between 80% and110% of the rated voltage.

d) Each relay shall be provided with at least 4 NO and 4 NC potential free contacts for the PURCHASER's use.

e) Coils of all the relays shall be adequately rated to avoid spurious operation of relays on DC system ground or induced surges. Minimum pick up current of relay coil shall be 100 milli amps.

f) All relays shall be tropicalized and suitable for maximum ambient temperature of 40 deg. C.

g) Make and type of relay shall be subject to the PURCHASER's approval.

h) <u>Space Heater</u>

Strip type space heaters of adequate capacity shall be provided inside each cabinet. Heaters shall be complete with rotary type ON-OFF switch, HRC fust on phase or a single-pole MCB with overload and short circuit protection, link on the neutral and a thermostat to cut off the heaters at 45 deg.C. The heaters shall be suitable for connecting to 240V, 1 phase, and 50 Hz supply.

i) <u>Interior Lighting and Receptacle</u>

Control cabinet shall be provided with a 240V, 1 phase, 50 Hz, 8W preferably LED fixture with cover for interior illumination controlled by

an ON-OFF switch and 240V, 1 phase, 5/15 amp. 6 pin receptacle. Power source for interior lighting and receptacles shall be completely independent of control power source.

j) Internal Wiring

i) LV control panels shall be completely wired, ready for the PURCHASER's external connections at the terminal blocks. All wiring shall be carried out with wires of 600V grade, stranded copper conductors. The insulation shall be fire retardant low smoke type, approved and tested in accordance with PURCHARSER's requirement. Power circuits shall be wired with stranded tinned copper conductors of adequate sizes to suit the rated current. Alarm and indication circuits shall be wired with stranded, tinned copper conductors of sizes not smaller than 1.25 sq.mm and shall be shielded type. CT circuits shall be wired with stranded copper conductor of size not smaller than 2.5 sq.mm.

ii) Engraved identification ferrules, marked to correspond with the wiring diagram shall be fitted at both ends of each wire. All wiring shall be terminated on terminal blocks. Terminals shall be adequately rated for the circuit current the minimum rating shall be 20 A. Control wiring shall be protected against mechanical damage and shall be colour coded in accordance with PURCHASER's requirement. Colour sleeves may be used in lieu of continuous colouring. Physical separation between various colour wiring shall be maintained as much as possible.

iii) The wire terminations shall be made with solder less crimping type oftinned copper lugs which firmly grip insulation and conduction.

iv) Panel wiring shall be securely supported, neatly installed by lacing and tying, readily accessible and connected to equipment terminals and terminal blocks. Flame retardant plastic wiring channels/troughs with strap on covers shall be used for this purpose.

k) Mimic Diagrams (Optional)

Mimic diagrams shall be provided on local control panels. The mimic strips shall be screwed onto the panel and shall be made of anodised

aluminium. Colours of the various voltages of the mimic bus shall be subject to thePURCHASER's approval. The width of mimic strip shall not be less than 7 mm.

l) Local Alarm/Annunciation

i) Window type alarm annunciation shall be provided on local control panels of each bay for various abnormal conditions. The alarm windows should have provisions for detecting cleared and un-cleared faults and flashing for new faults.

ii) The following abnormal conditions shall be annunciated (additional to list).

- Low gas pressure for each gas compartment of the bay.
- Low-Low gas pressure for each gas compartment of the bay.
- High gas pressure for each gas compartment of the bay.
- Spring motor excessive start.
- Spring motor run excessive.
- Spring motor overload.
- Spring motor circuit trouble.
- Spring is charged.
- Breaker pole discrepancy.
- Isolator open/close incomplete.
- Isolator motor overload, one for each bay ,
- D.C. control supply failure.
- Alarm circuit D.C. healthy (continuously 'ON') ,
- Selector switch local ,
- Four spare windows.

m) Labels and Diagram Plate

i) Every equipment mounted in the cabinet shall be provided with individual labels with equipment designation/rating. Also, the cabinet shall be provided on the front with a non-rusting label engraved with the designationof the cabinet.

ii) Inside the door, a circuit diagram engraved on non-rusting metal shall be fixed for reference.

13.0 SF6 Gas

13.1 Density and Pressure

The nominal operating pressure of SF6 insulated gas in the equipment shall be as low as is compatible with the requirements for electrical insulation and space limitations to reduce the effects of leaks and to ensure that there is no chance of the gas liquefying at the lowest ambient temperature. The initial gas pressure or density at the time of charging the equipment shall provide a sufficient margin above the minimum allowable pressure for the plant to be safely operated for a reasonably longperiod before recharging is necessary.

13.2 SF6 Gas Purity

a) The SF6 switchgear shall be designed for use with SF6 gas complying with the recommendations of IEC-60376 at the time of the first charging with gas. All SF6 gas supplied as part of the contract shall comply with the requirements of IEC. 60376.

b) Molecular sieve or activated alumina or other absorbent for removal of SF6 arc products and moisture absorbents shall be provided in each gas compartment.

c) The SF6 gas shall have the following characteristics:

i) Physical properties: Colourless, odourless, non-toxic and non-flammable.

ii) Density at 20◦C and/Bar 6.08 g/l 8) Preferred cylinder size 40 Ltr.

iii) Type of cylinder Seamless type

13.3 SF6 Gas Monitoring Devices

a) All gas compartments must have their own independent gas supervision and alarm systems. Each gas supervision circuit shall be equipped with a temperature compensated pressure gauge, test connection point and maintenance connection point and the same shall be easily accessible. Bus bar side Disconnecter (DS)/Earth Switches (ES) shall have common gas density monitor for all the three phase.

All other equipments such as Circuit breaker, Line side DS/ES can either have common or separate gas density monitor system for all the three phases.

b) The gas density and pressure sensitive devices, together with all relays

supplied by the manufacturer for use in protection, shall be approved by the PURCHASER. It shall be possible to test all gas monitoring relays without de- energising the primary equipment and without reducing pressure in the main section. Disconnecting type plugs and sockets shall be used for test purposes; the pressure/density device shall be suitable for connecting to the male portion ofthe plug.

c) Two potential free electrical contacts shall be provided with each and every alarm condition. These are to be grouped together and wired to the cable termination blocks in the local control panels to give remote alarm indications/annunciations in equipment being supplied by the PURCHASER. TheBIDDER will be advised of the grouping required after the contract has been placed.

d) BIDDER shall advise if the breakers are suitable for breaking the load current even if SF6 gas pressure has reduced to atmospheric pressure.

13.4 Sectionalization

a) The assembly shall consist of completely separate, pressurized sections. The switchgear gas enclosures must be sectionalized with gastight barriers between sections or compartments as per the below:
   i) One compartment for bus bar, Isolator and earthing switch
   ii) One compartment of circuit breaker and cable connection

13.5 The mass of gas in all the individual compartments at rated nominal density shall beindicated in the bid.

13.6 Support Insulators and Section Barriers

a) The support insulators and section barriers/insulators shall be manufactured fromthe highest quality material. They shall be free from all voids and the design shall be such as to reduce the electrical stresses in the insulators to a minimum. They shall be sufficiently strong to ensure that the conductor spacing and clearances are maintained when short circuit faults occur.

b) Tests shall be carried out during the manufacture of the switchgear to ensure that all insulators and barriers are free of partial discharge at a voltage which isat least 20% greater than the maximum service voltage.

c) The Gas section barriers including seals to the conductor and

enclosure wall shall be gas-tight and shall be capable of withstanding the maximum differential pressure that could occur across the barrier i.e with a vacuum drawn on one side of the barrier and on the other side, at least twice the rated gas service pressure that can exist under normal operating and maintenance conditions or the maximum gas over pressure, at least equal to the operating pressure of the relief devices, that could be attained with a persistent internal arc fault.

13.7 Gas Seals

All gas seals shall be designed to ensure that leakage rates are kept to specified minimum under all normal pressure, temperature, electrical load and fault conditions.

13.8 Expansion Joints and Flexible Connections

a) Expansion joints or flexible connections, in the metal enclosures, to absorb the actual or relative thermal expansion and contraction of the SF6 equipment as well as structures, foundations and floors on which the equipment is mounted, resulting from variations in the temperature of the switchgear equipment shall be provided, if required.

b) The number and position of expansion joints or flexible connections are to be determined by the BIDDER to ensure that the complete installation will not be subjected to any expansion stresses which could lead to distortion or premature failure of any piece of the GIS equipment, support structure or foundations.

c) Electrical continuity of the connection for all enclosures across bolted joints/ expansion/flexible connections shall be achieved.

13.9 Supply of SF6 Gas

The contract shall include the supply of all the SF6 gas necessary for filling and putting into commercial operation the complete switchgear installation being supplied including loss during installation. In addition, ten percent of the total SF6 gas required for the GIS shall be supplied as spare and shall be included in the contract.

14.0 Earthing

a) The MANUFACTURER shall provide a "Main Ground Bus", rated 25 kA for 3sec to which all intentionally earthed parts of the assembly must be connected.

b) It shall be the responsibility of the VENDOR to provide a sufficient number of earth points so that dangerous voltages are not induced in the enclosure by the fault currents circulating in the inner conductor.

c) Every section of the SF6 switchgear equipment including all panels, cubicles, kiosks and boxes shall be solidly bonded to the earthing system.

d) Earth switches, voltage transformers and panels shall be bonded to the earthingsystem as specified in the relevant previous clauses

e) All steelwork, access decking, handrails etc., shall also be effectively bonded to the earthing system.

f) The design of the earthing system shall be such as to ensure the safety and protection of all operating and maintenance personnel under all normal and faultconditions.

g) The enclosure of the equipment and support structure of GIS shall be earthed in such a way that the following conditions are obtained:

i) The touch potential at any part of the enclosure is less than 65 V.

ii) The induced current during normal operation is prevented from entering the earthing grid.

15.0 Interlocks

All interlocks required between circuit breaker, disconnect and earth switches shallbe as per the recommendation of the GIS manufacturer.

16.0 Future Extension

It is proposed to make provision for additional bays at a later date.

a) It shall be possible in future to extend the bus bars. BIDDER shall separately quote for additional items required to be provided now to facilitate future extension without necessitating complete outage of the bus bars.

b) It is a firm requirement that no changes are made to the enclosure during future extension. Also, the downtime must be minimum when extension

is carried out. During erection/testing of extension, outage of only one bus section and associated equipment will be available. Under no circumstances outage of both the bus sections (resulting in complete shutdown of the station) will be permissible. The BIDDER is required to bring out in detail his proposal for achieving future extension and indicate if shutdown of any part of the equipment/circuit will be required for erection, dielectric testing along with Gas Line Diagram etc. The bidder will give step by step procedure for extension of bays on either side of GIS, at later date.

17.0 Foundation Channels & Supporting frame work

a) All supporting steel structures for switchgear bays, bus duct support, etc. shall be a part of Bidder's supply.

b) All 33kV GIS shall be supplied with bolts, nuts, washers and accessories required for fixing the GIS to the foundation.

18.0 Temperature Rise

Temperature rise of enclosure and conductor shall be such that the final temperaturedoes not exceed the values specified for specified site conditions including the effects of solar radiation. BIDDER shall provide test reports/ calculations to provethis.

19.0 Gas Leakage

The guaranteed maximum gas leakage shall be less than 0.2% per year for any individual gas compartment and for the whole equipment.

20.0 Losses

Manufacturers shall provide details of the losses at rated current.

21.0 Tests and Test Reports

a) The Type test reports shall be submitted with the bid.

b) Acceptance and routine tests for all supply equipments/components parts shall be carried out as per the relevant standards for the respective equipment. These test reports and shall be submitted to the PURCHASER

before dispatch of the equipment.

c) Local control panel shall be subjected to the following tests:
   i) High Voltage test (2000V for 1 minute)
   ii) Megger test.
   iii) Electrical control, interlock and sequential operation tests.

22.0 DRAWINGS DATA AND GUARANTEED TECHNICAL PARTICULARS TO BE FURNISHED BY THE BIDDER

a) The following drawings/information for each items are to be supplied as part ofthis contract:
   i) Outline dimensional drawings of 33kV GIS and accessories.
   ii) Shipping drawings showing dimensions and weights of each package.
   iii) Assembly drawings and weights of main component parts.
   iv) Drawings giving the weights for foundations.
   v) Name plate diagrams.
   vi) Schematic control along with logic blocks diagram and wiring diagram forall auxiliary equipment.
   vii) Test reports
   viii) Crane requirements for assembly and dismantling
   ix) Cable box connections.
   x) Foundation drawing of GIS, support structures, cable box etc.

b) Manufacturer shall submit following for Purchaser's reference before dispatch ofthe transformer.
   i) Six (06) copies of instruction books/operation and maintenance manualsand spare part bulletins.
   ii) Descriptions literature and data on GIS construction.

c) After the award of the contract six (6) copies of drawings, drawn to scale, describing the equipment in detail shall be forwarded for Purchasers approval, and shall subsequently provide eight (8) complete sets of final drawings, one of which shall be auto positive and editable soft copy suitable for reproduction, before the dispatch of the equipment.

23.0 TECHNICAL PARTICULARS OF 33KV CUBICLE GIS

Sl. No.	Particulars	33 kV GIS (Cubicle type)
1.		
a)	Type (Model No.)	To be specified by the bidder.
b)	Standard Applicable	IEC-62271-100 / IEC-62271-200
2.	Service	Indoor
3.	Enclosure	Sheet Steel with anti corosion paints.
4.	Nominal System Voltage	33 Kv
5.	Highest System Voltage	36 kV
6.	No. of phases and frequency	3ph. 50 Hz
7.	Busbar material	Aluminium
8.	Bus Color code	RYB
9.	System Earthing	Solidly earthed
10.	Circuit Breaker Rating	
10.1	Continuous Current Rating at 40 Deg C	1250A
10.2	Short Circuit Rating	25 kA
10.3	Short Circuit duration	3 sec
11.	Rated making Current	As per IEC-62271
12	Operating duty	O-0.3sec-CO-3 minutes -CO
13	Leakage rate per year in gas Compartment	Less than 0.2%
12.	Busbar rating	As per SLD
13.	Outgoing feeder rating	As per SLD
13.	Power Frequency Withstand voltage	70 kV for 1 minute
14.	Impulse withstand voltage (1.2/50 micro sec)	170 kV
15.	Control Voltage	48 V DC
16	Spring charge motor voltage	220V AC
17.	CT Ratio	Secondary Current 1A (Ratio during detail engineering)
18. a	PT ratio -STAR/ STAR/ Open delta	(33//3) / (.11//3) / (. 11/3)

18.b	CT Ratio	600-300/1-1-1 for Transformer feeder & 800-400/1-1 for feeder
19.	Aux. Contacts	As per manufacturer standard
20.	Termination	
20.1	Incomers	XLPE Cables **
20.2	Outgoings	XLPE Cables **
21.	Degree of protection (HV equipment)	IP – 65 for Gas Compartment

**Notes

1) The length details of the XLPE cables shall be estimated during detailed engineering.
2) Interface of 33kV GIS the feeder bays to be finalized during detailed engineering.
3) From the 33 KV GIS XLPE cable shall be used for station transformers.

GUARANTEED TECHNICAL PARTICULARS FOR 33KV GIS SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR BREAKERS /PANELS

01.	Manufacturer's Name and Country of origin	
02.	Manufacturer's Design / type Ref	
03.	Frequency	
04.	Rated Voltage	
05.	Highest system voltage	
06.	Rated current	
07.	Short Circuit current rating with duration	
08.	Certificate or report of short circuit type test	
09.	Rated operating duty cycle	
10.	Short Circuit Breaking Current : (a) Symmetrical (b) Symmetrical at rated voltage (c) Asymmetrical at rated voltage (i) Per Phase (ii) Average (iii) D.C. Component	
11	Arcing time (at rated breaking current) in ms.	
12	Opening time	

13	Total break time in milli sec.	
	(a) At 10% rated interrupting capacity (b) At rated interrupting capacity	
14.	Make time in ms.	
15.	Dry 1 minute power frequency withstand test voltage (a) Between line terminal and Earth KV rms (b) Between terminals with breaker contacts open	
16.	1.2/50 full wave impulse withstand test voltage (a) Between line terminal and Earth KV p (b) Between terminals with breaker contacts open KVp	
17.	Contact pressure	
18.	Contact Resistance	
19	Control Circuit Voltage AC / DC	
20	Power required for Closing Coil at 220 V	
21	Power required for Tripping Coil at 220V	
22	Whether Trip free or not	

23	Whether all the interlocks provided	
24	Overall dimensions	
25	Gauge of the MS sheet used for the fabrication of the cubicle Size and type of stiffeners used	
26	Total weight of one complete Breaker	

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR 33KV CURRENT TRANSFORMERS

01.	Manufacturer's Name and country of origin	
02.	Manufacturer's design Ref / Model	
03.	Applicable Standards	
04.	Type	
05.	Rated Primary current	
06.	Rated secondary current	
07.	Rated frequency	
08.	Transformation ratios	

09	Number of cores	
10	Rated output (Core wise)	
11	Class of insulation	
12	Class of accuracy (a) For metering (b) For Protection	
13	Short circuit current rating and its duration	
14	Secondary resistance at 70 Deg C	
15	Continuous over load (percentage)	
16	One minute power frequency dry withstand voltage	
17	1.2/50 micro sec. impulse withstand test voltage	
18	One minute power frequency withstand test voltage on secondary	
19	Instrument safety factor	
20	Type of primary winding	

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR 33KV POTENTIAL TRANSFORMERS

01.	Manufacturer's Name and country of origin	
02.	Manufacturer's design reference	
03.	Applicable Standards	
04.	Type	
05.	Ratio	
06.	Rated Primary voltage	
07.	Rated secondary voltage	
08.	Rated frequency	
09.	Class of accuracy	
10.	No. of phase and method of connection	
11.	Burden	

12.	One min. power frequency dry flash overvoltage	
13.	1.2/50 micro sec. impulse withstand testvoltage	
14.	Class of insulation	

Note: Bidders shall also to provide the GTP for the Numerical BCPU & Transformer Differential relay

24.0 TESTS

All tests shall be carried out according to relevant IEC standards.

24.1 TYPE TESTS

A. Switchgear Panel (with Circuit Breaker installed)Short circuit duty test
   a. Short time and peak withstand current test
   b. Power frequency withstand test
   c. Lightning impulse withstand test
   d. Temperature rise test
   e. Internal Arc Test as per IEC 62271-200 (for 1 second)
   f. Measurement of resistance of main circuit
   g. Test to verify pressure relief operation of the panel **(During internal arc test)**
   h. Cable charging test
   i. Pressure Withstand Test of Gas Filled compartment

B. Circuit Breaker
   a. Mechanical Endurance Test

C. Current Transformer
   a. Short time current test
   b. Temperature rise test
   c. Lighting Impulse voltage withstand test

D. Potential Transformer
   a. Temperature rise test
   b. Lighting Impulse voltage withstand test

E. Switchgear Panel
   a. IP 4X test

F. Protective Relay
   a. EMC Test

24.2 ROUTINE TESTS

Tests shall be carried out according to IEC requirements. The following minimumtests apply:-

a) Wiring and function tests
b) Equipment verification tests
c) Low voltage circuit insulation test
d) High voltage power frequency test

24.3 FACTORY INSPECTION TESTS

Notification for factory tests along with list of proposed tests shall be submitted asrequired.

24.4 SITE TESTS

The site tests shall include the following:

a) Power frequency withstand test (at 80% of the rated power frequency withstand voltage)
a) Insulation resistance
b) Functional test of the fully installed and wired equipment delivered.
c) Testing of Protective Relay with Primary/Secondary Current Injection Kit

CHAPTER-E3
11kV GIS PANEL

TABLE OF CONTENTS

TECHNICAL SPECIFICATIONS FOR 11kV GIS PANEL

1.0 SCOPE

This specification covers the technical requirements of design, manufacture, testing at manufacturer's works, packing, forwarding of 11kV Gas Insulated Indoor switchgear complete with all accessories for trouble free and efficient performance including supervision of installation and commissioning of SF6 gas-insulated vacuum circuit breaker switchgear and associated equipment. The GIS Panel should have in built surge Arrester.

2.0 STANDARDS

Sl. No.	Item	Standard
1	Switchgear	IEC 62271-200 / EN 62271-200 IEC 60694 / EN 60694
2	Switchgear Behaviour in the eventof internal faults	IEC 62271-200 / EN 62271-200
3	Three-position disconnector and disconnector	IEC 62271-102 / EN 62271-102
4	Bus bar earthing switch	IEC 62271-102 / EN 62271-102
5	Circuit-breaker Current	IEC62271-100/EN 62271-100
6	transformer Voltage	IEC 60044-1 / EN 60044-1 IEC 60044-2 / EN 60044-2
7	transformer Voltage detectionsystems	IEC 61243-5
8	Protection against accidental contact, foreign Objects and waterInstallation	IEC 60529 / EN 60529 HD 637 S1

3.0 DESIGN CRITERIA

3.1 Operating Condition

a) Operating Conditions according to:- IEC 60694 / EN 60694

b) Temperature of ambient air Maximum value: 50 °C

3.2 Rated Normal Current

The rated normal currents of components are stated in the Technical data and shall be valid for design ambient temperature of 50° C.

3.3 Internal Arc Fault

a) Classifications to IEC 62271-200
b) Partition class- PM
c) Internal arc classification - AFLR (Authorized person access permitted from Front, Lateral and Rear side) for the panels with no rear access required

3.4 Insulating Gas

a) Insulating gas Type Sulphur hexafluoride (SF6)
b) Design pressure at 20 °C For 12 kV Class - 0.05 MPa

4.0 TECHNICAL DATA

4.1 Bus Rating:- 11kV GIS, 25kA for 3s, Single Bus Bar 2000A @ max.50°C to 35°C average 24h.

4.2 Required Technical Parameter:

Bus bar System	Common bus bar
Electrical Data	
Rated voltage	12kV
Rated operating voltage	11kV
Rated frequency	50
Rated power-frequency withstand voltage	28kV
Rated lightning impulse withstand voltage	75kV
Rated short-time withstand current	25kA
Rated short-circuit duration	3s
Rated Dynamic Short Circuit current	62.5kAp
Rated operating current bus bar	2000A
Degree of Protection	
Main circuits	IP65
Drives	IP 3X
Cable connection compartment	IP 3X
Low voltage cabinet	IP 4X
Auxiliary Voltage	

Control	48V DC
Motor	220V AC
Protection system	48V DC
Remote control	48V DC
Socket/lighting/heating	230V AC
IAC Classification acc. to IEC 62271-200	
Classification IAC	AFL
Internal arc	25 kA 1 s

5.0 DESIGN FEATURES OF SF6 GAS INSULATED SWITCHGEAR

5.1 General Description

The SF6 gas insulated switchgear shall be type-tested and of pre-fabricated metal construction. The offered Indoor GIS shall have VCB, Three Position Disconnecting Switch and Bus Bars enclosed in SF6 Gas. Single panels, each built up from a modular range of separate functional units, can be combined to produce the specified switchgear configuration. The modular units comprise:-

A) Standard basic module:
Incorporating the vacuum circuit-breaker

B) Floor-pan module, flange-mounted to the lower part of the basic module, with:

i) A wide range of cable connection options, appliance couplers for outer cone-type cable connection systems.
ii) Current transformers (toroidal type)

C) Cable compartment:
A metal-enclosed, air insulated clad compartment, with
i) Cable support for single and multiple cable installation
ii) Sufficient space for installation of current transformer.

Circuit-breaker and three-position switch drives are to be designed with mechanical interrogation interlocks and shall include all necessary auxiliary devices (auxiliary switches, releases etc.)

The three-position disconnecting switch (ON-OFF-EARTH) is to be designed with separate manual and motorized drives for the disconnector and earth switch functions.

All switching device drives shall be located outside of the gas compartments, for easy access. Under normal operating conditions for indoor switchgear units in accordance with IEC 50594 and when complying with the specified number of operations, no maintenance is required.

5.2 Functional Compartment

a) Circuit-breaker compartment – Gas insulated
b) Bus bar compartment – Gas insulated.
c) Gas compartments shall be segregated from each other and the panels shall also be physically segregated from each other. Unified (continuous) bus-barcompartment is not acceptable.
d) Each gas compartment shall be internal arc tested. In the event of an internal arc the plasma shall be carried through a duct outside the switchgear room.
e) Cable compartment shall also be internal arc tested. In the event of an internal arc the plasma shall be carried through a rear duct outside the switchgear room.
   Release of plasma in the cable basement is not acceptable.
f) Panel to panel connection shall be fully enclosed and shall not remain open. Gas handling shall not be required during coupling of panels or during future extension of switchboard.
g) Cable connection/transformer clad compartment are to be equipped with individual pressure relief devices - Air Insulated

5.3 Switchgear Operator Interfaces Requirements

a) A standard mechanical user interface, ergonomically Positioned at a convenient height**. It must be visible directly without opening of doors etc.**
b) The user interface comprises all the mechanical, panel related interfaces and continuous interrogating interlocks.
c) All the basic mechanical ON/OFF of CB, Isolator & earth switch operation, manual spring charge of CB must be possible without opening the door to ensure the operator safety.
d) Mechanical mimic directly linked to mechanism should be provided at the panel front door.
e) The basic switchgear unit is to be designed for suitable free- standing installation within a switch room.
f) The Interlocking shall be as per IEC.

5.4 Functional Intuitive Operator Interface Design

The SF6 Gas insulated switchgear shall be characterized especially by the following operating features:-

a) Ergonomic operability
b) Logical operation
c) Logical function states
d) Good visual communication of the overall function and operating states
e) Optimum operator guidance
f) All operations can be performed optionally via a motor-operated mechanism

The mechanical control panel is located at an optimum height for operation and arranged in a recessed position on the switchgear front. Thus, the operating area is clearly visible while no control elements protrude from the switchgear front. The position of the individual elements has been selected according to their function,

I.e. according to their allocation to the corresponding device functions. The elements which form part of a switching device, such as position indicators, crank ports or mechanical push buttons, are visually linked by a specific pattern and integrated in a mimic diagram. Mechanical operation is performed the same way as with the habitual operation with stationary switching devices. Separate control elements and mechanical switch position indicators are available for the following functions:

- Circuit breaker ON – OFF
- Disconnector ON - OFF- EARTH

5.5 Bus Bar / Panel Connections

The gas-insulated bus bar sections of the single panels shall be connected via single pole solid insulated connection elements which allows for easy exchange of a cubicle without SF6 works. Bus bar connection to be designed in such a way that no adjacent panels must be moved or opened for exchange of a panel.

Bus bar couplings between adjacent panels should be designed with a minimized quantity of electrical sealing joints.

5.6 Gas Compartment Technology

A Temperature Compensated Gas Monitoring Device shall be provided on the offered GIS to constantly monitor the Gas Pressure inside the Gas Compartment.

By design there should be no need for gas works during the whole time on site, not even for exchanging a centre panel or extending the switchgear at later stage, e.g. no gas handling shall be necessary during the anticipated service life of the switchgear, under normal operating conditions. (The gas filled compartments are to be designed to be maintenance-free and hermetically sealed pressure systems in accordance with IEC 62271-200)

The switchgear panels shall be filled with gas and checked for leakage in the factory. For a proper recycling/emergency replacement, a gas valve in gas compartment has to be provided. In addition, the standard tools for filling the SF6 Gas also have to be provided.

Disconnector & VCB shall be encapsulated in GIS, However Busbar may be Solid Insulated (Touch Proof).

5.7 Installation Facility

The panels are to be delivered to site as factory assembled and routine tested units. After linking the panels (or panel assemblies) by the bus bar connection system and connection of the power and control cables the system should be ready for operation. No gas filling is required at site during bus bar connection & installation.

6.0 CIRCUIT BREAKER

The three pole vacuum circuit breaker with its maintenance-free vacuum interrupters is installed horizontally in the gas compartment.

The CB shall be spring operated, motor charged, and manually released spring closing mechanism with three pole simultaneous operations. The speed of closing operation shall be independent of the hand-operating lever. The indicating device shall be **mechanical type directly linked to the mechanism & shall show the OPEN and CLOSE position of breaker visible from front of the cubicle.** The spring charging time of the motor shall not exceed **20sec** in case of Vacuum Circuit Breaker. The “TRIP” and “CLOSE” coils shall be of reliable design and low consumption.

The Breakers shall be capable of Making & Breaking the short time current in accordance with the requirement of IEC 62271-100 and latest amendment thereof. The continuous current rating of breaker shall not be less than 1250 A for outgoing feeders and incomer feeders. **Ratings are IN-Panel at 50 Deg C designs ambient.**

Comprehensive interlocking system to prevent any dangerous or inadvertent operation shall be provided. Two stage gas **density** alarm and lockout system with local and remote indication shall be provided.

Emergency **mechanical trip push button on each CB shall be provided on panel front & shall be accessible.**
Spring charge indication is to be provided.

The vacuum circuit breakers are to be equipped with:

a) Spring-stored-energy operating mechanism with motor, auto-reclosing
b) Mechanical OPEN and CLOSE push buttons
c) 1 closing solenoid
d) 2 shunt release
e) Operating cycle counter
f) Auxiliary switch with at least 6NO + 6NC
g) Auxiliary switch for "spring charged" signal

The circuit-breaker has to control at least **10,000 Make-Break cycles (One operating cycle of making & breaking) operations at rated current or 100 breaking operations at rated short-circuit** breaking current without maintenance. The mechanical life of the vacuum interrupter has to comprise at least **20,000** operating cycles.

The operating mechanism must be maintenance-free without time limit up to 10,000 operating cycles.

7.0 ISOLATORS AND EARTHING SWITCHES

Isolators or isolators combined with earth switches (3 position switches) shall be motor operated. In cases of emergency, manual operation must be possible.

The earthing position for all 3 phases must be visible via a mechanical position indicator (MIMIC) directly connected to the drive shaft on panel

front Fascia.

The mechanical operation of isolator/3 position disconnector switch must be possible with door closed for operator safety.

8.0 INSTRUMENT TRANSFORMERS

Only conventional inductive voltage and current transformers according to IEC 60044-1 and IEC 60044-2 or electronic current and voltage transformers to IEC 60044-7 and IEC60044-8 or a combination of both are acceptable. Current & voltage Sensors are not acceptable.

8.1 Current Transformers

The current transformers shall be toroidal type current transformers. The Current Transformers shall be located outside the Gas Compartment.

The transformer ratio, the accuracy class and the performance load to be selectedto suit the application requirements.

Transformer Feeder Variant

a) Toroidal type Current Transformer
b) CT Primary Current: 800 A
c) CT Secondary Current: 1-1-1A
d) Core 1: Cl-0.2s / 15 VA
e) Core 2: CL-PS, Vk:500V , Iex <30mA @Vk/2
f) Core 3: CL-PS, Vk:500V , Iex <30mA @Vk/2

Incomer Feeder Variant

a) Toroidal type Current Transformer
b) CT Primary Current: 600 A
c) CT Secondary Current: 1-1A
d) Core 1: Cl-0.2s / 15 VA
e) Core2: Cl-PS

(CT burden shall be provided as per relay and metering requirement and bidder to substantiate this with suitable calculations during detail engineering with CT/ VT burden calculation)

9.0 MECHANICAL SAFETY INTERLOCKING FEATURES

Internal mechanical interlocks of the panel should have:-

a) With the circuit-breaker closed, the interrogation slide is locked for the disconnector and the earth switch. (Restriction to the insertion of Hand Crank for Disconnector-Earth Switch when CB is ON)

b) The interrogation slide always releases one insertion opening only (disconnector or earth switch), or both of them are locked. (To ensure thateither Disconnector- or Earth Switch operating at a time)

c) The crank for the disconnector and earth switch can only be removed in its appropriate end position.

d) When the crank on the disconnector or earth switch is still in place, or when the interrogation slide is open, the following components are locked:
   - ON push button of circuit breaker
   - ON pulse is interrupted

10.0 PROTECTION & CONTROL SYSTEM

Relay Make: Schnieder (Micom Series), ABB (RE.. Series), Siemens(7SJ/7SR Series).
Following functions shall be available in the Protection Relay:-

10.1 Incomer & Outgoing Feeders protection (Numerical Relay (IEC-61850): BCPU having dual port facility)

a) Over current instantaneous (50)
b) Over current IDMT (51)
c) Earth fault instantaneous (50N)
d) Earth fault IDMT (51N)
e) Directional Earth fault IDMT (67N)
f) Directional Over Current IDMT (67)
g) Auto Reclosure – 4 Shots
h) Under & Over voltage protection
i) Frequency related protection
j) LBB protection
k) BCPU shall have adequate nos. of BI & BO and transducers to suit the site requirement for adopting the PRP based SCADA.

10.2 Bus PT (IVT)

11kV Bus PT (IVT) shall be housed in a separate Panel and it shall be air insulated.Voltage protection (Bus VTs shall be Part of Feeder Protection relay).

a) Overvoltage (59)
b) Under voltage (27)

c) Frequency Relay (81 O/U)

10.3 Outgoing Feeder (Transformer)

(I) : Back-up protection: (Numerical Relay (IEC-61850): BCPU having dual port facility)

a) Over current instantaneous (50)

b) Over current IDMT (51)

c) Earth fault instantaneous (50N)

d) Earth fault IDMT (51N)

e) Directional Earth fault IDMT (67N)

f) Directional over Current IDMT (67)

g) Auto Reclosure – 4 Shots

h) Under & over voltage protection

i) Frequency related protection

j) LBB protection

k) BCPU shall have adequate nos. of BI & BO and transducers to suit the site requirement for adopting the PRP based SCADA.

10.4 Other protections and related functions SCADA compatibility (Part of NumericalRelay)

l) Lock-out (86) relays

m) Trip circuit supervision (95) relays

10.5 Other protections and related functions (Part of Numerical Relay)

The protection relays shall have communication protocol on IEC 61850 Protocol.

11.0 SURGE ARRESTERS

Suitable 11 kV GIS surge arrestors in the incoming & outgoing feeders are to be provided. The specifications and characteristics of the surge arresters shall be finalized during detailed engineering.

12.0 LOW VOLTAGE PANELS

The accessories and auxiliary equipment required for the correct functioning of each circuit element shall be installed in conveniently located mechanism cabinet or could be an integral part of the circuit element.

General Requirements

12.1 Individual local control panels/Cabinets/Cubicles for each circuit shall be supplied as a part of this contract to facilitate local control of circuit breakers, isolators and earth switches. These panels shall also house the various relays, timers, etc. to realize various interlocks as per PURCHASER's requirement among circuit breakers, isolators and earth switches. The contacts, signals and conditions originating form/going to the gas insulated switchgear, associated auxiliary and monitoring equipment shall be wired up to the local control panel, for PURCHASER's further use.

12.2 Completely separate and isolated circuit shall be used for switchgear control, tripping, alarms and auxiliary devices. CLOSE and TRIP circuits shall be kept isolated to their final mechanical or electrical actuators. Trip circuits shall be individually and permanently monitored for continuity.

Each auxiliary control circuit shall be monitored and shall be protected by a two poleminiature circuit breaker with auxiliary contacts.

12.3 Constructional Features

i) All panels shall be totally enclosed rigid sheet steel structures. All doors, removable covers and plates shall be gasketed all around with neoprene gaskets. All accessible live connections shall be shrouded and it shall be possible to change individual fuses, switches, MCBs without danger of contact with live metal.

ii) A ground bar for terminating the ground wires of shielded control cables shall be located near the cable entrance location.

iii) A receptacle rated 240V, 16A, AC 1 phase, 2 wire shall be installed in each panel in addition to a light point with door switch and one 6 pin, 240V AC, 5/15A socket outlet.

iv) Adequate safety precautions shall be taken to avoid accidental contact with 240Vpotential. The following precautions shall be observed:

a) All live parts shall be completely shielded using a halogen free fire retardant insulating material.

b) 600V terminal blocks shall have removable covers and wiring shall be separated from other potentials.

c) A clear and legible warning notice carrying wording "DANGER 11KV" shall be

located on the enclosure door.

12.4 All control equipment shall be suitable for operating in an ambient temperaturevarying between +10 deg. C and +40 deg.C.

12.5 Cabinet doors shall have provision for padlocking. Door shall be constructed such that they do not seize in the event of an internal fire.

12.6 Clearances shall be as per Manufacturer's type tested design following IEC Norms.

12.7 Adequate interior cabling space and suitable removable cable gland plate shall be provided. Necessary number of cable glands including cable glands for cables from control room to GIS shall be supplied and fitted on to this gland plate. Cable glands shall be screwed-on type and made of brass. The cable entry shall be from bottom only.

12.8 All the hardware required for fixing the panel shall be in BIDDER's scope.

12.9 Terminal blocks for terminating all control, indication and monitoring wiring from the associated circuit element shall be installed in each cabinet. All terminal blocks shall be identified with marking strips. The conductor size range which the terminals can accommodate shall be clearly shown on the BIDDERS drawings. The terminal blocks used for cable connections shall be disconnecting type. All terminal blocks shall be covered by acrylic covers.

12.10 Disconnecting type terminal links shall be provided for current transformer circuits.

12.11 Switches/ MCBs

a) Switches/MCBs shall be hand operated, air break, heavy duty, quick make, quick break type conforming to applicable IEC standards.
b) It shall be the responsibility of the VENDOR to fully coordinate the overload and short circuit tripping of the MCBs with the downstream MCBs/fuses providesatisfactory discrimination.
c) A single throw isolating switches for complete isolation of the DC control circuits shall be provided.

12.12 Control & Auxiliary Power Supply

a) All control equipment shall be suitable for operation on specified DC voltage system.

b) In case two systems are working on two different battery potentials, say A and B, both A and B potentials shall not be connected to the contacts of same relay. However, it is permissible to use, for example, the relay coil on A andthe contacts on B battery. Dissimilar potentials shall not occur on contacts of same relay.

c) DC & AC power supply shall be done in a manner which will enable isolationof individual equipment. Common supply bus will be formed in the cubicle and then power supply shall be distributed into individual equipment through MCCBs.

d) Separate circuits with switches, fuses etc of adequate rating shall be provided for control of space heater, lighting and power receptacle etc. These shall be on 240V, 1 phase AC supply.

12.13 Relays

a) Relays for various control, monitoring and blocking functions of a particular circuit element shall be installed in associated local control panel. Protective relays shall be subject to transient tests and shall be approved by the PURCHASER. All relay shall have dust covers. Please refer Section C3 for detailed specifications of BCUs and BCPUs.

b) Necessary auxiliary relays for alarm, time-delay relays, voltage relays as required for control and protection shall be mounted inside the local control panel. Voltage relays shall have sufficient thermal capacity for continuous energization, using external resistors, if necessary.

c) Auxiliary relays shall be rated to operate satisfactorily between 80% and110% of the rated voltage.

d) Each relay shall be provided with at least 4 NO and 4 NC potential free contacts for the PURCHASER's use.

e) Coils of all the relays shall be adequately rated to avoid spurious operation of relays on DC system ground or induced surges. Minimum pick up current of relay coil shall be 100 milli amps.

f) All relays shall be tropicalized and suitable for maximum ambient temperature of 40 deg. C.

g) Make and type of relay shall be subject to the PURCHASER's approval.

h) Space Heater

Strip type space heaters of adequate capacity shall be provided inside each cabinet. Heaters shall be complete with rotary type ON-OFF switch, HRC fust on phase or a single-pole MCB with overload and short circuit protection, link on the neutral and a thermostat to cut off the heaters at 45 deg.C. The heaters shall be suitable for connecting to 240V, 1 phase, and 50 Hz supply.

i) Interior Lighting and Receptacle

Control cabinet shall be provided with a 240V, 1 phase, 50 Hz, 8W preferably LED fixture with cover for interior illumination controlled by an ON-OFF switch and 240V, 1 phase, 5/15 amp. 6 pin receptacle. Power source for interior lighting and receptacles shall be completely independent of control power source.

j) Internal Wiring

i) LV control panels shall be completely wired, ready for the PURCHASER's external connections at the terminal blocks. All wiring shall be carried out with wires of 600V grade, stranded copper conductors. The insulation shall be fire retardant low smoke type, approved and tested in accordance with PURCHARSER's requirement. Power circuits shall be wired with stranded tinned copper conductors of adequate sizes to suit the rated current. Alarm and indication circuits shall be wired with stranded, tinned copper conductors of sizes not smaller than 1.25 sq.mm and shall be shielded type. CT circuits shall be wired with stranded copper conductor of size not smaller than 2.5 sq.mm.

ii) Engraved identification ferrules, marked to correspond with the wiring diagram shall be fitted at both ends of each wire. All wiring shall be terminated on terminal blocks. Terminals shall be adequately rated for the circuit current the minimum rating shall be 20 A. Control wiring shall be protected against mechanical damage and shall be colour coded in accordance with PURCHASER's requirement. Colour sleeves may be used in lieu of continuous colouring. Physical separation between various colour wiring shall be maintained as much as possible.

iii)The wire terminations shall be made with solder less crimping type

oftinned copper lugs which firmly grip insulation and conduction.

iv) Panel wiring shall be securely supported, neatly installed by lacing and tying, readily accessible and connected to equipment terminals and terminal blocks. Flame retardant plastic wiring channels/troughs with strap on covers shall be used for this purpose.

k) Mimic Diagrams (Optional)

Mimic diagrams shall be provided on local control panels. The mimic strips shall be screwed onto the panel and shall be made of anodised aluminium. Colours of the various voltages of the mimic bus shall be subject to the PURCHASER's approval. The width of mimic strip shall not be less than 7 mm.

l) Local Alarm/Annunciation

i) Window type alarm annunciation shall be provided on local control panels of each bay for various abnormal conditions. The alarm windows should have provisions for detecting cleared and un-cleared faults and flashing for new faults.

ii) The following abnormal conditions shall be annunciated (additional to list).

- Low gas pressure for each gas compartment of the bay.
- Low-Low gas pressure for each gas compartment of the bay.
- High gas pressure for each gas compartment of the bay.
- Spring motor excessive start.
- Spring motor run excessive.
- Spring motor overload.
- Spring motor circuit trouble.
- Spring is charged.
- Breaker pole discrepancy.
- Isolator open/close incomplete.
- Isolator motor overload, one for each bay ,
- D.C. control supply failure.
- Alarm circuit D.C. healthy (continuously 'ON') ,
- Selector switch local ,
- Four spare windows.

m) Labels and Diagram Plate

i) Every equipment mounted in the cabinet shall be provided with

individual labels with equipment designation/rating. Also, the cabinet shall be provided on the front with a non-rusting label engraved with the designationof the cabinet.

ii) Inside the door, a circuit diagram engraved on non-rusting metal shall be fixed for reference.

13.0 SF6 Gas

13.1 Density and Pressure

The nominal operating pressure of SF6 insulated gas in the equipment shall be as low as is compatible with the requirements for electrical insulation and space limitations to reduce the effects of leaks and to ensure that there is no chance of the gas liquefying at the lowest ambient temperature. The initial gas pressure or density at the time of charging the equipment shall provide a sufficient margin above the minimum allowable pressure for the plant to be safely operated for a reasonably long period before recharging is necessary.

13.2 SF6 Gas Purity

a) The SF6 switchgear shall be designed for use with SF6 gas complying with the recommendations of IEC-60376 at the time of the first charging with gas. All SF6 gas supplied as part of the contract shall comply with the requirements of IEC. 60376.

b) Molecular sieve or activated alumina or other absorbent for removal of SF6 arc products and moisture absorbents shall be provided in each gas compartment.

c) The SF6 gas shall have the following characteristics:
   i) Physical properties: Colourless, Odourless, non-toxic and non-flammable.
   ii) Density at 20°C and/Bar 6.08 g/l 8) Preferred cylinder size 40 Ltr.
   iii) Type of cylinder Seamless type

13.3 SF6 Gas Monitoring Devices

a) All gas compartments must have their own independent gas supervision and alarm systems. Each gas supervision circuit shall be equipped with a temperature compensated pressure gauge, test connection point and maintenance connection point and the same shall be easily accessible. Bus

bar side Disconnector (DS)/Earth Switches (ES) shall have common gas density monitor for all the three phase.

All other equipments such as Circuit breaker, Line side DS/ES can either have common or separate gas density monitor system for all the three phases.

b) The gas density and pressure sensitive devices, together with all relays supplied by the manufacturer for use in protection, shall be approved by the PURCHASER. It shall be possible to test all gas monitoring relays without de- energizing the primary equipment and without reducing pressure in the main section. Disconnecting type plugs and sockets shall be used for test purposes; the pressure/density device shall be suitable for connecting to the male portion ofthe plug.
c) Two potential free electrical contacts shall be provided with each and every alarm condition. These are to be grouped together and wired to the cable termination blocks in the local control panels to give remote alarm indications/annunciations in equipment being supplied by the PURCHASER. TheBIDDER will be advised of the grouping required after the contract has been placed.
d) BIDDER shall advise if the breakers are suitable for breaking the load current even if SF6 gas pressure has reduced to atmospheric pressure.

13.4 Sectionalisation

a) The assembly shall consist of completely separate, pressurized sections. The switchgear gas enclosures must be sectionalized with gastight barriers between sections or compartments as per the below:
   i) One compartment for bus bar, Isolator and earthing switch
   ii) One compartment of circuit breaker and cable connection

13.5 The mass of gas in all the individual compartments at rated nominal density shall be indicated in the bid.

13.6 Support Insulators and Section Barriers

a) The support insulators and section barriers/insulators shall be manufactured fromthe highest quality material. They shall be free from all voids and the design shall be such as to reduce the electrical stresses in the insulators to a minimum. They shall be sufficiently strong to ensure

that the conductor spacing and clearances are maintained when short circuit faults occur.

b) Tests shall be carried out during the manufacture of the switchgear to ensure that all insulators and barriers are free of partial discharge at a voltage which isat least 20% greater than the maximum service voltage.

c) The Gas section barriers including seals to the conductor and enclosure wall shall be gas-tight and shall be capable of withstanding the maximum differential pressure that could occur across the barrier i.e with a vacuum drawn on one side of the barrier and on the other side, at least twice the rated gas service pressure that can exist under normal operating and maintenance conditions or the maximum gas over pressure, at least equal to the operating pressure of the relief devices, that could be attained with a persistent internal arc fault.

13.7 Gas Seals

All gas seals shall be designed to ensure that leakage rates are kept to specifiedminimum under all normal pressure, temperature, electrical load and fault conditions.

13.8 Expansion Joints and Flexible Connections

a) Expansion joints or flexible connections, in the metal enclosures, to absorb the actual or relative thermal expansion and contraction of the SF6 equipment as well as structures, foundations and floors on which the equipment is mounted, resulting from variations in the temperature of the switchgear equipment shall be provided, if required.

b) The number and position of expansion joints or flexible connections are to be determined by the BIDDER to ensure that the complete installation will not be subjected to any expansion stresses which could lead to distortion or premature failure of any piece of the GIS equipment, support structure or foundations.

c) Electrical continuity of the connection for all enclosures across bolted joints/ Expansion/flexible connections shall be achieved.

13.9 Supply of SF6 Gas

The contract shall include the supply of all the SF6 gas necessary for filling and putting into commercial operation the complete switchgear installation

being supplied including loss during installation. In addition, ten percent of the total SF6 gas required for the GIS shall be supplied as spare and shall be included in the contract.

14.0 Earthing

a) The MANUFACTURER shall provide a "Main Ground Bus", rated 25 kA for 3sec to which all intentionally earthed parts of the assembly must be connected.

b) It shall be the responsibility of the VENDOR to provide a sufficient number of earth points so that dangerous voltages are not induced in the enclosure by the fault currents circulating in the inner conductor.

c) Every section of the SF6 switchgear equipment including all panels, cubicles, kiosks and boxes shall be solidly bonded to the earthing system.

d) Earth switches, voltage transformers and panels shall be bonded to the earthingsystem as specified in the relevant previous clauses.

e) All steelwork, access decking, handrails etc., shall also be effectively bonded to the earthing system.

f) The design of the earthing system shall be such as to ensure the safety and protection of all operating and maintenance personnel under all normal and faultconditions.

g) The enclosure of the equipment and support structure of GIS shall be earthed in such a way that the following conditions are obtained:

i) The touch potential at any part of the enclosure is less than 65 V.

ii) The induced current during normal operation is prevented from entering the earthing grid

15.0 Interlocks

All interlocks required between circuit breaker, disconnect and earth switches shallbe as per the recommendation of the GIS manufacturer.

16.0 Future Extension

It is proposed to make provision for additional bays at a later date.

a) It shall be possible in future to extend the bus bars. BIDDER shall separately quote for additional items required to be provided now to facilitate future extension without necessitating complete outage of the bus bars.

b) It is a firm requirement that no changes are made to the enclosure during

future extension. Also, the downtime must be minimum when extension is carried out. During erection/testing of extension, outage of only one bus section and associated equipment will be available. Under no circumstances outage of both the bus sections (resulting in complete shutdown of the station) will be permissible. The BIDDER is required to bring out in detail his proposal for achieving future extension and indicate if shutdown of any part of the equipment/circuit will be required for erection, dielectric testing along with Gas Line Diagram etc. The bidder will give step by step procedure for extension of bays on either side of GIS, at later date.

17.0 Foundation Channels & Supporting frame work

a) All supporting steel structures for switchgear bays, bus duct support, etc. shallbe a part of Bidder's supply.

b) All 11kV GIS shall be supplied with bolts, nuts, washers and accessories required for fixing the GIS to the foundation.

18.0 Temperature Rise

Temperature rise of enclosure and conductor shall be such that the final temperaturedoes not exceed the values specified for specified site conditions including the effects of solar radiation. BIDDER shall provide test reports/ calculations to prove this.

19.0 Gas Leakage

The guaranteed maximum gas leakage shall be less than 0.2% per year for any individual gas compartment and for the whole equipment.

20.0 Losses

Manufacturers shall provide details of the losses at rated current.

21.0 Tests and Test Reports

a) The Type test reports shall be submitted with the bid.

b) Acceptance and routine tests for all supply equipments/components parts shall be carried out as per the relevant standards for the respective equipment. These test reports and shall be submitted to the PURCHASER before dispatch of the equipment.

c) Local control panel shall be subjected to the following tests:
   i) High Voltage test (2000V for 1 minute)
   ii) Megger test.
   iii)Electrical control, interlock and sequential operation tests

22.0 DRAWINGS DATA AND GUARANTEED TECHNICAL PARTICULARS TO BE FURNISHED BY THE BIDDER

a) The following drawings/information for each items are to be supplied as part ofthis contract:

i) Outline dimensional drawings of 11kV GIS and accessories.

ii) Shipping drawings showing dimensions and weights of each package.

iii) Assembly drawings and weights of main component parts.

iv) Drawings giving the weights for foundations.

v) Name plate diagrams.

vi) Schematic control along with logic blocks diagram and wiring diagram forall auxiliary equipment.

vii) Test reports

viii) Crane requirements for assembly and dismantling

ix) Cable box connections.

x) Foundation drawing of GIS, support structures, cable box etc.

b) Manufacturer shall submit following for Purchaser's reference before dispatch ofthe transformer.

i) Six (06) copies of instruction books/operation and maintenance manualsand spare part bulletins.

ii) Descriptions literature and data on GIS construction.

c) After the award of the contract six (6) copies of drawings, drawn to scale, describing the equipment in detail shall be forwarded for Purchasers approval, and shall subsequently provide eight (8) complete sets of final drawings, one of which shall be auto positive and editable soft copy suitable for reproduction, before the dispatch of the equipment.

23.0 TECHNICAL PARTICULARS OF 11kV CUBICLE GIS

Sl. No.	Particulars	11 kV GIS (Cubicle type)
1.		
a)	Type (Model No.)	To be specified by the bidder.
b)	Standard Applicable	IEC-62271-100 / IEC-62271-200

2.	Service	Indoor
3.	Enclosure	Sheet Steel with anti corrosion paints.
4.	Nominal System Voltage	11 kV
5.	Highest System Voltage	12 kV
6.	No. of phases and frequency	3ph. 50 Hz
7.	Busbar material	Aluminium
8.	Bus Color code	RYB
9.	System Earthing	Solidly earthed
10.	Circuit Breaker Rating	
10.1	Continuous Current Rating at 40 Deg C	1250A

10.2	Short Circuit Rating	25 kA
10.3	Short Circuit duration	3 sec
11.	Rated making Current	As per IEC-62271
12	Operating duty	O-0.3sec-CO-3 minutes –CO
13	Leakage rate per year in gas Compartment	Less than 0.2%
12.	Busbar rating	As per SLD
13.	Outgoing feeder rating	As per SLD
13.	Power Frequency Withstand voltage	28 kV for 1 minute
14.	Impulse withstand voltage (1.2/50 micro sec)	75 kV
15.	Control Voltage	48 V DC
16	Spring charge motor voltage	220V AC
17.	CT Ratio	Secondary Current 1A (Ratio during detail engineering)
18. a	PT ratio -STAR/ STAR/ Open delta	(33//3) / (.11//3) / (. 11/3)
18.b	CT Ratio	800/1-1-1 for Transformer feeder & 600/1-1 for feeder
19.	Aux. Contacts	As per manufacturer standard
20.	Termination	
20.1	Incomers	XLPE Cables **
20.2	Outgoings	XLPE Cables **

21.	Degree of protection (HV equipment)	IP – 65 for Gas Compartment

** Notes:

1) The length details of the XLPE cables shall be estimated during detailed engineering.
2) Interface of 11kV GIS the feeder bays to be finalized during detailed engineering.
3) From the 11 KV GIS XLPE cable shall be used for station transformers.

GUARANTEED TECHNICAL PARTICULARS FOR 11kV GIS SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR BREAKERS / PANELS

01.	Manufacturer's Name and Country of origin	
02.	Manufacturer's Design / type Ref	
03.	Frequency	
04.	Rated Voltage	
05.	Highest system voltage	
06.	Rated current	
07.	Short Circuit current rating with duration	
08.	Certificate or report of short circuit type test	
09.	Rated operating duty cycle	
10.	Short Circuit Breaking Current : (a) Symmetrical (b) Symmetrical at rated voltage (c) Asymmetrical at rated voltage (i) Per Phase (ii) Average (iii) D.C. Component	
11	Arcing time (at rated breaking current) in ms.	
12	Opening time	
13	Total break time in milli sec.	
	(a) At 10% rated interrupting capacity (b) At rated interrupting capacity	
14.	Make time in ms.	
15.	Dry 1 minute power frequency withstand test voltage (a) Between line terminal and Earth KV rms (b) Between terminals with breaker contacts open	

16.	1.2/50 full wave impulse withstand test voltage (a) Between line terminal and Earth KV p (b) Between terminals with breaker contacts open KVp	
17.	Contact pressure	
18.	Contact Resistance	
19	Control Circuit Voltage AC / DC	
20	Power required for Closing Coil at 220 V	
21	Power required for Tripping Coil at 220V	
22	Whether Trip free or not	
23	Whether all the interlocks provided	
24	Overall dimensions	
25	Gauge of the MS sheet used for the fabrication of the cubicle Size and type of stiffeners used	
26	Total weight of one complete Breaker	

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR 11KV CURRENT TRANSFORMERS

01.	Manufacturer's Name and country of origin	
02.	Manufacturer's design Ref / Model	
03.	Applicable Standards	
04.	Type	
05.	Rated Primary current	
06.	Rated secondary current	
07.	Rated frequency	
08.	Transformation ratios	
09	Number of cores	
10	Rated output (Core wise)	
11	Class of insulation	
12	Class of accuracy (a) For metering (b) For Protection	
13	Short circuit current rating and its duration	
14	Secondary resistance at 70 Deg C	
15	Continuous over load (percentage)	
16	One minute power frequency dry withstand voltage	
17	1.2/50 micro sec. impulse withstand test	

	voltage	
18	One minute power frequency withstand test voltage on secondary	
19	Instrument safety factor	
20	Type of primary winding	

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR 11KV POTENTIAL TRANSFORMERS

01.	Manufacturer's Name and country of origin	
02.	Manufacturer's design reference	
03.	Applicable Standards	
04.	Type	
05.	Ratio	
06.	Rated Primary voltage	
07.	Rated secondary voltage	
08.	Rated frequency	
09.	Class of accuracy	
10.	No. of phase and method of connection	
11.	Burden	
12.	One min. power frequency dry flash overvoltage	
13.	1.2/50 micro sec. impulse withstand test Voltage	
14.	Class of insulation	

Note: Bidders shall also to provide the GTP for the Numerical BCPU & Transformer Differential relay.

24.1 TESTS

All tests shall be carried out according to relevant IEC standards.

24.2 TYPE TESTS

The contractor shall submit the reports for the following type tests on the equipment to be supplied under the contract:

A. Switchgear Panel (with Circuit Breaker installed)Short circuit duty test
   a. Short time and peak withstand current test
   b. Power frequency withstand test
   c. Lightning impulse withstand test
   d. Temperature rise test
   e. Internal Arc Test as per IEC 62271-200 (for 1 second)
   f. Measurement of resistance of main circuit
   g. Test to verify pressure relief operation of the panel **(During internal arc test)**
   h. Cable charging test
   i. Pressure Withstand Test of Gas Filled compartment

B. Circuit Breaker
   a. Mechanical Endurance Test

C. Current Transformer
   a. Short time current test
   b. Temperature rise test
   c. Lighting Impulse voltage withstand test

D. Potential Transformer
   a. Temperature rise test
   b. Lighting Impulse voltage withstand test

E. Switchgear Panel
   a. IP 4X test

F. Protective Relay
   a. EMC Test

The metal-enclosed switchgear is to be type tested at a recognized and internationally well reputed test laboratory. Type test certificates shall be available for verification as evidence of successful completion of type tests.

The switchgear furnished under this specification shall be fully tested and documented by certified production test reports in accordance with IEC 62271-200.

24.3 ROUTINE TESTS

Tests shall be carried out according to IEC requirements. The following minimumtests apply:-

a) Wiring and function tests
b) Equipment verification tests

c) Low voltage circuit insulation test
d) High voltage power frequency test

24.4 FACTORY INSPECTION TESTS

Notification for factory tests along with list of proposed tests shall be submitted asrequired.

24.5 SITE TESTS

The site tests shall include the following:

a) Insulation resistance
b) Functional test of the fully installed and wired equipment delivered.
c) Testing of Protective Relay with Primary/Secondary Current Injection Kit

CHAPTER-E4
33KV RMU

TABLES OF CONTENTS

1. SCOPE:

This specification covers the technical requirements of design, manufacture, testing at manufacturer's works, packing, forwarding, supply and unloading at site/store and performance of 33 KV motorized Ring Main Units with all accessories for trouble free & efficient performance.

2. APPLICABLE STANDARDS:

The equipment covered by this specification shall unless otherwise stated, be designed, manufactured and tested in accordance with latest editions of the following IEC/IS Standards and shall conform to the regulations of local statutory authorities.

IEC 62271-200	HV switchgear and control gear-AC Metal Enclosed switchgear and control gear for voltages above 1 kV and upto and including 52kV .
IEC 60694	Common specifications for high voltage switchgear and control gear standards
IEC 62271-102	HV switchgear and control gear-Alternating current disconnectors and earthing switches
IEC 60265-1	High voltage switches — Part 1: Switches for rated voltages above 1 kV and less than 52 kV
IEC 60529.	Degrees of protection provided by enclosures (1P Code)
IEC 62262	Degrees of protection provided by enclosures for electrical equipment against mechanical impacts (IK Code)
IEC 60060	High-voltage test techniques
IEC 60947 /IS 13947	Low voltage switchgear and control gear
IEC 60439-1	Low-voltage switchgear and control gear assemblies-Type tested and partially type tested assemblies
IEC 60255-3	Electrical relays - Part 3: Single input energizing quantity measuring relays with dependent or independent time.
IEC 60044-1 / IS 2705	Current Transformers
IEC 60044-2 / IS 3156	Voltage Transformers
IEC 60376	Specification of technical grade sulfur hexafluoride (SF6) for use in electrical equipment
IEC 61958	High-voltage prefabricated switchgear and control gear assemblies - Voltage presence indicating system

3. CLIMATIC CONDITIONS OF THE INSTALLATION:

1	Maximum ambient temperature	50 deg C
2	Max. Daily average ambient temp	35 deg C
3	Min Ambient Temperature	0 deg C
4	Maximum Humidity	100%
5	Average Annual Rainfall	150cm
6	Average No. of rainy days per annum	120
7	Altitude above MSL not exceeding	1000m
8	Wind Pressure	300 Km/hr
9	Earthquakes of an intensity in horizontal direction	equivalent to seismic acceleration of 0.3g
10	Earthquakes of an intensity in vertical direction	equivalent to seismic acceleration of 0.15g (g being acceleration due to gravity)

4. GENERAL TECHNICAL REQUIREMENTS

Sr. No	Descriptions	As Specified By TPCOL
1	RMU Category-Motorised with Inbuilt Battery charger & Battery	3 Way Motorised (1 CB + 2 LBS) 4 Way Motorised (2 CB + 2 LBS)
2	RMU Application	Outdoor
3	Dielectric Medium	SF6
4	Interrupting Medium	SF6 / Vacuum
5	System Frequency	50 Hz
6	Rated voltage	36Kv
7	Service Voltage	33Kv
8	Rated Current-Line Switches	630A
9	Rated Current –CB	630A
10	Rated Short time Current Withstand	25KA for 1 Sec / 20KA for 3 Sec
11	Internal ARC (1 Sec)	25KA
12	Rated Short time	50Ka

	Making Capacity	
13	Rated Cable charging Interrupting current incomer load break switch	25A
14	Rated Load Interrupting Line Current	630A
15	Rated Magnetizing Interrupting Current of Line switch.	10A
16	No. Of Operations at rated Short Circuit Current on line Switches Earthing Switches and CB	5 close
17	i. Mechanical endurance for Isolator & earth switch	Min 1000 Operations
	ii. Mechanical endurance for circuit breaker	Min 2000 Operation
	CTs for Protection:	To be Finalised during Detailed Engineering
	Material : Epoxy resin cast/	
	Burden : 2.5VA	
	Ratio : 100-50/1 A	
	Accuracy Class : 5P10	
18	Electrical Operations of Isolator & E/Switch at rated current	To be Provided By Bidder
19	Temp Rise	Maximum permissible temperature for bus bar shall not be 105 deg C an ambient temperature not exceeding 50 deg C, as per IEC 60694 And IEC 62271. However, the temperature rise for accessible enclosures and covers shall not exceed 30K and in case, they are not required to be touched during normal operation, the limit shall be raised by 10K

20	Min Gas Pressure	0.05 Bar G
21	SF6 Gas Pressure Indicator	To be Provided by Bidder
22	SF6 Gas leakage Detector	1 per 20 RMUs Subject to Minimum One Number
23	Guaranteed SF6 Leakage per Annum	Less than 0.1%
24	Degree Of Protection	IP 67 for the tank and IP2X for the front cover/mimic board and IP55 for Outdoor RMUs .The RMU metal parts shall be greater than 2.0 mm thickness high tensile steel which must be shot blasted, spray galvanised with minimum thickness of 30 micron and subsequently powder coated. The overall Paint thickness shall be not less than 70 microns.
25	Internal arc test	25kA 1 Sec
26	Lightning Impulse withstand Phase to Earth	170kVp
27	Power frequency withstand for 1Minutes	70kVrms
28	SF6 tank design	Hermetically sealed unpainted stainless steel enclosure with SF6 Gas. Sealed pressure system by Laser welding so that no refilling of gas is required for 30 years. No gas work to prevent access to live parts. No gasket shall be used, No bolts Shall be provided
29	Earth Bus Bar Material & Size	To be provided by Bidder
30	Earthing of main CCT cables shall be earthed with earth switch with S/C making capacity as per IEC 129. Moving contacts of earthing switch shall be visible in closed position thru transparent covers AND closing shall be possible only when Isolator is	To be provided by Bidder

	open.	
31	Incomer load break switch shall be SF6 type with least maintenance and shall have at least 3 positions, Open, Close & earth with Natural interlocks. Fitting of motor at site shall be possible & shall have mechanical interlock.	To be provided by Bidder
32	Circuit Breaker Preferably SF6 type with minimum maintenance and shall have at least 2 positions i.e. open & close, manual operation & fitting of motor at site shall be possible if required.	To be provided by bidder
33	Protection Relay – Without Auxiliary Power & shall include 3 toroid transformer in trans. Tee-off bushing, electronics relay, low energy release & fast on test receptacle for protection testing.	Self powered O/C+E/F IDMT characteristics with 0.05 Sec TMS.
34	Make of Relay	SEG-WIP1 or Schneider-VIP 300 or REJ 603 or any other as per TPCODL Approval.
35	Flag indication on CB for trip on fault	To be Provided By bidder

36	Testing of cable-without opening the doors.If doors are opened then earth switch shall be in closed position and cable test rod shall be provided which can be fixed on terminations for testing purpose AND if doors are opened it shall not be possible to operate ,Isolator, E/switch or CB	To be confirmed. If separate test bushing are provided, it Shall be covered with suitable antitheft covers with anti vandal screws.
37	Protection against Theft	Design Of RMU shall be tamper & arc proof. And vandal Screws shall be provided. Cable covers shall be pad lockable. All live parts / test Bushing etc. Shall be covered with antitheft covers.
38	Doors	Hinged doors shall be provided. the hinges for the doors need to be riveted and shall not have any access from outside. Bolted hinges shall not be acceptable.
39	Voltage indicator box shall be fixed type- This device shall be in compliance with IEC 61958 standard.	Capacitive dividers type which will supply low voltage to power the lamps and 3 inlets can be used to check phase sequence.
40	Phase comparator	1 per RMU
41	Cable Clamps	HDPE
41.1	Cable Termination	
41.2	Type	Heat/Cold shrinkable
41.3	Size (To be finalized in detailed Engineering Stage)	Suitable for 3C x 400 Sqmm/ 1CX400Sqmm / 1CX630Sqmm
42	Height	Minimum 1200mm above GL
43	Earth fault passage indicator	One Per RMU with as a part of RMU
44	Operating handle	To be provided by bidder as part of RMU
45	MIMIC Diagram in Front of panel	To be provided by bidder
45.1	Bus bar	

45.2	Material	Copper
46	Cross Section	To be specified by bidder
47	Opening & Closing times (Max)	Opening Time: 2.5 Cycle Closing Time: 3 Cycles
47.1	Current Transformer	Shall be epoxy resin and are mounted around the cable outside SF6 gas compartment. The CTs around the cables shall be supported on the sheet steel bracket base sized for CTs .CTs shall not be kept hanging or put on base frame directly
48	CT Dimension	Suitable for 3C x 400 Sqmm/ 1CX400Sqmm / 1CX630 Sqmm
49	SCADA Compatibility- Remote operation of RMU shall be possible by using motors fitted to operating mechanism of isolators & CB etc.	As per specification
50	Harting Plug arrangement for individual isolator as well as breaker motor connections, which will be fitted on RMU body itself	As per specification
51	Guarantee- From date of taking over by TPL	48 Months from the date of commissioning or 60 months from the date of supplies made under the contract whichever is later
52	Dimension (LxWxH) (mm x mm x mm)	To be provided by bidder
53	Total weight	To be provided by bidder
54	Paint	TPL Blue PANTON E 2727C
55	Power Supply	24VDC for Control Circuit from Battery & Battery Charger 15AH Input Supply to Battery Charger : 220VAC
56	Motor	Coupled type DC operated motors shall be suitable for

		the installation on the indoor type RMU's on the isolator function and to be flitted in/from the LV compartment side. There shall be provision to fit the motor on Circuit breaker also Motor Voltage: 24 VDC Operating Time:4-8 Sec Rating: To be submitted by Bidder

Type of Ring Main Units shall be as under:

3 Way/4 Way Non Extensible Type (For Outdoor application):

3 Way RMU: 2 LBS 1 VCB with Self powered O/C & E/F Relay and 1 FPI

4 Way RMU: 2 LBS 2 VCB with Self powered O/C & E/F Relay and 1 FPI

5. GENERAL CONSTRUCTIONS

5.1 GENERAL CONSTRUCTION FOR RMU

5.1.1 The switchgear and bus bar shall be contained in a stainless steel tank filled with SF6 gas and the outer body shall be made of minimum CRCA of 2mm or GI high tensile steel 2mm thick with thick gland plates of 3mm. The sheet steel shall have surface treatment of 7 tank process With powder coating of minimum 70 microns. The tank shall have SS sheet of 1 minimum 2mm thickness with internal Arc Type tested and meet the "sealed pressure system" criteria in accordance with the IEC 62271-200. This is a system for which no handling / refilling of gas shall be required throughout the expected operating life, i.e. 30 years. Sealed pressure systems are completely assembled, filled and tested in the factory. The maximum leakage rate of SF6 gas shall be lower than 0.1 % of the total initial mass of SF6 gas per annum. The filling pressure for the switchgear shall be just above the atmospheric pressure so as to reduce the tendency to leak. SF6 gas used for the filling of the RMU shall be in accordance with .IEC 376. It is preferable to fit an absorption material in the tank to absorb the moisture

from the SF6 gas and to regenerate the SF6 gas following arc interruption. The degree of protection for RMU tank (Indoor/Outdoor) shall be IP 67. The mimic board shall be provided with IP2X /IP3X degree of protection for Indoor RMUs and protection for Outdoor RMUs shall be minimum IP 54

The RMU shall be suitable for mounting on plinth with provision for cabling through gland plate in the base and trench below, The RMU shall be designed so that the position of the different devices is visible to the operator on the front and operations are also visible. The RMU shall be identified by an appropriately sized label which clearly indicates the functional units and their electrical characteristics. The RMU shall be designed to be tamper proof so as to prevent access to all live parts during operation without the use of tools.

5.1.2 The RMU shall be completed with all connection and tinned copper bus bar with continuous current carrying capacity of 630A at 40 Deg C ambient. The bus bar shall be fully encapsulated by SF6 gas inside the steel tank. There shall be continuity between the metallic parts of the RMU and cables so that there is no electric field pattern in the surrounding air, thereby ensuring the safety of people. The earth bus bar shall be preferably enclosed in an enclosure to prevent theft/tampering.

5.1.3 All parts of main circuit to which access is required or provided shall be capable of being earthed prior to becoming accessible. This does not apply to removable parts which become accessible after being separated from the switchgear and control gear. The cables shall be earthed by an earth switch with short-circuit making capacity in compliance with IEC 62271-102. Circuit breaker shall not be closed in case Earth Switch is closed. The earth switch shall be fitted with its own operating mechanism and manual closing shall be driven, by a fast-acting mechanism, independent of operator action. Mechanical interlocking systems shall prevent access to the operating shaft to avoid all operator errors such as closing the earth switch when cable is charged.

5.1.4 Any accidental over pressure inside the sealed chamber shall be limited by the opening of a pressure limiting device provided in the rear part of the tank. Gas shall be released to the rear of the RMU away from the operator. Bidder shall provide type test report to prove compliance to the 'Internal fault IAC AFLR as per IEC

62271-200. An anti-reflex mechanism on the operating lever shall prevent any attempts to reopen immediately after closing of the switch-or earth switch. All manual operations shall be carried out on the front of the RMU. The instrument transformers (CT/PT) shall be required and to be incorporated in the drawing for discussion at the final stage.

5.1.5 Circuit Breaker for Transformer Local Feeder Control

The circuit breakers shall be of the maintenance free. The position of the power and earthing contacts shall be clearly visible on the front of the RMU. The circuit breakers shall have at least 2 positions: Open-disconnected and closed and shall be constructed in such a way that natural interlocks prevent all unauthorized operations. They shall be fully mounted and inspected in the factory. Breaker operation counter should be provided. Breaker contact resistance should be <=50 micro-ohms.

An operating mechanism can be used to manually close the circuit breaker and charge the mechanism in a single movement. It shall be fitted with a local system for manual tripping by, an integrated push button. There will be no automatic re-closing. The operating mechanism shall be compatible for remote/SCADA operation. The circuit breaker shall be associated with an integrated protection unit that will operate without any auxiliary power supply and shall include three toroid transformers incorporated in the transformer tee-off bushings, an electronic self powered relay, a low energy release, and a "fast-on" test receptacle for protection testing (with or without CB tripping).

The protection system shall ensure circuit breaker tripping as of a minimum operating. current which is the rated current of the underground network to be protected. The CT settings shall be adjustable between 600 to 300/5 Amps'as per the requirement at site. Protection core CT complete details should be furnished (Burden, class, ALF).

The circuit breaker shall be provided with Phase protection of Definite time/ IDMT element for .overcurrent and earth fault with minimum PSM-0.05,Tsm-0.01 having standard characteristics of Standard Inverse, Very inverse, Extremely Inverse as per IEC 60255-3 standard. The Earth Fault Protection shall be provided of. Definite time/ IDMT element having standard characteristics of Standard Inverse, Very inverse, Extremely Inverse as per IEC 60255-3 standard. The "Time Multiplier" with minimum set point of 0.05 TMS shall be available. The breaker shall have the provision of flag Relay for indication of Trip on Fault. High set (DT) for overcurrent

and earth fault-min .current setting-0.5 In, minimum Time Delay-20 millisecond. The relays shall be suitable numerical relay with necessary elements or any other relay as per the Purchaser's approval.

There' shall be provision for testing of cable without opening the front door by suitable arrangements. In case cables are to be tested with front door open, doors shall have interlocks such that doors can be opened only with earth switch in closed position & a cable test rod shall be provided which can be fixed on the terminations to facilitate testing. Termination boots as approved by the Purchaser's should have a proper opening to facilitate the testing. The opening shall be covered by means of removable protection cap

In case of front door opened, it shall not be possible to operate the breaker. All panel covers shall be provided with anti vandal screw bolts so that opening of panel covers is only possible with special tools, which shall be provided by the Bidder. This is required to prevent pilferage. The cable cover door shall be pad lockable and shall be Tamper and Arc proof. There shall be proNAsion of hinged doors in the RMU. The circuit breaker and earth switch shall be lockable in the open or closed positions by 1 to 3 padlocks. Breaker shall have mechanical fftdurance of at least 2000 operations.

The circuit breaker shall be compatible for remote operation and can close (ON) and open (OFF) by remote operation.

5.1.6 Incomer Load Break Switches :

The Load break switches shall have positions, open-disconnected closed, and earthed, and will be constructed in such a way that natural interlocking prevents unauthorized operations

The position indicator shall provide positive contact indication in accordance with IEC 265-1 standard. In addition, manufacturer shall prove reliability of indication in accordance with IEC 129.

The switches shall be fully mounted and inspected in the factory. Manual opening and closing will be driven by a fast-acting mechanism, independent of operator action.

Mechanical Interlock should be provided for Earth switch, If cable is back charged Earth switch should not be closed.

Each switch can be fitted with an electrical operating mechanism in a specially

reserved location, without any modification of the operating mechanism and without de-energizing the RMU.

Load break Switch should be operated manually & motorized.

5.1.7 Bushings and Cable terminations:

Each cable compartment shall_ be_ provided_ with three-_ bushings _of adequate _sizes to terminate the incoming and outgoing cables along with a terminal block (TB) located at convenient accessible location so as to wire all inputs & outputs (I0s) up to the terminal block (TB). The bushings shall be conveniently located for proper bend so as to allow easy working and termination of cables. The cable termination shall be done with Heat shrinkable /Push ON termination method so that adequate clearances are maintained between phases & cable shall be held by HDPE (fire retardant) cleat. 2 runs, of 3CX400 Sq mm, OR 1R of 3 NO. 1CX630 Sq mm shall be used for cable termination.(It shall be finalized during detailed engineering) All the cable secondary Wiring should 'be rooted through marshaling box separately for relay, CT etc.BA should provide bimetallic washer for tightening of cable.

5.1.8 Earthing:

The RMU outdoor metal clad, switchgear,, Distribution Transformer, R.S. Joists, M.S Channels/M.S. angles etc, shall be equipped with an earth bus securely fixed along the base of the RMU. The size of earth busbar of GI Strip (75X12 sq.mm) shall be as per IEC/IS. Provision shall be made on end of RMU for connecting the earth bus to the earth grid by erecting suitable 2 earth pipes of 50mm dia. M.S. rod of 3 meter in Pits. Both the earth pipes are also to be connected in a grid formation. Necessary terminal clamps and connectors shall be included in the scope of supply.

5.1.9 Voltage indicator lamps and phase comparators:

Each function shall be equipped with a fixed type voltage indicator box on the front to indicate whether or not there is voltage in the cables. The capacitive dividers will supply low voltage power to the lamps. Three inlets can be used to check the synchronization of phases. These devices shall be in compliance with IEC 61958 standard.

5.1.10 Front Cover

The front cover shall provide a clear mimic diagram that indicates the different functions. The position indicators shall give a true reflection of the position of the

main contacts. They shall be clearly visible to the operator. The lever operating direction shall be clearly indicated in the mimic diagram. The bidder shall provide a marking plate showing RMU's main electrical characteristics.

5.1.11 Fault Passage Indicators

Fault Passage Indicators shall be installed on the Ring Main Unit. These devices shall be, electronic devices with their own energy source and connected to Single 3 phase Split Core CTs (CBCT). These shall be provided with bright LED s / flag. Indicators, which shall be clearly visible in the day time. These shall have the following resetting facilities:

-Manual reset

-Resetting after a set time duration

-Electrically reset from remote with at least 2-spare potential free Contacts.

The unit shall have Short Circuit and Earth fault adjustable to different settings with separate Current transformer. They shall be fully field-programmable and shall have at least 16 settings for Earth Fault + 4 settings for Phase-Phase. It shall be possible to Test these indicators at site thru "Test" push button. The Fault Passage Indicators shall also be provided with a SCADA output contact. These shall confirm to the following standards:

IEC 60068-2-6, IEC 60068-2-9	: Environmental testing — For Vibration, solar
IEC 60950	:radiations :Information Technology equipment - Safety
IEC 1000-2	: Electromagnetic compatibility for low-frequency
IEC 1000-4	conducted disturbances and signaling in public low
IEC 1000-6	power supply systems
	: EMC - Testing & Measurement
	: EMC- Immunity for Residential, Commercial and light

5.1.12 Remote Control of the RMU:

Remote operation of the RMU line switches shall be possible using pre- fitted motors to the operating mechanism for both line switch and circuit-breaker functions. All the necessary accessories shall be supplied separately, to stores.

Auxiliary contacts for remote indication of switch status are also required.

The fitting of the motors to the mechanism must not in any _way impede or

interfere with the manual operation of the switches. An auxiliary contact to prevent motorized operation of the mechanism while the operating handle is inserted into the operating point shall also be provided.

Preferred Communication protocol for FRTU shall IEC-60870-5-104

Signal requirement for field RTU (which shall be mounted near RMU) is attached (refer Annexure1). Bidder shall quote the cost of field RTU (FRTU) separately with all technical details for acquisition of the signal as described in Annexure-1.

5.1.13 Paint

All paint shall be applied on clean dry surfaces under suitable atmospheric conditions by seven tank process and powder coating. The overall paint thickness shall not be less than 100 microns ±25 micron as standard. The paint shall not scale off or crinkle or be removed by abrasion during normal handling. The enclosure of the RMU shall be painted with shade Dark Gray, i.e., BS381C or RAL 7032. Sufficient quantity of touch-up paint shall be furnished for application at site.

6. MARKING

All the components and operating devices of the RMU shall be provided with durable and legible nameplates containing all technical parameters. Name plates shall be suitably embossed with" PO no. with date", "PROPERTY OF TPCODL & PO Number along with the following information. A Danger plate of appropriate size shall also be provided on the enclosure.

a) Manufacturer's Name
b) Month and year of supply
c) PO Number
d) Rated Voltage
e) System Frequency
f) Rated Short time withstand current for 'I sec
g) Rated Impulse withstand Voltage
h) Degree of Protection
i) Type Designation or Serial no.
j) Year of manufacture
k) Applicable Rated values
l) Mass of unit
m) SF6 gas filling pressure

7. TESTS

7.0 TESTS FOR RMU

All the Routine and acceptance tests shall be carried out in accordance with the relevant IS/IEC standards. All routine/acceptance tests shall be witnessed by the purchaser/his authorized representative. All the components within the RMU enclosure shall have been tested for Routine/acceptance and Type tests as per the relevant standards. All Type tests as per latest IS / 1EC shall have been carried out on the RMU as a whole as per relevant IS/IEC. Following tests shall be necessarily conducted on the equipment and its components in addition to others specified in the IS/IEC:

Type Test

a) Dimensional and visual check
b) Mechanical operation test and checking of interlocks
c) Dielectric test on main and control circuits.
d) Temperature Rise test.
e) Internal Arc withstand test,
f) Degree of Protection test.
g) Test to check the capability of main and earthing circuits subjected to rated peak and short time withstand current.
h) Test to check the total time taken to clear the faults (relay pick up+ Trip coil pick up + breaker trip) for instantaneous & time delay modes.under various settings of relay and trip coil thru secondary current injection.
i) Salt Spray Test

The above type test certificates must accompany drawing of type tested equipment, duly signed by type testing authority.

The above tests must not have been conducted on the equipment within time frame as per latest CEA Guidelines In case of any change in design/type of Breaker already type tested and the one offered against this specification, the owner reserves the right to demand repetition of type tests, without any extra cost.

Routine test:

Following routine tests are to be done on 100% of the lot quantity

1. Power Frequency Withstand Test.
2. Dimensional & Visual Checks
3. Operational & Interlock Tests of breaker & isolator switches
4. Measurement of Circuit Resistance
5. Sf-6 chamber pressure withstands/leakage test.
6. HV withstand test across isolator distance.
7. HV withstand test of control and auxiliary circuits.
8. Voltage Indication Tests.
9. Breaker Contact Resistance Test
10. Total Trip Time Check Test through Current Injection in primary.
11. IR Value.

Below routine test has to be provided on cable Boot for cable termination:

a) Visual inspection of the final finished product.
b) Intactness with Bushing.
c) Insulation Test.
d) AC HV test.

Acceptance test:

All the tests specified under Routine Test Clause above shall be carried out as acceptance test on random samples as per sampling plan under IEC/IS for each lot.

Bidder should have all the requisite testing equipment's to carry out routine and acceptance test mentioned above including:

a. Facility for primary current injection up to 1000amp.

b. Facility to check total trip timing of breaker along with breaker main contacts through primary current injection

8.0 TYPE TEST CERTIFICATE

The Bidder shall furnish the type test certificates of the 33 KV RMU for the tests as mentioned above as per the corresponding standards. All the tests shall be conducted at CPRI or any other International Laboratory as per the relevant standards. Type tests shall have been conducted in certified Test laboratories during the period not exceeding time span as per CEA guidelines. In the event of any discrepancy in the test reports, i.e. any test report not acceptable or

any/all type tests (including additional type tests, if any) not carried out, same shall be carried out without any cost implication to TPCODL.

9.0 PRE-DISPATCH INSPECTION

Equipment shall be subjected to inspection by a duly authorized representative of the TPCODL. Inspection may be made at any stage of manufacture at the option bf the purchaser and the equipment if found unsatisfactory as to workmanship or material is liable to. rejection. Supplier shall grant free access to the places of manufacture to TPCODL's representatives at all times when the work is in progress. Inspection by the TPCODL or it's authorized representatives shall not relieve the supplier of his obligation of furnishing equipment in accordance with the specifications. Material shall be dispatched after specific MDCC (Material Dispatch Clearance Certificate) is issued by TPCODL. Following documents shall be sent along with material

a) Test reports
b) MDCC issued by TPCODL
c) Invoice in duplicate
d) Packing list
e) Drawings & catalogue
f) Guarantee / Warrantee card
g) Other Documents (as applicable)

10.0 INSPECTION AFTER RECEIPT AT STORE

The material received at TPCODL Store will be inspected for acceptance and shall be liable for rejection if found different from the reports of the pre-dispatch inspection and one copy of the report shall be sent to Project Engineering department.

11.0 GUARANTEE

Bidder shall stand guarantee towards design, materials, workmanship & quality of process / manufacturing of items under this contract for due and intended performance of the same, as an integrated product delivered under this contract. In the event any defect is found by the Purchaser up to a period of at least 48 months from the date of commissioning or 60 months from the date of last supplies made under the contract whichever is later, Bidder shall be liable to undertake to replace/rectify such defects at its own costs, within mutually agreed time frame, and to the entire satisfaction of the Purchaser, failing which the

Purchaser will be at liberty to get it replaced/rectified at Bidder's risks and costs and recover all such expenses plus the Purchaser's own charges (@ 20% of expenses incurred), from the Bidder or from the " Security cum Performance Deposit" as the case may be.

Bidder shall further be responsible for 'free replacement for another period of THREE years from the end of the guarantee period for any 'Latent Defects' if noticed and reported by the Purchaser.

12.0 PACKING

Bidder shall ensure that all equipment covered by this specification shall be prepared for rail/road transport (local equipment) and be packed in such a manner as to protect it from damage in transit

13.0 TENDER SAMPLE

Not applicable.

14.0 QUALITY CONTROL

The bidder shall submit with the offer, assurance plan indicating the various stages of inspection, the tests and checks which will be carried out on the material of construction, components during manufacture and after finishing, bought out items and fully assembled component and equipotent including drives. As part of the plan, a schedule for stage and final inspection within the parameters of the delivery schedule shall be furnished. The Purchaser's or its nominated representative engineer shall have free access to the manufacturer/sub-supplier's works to carry out inspections.

15.0 TESTING FACILITIES

Bidder shall have adequate in house testing facilities for carrying out all routine tests & acceptance tests as per relevant International / Indian standards.

16.0 MANUFACTURING ACTIVITIES

The successful bidder will have to submit the bar chart for various manufacturing activities clearly elaborating each stage with quantity. This bar chart shall be in line with the Quality Assurance Plan, submitted with the offer. This bar chart will have to be submitted within 15 days from the release of the order.

17.0 SPARES, ACCESSORIES & SPECIAL TOOLS/GAUGES

Bidder shall provide a list of recommended spares with quantity and unit prices for 5 years of operation after commissioning. The Purchaser may order all or any of the spare parts listed at the time of contract award and the spare parts so ordered shall be supplied as part of the definite works. The Purchaser may order additional spares at any time during the contract period at the rates stated in the Contract Document. Bidder 'shall give an assurance that spare parts and consumable items will continue to be available through the life of the equipment which shall be 25 years minimum. However, the Purchaser shall give a minimum of 12 months notice in the event that the Bidder or any sub-vendor plans to discontinue manufacture of any component used in this equipment.

Any spare apparatus, parts or tools shall be subject to the same specification, tests and conditions as similar material supplied under the Contract. They shall be strictly interchangeable and suitable for use in place of the corresponding parts supplied with the plant and must be suitably marked and numbered for identification.

18.0 DRAWINGS & DOCUMENTS

Following drawings and documents shall be prepared based on TPCODL specifications and statutory requirements and shall be submitted with the bid:

a) Completely .filled in Technical Particulars
b) General description of the equipment and all components including brochures.
c) General arrangement for RMU
d) Power flow diagram
e) Foundation plan
f) Bill of material
g) Experience List
h) Type test certificates

Drawings / documents to be submitted after the award of the contract are as under:

Sl. No.	Description	For Approval	For Review/Informa	Final Submission
1	General Technical Particulars	✓		✓
2	General Arrangement	✓		✓
3	Schematic Diagram	✓		✓
4	Bill of materials	✓	✓	✓
5	Foundation Plan & loading			✓
6	Installation Instructions		✓	✓
7	Instruction for Use		✓	✓
8	Transport/ Shipping dimension	✓	✓	✓
9	QA & QC Plan	✓	✓	✓
10	Test Certificates			

All the documents &drawings shall be in English language.

After the receipt of the order, the successful bidder will be required to furnish five copies of all relevant drawings for TPCODL approval.

Instruction Manuals: Bidder shall furnish two softcopies (CD) and four (4) hard copies of nicely bound manuals (In English language) covering erection and 'maintenance instructions and all relevant information and drawings pertaining to the main equipment as well as auxiliary devices.

19. GUARANTEED TECHNICAL PARTICULARS

Sr. No	Descriptions	As Specified By TPCOL	Bidders Response
1	RMU Category-Motorised with Inbuilt Battery charger & Battery	3 Way Motorised (1 CB + 2 LBS) 4 Way Motorised (2 CB + 2 LBS)	
2	RMU Application	Outdoor	
3	Dielectric Medium	SF6	
4	Interrupting Medium	SF6 / Vacuum	
5	System Frequency	50 Hz	

6	Rated voltage	36Kv	
7	Service Voltage	33Kv	
8	Rated Current-Line Switches	630A	
9	Rated Current –CB	630A	
10	Rated Short time Current Withstand	25KA for 1 Sec / 20KA for 3 Sec	
11	Internal ARC (1 Sec)	25KA	
12	Rated Short time Making Capacity	50kA	
13	Rated Cable charging Interrupting current incomer load break switch	25A	
14	Rated Load Interrupting Line Current	630A	
15	Rated Magnetizing Interrupting Current of Line switch.	10A	
16	No. Of Operations at rated Short Circuit Current on line Switches Earthing Switches and CB	5 close	
17	i. Mechanical endurance for Isolator & earth switch	Min 1000 Operations	
	ii. Mechanical endurance for	Min 2000 Operation	

	circuit breaker		
	CTs for Protection:	To be Finalised during Detailed Engineering	
	Material : Epoxy resin cast/		
	Burden : 2.5VA		
	Ratio : 100-50/1 A		
	Accuracy Class : 5P10		
18	Electrical Operations of Isolator & E/Switch at rated current	To be Provided By Bidder	
19	Temp Rise	Maximum permissible temperature for bus bar shall not be 105 deg C an ambient temperature not exceeding 50 deg C, as per IEC 60694 And IEC 62271. However, the temperature rise for accessible enclosures and covers shall not exceed 30K and in case, they are not required to be touched during normal operation, the limit shall be raised by 10K	
20	Min Gas Pressure	0.05 Bar G	
21	SF6 Gas Pressure Indicator	To be Provided by Bidder	
22	SF6 Gas leakage Detector	1 per 20 RMUs Subject to Minimum One Number	
23	Guaranteed SF6 Leakage per Annum	Less than 0.1%	

24	Degree Of Protection	IP 67 for the tank and IP2X for the front cover/mimic board and IP55 for Outdoor RMUs .The RMU metal parts shall be greater than 2.0 mm thickness high tensile steel which must be shot blasted, spray galvanised with minimum thickness of 30 micron and subsequently powder coated. The overall Paint thickness shall be not less than 70 microns.	
25	Internal arc test	25kA 1 Sec	
26	Lightning Impulse withstand Phase to Earth	170kVp	
27	Power frequency withstand for 1Minutes	70kVrms	
28	SF6 tank design	Hermetically sealed unpainted stainless steel enclosure with SF6 Gas. Sealed pressure system by Laser welding so that no refilling of gas is required for 30 years. No gas work to prevent access to live parts. No gasket shall be used, No bolts Shall be provided	
29	Earth Bus Bar Material & Size	To be provided by Bidder	

30	Earthing of main CCT cables shall be earthed with earth switch with S/C making capacity as per IEC 129. Moving contacts of earthing switch shall be visible in closed position thru transparent covers AND closing shall be possible only when Isolator is open.	To be provided by Bidder	
31	Incomer load break switch shall be SF6 type with least maintenance and shall have at least 3 positions, Open, Close & earth with Natural interlocks. Fitting of motor at site shall be possible & shall have mechanical interlock.	To be provided by Bidder	
32	Circuit Breaker Preferably SF6 type with minimum maintenance and shall have at least 2 positions i.e.	To be provided by bidder	

	open & close, manual operation & fitting of motor at site shall be possible if required.		
33	Protection Relay – Without Auxiliary Power & shall include 3 toroid transformer in trans. Tee-off bushing, electronics relay, low energy release & fast on test receptacle for protection testing.	Self powered O/C+E/F IDMT characteristics with 0.05 Sec TMS.	
34	Make of Relay	SEG-WIP1 or Schneider-VIP 300 or REJ 603 or any other as per TPCODL Approval.	
35	Flag indication on CB for trip on fault	To be Provided By bidder	
36	Testing of cable-without opening the doors.If doors are opened then earth switch shall be in closed position and cable test rod shall be provided which can be fixed on terminations for testing purpose AND if doors are	To be confirmed. If separate test bushing are provided, it Shall be covered with suitable antitheft covers with anti vandal screws.	

	opened it shall not be possible to operate ,Isolator, E/switch or CB		
37	Protection against Theft	Design Of RMU shall be tamper & arc proof. And vandal Screws shall be provided. Cable covers shall be pad lockable. All live parts / test Bushing etc. Shall be covered with antitheft covers.	
38	Doors	Hinged doors shall be provided. the hinges for the doors need to be riveted and shall not have any access from outside. Bolted hinges shall not be acceptable.	
39	Voltage indicator box shall be fixed type- This device shall be in compliance with IEC 61958 standard.	Capacitive dividers type which will supply low voltage to power the lamps and 3 inlets can be used to check phase sequence.	
40	Phase comparator	1 per RMU	
41	Cable Clamps	HDPE	
41.1	Cable Termination		
41.2	Type	Heat/Cold shrinkable	
41.3	Size (To be finalized in detailed	Suitable for 3C x 400 Sqmm/ 1CX400Sqmm / 1CX630Sqmm	

	Engineering Stage)		
42	Height	Minimum 1200mm above GL	
43	Earth fault passage indicator	One Per RMU with as a part of RMU	
44	Operating handle	To be provided by bidder as part of RMU	
45	MIMIC Diagram in Front of panel	To be provided by bidder	
45.1	Bus bar		
45.2	Material	Copper	
46	Cross Section	To be specified by bidder	
47	Opening & Closing times (Max)	Opening Time: 2.5 Cycle Closing Time: 3 Cycles	
47.1	Current Transformer	Shall be epoxy resin and are mounted around the cable outside SF6 gas compartment. The CTs around the cables shall be supported on the sheet steel bracket base sized for CTs .CTs shall not be kept hanging or put on base frame directly	
48	CT Dimension	Suitable for 3C x 400 Sqmm/ 1CX400Sqmm / 1CX630 Sqmm	
49	SCADA Compatibility- Remote operation of RMU shall be possible by using motors fitted to operating	As per specification	

	mechanism of isolators & CB etc.		
50	Harting Plug arrangement for individual isolator as well as breaker motor connections, which will be fitted on RMU body itself	As per specification	
51	Guarantee- From date of taking over by TPL	48 Months from the date of commissioning or 60 months from the date of supplies made under the contract whichever is later	
52	Dimension (LxWxH) (mm x mm x mm)	To be provided by bidder	
53	Total weight	To be provided by bidder	
54	Paint	TPL Blue PANTON E 2727C	
55	Power Supply	24VDC for Control Circuit from Battery & Battery Charger 15AH Input Supply to Battery Charger : 220VAC	
56	Motor	Coupled type DC operated motors shall be suitable for the installation on the indoor type RMU's on the isolator function and to be	

		flitted in/from the LV compartment side. There shall be provision to fit the motor on Circuit breaker also Motor Voltage: 24 VDC Operating Time:4-8 Sec Rating: To be submitted by Bidder	

20. SCHEDULE OF DEVIATIONS

(TO BE ENCLOSED WITH TECHNICAL BID)

All deviations from this specification shall be set out by the Bidders, clause by Clause in this schedule. Unless specifically mentioned in this Schedule, the tender shall be deemed to confirm the purchaser's specifications:

S. No	Clause No.	Details of deviation with justifications

ANNEXURE – 1
SIGNAL LIST FOR AUTOMATION

Description	Analog Inputs(AI)					Status(DI)		
Type	Amp. Loading-R ph	Amp. Loading-Y ph	Amp. Loading-B ph	Phase Voltage	Power factor	Switch close	Switch Open	Reset Element
RMU Switch *	0	0	0	0	0	1	1	
Breakers *	1	1	1	1	0	0	0	
FPI							1	1
Pressure Gauge (manometer)							1	

FRTU SIGNAL LIST

Description	Analog Inputs (AI)				
Type	Amp. Loading-R ph	Amp. Loading-Yph	Amp. Loading-B ph	Phase Voltage	Power factor
Switch *	0	0	0	0	0
Breakers *	1	1	1	1	1
Fault passage indicator *	0	0	0	0	0

Note: 0 indicate functionality not req. for that element, 1 indicate functionality required for that element

* Denotes the nos of switches/ Breaker s in RMU based on the type of RMU (3way, 4way, 5way & 7way).

Additional IOs

RMU switch Control Command
Earth Sw. 1 Status Input
Earth Sw. 2 Status Input
FPI Reset
FRTU Local/Remote Position
FRTU Door Open
FRTU Battery Charger Faulty
FRTU Battery Faulty
FRTU SwitchGear Supply Off
FRTU Aux Supply Off
FRTU Fault
Relay operation
CB OFF status
CB ON status
CB ON/OFF Command

CHAPTER-E5
11KV RMU

TABLES OF CONTENTS

1. **SCOPE:**

This specification .covers the technical requirements of design, manufacture, testing at manufacturer's works, packing, forwarding, supply and unloading at site/store and performance of 11 KV motorized Ring Main Units with all accessories for trouble free & efficient performance .

2. APPLICABLE STANDARDS:

The equipment covered by this specification shall unless otherwise stated, be designed, manufactured. and tested in accordance with latest editions of the following IEC/IS Standards and shall conform to the regulations of local statutory authorities.

IEC 62271-200	HV switchgear and control gear-AC Metal Enclosed switchgear and control gear for voltages above 1 kV and upto and including 52kV .
IEC 60694	Common specifications for high voltage switchgear and control gear standards
IEC 62271-102	HV switchgear and control gear-Alternating current disconnectors and earthing switches
IEC 60265-1	High voltage switches — Part 1: Switches for rated voltages above 1 kV and less than 52 kV
IEC 60529.	Degrees of protection provided by enclosures (1P Code)
IEC 62262	Degrees of protection provided by enclosures for electrical equipment against mechanical impacts (IK Code)
IEC 60060	High-voltage test techniques
IEC 60947 /IS 13947	Low voltage switchgear and control gear
IEC 60439-1	Low-voltage switchgear and control gear assemblies- Type tested and partially type tested assemblies
IEC 60255-3	Electrical relays - Part 3: Single input energizing quantity measuring relays with dependent or independent time.
IEC 60044-1 / IS 2705	Current Transformers
IEC 60044-2 / IS 3156	Voltage Transformers

IEC 60376	Specification of technical grade sulfur hexafluoride (SF6) for use in electrical equipment
IEC 61958	High-voltage prefabricated switchgear and control gear assemblies - Voltage presence indicating system

4. CLIMATIC CONDITIONS OF THE INSTALLATION:

1	Maximum ambient temperature	50 deg C
2	Max. Daily average ambient temp	35 deg C
3	Min Ambient Temperature	0 deg C
4	Maximum Humidity	100%
5	Average Annual Rainfall	150cm
6	Average No. of rainy days per annum	120
7	Altitude above MSL not exceeding	1000m
8	Wind Pressure	300 Km/hr
9	Earthquakes of an intensity in horizontal direction	equivalent to seismic acceleration of 0.3g
10	Earthquakes of an intensity in vertical direction	equivalent to seismic acceleration of 0.15g (g being acceleration due to gravity)

4. GENERAL TECHNICAL REQUIREMENTS

Sl. No	Descriptions	As Specified By TPCODL
1	RMU Category	3Way Motorised (1CB + 2 LBS) 4Way Motorised (2CB + 2 LBS)
2	RMU application	Outdoor.
3	Offered Model nos. and OEM type	a. 3 Way Non Extensible b. 4 Way Non Extensible
4	Dielectric medium	SF6

5	Interrupting medium	Vacuum- for CB SF6 for LBS and earth switch
6	System Frequency	50 Hz
7	Rated Voltage	12 KV
8	Service Voltage	11 KV
9	Rated current -Line Switches	630 A
10	Rated Current-CB and LBS	630 A for all type
11	Rated Short time current withstand (3 sec)	21 KA
12	Rated Short time Making capacity	50 KA
13	Rated cable charging interrupting current of incomer load break switch	10 A
14	Rated load interrupting line current	630 A
15	Rated cable charging breaking current of breaker	25 A
16	No. of operations at rated short circuit current on line switches, earthing switches should be E2	LBS- 5 close ES- 5 close The ES in line with CB
17	Opening time of breaker (max.) Without relay time	2.5 cycle
18	Closing time of breaker (max.)	3 cycle
19	Breaker Duty Cycle	O – 3min - CO - 3min – CO
20	i. Mechanical endurance for Isolator & Earth Switch	Min 1000 Operations
	ii. Mechanical endurance for Circuit Breake	Min 2000 Operations
21	Electrical operations of at rated current a. LBS/Disconnector b. Earth Switch	To be provided by bidder
22	Temp rise above ambient of 50 deg.	50 Deg C. (Type Tested as per IEC and complying to requirements)
23	Min Gas pressure in bar	To be provided by bidder based on type tested design

24	SF6 Gas pressure manometer with indicating bars/scale to measure the actual gas pressure (indirect method RFS etc. not accepted)	1. Dial type Manometer to be provided for gas pressure indication 2. Contacts to be provided and wires up on the TB for SCADA communication of gas status.
25	Enclosure	The RMU metal parts shall be greater than 2mm thickness high tensile steel/CRCA. The overall paint thickness shall be not less than 70 microns.
26	Guaranteed SF6 leakage per annum	Less than 0.1% from main tank
27	Degree of protection	a. IP 67 for the tank and b. IP2X for the front cover / mimic board and c. IP 54 (Main door closed) for Outdoor RMUs. d. IP 54 for cable compartment
28	Internal Arc rating	IAC AFL or better
29	Internal Arc test	20kA for 1 Sec.
30	Lightning Impulse withstand Voltage	75 kVp
31	Power Frequency withstand voltage	28 kVrms.
32	SF6 Tank design	Hermetically/robotically sealed unpainted stainless steel enclosure with SF6 Gas. Sealed pressure system by Laser welding so that no refilling of gas is required for 30 years. No gas work at site. Complete body shall be tamperproof to prevent access to live parts. No gaskets shall be used. No bolts shall be provided.
32.1	Tank material and grade of SS and welding	Should be of SS and non-corrosive, offered grade of SS to be mentioned. The welding shall be

		such that there shall be corrosion of welding for useful life of equipment.
33	Earth bus bars	In enclosure to prevent tampering.
34	Material & size of earth bus bar	To be provided by the bidder
35	Earthing of main CCT Cables shall be earthed with earth switch with S/C making capacity as per IEC 129. Moving contacts of earthing switch shall be visible in closed position thru transparent covers AND closing shall be possible only when Isolator is open	To be provided by the bidder
36	Incomer Load Break switch: Shall be SF6 insulated with least maintenance. Shall have at least 3 positions, Open, Close & earth with natural interlocks. Fitting of motor at site shall be possible & shall have mechanical interlock. The electrical interlock of cable charge with earth switch is preferred.	To be provided by the bidder
37	Circuit Breakers: a. With VCB interrupter and SF6 insulated bus with minimum maintenance and shall have at least 2 positions I.e. Open & Close, Manual operation & fitting of motor at site shall be possible if required. b. In view of safety each VCB shall be assisted with feeder side disconnector having 3 positions, opendisconnected, closed, and earth (having fault making capacity) and shall be constructed in such a way that natural interlocking prevents unauthorized operations.	To be provided by bidder as per specs.

38	Protection Relay-Without auxiliary power & shall include , electronic relay, low energy release & fast on test receptacle for protection testing	
39	Make of self-powered Relay & offered model	a. For TPCODL, ODISHA – ABB ,Ashida, Schneider, Siemens
40	Flag indication for CB Trip on fault in relay/ mechanical	To be provided by bidder
41	Testing of Cable- If doors are opened then earth switch shall be in closed position with necessary interlocks and cable test rod fixing provision in bolt head which can be fixed on terminations through boot cap/opening for testing purpose AND if doors are opened it shall not be possible to operate, Isolator, E/Switch or CB through interlocks	To be confirmed. If separate test bushing are provided, it shall be covered with suitable antitheft covers with anti vandal screws
42	Protection against theft	Design of RMU shall be tamper & arc proof. Anti vandal screws shall be provided. Cable covers shall be pad lockable. All live parts and internal parts etc. shall be covered with antitheft covers.
43	Doors	Hinged Main doors shall be provided for outdoor type RMU. The hinges for the doors need to be riveted and shall not have any access from outside. Bolted shall not be acceptable.
44	Voltage indicator box shall be fixed type-This device shall be in compliance with IEC 62271-206:2011 standard only	Capacitive dividers type which will supply low voltage to power the lamps AND 3 inlets can be used to check phase sequence or presence of voltage in cable

45	Cable cleats (full circle)	HDPE/Nylon (Fire Retardant)
46	Cable termination and bushing suitability	Heat/ Cold shrink terminations
46A	Cable Termination boot /Cable boot	Cable Termination Kit & Termination Boot in scope of Supplier. Cable Size in detailed Engineering Stage
46	Cable compartment suitability shall be	Suitable for cable sizes a. 11kV 3CX400 sq.mm having dia of 92mm in all compartment and b. For three way with two CB the LBS shall be suitable for 11kV 1CX630 sq.mm cable having diameter of 51mm in incomer LBS- the necessary cleat and nonmagnetic base plate cable entry arrangement and 15mm longer bolt than other compartment shall be provided.
47	The cable compartment	All cable compartment shall be bottom entry and front opening type only
48	Size of bimetallic washer in all compartments	Must be suitable for M16 for TPCODL, ODISHA) bolt and bushing sizes with min. 2mm thick.
49	Height of bushing terminal from base plate	Minimum 800mm for proper termination space.
50	Fault passage indicator	FPI on each LBS as a part of each RMU with specified default setting.
51	Operating handle	To be provided by bidder as a part of RMU with each RMU and to be placed on front or on door

52	Non removable MIMIC Diagram on Front of panel	To be provided by bidder with detailed descriptions as mentioned in specs. And earth switch marking background shall be yellow for TPCODL-ODISHA As per annexture-2
53	Main Bus bar Material	Copper
53.1	Bus bar Cross Section	To be specified by bidder as per current density
54	Opening & Closing times with relay	125 ms maximum
55	Current Transformer for CB compartment	Shall be epoxy resin casted and mounted on cables. The CTs around the cables shall be supported on the sheet steel bracket and should be fixed with bolts. The mounting frame should be moveable up and down or to and fro but shall be fixed at coaxial position with base plat holes and bushing terminal bolts. a. For TPCODL, ODISHA The CT settings shall be adjustable between 50-150-300/1 Amp at terminal block. CT ratio is 50-150-300/1A, Burden is 2.5 VA, Class - 5P20.
56	Future motorization and SCADA Compatibility	To be provided
57	Guarantee	As per specification
58	Dimension (LxWxH) (mm x mm x mm)	To be provided by bidder
59	Total weight	To be provided by bidder
60	Paint	Light Gray shade RAL 7032
61	Type test of product	To be provided by bidder as per specification

62	Availability of spares	Assurance by bidder for 25 years,list of spares as mentioned in specification to be provide along with RMU lot
63	VPIS auxiliary contact	The VPIS shall have auxiliary contact such that it can be configured with SCADA for remote status indication of cable charged. The auxiliary contact to be wired up in TB.
64	VPIS	In all compartments
65	Breaker operation counter	To be provided by bidder
66	LBS operation counter	To be provided by bidder
67	Moisture absorption material in SF6 tank	Bidder should provide the detail of the moisture absorption material.
68	Bidder should provide the detail of the moisture absorption material.	a. LBS – ON/off b. ES- Open/ close c. CB disconnector- ON/off d. CB earth switch-Open/ close
69	Making of earthing operations	a. For TPCODL, ODISHA All earth operation to be marked with Yellow back ground and permanent in nature.
70	Auxiliary contacts (total numbers and spare numbers)	LBS Earth Switch CB CB Disconnector - CB earth switch
71	Control cable entry provision	To be provided
72	Shunt trip coil 24V DC	To be provided
73	MCB for LT AC incomer and TB	To be provided

	connection of all CT, Aux switches and relay wiring	
74	RMU Cable Boot/ terminal protector	
a	Terminal protector	Insulating Boots
b	System voltage	12 kV
c	AC High voltage	28kV For 1 min
d	Impulse withstand voltage	75kV
e	Bushing Diameter	To be provided by bidder
f	Bushing Types	To be mentioned by bidder
g	Cable cross section suitability	Bidder to provide complying to specs.
h	Dimensions of cable protector	Suitable for cables & bushing in specs (offered size to be provided by bidder)
i	Material of the component	To be specified by bidder
j	Type test reports	Bidders to provide detailed list of tests conducted at lab name, conducted dates, report number along with full reports.
For motorized RMU		
1	SCADA Compatibility-Remote operation of RMU shall be possible by using motors fitted to operating mechanism of isolators & CB etc.	To be provided
2	Harting Plug arrangement for individual isolator as well as breaker motor connections, which will be fitted on RMU body itself	To be provided
3	Details of I/O	As per Annexure-IO list of this specs
4	System to prevent mal operation in case of latch command	Bidder to provide inbuilt system to prevent any mal operation in case of latch command at RMU in case of any fuse failure or DC fail

		situation
5	Technical Details of motors	
a	Operating Voltage	24 V DC
b	Max. power rating	240 Watts
c	Max current drawn	9 Amp (±10%)
d	Operating time	4-8 seconds
e	Power Supply	24VDC from Battery Charger and 230 VAC from Aux PT in scope of Supplier

Type of Ring Main Units shall be as under:

3 Way/4 Way Non Extensible Type (For Outdoor application):

3 Way RMU: 2 LBS 1 VCB with Self powered O/C & E/F Relay and 1 FPI

4 Way RMU: 2 LBS 2 VCB with Self powered O/C & E/F Relay and 1 FPI

5.0 GENERAL CONSTRUCTIONS

5.1 GENERAL CONSTRUCTION FOR RMU

5.1.1 The switchgear and bus bar shall be contained in a stainless steel tank filled with SF6 gas and the outer body shall be made of minimum CRCA of 2mm or GI high tensile steel 2mm thick with thick gland plates of 3mm. The sheet steel shall have surface treatment of 7 tank process With powder coating of minimum 70 microns. The tank shall have SS sheet of minimum 2mm thickness with internal Arc Type tested and meet the "sealed pressure system" criteria in accordance with the IEC 62271-200. This is a system for which no handling / refilling of gas shall be required throughout the expected operating life, i.e. 30 years. Sealed pressure systems are completely assembled, filled and tested in the factory. The maximum leakage rate of SF6 gas shall be lower than 0.1 % of the total initial mass of SF6 gas per annum. The filling pressure for the switchgear shall be just above the atmospheric pressure so as to reduce the tendency to leak. SF6 gas used for the filling of the RMU shall be in accordance with .IEC 376. It is preferable to fit an absorption material in the tank to

absorb the moisture from the SF6 gas and to regenerate the SF6 gas following arc interruption. The degree of protection for RMU tank (Indoor/Outdoor) shall be IP 67. The mimic board shall be provided with IP2X /IP3X degree of protection for Indoor RMUs and protection for Outdoor RMUs shall be minimum IP 54

The RMU shall be suitable for mounting on plinth with provision for cabling through gland plate in the base and trench below, The RMU shall be designed so that the position of the different devices is visible to the operator on the front and operations are also visible. The RMU shall be identified by an appropriately sized label which clearly indicates the functional units and their electrical characteristics. The RMU shall be designed to be tamper proof so as to prevent access to all live parts during operation without the use of tools.

5.1.2 The RMU shall be completed with all connection and tinned copper bus bar with continuous current carrying capacity of 630A at 40 Deg C ambient. The bus bar shall be fully encapsulated by SF6 gas inside the steel tank. There shall be continuity between the metallic parts of the RMU and cables so that there is no electric field pattern in the surrounding air, thereby ensuring the safety of people. The earth bus bar shall be preferably enclosed in an enclosure to prevent theft/tampering.

5.1.3 All parts of main circuit to which access is required or provided shall be capable of being earthed prior to becoming accessible. This does not apply to removable parts which become accessible after being separated from the switchgear and control gear. The cables shall be earthed by an earth switch with short-circuit making capacity in compliance with IEC 62271-102. Circuit breaker shall not be closed in case Earth Switch is closed. The earth switch shall be fitted with its own operating mechanism and manual closing shall be driven, by a fast-acting mechanism, independent of operator action. Mechanical interlocking systems shall prevent access to the operating shaft to avoid all operator errors such as closing the earth switch when cable is charged.

5.1.4 Any accidental over pressure inside the sealed chamber shall be limited by the opening of a pressure limiting device provided in the rear part of the tank. Gas shall be released to the rear of the RMU away from the operator. Bidder shall provide type test report to prove compliance to the 'Internal fault IAC AFLR as per IEC 62271-200. An anti-reflex mechanism on the operating lever shall prevent any attempts to reopen immediately after closing of the switch-or earth switch. All

manual operations shall be carried out on the front of the RMU. The instrument transformers (CT/PT) shall be required and to be incorporated in the drawing for discussion at the final stage.

5.1.5 Circuit Breaker for Transformer Local Feeder Control

The circuit breakers shall be of the maintenance free. The position of the power and earthing contacts shall be clearly visible on the front of the RMU. The circuit breakers shall have at least 2 positions: Open-disconnected and closed and shall be constructed in such a way that natural interlocks prevent all unauthorized operations. They shall be fully mounted and inspected in the factory. Breaker operation counter should be provided. Breaker contact resistance should be <=50 micro-ohms.

An operating mechanism can be used to manually close the circuit breaker and charge the mechanism in a single movement. It shall be fitted with a local system for manual tripping by, an integrated push button. There will be no automatic re-closing. The operating mechanism shall be compatible for remote/SCADA operation. The circuit breaker shall be associated with an integrated protection unit that will operate without any auxiliary power supply and shall include three toroid transformers incorporated in the transformer tee-off bushings, an electronic self powered relay, a low energy release, and a "fast-on" test receptacle for protection testing (with or without CB tripping).

The protection system shall ensure circuit breaker tripping as of a minimum operating. current which is the rated current of the underground network to be protected. The CT settings shall be adjustable between 600 to 300/5 Amps'as per the requirement at site. Protection core CT complete details should be furnished (Burden, class, ALF).

The circuit breaker shall be provided with Phase protection of Definite time/ IDMT element for .overcurrent and earth fault with minimum PSM-0.05,Tsm-0.01 having standard characteristics of Standard Inverse, Very inverse, Extremely Inverse as per IEC 60255-3 standard. The Earth Fault Protection shall be provided of. Definite time/ IDMT element having standard characteristics of Standard Inverse, Very inverse, Extremely Inverse as per IEC 60255-3 standard. The "Time Multiplier" with minimum set point of 0.05 TMS shall be available. The breaker shall have the provision of flag Relay for indication of Trip on Fault. High set (DT) for overcurrent and earth fault-min .current setting-0.5 In, minimum Time Delay-20 millisecond. The relays shall be suitable numerical relay with necessary elements or any other relay as per the Purchaser's approval.

There' shall be provision for testing of cable without opening the front door by suitable arrangements. In case cables are to be tested with front door open, doors shall have interlocks such that doors can be opened only with earth switch in closed position & a cable test rod shall be provided which can be fixed on the terminations to facilitate testing. Termination boots as approved by the Purchaser's should have a proper opening to facilitate the testing. The opening shall be covered by means of removable protection cap

In case of front door opened, it shall not be possible to operate the breaker. All panel covers shall be provided with anti vandal screw bolts so that opening of panel covers is only possible with special tools, which shall be provided by the Bidder. This is required to prevent pilferage. The cable cover door shall be pad lockable and shall be Tamper and Arc proof. There shall be proNAsion of hinged doors in the RMU. The circuit breaker and earth switch shall be lockable in the open or closed positions by 1 to 3 padlocks. Breaker shall have mechanical fftdurance of at least 2000 operations.

The circuit breaker shall be compatible for remote operation and can close (ON) and open (OFF) by remote operation.

5.1.6 Incomer Load Break Switches :

The Load break switches shall have positions, open-disconnected closed, and earthed, and will be constructed in such a way that natural interlocking prevents unauthorized operations

The position indicator shall provide positive contact indication in accordance with IEC 265-1 standard. In addition, manufacturer shall prove reliability of indication in accordance with IEC 129.

The switches shall be fully mounted and inspected in the factory. Manual opening and closing will be driven by a fast-acting mechanism, independent of operator action.

Mechanical Interlock should be provided for Earth switch, If cable is back charged Earth switch should not be closed.

Each switch can be fitted with an electrical operating mechanism in a specially reserved location, without any modification of the operating mechanism and without de-energizing the RMU.

Load break Switch should be operated manually & motorized.

5.1.7 Bushings and Cable terminations:

Each cable compartment shall be provided_ with three-_ bushings _of adequate _sizes to terminate the incoming and outgoing cables along with a terminal block (TB) located at convenient accessible location so as to wire all inputs & outputs (I0s) up to the terminal block (TB). The bushings shall be conveniently located for proper bend so as to allow easy working and termination of cables. The cable termination shall be done with Heat shrinkable /Push ON termination method so that adequate clearances are maintained between phases & cable shall be held by HDPE (fire retardant) cleat. 2 runs, of 3CX400 Sq mm, OR 1R of 3 NO. 1CX630 Sq mm shall be used for cable termination.(It shall be finalized during detailed engineering) All the cable secondary Wiring should 'be rooted through marshaling box separately for relay, CT etc.BA should provide bimetallic washer for tightening of cable.

5.1.8 Earthing:

The RMU outdoor metal clad, switchgear„ Distribution Transformer, R.S. Joists, M.S Channels/M.S. angles etc, shall be equipped with an earth bus securely fixed along the base of the RMU. The size of earth busbar of GI Strip (75X12 sq.mm) shall be as per IEC/IS. Provision shall be made on end of RMU for connecting the earth bus to the earth grid by erecting suitable 2 earth pipes of 50mm dia. M.S. rod of 3 meter in Pits. Both the earth pipes are also to be connected in a grid formation. Necessary terminal clamps and connectors shall be included in the scope of supply.

5.1.9 Voltage indicator lamps and phase comparators:

Each function shall be equipped with a fixed type voltage indicator box on the front to indicate whether or not there is voltage in the cables. The capacitive dividers Will supply low voltage power to the lamps. Three inlets can be used to check the synchronization of phases. These devices shall be in compliance with IEC 61958 standard.

5.1.10 Front Cover

The front cover shall provide a clear mimic diagram that indicates the different functions. The position indicators shall give a true reflection of the position of the main contacts. They shall be clearly visible to the operator. The lever operating direction shall be clearly indicated in the mimic diagram. The bidder shall provide a marking plate showing RMU's main electrical characteristics.

5.1.11 Fault Passage Indicators

Fault Passage Indicators shall be installed on the Ring Main Unit. These devices shall be, electronic devices with their own energy source and connected to Single 3 phase Split Core CTs (CBCT) . These shall be provided with bright LED s / flag. Indicators, which shall be clearly visible in the day time. These shall have the following resetting facilities:

-Manual reset

-Resetting after a set time duration

-Electrically reset from remote with at least 2-spare potential free Contacts.

The unit shall have Short Circuit and Earth fault adjustable to different settings with separate Current transformer. They shall be fully field-programmable and shall have at least 16 settings for Earth Fault + 4 settings for Phase-Phase. It shall be possible to Test these indicators at site thru "Test" push button. The Fault Passage Indicators shall also be provided with a SCADA output contact. These shall confirm to the following standards:

IEC 60068-2-6, IEC 60068-2-9	: Environmental testing — For Vibration, solar radiations
IEC 60950	:Information Technology equipment - Safety
IEC 1000-2	: Electromagnetic compatibility for low-frequency
IEC 1000-4	conducted disturbances and signaling in public low
IEC 1000-6	power supply systems
	: EMC - Testing & Measurement
	: EMC- Immunity for Residential, Commercial and light industrial environments

5.1.12 Remote Control of the RMU:

Remote operation of the RMU line switches shall be possible using pre- fitted motors to the operating mechanism for both line switch and circuit-breaker functions. All the necessary accessories shall be supplied separately, to stores.

Auxiliary contacts for remote indication of switch status are also required.

The fitting of the motors to the mechanism must not in any _way impede or interfere with the manual operation of the switches. An auxiliary contact to prevent motorized

operation of the mechanism while the operating handle is inserted into the operating point shall also be provided.

Preferred Communication protocol for FRTU shall IEC-60870-5-104

Signal requirement for field RTU (which shall be mounted near RMU) is attached (refer Annexure1). Bidder shall quote the cost of field RTU (FRTU) separately with all technical details for acquisition of the signal as described in Annexure-1.

5.1.13 Paint

All paint shall be applied on clean dry surfaces under suitable atmospheric conditions by seven tank process and powder coating. The overall paint thickness shall not be less than 100 microns ±25 micron as standard. The paint shall not scale off or crinkle or be removed by abrasion during normal handling. The enclosure of the RMU shall be painted with shade Dark Gray, i.e., BS381C or RAL 7032. Sufficient quantity of touch-up paint shall be furnished for application at site.

6. MARKING

All the components and operating devices of the RMU shall be provided with durable and legible nameplates containing all technical parameters. Name plates shall be suitably embossed with" PO no. with date", "PROPERTY OF TPCODL & PO Number along with the following information. A Danger plate of appropriate size shall also be provided on the enclosure.

a) Manufacturer's Name
b) Month and year of supply
c) PO Number
d) Rated Voltage
e) System Frequency
f) Rated Short time withstand current for 1 sec
g) Rated Impulse withstand Voltage
h) Degree of Protection
i) Type Designation or Serial no.
j) Year of manufacture
k) Applicable Rated values
l) Mass of unit
m) SF6 gas filling pressure

7. TESTS

7.0 TESTS FOR RMU

All the Routine and acceptance tests shall be carried out in accordance with the relevant IS/IEC standards. All routine/acceptance tests shall be witnessed by the purchaser/his authorized representative. All the components within the RMU enclosure shall have been tested for Routine/acceptance and Type tests as per the relevant standards. All Type tests as per latest IS / 1EC shall have been carried out on the RMU as a whole as per relevant IS/IEC. Following tests shall be necessarily conducted on the equipment and its components in addition to others specified in the IS/IEC:

Type Test

a) Dimensional and visual check
b) Mechanical operation test and checking of interlocks
c) Dielectric test on main and control circuits.
d) Temperature Rise test.
e) Internal Arc withstand test,
f) Degree of Protection test.
g) Test to check the capability of main and earthing circuits subjected to rated peak and short time withstand current.
h) Test to check the total time taken to clear the faults (relay pick up+ Trip coil pick up + breaker trip) for instantaneous & time delay modes.under various settings of relay and trip coil thru secondary current injection.
i) Salt Spray Test

The above type test certificates must accompany drawing of type tested equipment, duly signed by type testing authority.

The above tests must not have been conducted on the equipment within time frame as per latest CEA Guidelines In case of any change in design/type of Breaker already type tested and the one offered against this specification, the owner reserves the right to demand repetition of type tests, without any extra cost.

Routine test:

Following routine tests are to be done on 100% of the lot quantity

1. Power Frequency Withstand Test.
2. Dimensional & Visual Checks
3. Operational & Interlock Tests of breaker & isolator switches
4. Measurement of Circuit Resistance
5. Sf-6 chamber pressure withstands/leakage test.
6. HV withstand test across isolator distance.
7. HV withstand test of control and auxiliary circuits.
8. Voltage Indication Tests.
9. Breaker Contact Resistance Test
10. Total Trip Time Check Test through Current Injection in primary.
11. IR Value.

Below routine test has to be provided on cable Boot for cable termination:

a) Visual inspection of the final finished product.
b) Intactness with Bushing.
c) Insulation Test.
d) AC HV test.

Acceptance test:

All the tests specified under Routine Test Clause above shall be carried out as acceptance test on random samples as per sampling plan under IEC/IS for each lot.
Bidder should have all the requisite testing equipment's to carry out routine and acceptance test mentioned above including:

a. Facility for primary current injection up to 1000amp.
b. Facility to check total trip timing of breaker along with breaker main contacts through primary current injection

8.0 TYPE TEST CERTIFICATE

The Bidder shall furnish the type test certificates of the 11 KV RMU for the tests as mentioned above as per the corresponding standards. All the tests shall be conducted at CPRI or any other International Laboratory as per the relevant standards. Type tests shall have been conducted in certified Test laboratories during the period not exceeding time span as per CEA guidelines. In the event of

any discrepancy in the test reports, i.e. any test report not acceptable or any/all type tests (including additional type tests, if any) not carried out, same shall be carried out without any cost implication to TPCODL.

9.0 PRE-DISPATCH INSPECTION

Equipment shall be subjected to inspection by a duly authorized representative of the TPCODL. Inspection may be made at any stage of manufacture at the option bf the purchaser and the equipment if found unsatisfactory as to workmanship or material is liable to. rejection. Supplier shall grant free access to the places of manufacture to TPCODL's representatives at all times when the work is in progress. Inspection by the TPCODL or it's authorized representatives shall not relieve the supplier of his obligation of furnishing equipment in accordance with the specifications. Material shall be dispatched after specific MDCC (Material Dispatch Clearance Certificate) is issued by TPCODL. Following documents shall be sent along with material

a) Test reports
b) MDCC issued by TPCODL
c) Invoice in duplicate
d) Packing list
e) Drawings & catalogue
f) Guarantee / Warrantee card
g) Other Documents (as applicable)

10.0 INSPECTION AFTER RECEIPT AT STORE

The material received at TPCODL Store will be inspected for acceptance and shall be liable for rejection if found different from the reports of the pre-dispatch inspection and one copy of the report shall be sent to Project Engineering department.

11.0 GUARANTEE

Bidder shall stand guarantee towards design, materials, workmanship & quality of process / manufacturing of items under this contract for due and intended performance of the same, as an integrated product delivered under this contract. In the event any defect is found by the Purchaser up to a period of at least 48 months from the date of commissioning or 60 months from the date of last supplies made under the contract whichever is later, Bidder shall be liable to undertake to replace/rectify such defects at its own costs, within mutually agreed time frame, and to the entire satisfaction of the

Purchaser, failing which the Purchaser will be at liberty to get it replaced/rectified at Bidder's risks and costs and recover all such expenses plus the Purchaser's own charges (@ 20% of expenses incurred), from the Bidder or from the " Security cum Performance Deposit" as the case may be.

Bidder shall further be responsible for 'free replacement for another period of **THREE** years from the end of the guarantee period for any 'Latent Defects' if noticed and reported by the Purchaser.

12.0 PACKING

Bidder shall ensure that all equipment covered by this specification shall be prepared for rail/road transport (local equipment) and be packed in such a manner as to protect it from damage in transit

13.0 TENDER SAMPLE

Not applicable.

14.0 QUALITY CONTROL

The bidder shall submit with the offer, assurance plan indicating the various stages of inspection, the tests and checks which will be carried out on the material of construction, components during manufacture and after finishing, bought out items and fully assembled component and equipotent including drives. As part of the plan, a schedule for stage and final inspection within the parameters of the delivery schedule shall be furnished. The Purchaser's or its nominated representative engineer shall have free access to the manufacturer/sub-supplier's works to carry out inspections.

15.0 TESTING FACILITIES

Bidder shall have adequate in house testing facilities for carrying out all routine tests & acceptance tests as per relevant International / Indian standards.

16.0 MANUFACTURING ACTIVITIES

The successful bidder will have to submit the bar chart for various manufacturing activities clearly elaborating each stage with quantity. This bar chart shall be in line with the Quality Assurance Plan, submitted with the offer. This bar chart will have to be submitted within 15 days from the release of the order.

17.0 SPARES, ACCESSORIES & SPECIAL TOOLS/GAUGES

Bidder shall provide a list of recommended spares with quantity and unit prices for 5 years of operation after commissioning. The Purchaser may order all or any of the spare parts listed at the time of contract award and the spare parts so ordered shall be supplied as part of the definite works. The Purchaser may order additional spares at any time during the contract period at the rates stated in the Contract Document. Bidder 'shall give an assurance that spare parts and consumable items will continue to be available through the life of the equipment which shall be 25 years minimum. However, the Purchaser shall give a minimum of 12 months notice in the event that the Bidder or any sub-vendor plans to discontinue manufacture of any component used in this equipment.

Any spare apparatus, parts or tools shall be subject to the same specification, tests and conditions as similar material supplied under the Contract. They shall be strictly interchangeable and suitable for use in place of the corresponding parts supplied with the plant and must be suitably marked and numbered for identification.

18.0 DRAWINGS & DOCUMENTS

Following drawings and documents shall be prepared based on TPCODL specifications and statutory requirements and shall be submitted with the bid:

a) General description of the equipment and all components including brochures.
b) General arrangement for RMU
c) Power flow diagram
d) Foundation plan
e) Bill of material
f) Experience List
g) Type test certificates

Drawings / documents to be submitted after the award of the contract are as under:

SI. No.	Description	For Approval	For Review/Informati	Final Submission
1	General Technical Particulars	✓		✓
2	General Arrangement drawings	✓		✓
3	Schematic Diagram	✓		✓
4	Bill of materials	✓	✓	✓
5	Foundation Plan & loading			✓
6	Installation Instructions		✓	✓
7	Instruction for Use		✓	✓

8	Transport/ Shipping dimension drawing	✓	✓	✓
9	QA & QC Plan	✓	✓	✓
10	Test Certificates			

All the documents &drawings shall be in English language.

After the receipt of the order, the successful bidder will be required to furnish five copies of all relevant drawings for TPCODL approval.

Instruction Manuals: Bidder shall furnish two softcopies (CD) and four (4) hard copies of nicely bound manuals (In English language) covering erection and 'maintenance instructions and all relevant information and drawings pertaining to the main equipment as well as auxiliary devices.

19. GUARANTEED TECHNICAL PARTICULARS

Sl. No	**Descriptions**	**As Specified By OPTCL**
1	RMU Category	
2	RMU application	
3	Offered Model nos. and OEM type	
4	Dielectric medium	
5	Interrupting medium	
6	System Frequency	
7	Rated Voltage	
8	Service Voltage	
9	Rated current -Line Switches	
10	Rated Current-CB and LBS	
11	Rated Short time current withstand (3 sec)	
12	Rated Short time Making capacity	
13	Rated cable charging interrupting current of incomer load break switch	
14	Rated load interrupting line current	
15	Rated cable charging breaking current of breaker	

16	No. of operations at rated short circuit current on line switches, earthing switches should be E2	
17	Opening time of breaker (max.) Without relay time	
18	Closing time of breaker (max.)	
19	Breaker Duty Cycle	
20	i. Mechanical endurance for Isolator & Earth Switch	
	ii. Mechanical endurance for Circuit Breake	
21	Electrical operations of at rated current a. LBS/Disconnector b. Earth Switch	
22	Temp rise above ambient of 50 deg.	
23	Min Gas pressure in bar	
24	SF6 Gas pressure manometer with indicating bars/scale to measure the actual gas pressure (indirect method RFS etc. not accepted)	
25	Enclosure	
26	Guaranteed SF6 leakage per annum	
27	Degree of protection	
28	Internal Arc rating	
29	Internal Arc test	
30	Lightning Impulse withstand Voltage	
31	Power Frequency withstand voltage	
32	SF6 Tank design	
32.1	Tank material and grade of SS and welding	
33	Earth bus bars	
34	Material & size of earth bus bar	
35	Earthing of main CCT Cables shall be earthed with earth switch with S/C making capacity as per IEC 129. Moving contacts of earthing switch shall be visible in closed	

	position thru transparent covers AND closing shall be possible only when Isolator is open	
36	Incomer Load Break switch: Shall be SF6 insulated with least maintenance. Shall have at least 3 positions, Open, Close & earth with natural interlocks. Fitting of motor at site shall be possible & shall have mechanical interlock. The electrical interlock of cable charge with earth switch is preferred.	
37	Circuit Breakers: a. With VCB interrupter and SF6 insulated bus with minimum maintenance and shall have at least 2 positions I.e. Open & Close, Manual operation & fitting of motor at site shall be possible if required. b. In view of safety each VCB shall be assisted with feeder side disconnector having 3 positions, open disconnected, closed, and earth (having fault making capacity) and shall be constructed in such a way that natural interlocking prevents unauthorized operations.	
38	Protection Relay-Without auxiliary power & shall include , electronic relay, low energy release & fast on test receptacle for protection testing	
39	Make of self-powered Relay & offered model	
40	Flag indication for CB Trip on fault in relay/ mechanical	

41	Testing of Cable- If doors are opened then earth switch shall be in closed position with necessary interlocks and cable test rod fixing provision in bolt head which can be fixed on terminations through boot cap/opening for testing purpose AND if doors are opened it shall not be possible to operate, Isolator, E/Switch or CB through interlocks	
42	Protection against theft	
43	Doors	
44	Voltage indicator box shall be fixed type- This device shall be in compliance with IEC 62271-206:2011 standard only	
45	Cable cleats (full circle)	
46	Cable termination and bushing suitability	
46A	Cable Termination boot /Cable boot	
46	Cable compartment suitability shall be	
47	The cable compartment	
48	Size of bimetallic washer in all compartments	
49	Height of bushing terminal from base plate	
50	Fault passage indicator	
51	Operating handle	
52	Non removable MIMIC Diagram on Front of panel	
53	Main Bus bar Material	
53.1	Bus bar Cross Section	
54	Opening & Closing times with relay	
55	Current Transformer for CB compartment	
56	Future motorization and SCADA Compatibility	
57	Guarantee	
58	Dimension (LxWxH) (mm x mm x mm)	
59	Total weight	

60	Paint	
61	Type test of product	
62	Availability of spares	
63	VPIS auxiliary contact	
64	VPIS	
65	Breaker operation counter	
66	LBS operation counter	
67	Moisture absorption material in SF6 tank	
68	Bidder should provide the detail of the moisture absorption material.	
69	Making of earthing operations	
70	Auxiliary contacts (total numbers and spare numbers)	
71	Control cable entry provision	
72	Shunt trip coil 24V DC	
73	MCB for LT AC incomer and TB connection of all CT, Aux switches and relay wiring	
74	RMU Cable Boot/ terminal protector	
a	Terminal protector	
b	System voltage	
c	AC High voltage	
d	Impulse withstand voltage	
e	Bushing Diameter	
f	Bushing Types	
g	Cable cross section suitability	
h	Dimensions of cable protector	
i	Material of the component	
j	Type test reports	
For motorized RMU		
1	SCADA Compatibility-Remote operation of RMU shall be possible by using motors fitted to operating mechanism of isolators & CB etc.	
2	Harting Plug arrangement for individual isolator as well as breaker motor	

	connections, which will be fitted on RMU body itself	
3	Details of I/O	
4	System to prevent mal operation in case of latch command	
5	Technical Details of motors	
a	Operating Voltage	
b	Max. power rating	
c	Max current drawn	
d	Operating time	
e	Power Supply	

20. SCHEDULE OF DEVIATIONS
(TO BE ENCLOSED WITH TECHNICAL BID)

All deviations from this specification shall be set out by the Bidders, clause by Clause in this schedule. Unless specifically mentioned in this Schedule, the tender shall be deemed to confirm the purchaser's specifications:

S. No	Clause No.	Details of deviation with justifications

ANNEXURE – 1
SIGNAL LIST FOR AUTOMATION

Description	Analog Inputs(AI)					Status(DI)		
Type	Amp. Loading-R ph	Amp. Loading-Y ph	Amp. Loading-B ph	Phase Voltage	Power factor	Switch close	Switch Open	Reset Element
RMU Switch *	0	0	0	0	0	1	1	
Breakers *	1	1	1	1	0	0	0	
FPI							1	1
Pressure Gauge (manometer)							1	

FRTU SIGNAL LIST

Description	Analog Inputs (AI)				
Type	Amp. Loading-R ph	Amp. Loading-Yph	Amp. Loading-B ph	Phase Voltage	Power factor
Switch *	0	0	0	0	0
Breakers *	1	1	1	1	1
Fault passage indicator *	0	0	0	0	0

Note: 0 indicate functionality not req. for that element, 1 indicate functionality required for that element

* Denotes the nos of switches/ Breaker s in RMU based on the type of RMU (3way, 4way, 5way & 7way).

Additional IOs

RMU switch Control Command
Earth Sw. 1 Status Input
Earth Sw. 2 Status Input
FPI Reset
FRTU Local/Remote Position
FRTU Door Open
FRTU Battery Charger Faulty
FRTU Battery Faulty
FRTU SwitchGear Supply Off
FRTU Aux Supply Off
FRTU Fault
Relay operation
CB OFF status
CB ON status
CB ON/OFF Command

CHAPTER-E6
SUBSTATION AUTOMATION SYSTEM

TABLE OF CONTENT

SUBSTATION AUTOMATION SYSTEM

1.0 Scope of Supply

This specification covers the design, manufacture, inspection, testing at the manufacturer's works and erection and commissioning of a Substation Automation System described in the following sections, to control and operate the 33/11 kV GIS substation.

This describes the facilities required to provide the control of plant and system within a substation and outlines the facilities to be provided on site, interface requirements and performance criteria.

The Substation Automation System (SAS) shall comprise full station and bay protection, control, monitoring and communication functions. It shall enable local station control via PC by means of a human machine interface (HMI) and control software package and perform the necessary system control and data acquisition functions. It shall include communication gateway to inter- bay-bus, intelligent electronic devices (IED) for bay control and protection as shown in the enclosed general system architecture drawing.

The communication gateway shall secure control from and information flow to remote network control centres. The inter-bay bus, configured as a star connection (via star couplers) shall provide independent station-to-bay and bay-to-bay data exchange. The bay level intelligent electronic devices (IED) for protection and control shall be directly connected to the instrument transformer without any interposing equipment and perform control, protection, and monitoring functions subject to a detail proposal approved by the Engineer in charge.

The IED's for protection and control functions shall maintain high availability and reliability together with bay independence through extensive self-supervision and state-of-the-art technology.

The system shall be capable of having its computing power increased in the future by the addition of additional computing systems.

The bidder shall provide

(i) IEC 61850 compliance report for the offered system with IEDs and

(ii) Interoperability test report for the offered system with SAS manufacturers with IEC

61850 protocol from any UCA approved system verification and validation centre along with the bid document.

The capacity of the SA system shall be sufficient for the ultimate development of the substation as set out in the project requirements.

The SA supplier shall demonstrate that the system proposed has been designed, installed and commissioned in accordance with relevant international standards and the specification shall provide evidence of satisfactory service experience during the past 5 years.

The contractor shall provide the installation software of the substation automation system.

Installation, testing and commissioning of substation automation system shall be done by the automation Engineer(s) of the substation automation manufacturer(s).

The software architecture and the database structure shall be finalized with the Owner. The facilities shall be incorporated in order to access the database from the backend by the authorised user of the Owner. Object oriented technology shall be used in the software development.

The Source Codes of the software standard documentation shall be handed over to the Purchaser. The standard database like Oracle, MySQL, SQL shall be used.

Cyber Security of this system shall be built in with the system. The objective of cyber security is to protect information and physical assets from damages

caused by theft, corruption or natural disasters while allowing the information and assets to remain accessible and productive to employer. All potential causes of cyber attacks need to be considered when employing a defense in depth approach.

2.0 Compliance with Standards

For design and type testing of the protection and control equipment, the following standards shall be applicable:
General List of Specifications

IEC 255:Electrical Relays
IEC 60038:IEC Standard voltages
IEC 68068:Environmental testing
IEC 60664:Insulation co-ordination for equipment within low-voltage systems
IEC 61850:Standard for Substation integrated protection and control data communication

Detailed List of Specifications
IEC 255-6:Measuring relays and protection equipment
IEC 255-7:Test and measurement procedures for electromechanical all-or-nothing relays
IEC 68-2-3:Test Ca: Damp heat steady state
IEC 68-2-30:Test Db and guidance; Damp heat, cyclic
IEC 255-5:Insulation tests for electrical relays
IEC 255-22:Electrical disturbance tests for measuring relays and protection equipment: IEC 255-22-1:1 MHz burst disturbance test
IEC 255-22-2:Electrostatic discharge test
IEC 255-22-3:Radiated electromagnetic field disturbance test
IEC 255-22-4:Fast transient disturbance test
IEC 255-11:Interruptions to and alternating component (ripple) in D.C .auxiliary energizingquantity to measuring relays
IEC 255-6:Measuring relays and protection equipment

IEC 255-21:Vibration, shock, bump and seismic tests on measuring relays and protectionequipment:

IEC 255-21-1:Vibration tests (sinusoidal)

IEC 255-21-2:Shock and bump tests

IEC 255-21-3:Seismic tests

IEC 255-0-20:Contact performance of electrical relays

IEC 870-3 class 2:Digital I/O, Analogue I/O dielectric testsIEC 801-5/class 3: Digital I/O Surge withstand test

IEC 870-3/class2:Radio interference test

IEC 801-4/4:Transient fast burst test

IEC 801-2/4:Static discharge

IEC 801-3/3:Electromagnetic fields

3.0 Design and Operating Requirements

3.1 General

The SA shall be suitable for operation and monitoring of the complete substation including future extensions. The offered products shall be suitable for efficient and reliable operation and maintenance support of the substations.

The SA system shall be state-of-the art design suitable for operation in high voltage substation environment, follow the latest engineering practice, and ensure long-term compatibility requirements and continuity of equipment supply and the safety of the operating staff.

Protection is an integral part of the SA system and protective relays shall be directly connectedto the inter bay bus in order to provide unrestricted access to all data and information stored in the relays and for changing protection parameters from the remote control location.

Failure behaviour of the hardware and software functions shall be addressed and related diagnostic and rectification working instructions shall be provided. The system performance, if failure of communication to main and redundant computer base workstations, central functions, data model, control and protection IED's, station and bay level communication shall also be clearly addressed (shall be provided by the manufacturer).

The substation can also be controlled from Local Control Panel. The following modes of operationshall be possible

(a) Emergency operation of breaker, disconnector, earthing switch etc. from the Local Panel.

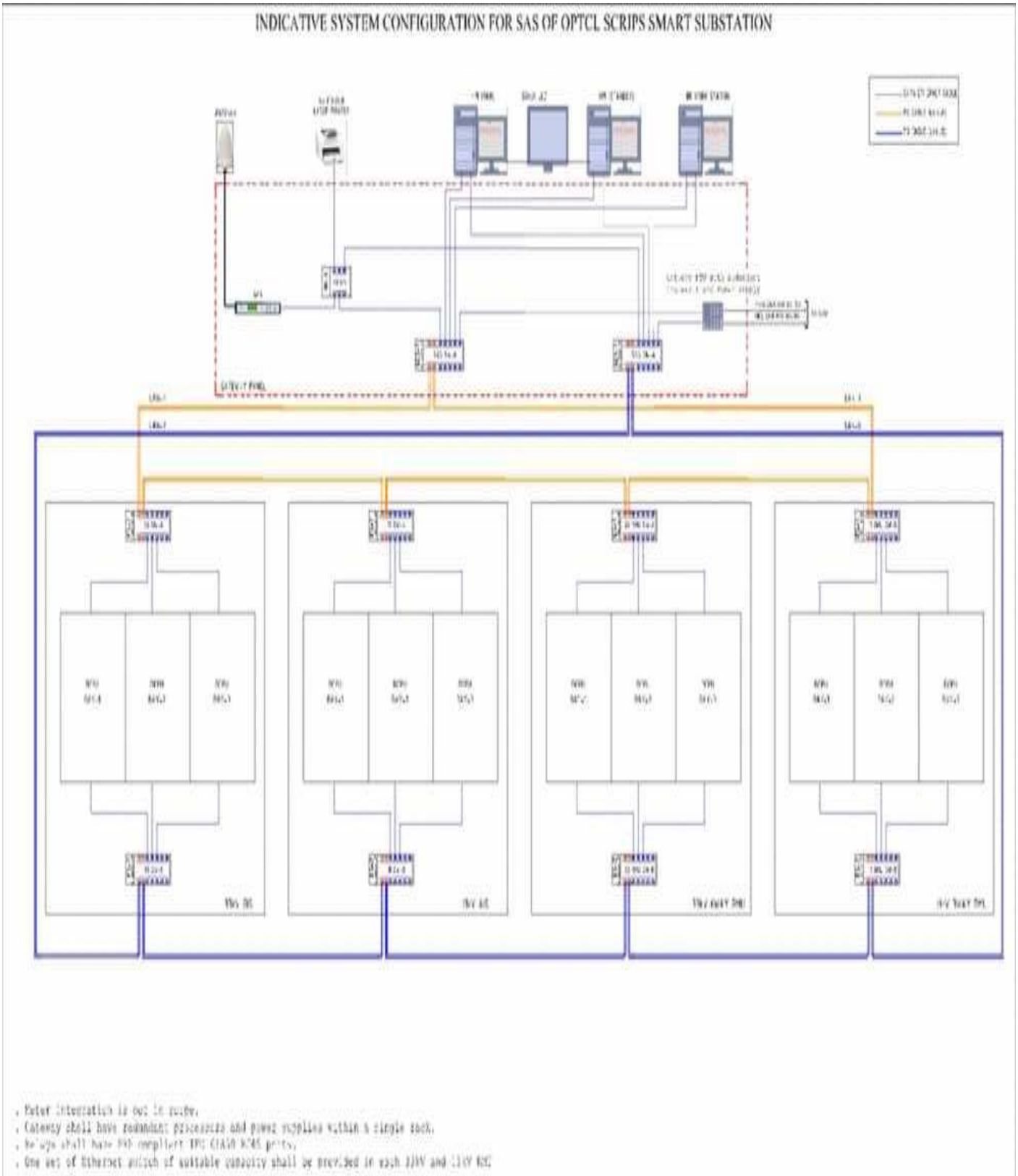
(b) Emergency operation of breaker, disconnector, earthing switch etc. from the backup mimic panel located in the control room. Both bay controller guided and unguided operation shall be possible from this panel.

(c) Normal operation of breaker, disconnector, earthing switch etc. from the Station AutomationSystem HMI.

INVERTER OF 3 KVA CAPACITY:

The SAS shall be provided with supply backup by means of Inverter of 3 KVA capacity to takecare of the entire SCADA system.

SAS Architecture



3.2 Modes of Operation

The operator stations and specified remote users shall have following operational modes, eachpassword protected.

Monitoring ability to select graphic displays and lists for viewing only. No capability to acknowledgealarms, complete controls or select items for inclusion in program functions.

Control: Selection of graphic display and lists. Able to acknowledge station and SA alarms, complete controls, dressing etc. associate with normal real time of the control of the substation.

SAS Engineering: Provides all the SAS monitoring functions, together with online facilities for program/database/format modifications and checking without the possibility of executing power system controls.

System Manager: Provides access to all system functions, including assignment of passwords and system maintenance activities.

In addition a facility to provide access to the numerical Protection relays, change / modify relaysettings & AVR parameters and Fault Recorder data shall be provided.

A series of passwords shall be personally assigned to operators in each of the above categories. It shall be possible for substation operators to log on either of the substation workstation and to be allocated the appropriate mode of operation relevant to the password. SA System Engineering workand access to the protection relay and disturbance reorder information shall generally be carried out at the Engineering workstation or remote master station.

All the workstation and the system database shall function as a system. It shall not be necessary for example to acknowledge an alarm at more than one workstation.

Similarly, an operator manual entry applied at a workstation shall be immediately displayed at other workstations where this data is presented.

3.3 Project Specifications

Specific functions required and boundary conditions of the SAS are detailed elsewhere in this specification. The project specific drawings are attached:

- Overall single line diagram
- General system architecture
- Location of substation buildings
- Control and operation principles
- Protection schemes

3.4 Vendor's Experience and Local Support

Only experienced and technically capable manufacturers with minimum 5 years' experience indesign and supply of control and protection systems for electricity transmission and distribution applications will be accepted. Preferred manufactures will be those who have experience in deliveries of the full scope of station automation systems and services. This experience has to be substantiated by means of reference installations being in service under similar environmental conditions for at least 5 years. In order to assess the vendor's experience with similar projects, the vendor is required to submit the following with his Bid:

- Technical design specifications and description of SAS
- Catalogues and brochures of equipment and devices offered
- Reference list

The vendor shall assure for long-term maintenance and availability of spares. Moreover, a guarantee shall be submitted for the availability of spares during the lifetime of the SAS equipment (not less than 10 years).

4.0 General System Design

The system shall be so designed that personnel without any background in microprocessor basedtechnology can operate the system easily after they have been provided with some basic training.

System control from the substation control room will be with the help of an Industrial Computer (PC)operated by a mouse. The following HMI (Human Machine Interface) functions shall be provided:

- Acquisition and plausibility check of switchgear status
- Control of switchgear
- Remote checking of device parameters and activation of alternative parameter sets in theconnected protective relays
- Display of actual measured values (U, I, P, Q, f, PF)
- Display of Energy (kWh and kVarh export and import)
- Display of events
- Display of alarms
- Display of trends
- Sequence control functions
- Disturbance records and fault location
- System self-supervision
- Hard copy printing

Maintenance, modification or extension of components shall not require a shutdown of the whole station automation system. Self-monitoring of single components, modules and communication shall be incorporated to increase the availability of the equipment while minimising maintenance time to repair.

The data exchange between the electronic devices shall take place via an inter-bay bus using IEC 61850 protocol (PRP based). The high speed bus shall permit peer-to-peer communication between the connected devices with democratic access. The entire station shall be controlled and supervised from the station level PC. It shall also be possible to control, monitor and protect each individual bay from the respective bay level equipment for maintenance purposes or if the communication to a particular bay should fail. Clear control priorities shall prevent initiation of operation of a singleswitch at the same time from more than one of the various control levels viz., station level, bay level or switchgear (apparatus) level. The priority shall always be with the lowest enabled control level.

Each bay control and protection unit shall be independent of each other or may be in one unit as BCPU and its functioning shall not be affected by any fault occurring in any of the other bay control and protection units of the station.

The SAS (PRP based) shall contain the following main functional parts:

- Human Machine Interface (HMI) with process database
- Gateway function for remote control via an industrial grade hardware
- Dial in facility / Desk top workstation for protection relay parameterization,disturbance analysis and SA system fault analysis.
- Data exchange between the different system components via high speed bus
- Bay level devices for control, monitoring and protection
- Bay oriented local control and protection panels with mimic inserts
- Facility for emergency operation of all the switchgear, if bay controller fails. (Key/ masterkey system.)
- Provision for future gateway for remote supervisory control via SCADA
- GPS Mater Clock with GPS antenna & its accessories in all respect.

The main process information of the station shall be stored in distributed databases. The system shall be based on a de-centralized concept with bay oriented distributed intelligence for safety and availability reasons. Functions shall be decentralized, object oriented and located as close as possible to the process.

The substation monitoring/protection system shall supply data for maintenance, repair and remote parameter setting of protection and control devices in the switchyard.

In the event of a fault in the electrical network, the substation monitoring shall provide a quick means for collecting the relevant and critical data of the fault.

The monitoring system shall be suitable for the supervision and monitoring of all the secondary (lED) and primary devices in a substation including future extensions.

Maintenance, modification or extension of components shall not cause a shut-off of the whole station monitoring system. Self-monitoring of single components, modules and communication shall be incorporated to increase the

availability and the reliability of the equipment and minimize maintenance.

It shall be possible to access all protection and control devices for reading the terminal parameters (settings). The setting of parameters or activation of parameter sets shall be restricted by password to the protection engineer.

5.0 Flexibility and Scalability

The offered SA system (PRP based) concept shall be flexible and shall permit future extensions to be realized easily. Preference will be given to those suppliers who are in a position to provide protection and control devices which can be freely adapted to the application functions required.

6.0 System Hardware

6.1 Operator Station

The main operator station shall be based on an industrial PC hardware and high-resolution full- graphics screen with manufacturer's standard type tested software operating under Windows NT environment. An Event printer and a Hard Copy printer shall be connected via a printer server and LAN to the operator station. The CPU shall be installed in the automation panel.

Dual station computers shall control the SA system and drive the work stations and other peripherals. One of the station computers shall operate the system in the "on line" state while the other acts as a "redundant hot standby". The standby computer shall be continuously updated and shall immediately take over the SA system duties without interruption or transfer mechanism should the on line operator workstation fail.

Disturbance Records shall be analysed using the installed Disturbance Record Analysis programmes. The Disturbance Records will be collected, over the interbay bus, from the connected IED's by the system software. All necessary facilities shall be provided to allow the system to perform spontaneous upload of Disturbance data or upload them in a pre- programmed manner. The Event printer shall print events spontaneously as they arrive in the main operator station.

Each uploaded data report file shall be reported on one line that shall contain:

- The event date and time
- The name of the event object
- A descriptive text
- The state or value of the object

The information fields above shall be structured in columns for maximum readability.

The hard copy printer shall permit printing of any picture (or part thereof) from the station level PC'susing easily accessible commands from the window menus.

The main Station PC's shall be supplied by the station DC battery and a UPS system with a supplyduration of not less than 30 minutes shall be provided to supply the monitor and the printers.

6.2 Station Inter-bay Bus:

The LAN connecting the industrial computer based operator workstations, printers shall be Ethernet

802.3 LAN, Protocol TCP/IP (10 M.bits/ sec or higher) and the physical medium shall be thinEthernet or fiber optic bus, provided this LAN is kept within the confines of the control room.

The bay control and protection units shall be connected via glass fiber optic cables to a station inter- bay bus, operating on high speed bus, via star couplers. The star coupler shall permit the data exchange between the different system components. Glass Fiber optic connections are used in order to avoid EMI in the switchgear and substation environment.

All protection and control units with serial communication facilities are connected in a star topology via glass fiber optics to the star coupler. Under no circumstances shall events from the protections be taken into the system via bay control unit hardware i.e., each protection device should have its own independent fiber optic communication channel to the star coupler. The star couplers shall be mounted in a separate communication cubicle.

7.0 Protection and Control IED's on 33 kV Level and 11KV Level:

The control IED's, based on microprocessor technology, shall use numerical techniques for the calculation and evaluation of externally input analogue signals. They shall incorporate select- before- operate control principles as safety measures for operation via the HMI. They shall perform all bay related functions, such as protection, commands, bay interlocking, data acquisition, data storage and event recording and shall provide inputs for status indication and outputs for commands. They shall be mounted in the LV compartment of the switchgear and shall be directly connected to it without any need for separate interposing equipment or transducers.

The 33 kV and 11kV bay control & protection IED shall have the following features depending on the requirement:

- Minimum of 8 analogue channels
- At least 15 binary inputs, 5 signal relays and 2 command relays
- 8 nos. programmable LED's on the front of the unit for indication
- Instantaneous Phase Over current Protection
- Instantaneous Earth Fault Protection
- Inverse Time Phase Over current Protection
- Inverse Time Earth Fault Over current Protection
- Over voltage / under voltage Protection
- Frequency based protection
- Synchro check function
- Built-in mimic display with controls for operating the switchgear. In the event of failure of the bay unit a backup system for emergency operation should be provided.
- High speed bus serial communication port (Dual port)
- Sequence of Events Recorder with a buffer for 256 events and a resolution of

  1msec. The events that are to be recorded should be freely programmable. These could be alarm/trip signals, external signals connected to upto coupler inputs, internal signals, etc. Once events are defined, they are recorded in chronological order as they occur.

- Disturbance Recorder function which can record 9 analogue values, 16 Binary signals and 12 analogue channels for internal measurement values. It shall be possible for the Disturbance Recorder function to be triggered by any internal or external binary signal or internal protective function.
- Comprehensive self-supervision
- Battery-free memory back-up of Event and Disturbance Records
- Logic functions (AND, OR, bi stable flip flop, etc.)
- Delay/Integrator function

The numerical bay control IED's shall be mounted together with all the relevant bay protective relays in cubicles of Protection Class IP54 or better. Distributed back-up control mimics with associated switches meters and Indicating LED's shall also be provided on these cubicles. These cubicles shall be installed in an air-conditioned room in the substation.

The distributed backup mimic for Local Control shall be installed next to the bay controller IED, which can be used in case of maintenance or emergency or if bay control IED fails. Local bay control via the back-up control mimic on the Control & Protection cubicles shall incorporate the same user safety measures e.g. bay interlocking, synchro check, interlock override user guidance etc. as the station HMI. Local bay control shall be key-locked and the control either from GIS local control panel or station HMI or from remote shall be disabled if the local/remote selector switch on the back-up control mimic is in the 'local' position.

The electronic system has to be provided with functions for self-supervision and testing. Each circuit board shall contain circuits for automatic testing of its own function.

Faults in the bay control IED shall be indicated on a front HMI and a message shall be sent to the station level HMI. The time for fault tracing and replacement of a faulty unit shall be reduced to a minimum. The supervision shall also cover the power supply system, the internal system bus andthe ability of the central processing module to communicate with different printed circuit boards.

Failure of any single component within the equipment shall neither cause

unwanted operation nor lead to a complete system breakdown. The n-1 criteria must be maintained in worst case scenarios also. Further, a single failure must not have any affect on the primary system, which is monitored and controlled.
It shall have transducers to accommodate signal from the objects for SCADA connectivity. The nos. of such transducers shall be decided during detailed Engg. as per the site requirement.

Only the backup protection can be incorporated in the bay control unit and not the main protections. Main protection shall be provided separately.

NOTE: BCPU having all the above features can also be considered for bay control & Protection IED's in lieu of separate IED for protection & Bay control.

All IED's shall have at least 5 years of successful proven experience in HV applications shall be provided.

8.0 Software Structure

The software package shall be structured according to the SA architecture and strictly divided in various levels. It shall be possible to extend the station with the minimum possible effort. Maintenance, modification or extension of components of any feeder may not force a shut-down of the parts of the system which are not affected by the system adaptation.

Confirmation that the software programs will be supported for a minimum of 20 years is required tobe submitted with the Bid.

It shall be the responsibility of the contractor to obtain any license required for the operation software. The contractor shall indemnify the client against all claims of infringement of any patent, registered design, copyright, trademark or trade name or other intellectual property right.

8.1 Station Level Software

8.1.1 Human Machine Interface (HMI)(22" TFT Monitor)

The base HMI software package for the operator station shall include the main SA functions and it shall be independent of project specific hardware version and operating system. Itshall further include tools for picture editing,

engineering and system configuration. The system shall be easy to use, to maintain, and to adapt according to specific user requirements. The System shall contain a library with standard functions and applications.

8.1.2 Operating System

Windows operating system shall be used for the operator station as it supports several standard system features, e.g support for several Windows office applications, multitasking, security levels, data exchange mechanisms (DDE, OLE), open data base communication standards (ODBC) and a standardised, user-friendly look & feel HMI. The licensed copy of the operating system backup software shall be provided.

8.2 Bay Level Software

8.2.1 System Software

The system software shall be structured in various levels. This software shall be placed in a non- volatile memory. Its lowest level shall assure system performance and contain basic functions, which shall not be accessible by the application and maintenance engineer for modifications. The system shall support the generation of typical control macros and a process database for user specific data storage.

8.2.2 Application Software

In order to ensure robust quality and reliable software functions, the main part of the application software shall consist of standard software modules built as functional block elements. The

functional blocks shall be documented and thoroughly tested. They shall form part of a library. The application software within the control/protective devices shall be programmed in afunctional block language.

9.0 System Testing

The supplier shall submit a test specification for factory acceptance test (FAT) and commissioning tests of the station automation system for approval. For the individual bay level IED's, applicable Type Test certificates shall be submitted.

The manufacturing phase of the SA shall be concluded by a Factory Acceptance Test (FAT). The purpose is to ensure that the Contractor has interpreted the specified requirements correctly. The general philosophy shall be to deliver a system to site only after it has been thoroughly tested and its specified performance has been verified with site conditions simulated to the extent possible in a test lab. If the FAT involves only a certain portion of the system for practical reasons, it has to be assured that this test configuration contains at least one unit of each and every type of equipment incorporated in the delivered system.

If the complete system consists of parts from various suppliers, the supplier shall arrange interoperability test at factory during stage inspection or FAT. The complete system test shall also be performed at site in the Site Acceptance Test (SAT).

10.0 System Functions

10.1 Control Unit Functions

10.1.1 Control

The different high voltage apparatuses within the station shall either be operated manually by the operator or automatically by programmed switching sequences.

The control function shall comprise:

Commands from different operator places, e.g. from the station HMI, or local control panel according tothe operating principle

Select-before execute commands

Operation from only one operator place at a time.

Operation depending on conditions from other functions, such as interlocking, synchrocheck,operator mode, or external status conditions.

The control function shall also include:

- Prevention of double operation
- Command supervision
- Selection of operator place
- Block/deblock of operation
- Block/deblock of updating of position indications

- Manual setting of position indications
- Overriding of the interlocking function (Second key switch.)
- Switchgear run time supervision

10.1.2 Status Supervision

The position of each switchgear, e.g. circuit breaker, isolator, earthing switch, etc., shall be permanently supervised. Every detected change of position shall be immediately visible on the screen in the single-line diagram, recorded in the event list, and a hard copy printout shall be produced. Alarms shall be initiated in cases when spontaneous position changes have taken place.

Each position of an apparatus shall be indicated using two binary auxiliary normally closed (NC) and normally open (NO) contacts. An alarm shall be initiated if these position indications are inconsistent or indicate an excessive running time of the operating mechanism to change position.

10.1.3 Interlocking:

The interlocking function prevents unsafe operation of apparatuses such as isolators and earthing switches within a bay or station wide. The operation of the switchgear shall only be possible when certain conditions are fulfilled. The interlocking function is required to be decentralized so that it does not depend on a central control device. Communication between the various bays for the station interlocking shall take place via bay communication system. An override function shall be provided, which can be enabled to by-pass the interlocking function viaa key/password, in cases of maintenance or emergency situations.

10.1.4 Measurements:

Analogue inputs for voltage and current measurements shall be connected directly to the voltage transformers (VT) and the current transformers (CT) without intermediate transducers.

The correlated values of active power (W), reactive power (VAr), frequency (Hz), and the rms values for voltage (U) and current (I) shall be calculated.

10.1.5 Event and Alarm Handling:

Events and alarms shall be generated either by the switchgear, by the control devices and by the station level unit. They shall be recorded in an event list in the station HMI. Alarms shall be recorded in a separate alarm list and appear on the screen. All or a freely selectable group of events and alarms shall also be printed out on an event printer. The alarms and events shall be time tagged with a time resolution of 1 ms. The time tagging shall be done at the lowest level where the event occurs and the information shall be distributed with the time tagging.

10.1.6 Time Synchronization:

The time within the SAS shall be set via a GPS Clock Receiver connected directly to the Bay Level LAN. The time shall then be distributed to the control/protective devices via the high speed optic fibre bus. An accuracy of ±1 ms within the station is required.

10.1.7 Synchronism and Energizing Check

The synchronism and energizing check functions shall be distributed to the control and/or protectivedevices and shall have the following features:

- Adjustable voltage, phase angle, and frequency difference.
- Energizing for dead line - live bus, or live line - dead bus.
- Settings for manual close command and auto-reclose command shall be adaptable to theoperating times of the specific switchgear.

10.1.8 Voltages selection

The voltages, which are relevant for the synchro check functions, depend on the station topology i.e. on the positions of the circuit breakers and/or the isolators. The correct voltage for synchronizing and energizing is derived from the auxiliary switches of the circuit breakers, isolator, and earthing switch

and shall be selected automatically by the control and protection IED.

10.2 HMI Functions

10.2.1 General

The operator station HMI shall provide basic functions for supervision and control of the substation. The operator shall give commands to the switchgear via the station monitor with the help of mouse clicks on soft-keys.

The HMI shall provide the operator with access to alarms and events displayed on the screen. Besides these lists on the screen, there shall be a print out of hard copies of alarms or events in an event log. The Alarm List shall indicate persisting and fleeting alarms separately.

An acoustic alarm shall indicate abnormalities and all unacknowledged alarms shall beaccessible from any screen selected by the operator.

Following standard pictures shall be available from the HMI:

- Single line diagram showing the switching status and measured values
- Control dialogues
- Measurement dialogues
- Blocking dialogues
- Alarm list, station / bay oriented
- Event list, station / bay oriented
- System status
- Checking of parameter setting

10.2.2 HMI Design Principles

Consistent design principles shall be provided with the HMI (22”) concerning labels, colours, dialogues and fonts. Non-valid selections shall be dimmed out.

Object status shall be indicated using different status colours for:

- Selected object under command
- Selected on the screen

- Not updated, obsolete value, not in use or not sampled
- Alarm or faulty state
- Warning or blocked
- Update blocked or manually updated
- Control blocked
- Normal state
- Busbar colouring to show live & dead bus

10.2.3 Process Status Displays and Command Procedures

The process status of the substation in terms of actual values of currents, voltages, frequency, active and reactive powers as well as the positions of circuit breakers, isolators and transformer tap changers are displayed in the station single line diagram.

In order to ensure a high degree of security against unwanted operation, a special "select — before - execute" command procedure shall be provided. After the "selection" of a switch, the operator shall be able to recognise the selected device on the screen and all other switchgear shall be blocked. After the “execution” of the command, the operated switch symbol shall blink until the switch has reached its final new position.

The system shall permit the operator to execute a command only if the selected object is not blocked and if no interlocking condition is going to be violated.The interlocking conditions shall be checked by the interlocking scheme which is implemented on bay level.

After command execution, the operator shall receive a confirmation that the new switching position is reached or an indication that the switching procedure was unsuccessful with the indication of the reason for non-functioning.

10.2.4 System Supervision Display

The SA system shall feature comprehensive self-supervision such that faults are immediately indicated to the operator before they possibly develop into

serious situations. Such faults are recorded as faulty status in a system supervision display. This display shall cover the status ofthe entire substation including all switchgear, IED's, communication links, and printers at the station level etc.

10.2.5 Reports

The SA shall generate reports that provide time related information on measured values andcalculated values. The data displayed shall comprise:

Trend reports:

- Day (mean, peak)
- Month (mean, peak)
- Semi-annual (mean, peak)
- Year (mean, peak) Historical reports:
- Day
- Week
- Month
- Year

It shall be possible to select displayed values from the database on-line in the process display. Scrolling between e.g. days shall be possible. Unsure values shall be indicated. It shall be possible to select the time period for which the specific data are kept in the memory.

This report shall be printed automatically at pre-selected times. It shall also be possible to print this report on request.

10.2.6 Trend Display (Historical Data)

A trend is a time-related follow-up of process data. The analogue channels of all the connected bay level devices on the 33 kV level shall be illustrated as trends. The trends shall be displayed in graphical form as columns or curve diagrams with 10 trends per screen as maximum.

It shall be possible to change the type of value logging (direct, mean, sum, or difference) on-line in the window. It shall also be possible to change the update intervals on-line in the picture as well as the selection of threshold values for alarming purposes.

10.2.7 Event List

The event list shall contain events, which are important for the control and monitoring of thesubstation. The time has to be displayed for each event.

The operator shall be able to call up the chronological event list on the monitor at any time for the whole substation or sections of it.

A printout of each display shall be possible on the hard copy printer.

The events shall be registered in a chronological event list in which the type of event and its time of occurrence are specified. It shall be possible to store all events in the computer. The information shall be obtainable also from printed event log.

The chronological event list shall contain:

- Position changes of circuit breakers, isolators and earthing devices.
- Indication of protective relay operations
- Fault signals from the switchgear
- Violation of upper and lower limits of analogue measured value.
- Loss of communication

Filters for selection of a certain type or group of events shall be available. The filters shall bedesigned to enable viewing of events grouped per:

- Date and time
- Bay
- Device
- Function
- Alarm class

10.2.8 Alarm List

Faults and errors occurring in the substation shall be listed in an alarm list and shall be immediately transmitted to the control centre. The alarm list shall substitute a conventional alarm tableau, and shall constitute an evaluation of all station alarms. It shall contain unacknowledged alarms and persisting faults. Date and time of occurrence shall be indicated.

The alarm list consists of a summary display of the present alarm situation. Each

alarm shall bereported on one line that contains:

- The alarm date and time
- The name of the alarming object
- A descriptive text
- The acknowledgement state

The operator shall be able to acknowledge alarms, which shall be either audible or only displayed on the monitor. Acknowledged alarms shall be marked at the list.

Faults that appear and disappear without being acknowledged shall be specially presented in aseparate list for fleeting alarms. For example due to bad contacts or intermittent operation.
Filters for selection of a certain type or group of alarms shall be available as for events.

10.2.9 Object Picture

When selecting an object such as a circuit breaker or isolator in the single line diagram, first the associated bay picture shall be presented. In the selected object picture, all attributes such as-

- type of blocking,
- authority
- local / remote control
- SAS control
- errors,
- etc.,

shall be displayed.

10.2.10Control Dialogues

The operator shall give commands to the system by means of soft keys located on the single line diagram. It shall also be possible to use the keyboard for soft key activation. Data entry is performed with the keyboard.

10.2.11 User Authority Levels

It shall be possible to restrict the activation of the process pictures of each object (bays, apparatus, etc.) to a certain user authorisation group. Each user shall then be given access rights toeach group of objects, e.g.:

- Display only
- Normal operation (e.g. open/close apparatus)
- Restricted operation (e.g. by-passed interlock)
- System administrator

For maintenance and engineering purposes of the station HMI, the following authorisation levels shallbe available:

- No engineering allowed
- Engineering/configuration allowed
- Entire system management allowed

The access rights shall be defined by passwords assigned during the log-in procedure. Only the system administrator shall be able to add/remove users and change access rights.

11.0 System Performance

The refresh/update times on the operator station PC under normal and calm conditions in thesubstation shall be according to the levels specified below:

Function	**Typical values**
Exchange of display (first reaction)	< 1 s
Presentation of a binary change in the process display	< 0.5 s
Presentation of an analogue change in the process display	< 1 s
From order to process output	< 0.5 s
From order to update of display	< 1.5 s

12.0 System Reliability

The SA system shall be designed to satisfy very high demands for reliability and availabilityconcerning:

- Solid mechanical and electrical design
- Security against electrical interference (EMI)
- High quality components and boards
- Modular, well-tested hardware
- Thoroughly developed and tested modular software
- Easy-to-understand programming language for application programming
- Detailed graphical documentation, according to IEC 1131-3, of the application software
- Built-in supervision and diagnostic functions
- After sales service
- Security
- Experience of security requirements
- Process know-how
- Select before execute at operation
- Process status representation as double indications
- Distributed solution
- Independent units connected to the local area network
- Back-up functions
- Panel design appropriate to the harsh electrical environment and ambient conditions
- Panel grounding to provide immunity against transient ground potential rise

13.0 Configuration Tools:

The configuration of the station HMI shall be made using the operator station working in Windows environment. The various functions shall be customised by easy to use interactive configuration tools. Configuration shall include the visual presentation of the object, adaptations needed in process database and adaptations of the communication configuration data.

A portable Personal Computer (PC) as a service unit shall be foreseen for on-site modifications of the control and protection devices. The service unit shall be used for documentation, test and commissioning.

The PC based service & support system shall be used for the following purposes:System configuration

- System testing
- Help functions
- Program documentation
- Down- and up-loading of programs
- System commissioning
- Data base management
- Changing peripheral parameters

The service & support system shall be able to monitor data in the running substation control system and to present changing variables on the display screen in graphic representation.

14.0 Information Required

The following documentation shall be provided for the system during the course of the project and they shall be consistent, CAD supported, and of similar look/feel:

- List of Drawings
- Control Room Lay-out
- Assembly Drawing
- Single Line Diagram
- Block Diagram
- Circuit Diagram
- List of Apparatus
- List of Labels
- Functional Design Specification (FDS)
- Test Specification for Factory Acceptance Test (FAT)
- Logic Diagram
- List of Signals

- Operator's Manual
- Product Manuals
- Calculation for uninterrupted power supply (UPS) dimensioning
- Licensed Copy of all software
- Third Party cyber security certification
-

15.0 Documentation required

The following documents shall be submitted with the offer **otherwise, bid will be rejected**

a) Letter of authorization from the Manufacturers, in case, the bidder is not themanufacturer.

b) Manufacturer's authorization Letter for relay and other protection equipment as mentionedin the technical specification.

c) Satisfactory Performance certificates (SPC) issued within the last 7 years from at least 2 End users depicting that the offered type automation system.

d) Submission of Type Test Reports/ Certificate as stated in per relevant IEC fromrecognized independent laboratories.

CHAPTER-E7
12.5MVA POWER TRANSFORMER

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TECHINICAL SPECIFICATION FOR 33/11 kV, ONAN, POWERTRANSFORMERS

1.0 SCOPE

This Specification provides for design, engineering, manufacture, assembly, stage inspection, final inspection and testing before dispatch, packing, loading and deliveryat destination Substation by road transport, transit insurance, unloading at site/stores of 12.5MVA,33/11 KV Power Transformer(s),complete with all fittings, accessories, associated equipments, spares,10% extra Transformer On load tap changer, required for it's satisfactory operation.

The core shall be constructed either from high grade, non-aging Cold Rolled Grain Oriented (CRGO) silicon steel laminations conforming to HIB grade with lamination thickness not more than 0.23mm to 0.27mm or better(Quoted grade and type shall be used). The maximum flux density in any part of the core and yoke at normal voltage and frequency shall not be more than 1.5 Tesla. The Bidder shall provide saturation curve of the core material, proposed to be used. Laminations of different grade(s) and different thickness(s) are not allowed to be used in any manner or under any circumstances.

The scope of supply should also include the provision of type test. OPTCL reservesthe right to carry out/ waive type tests as indicated in the section on Quality Assurance,Inspection and Testing in this specification.

The Power Transformer shall conform in all respect to highest standards of engineering, design and workmanship, as per this specification and the latest revisions of relevant standards at the time of offer and OPTCL shall have the power to reject anywork or material, which in their judgment, is not in full accordance there with. The Transformer(s) offered, shall be complete with all components, necessary for their effective and trouble free operation. Such components shall be deemed to be within the scope of supply, irrespective of whether those are specifically brought out in this specification and/ or the commercial order or not.

OPTCL reserves the right to reject the transformers, if, on testing the losses exceed the declared losses or the temperature rise in oil and/or winding exceeds the value, specified in technical particular or impedance

value differ from the guaranteed value as per this specification and or any of the test results do not match with the values, given in the guaranteed technical particulars/ as per technical specification.

2.0 SPECIFIC TECHNICAL REQUIREMENTS

TECHNICAL REQUIREMENTS			
1	Rated MVA (ONAN rating)	12.5 MVA	
2	No. of phases	3	
3	Type of installation	Outdoor	
4	Frequency	50 Hz (± 5%)	
5	Cooling medium	Insulating Oil (ONAN)	
6	Type of mounting	On Wheels, Mounted on rails.	
7	Rated voltage		
a.	High voltage winding	33kV	
TECHNICAL REQUIREMENTS			
b.	Low voltage winding	11kV	
8	Highest continuous system voltage		
a.	Maximum system voltage ratio(HV / LV)	36kV / 12kV	
b.	Rated voltage ratio (HV / LV)	33kV /11kV	
9	No. of windings	Two winding Transformers	
10	Type of cooling	ONAN (Oil natural / Air natural)	
11	MVA Rating corresponding toONAN	100% Cooling system	
12	Method of connection:		
a.	HV:	Delta	
b.	LV:	Star	
13	Connection symbol	Dyn11	
14	System earthing	Neutral of LV side to be solidly earthed	
15	Percentage impedance voltage onnormal tap and MVA base at 75ºC corresponding to HV/ LV rating and applicable tolerances :	% Impedance 10	Tolerance %10 **(No negative tolerance will be allowed)**

16	Intended regular cyclic overloading of windings	As per IEC –76-1, Clause 4.2	
17a.	Anticipated unbalanced loading	Around 10%	
17b.	Anticipated continuous loading ofwindings (HV / LV)	110 % of rated current	
18a.	Type of tap changer	On-load tap changer.	
18b.	Range of taping	+5% to – 15% in 17 equal steps of 1.25%each on HV winding	
18c.	Rated Current of OLTC	300A (Min.)	
18d.	Rated Short Circuit Current ofOLTC	3 kA (Min.)	
19	Neutral terminal to be brought out	On LV side only	
20	Over Voltage operating capabilityand duration	115 % of rated voltage (continuous)	
21	Maximum Flux Density in any partof the core and yoke at rated MVA, rated voltage i.e. 33kV / 11kV and system frequency of 50 HZ	1.5 Tesla	
22	Insulation levels for windings :-	33Kv	11kV
a.	1.2 / 50 microsecond wave shapeImpulse withstand (kVP)	170	95
TECHNICAL REQUIREMENTS			
b.	Power frequency voltagewithstand (kV rms)	70	98
23	Type of winding insulation		

a.	HV winding	Uniform	
b.	LV winding	Uniform	
24a.	Withstand time for three phaseshort circuit system	3 Seconds	
24b.	Short circuit level for whichtransformer shall withstand	2.2 kA in 33kV & 6.6 kA in 11kV	
25	Noise level at rated voltage andfrequency	As per NEMA Publication No.	
26	Permissible Temperature Rise over ambient temperature of 50°C		
a.	Of top oil measured by thermometer.	45°C	
b.	Of winding measured by resistance.	55°C	
27	Minimum clearances in air (mm) :-	Phase to Phase	Phase to ground
a.	HV	400	320
b.	LV	280	140
28	Terminals		
a.	HV winding line end	36kV porcelain type of bushings(Antifog type)	
b.	LV winding	17.5kV porcelain type of bushing (Antifog type)	
29	Insulation level of bushing	HV	LV
a.	Lightning Impulse withstand (kVP)	170	95
b.	1 Minute Power Frequency withstand voltage (kV –rms)	70	28
c.	Creepage distance (mm)(minimum)	900	300
30	Material of HV & LV Conductor	Electrolytic Copper	
31	Maximum current density for HVand LV winding for	2.4 A/ mm²	

	rated current	
32	Polarization index i.e. ratio of insulation resistance values at 600sec. to 60 sec for HV to earth, L.V to earth and HV to LV.	Shall be greater than or equal to 1.5, but less than or equal to 5.
33	Core Assembly	Boltless type
34	Temperature Indicator	
a.	Oil	One number
TECHNICAL REQUIREMENTS		
b.	Winding	One number
35	Maximum permissible no load lossat rated voltage and rated frequency.	7 kW
36	Maximum permissible load loss atrated current and at 75°C	55 kW
37	Accommodation on tank foroutdoor neutral CT	Yes
38	Neutral side C.T. for owner's use	
a.	Type	Single phase outdoor mounted
b.	Quantity	One on LV side
c.	Voltage Class	12 KV
d.	No. of cores	One
e.	Current ratio (A/A)	1000/1A
f.	Turn ratio	Identical to the turns ratio provided onHV & LV side
g.	Knee point voltage	600 volts (Min.)
h.	Class of Accuracy	PS (I mag at Vk/2 = <100mA)
i.	Maximum secondary resistance(Ohms) at 75°C	5

j.	Location for mounting	In neutral lead before connection tostation earth.
k.	Secondary current of C.T.	1A

3.0 MARSHALLING BOX

A metal enclosed, weather, vermin and dust proof marshalling box fitted with required glands, locks, glass door, terminal board, heater with switch, illumination lamp with switch etc. shall be provided with each transformer to accommodate temperature indicators, terminal blocks etc. It shall have degree of protection of IP55 or better as per IS: 2147(ReferClause3.12).

4.0 PERFORMANCE

i) Transformer shall be capable of withstanding for five seconds without damage to any external circuit, with the short circuit MVA available at the terminals.

ii) The maximum flux density in any part of the core and yoke at rated MVA, Voltage and frequency shall be 1.5 Tesla (maximum).

iii) Transformer shall under exceptional circumstances due to sudden disconnection of the load, be capable of operating at the voltage approximately 25% above normal rated voltage for a period of not exceeding one minute and 40% above normal for a period of 5 seconds.

iv) The transformer may be operated continuously without danger on any particular tapping at the rated MVA ± 12.5% of the voltage corresponding to the tapping.

v) The thermal ability to withstand short circuit shall be demonstrated by calculation.

vi) Transformer shall be capable of withstanding thermal and mechanical stress caused by any symmetrical and asymmetrical faults on any winding.

5.0 AUXILIARY POWER SUPPLIES

The following power supplies shall be available at site:

i) AC 3phase,400volts,50Hz.Earthed

ii) AC1phase,230volts,50Hz.Earthed

iii) 24 V DC./ 48 V DC

6.0 DRAWINGS/DOCUMENTS INCORPORATING THE FOLLOWING PARTICULARSSHALL BE SUBMITTED WITH THE BID

i) General outline drawing showing shipping dimensions and overall dimensions, net weights and shipping weights, quality of insulating oil, spacing of wheels in either direction of motion, location of coolers, marshalling box and tap changers etc.

ii) Assembly drawings of core, windings etc. and weights of main components / parts.

iii) Height of center line on HV and LV connectors of transformers from the rail top level.

iv) Dimensions of the largest part to be transported.

v) GA drawings / details of various types of bushing

vi) Tap changer and Name Plate diagram

vii) Type test certificates of transformers of similar design.

viii) Illustrative & descriptive literature of the Transformer. i) Maintenance andOperating Instructions.

7.0 MISCELLANEOUS

i) Padlocks along with duplicate keys as asked for various valves, marshalling box etc. shall be supplied by the contractor, wherever locking arrangement is provided.

ii) Foundation bolts for wheel locking devices of Transformer shall be supplied by theContractor.

8.0 DELIVERY

The full quantity of the equipments shall be delivered as per the delivery schedule appended to this specification.

9.0 SCHEDULES

All Schedules annexed to the specification shall be duly filled by the bidder separately.

10.0 ALTITUDE FACTOR

If the equipment is to be installed in the hilly area, necessary correction factors as given in the Indian Standard for oil temperature rise, insulation level etc. shall be applied to the Standard Technical Parameters given

above.

11.0 NAME PLATE

Transformer rating plate shall contain the information as given in clause 15 of IS-2026 (part-I). The details on rating plate shall be finalized during the detailed engineering. Further, each transformer shall have inscription as per the instruction during detail Engineering.

The name plate shall also include:-

i) The short circuit rating

ii) Measured no load current and no load losses at rated voltage and ratedfrequency

iii) Measured load losses at 75°C (normal tap only)

iv) D.C. resistance of each winding at 75°C.

12.0 SERVICE CONDITIONS

The service conditions shall be as follows:-

1	Maximum altitude above sea level	1,000m
2	Maximum ambient air temperature	50°C
3	Maximum daily average ambient airtemperature	35°C
4	Minimum ambient air temperature	5°C
5	Maximum temperature attainable by anobject exposed to the sun	60°C
6	Maximum yearly weighted average ambienttemperature	32°C
7	Maximum relative humidity	100%
8	Average number of thunderstorm days perannum (isokeraunic level)	70
9	Average number of rainy days per annum	120
10	Average annual rainfall	1500 mm
11	Maximum wind pressure	260Kg / m^2

Environmentally, the region where the equipment will be installed includes coastal areas, subject to high relative humidity, which can give rise to condensation. Onshore winds will frequently be salt laden. On occasions, the combination of salt and condensation may create pollution conditions for outdoor insulators.

Therefore, outdoor material and equipment shall be designed and protected for use in exposed, heavily polluted, salty, corrosive, tropical and humid coastal atmosphere.

13.0 SYSTEM CONDITIONS

The equipment shall be suitable for installation in supply systems of the following characteristics.

1	Frequency	50 Hz± 5%
2	Nominal system voltages	33kV/11k V
3	Maximum system voltages	33 kV System 36.3 kV
		11 kV System 12 kV
4	Nominal short circuit level (Basing on apparent power)	33 kV System 31.5kA
		11 kV System 25kA
5	Insulation levels : 1.2/50 µ secimpulse withstand voltage	33 kV System 170 kV(peak)
6		11 kV System 95 kV (peak)
7	Power frequency one minute withtand (wet and dry) voltage	33 kV System 70 kV(rms)
8		11 kV System 28 kV (rms)
9	Neutral earthing arrangements :	11 kV System Solidly earthed

14.0 CODES & STANDARDS

14.1 The design, material, fabrication, manufacture, inspection, testing before dispatch and performance of power transformers at site shall comply with all currently applicable statutory regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to the latest applicable standards and codes of practice. Nothing in this specification shall be construed to relieve the contractor of this responsibility.

14.2 The equipment and materials covered by this specification shall conform to the latest applicable provision of the following standards.

IS:5	Colour for ready mixed paints
IS:325	Three Phase Induction Motors
IS:335	New insulating oil for transformers, switch gears
IS:1271	Classification of insulating materials for electrical machinery andapparatus in relation to their stability in services
IS:2026(Part I toIV)	Power Transformer
IS:2071	Method of high voltage testing
IS:2099	High voltage porcelain bushings
IS:2147	Degree of protection
IS:2705	Current Transformers
IS:3202	Code of practice for climate proofing of electrical equipment
IS:3347	Dimensions for porcelain Transformer Bushings
IS:3637	Gas operated relays
IS:3639	Fittings and accessories for power Transformers
IS:5561	Electric Power Connectors
IS: 6600/BS: CP'10:0	Guide for loading of oil immersed Transformers
IS:10028	Code of practice for selection, installation and maintenance oftransformers, Part I. II and III
C.B.I.P. Publication	Manual on Transformers

If the standard is not quoted for any item, it shall be presumed that the latest versionof Indian Standard shall be applicable to that item.

The equipment complying other internationally accepted standards, may also be considered if they ensure performance superior to the Indian Standards.

15.0 DRAWINGS

i) The contractor shall furnish, within fifteen days after issuing of Letter of Award. Three copies each of the following drawings/documents incorporating the transformer rating for approval.

a) Detailed overall general arrangement drawing showing front and side elevations and plan of the transformer and all accessories including radiators and external features with details of dimensions, spacing of wheels in either direction of motion, net weights and shipping weights, crane lift for un-tanking, size of lugs and eyes, bushing lifting dimensions, clearances between HV and L.V terminals and ground, quantity of insulating oil etc.
b) Assembly drawings of core and winding and weights of main components/ parts.
c) Foundation plan showing loading on each wheel and jacking points with respect to centre line of transformer.
d) GA drawings details of bushing and terminal connectors.
e) Name plate drawing with terminal marking and connection diagrams.
f) Wheel locking arrangement drawing.
g) Transportation dimensions drawings.
h) Magnetization characteristic curves of PS class neutral and phase side currenttransformers, if applicable.
i) Inter connection diagrams.
j) Over fluxing withstand time characteristic of transformer
k) GA drawing of marshalling box.
l) Control scheme/wiring diagram of marshalling box.
m) Technical leaflets of major components and fittings.
n) As built drawings of schematics, wiring diagram etc.
o) Setting of oil temperature indicator, winding temperature indicator.
p) Completed technical datasheets.
q) Details including write-up of tap changing gear.
r) HV conductor bushing.
s) Bushing Assembly.
t) Bi-metallic connector suitable for connection to 100 mm^2 up to 232 mm^2 AAACConductor.
u) GA of LV cable Box.
v) Radiator type assembly.

ii) All drawings, documents, technical data sheets and test certificates, results calculations shall be furnished.

Any approval given to the detailed drawings by the OPTCL shall not relieve the contractor of the responsibility for correctness of the drawing and in the manufactureof the equipment. The approval given by the OPTCL shall be general with overall responsibility with contractor.

16.0 GENERAL CONSTRUCTIONAL FEATURES

16.1 All material used shall be of best quality and of the class most suitable for working under the conditions specified and shall with stand the variations of temperature and atmospheric conditions without distortion or deterioration or the setting up of undue stresses which may impair suitability of the various parts for the work which they have to perform.

16.2 Similar parts particularly removable ones shall be interchangeable. Pipes and pipe fittings, screws, studs, nuts and bolts used for external connections shall be as per the relevant standards. Steel bolts and nuts exposed to atmosphere shall be galvanized.

16.3 Nuts, bolts and pins used inside the transformers and tap changercompartments shall be provided with lock washer or locknuts.

16.4 Exposed parts shall not have pockets where water can collect.

16.5 Internal design of transformer shall ensure that air is not trapped in any location.

16.6 Material in contact with oil shall be such as not to contribute to the formation of acid in oil. Surface in contact with oil shall not be galvanized or cadmium plated.

16.7 Labels, indelibly marked, shall be provided for all identifiable accessories like Relays, switches current transformers etc. All label plates shall be of in corrodible material.

16.8 All internal connections and fastenings shall be capable of operating under over loads and over-excitation, allowed as per specified stands without injury.

16.9 Transformer and accessories shall be designed to facilitate proper operation, inspection, maintenance and repair.

16.10 No patching, plugging, shimming or other such means of overcoming defects, discrepancies or errors will be accepted.

16.11 Schematic Drawing of the wiring, including external cables shall be put under the propane sheet on the inside door of the transformer marshalling box.

16.12 Painting :

16.13.1.

All paints shall be applied in accordance with the paint manufacturer's recommendations. Particular attention shall be paid to the following:

a) Proper storage to avoid exposure as well as extremes of temperature.
b) Surface preparation prior to painting.
c) Mixing and thinning
d) Application of paints and the recommended limit on time intervals between coats.
e) Shelf life for storage.

16.13.2.

All paints, when applied in normal full coat, shall be free from runs, sags, wrinkles, patchiness, brush marks or other defects.

16.13.3.

All primers shall be well marked into the surface, particularly in areas where painting is evident, and the first priming coat shall be applied as soon as possible after cleaning. The paint shall be applied by airless spray according to the manufacturer's recommendations. However, wherever airless spray is not possible, conventional spray be used with prior approval of OPTCL.

16.13.4.

The supplier shall, prior to painting protect nameplates, lettering gauges, sight glasses, light fittings and similar such items.

16.13.5.

Cleaning and Surface Preparation :

a) After all machining, forming and welding has been completed, all steel work surfaces shall be thoroughly cleaned of rust, scale, welding slag or spatter and other contamination prior to any painting.
b) Steel surfaces shall be prepared by Sand/Shot blast cleaning or chemical cleaning by seven tank process including phosphating to the appropriate quality.
c) The pressure and Volume of the compressed air supply for the blast cleaning shall meet the work requirements and shall be sufficiently free from all water contamination prior to any painting.
d) Chipping, scraping and steel wire brushing using manual or power driven tools cannot remove firmly adherent mill-scale and shall only be used where blast cleaning is impractical.

16.13.6.

Protective Coating :As soon as all items have been cleaned and within four hours of the subsequent drying, they shall be given suitable anti corrosion protection.

16.13.7.

Paint Material :Followings are the type of paints that may be suitably used for the itemsto be painted at shop and supply of matching paint to site:

a) Heat resistant paint (Hot oil proof) for inside surface.
b) For external surfaces one coat of Thermo Setting Paint or 2 coats of Zinc chromate followed by 2 coats of POLYURETHANE.
c) The color of the finishing coats shall be dark admiral grey conforming to No.632 or IS 5:1961.

16.13.8.

Painting Procedure:

a) Al painting shall be carried out in conformity with both specifications and with the paint manufacture's recommendations. All paints in any one particular system. Whether shop or site applied, shall originate from one paint manufacturer.
b) Particular attention shall be paid to the manufacturer's instructions on storage, mixing, thinning and pot life. The paint shall only be applied in the manner detailed by the manufacturer e.g. brush, roller, conventional or airless spray and shall be applied under the manufacturer's recommended conditions. Minimum and maximum time intervals between coats shall be closely followed.
c) All prepared steel surfaces should be primed before visible re-rusting occurs or within 4 hours whichever is sooner. Chemical treated steel
d) surfaces shall be primed as soon as the surface is dry and while the surface is warm.
e) Where the quality of film is impaired by excess film thickness, (wrinkling, mud cracking or general softness) the supplier shall remove the unsatisfactory paint coatings and apply another. As a general rule, dry film thickness should not exceed the specified minimum dry film thickness by more than 25%. In all instances, where two or more coats of the same paints are specifies, such coatings may or may not be of contrasting colors.
f) Paint applied to items that are not to be painted, shall be removed at supplier's expense, leaving the surface clean, un-stained and undamaged.

16.13.9.

Damages to Paints Work:

a) Any damage occurring to any part of the painting scheme shall be made good to the same standard of corrosion protection and appearance as that originally employed.
b) Any damaged paint work shall be made as follows:

i. The damaged area, together with an area extending 25mm around its boundary, shall be cleaned down to bare metal.

ii. A priming coat shall immediately be applied, followed by a full paint finish equal to that originally applied and extending 50mm around the perimeter of the originally damaged.

c) The repainted surface shall present a smooth surface. This shall be obtained by carefully chamfering the paint edges before & after priming.

16.13.10.

Dry Film Thickness :

a) To the maximum extent practicable, the coats shall be applied as a continuous film of uniform thickness and free of pores. Over-spray, skips, runs, sags and drips should be avoided. The different coats mayor may not be of same colour.

b) Each coat of paint shall be allowed for hardening before the next is applied as per manufacture's recommendations.

c) Particular attention must be paid to full film thickness at edges.

d) The requirement for the dry film thickness (DFT) of paint and the material to be used shall be as given below:

Sl. No	**Paint Type**	**Area to be painted**	**No of Coats**	**Total Dry film thickness(Min)**
1	Liquid paint			
Sl. No	Paint Type	Area to be painted	No of Coats	Total Dry film thickness(Min)
2	Zinc Chromate (Primer)	Outside	2	45 micron
3	a) POLYURETHANE (Finish Coat)	Outside	2	55 micron
4	b) Hot Oil paint	Inside	1	35 micron

17.0 DETAILED DESCRIPTION

17.1. Tank

17.1.1 The transformer tank and cover shall be fabricated from high grade low carbon plate steel of tested quality. The tank shall be of welded construction.

17.2.1 Tank shall be designed to permit lifting by crane or jacks of the complete transformer assembly filed with oil. Suitable lugs and bossed shall be provided for this purpose.

17.3.1 All breams, flanges, lifting lugs, braces and permanent parts attached to the tank shall be welded and where practicable, they shall be double welded.

17.4.1 The main tank body of the transformer, excluding tap changing compartments and radiators, shall be capable of withstanding pressure of 760mm of Hg.

17.5.1 Inspection hole(s) with welded flange(s) and bolted cover(s) shall be provided on the tank cover. The inspection hole(s) shall be of sufficient size to afford easy access to the lower ends of the bushings, terminals etc.

17.6.1 Gaskets of nitrile rubber or equivalent shall be used to ensure perfect oil tightness. All gaskets shall be closed design (without open ends) and shall be of one piece only. Rubber gaskets used for flange type connections of the various oil compartments shall be laid in grooves or in groove-equivalent sections on bolt sides of the gasket, throughout their total length. Care shall be taken to secure, uniformly distributed mechanical strength over the gaskets and to retain throughout the total length. Gaskets of neoprene and/or any kind of impregnated/bonded core or cork, which can easily be damaged by over-pressing, is not acceptable. Use of hemp as gasket materials is also not acceptable.

17.7.1 Suitable guides shall be provided for positioning the various parts during assembling or dismantling. Adequate space shall be

provided between the cores and windings and the bottom of the tank for collection of any sediment.

17.7.2 Tank Thickness:

Tank Side wall(mm): 10 mm

Tank top & Bottom wall(mm): 12 mm

Conservator Side wall(mm): 06 mm

17.2. Tank Cover

The transformer top shall be provided with a detachable tank cover with bolted flanged gasket joint. Lifting lugs shall be provided for removing the cover. The surface of the cover shall be suitably sloped to an angle from HV to LV side so that it does not retain rain water. There should be 25–30 mm projection for inspection covers of HV and LV bushings.

17.3. Under Carriage

The transformer tank shall be supported on steel structure with detachable plain rollers completely filled with oil. Suitable channels for movement of rollers with transformer shall be spaced accordingly. Roller wheels shall be provided with suitable roller bearings, which will resist rust and corrosion and shall be equippedwith fittings for lubrication. It shall be possible to swivel the wheels in two directions,at right angle to or parallel to the main axis of the transformers.

17.4. Core

17.4.1. Stage level inspection for core construction shall be carried out by the owner.

17.4.2. Each lamination shall be insulated such that it will not deteriorate due to mechanical pressure and the action of hot transformer oil.

17.4.3. The core shall be constructed either from high grade, non-aging Cold Rolled Grain Oriented (CRGO) silicon steel laminations conforming to HIB grade with lamination thickness not more than (For CRGO≤0.23mm& for HIB
≤0.25mm) or better (Quoted grade and type shall be used). The maximumflux density in any part of the core and yoke at normal

voltage and frequency shall not be more than 1.5 Tesla. The Bidder shall provide saturation curve of the core material, proposed to be used. Laminations of different grade(s) and different thickness(s) are not allowed to be used in any manner or under any circumstances.

17.4.4. The bidder should offer the core for inspection starting from the destination port to enable OPTCL for deputing inspecting officers for detail verification as given below and approval by the OPTCL during the manufacturing stage. Bidder's call notice for the purpose should be accompanied with the following documents as applicable as a proof towards use of prime core material. The core coils, if found suitable, are to be sealed with proper seals which shall be opened in presence of the inspecting officers during core-cutting at the manufacturer's or it's sub-vendor's premises as per approved design & drawing.

a) Purchase Order No. & Date.
b) Invoice of the supplier
c) Mills test certificate
d) Packing list
e) Bill of lading
f) Bill of entry certificate to customs

Core material shall be directly procured either from the manufacturer or through their accredited marketing organization of repute, but not through anyagent.

17.4.5. For Transformer Manufacturer (TM), who has in-house core-cutting facility, the packed core coils shall be verified at their works as per followings along with witnessing of core- cutting.

a) Purchase Order No. & Date
b) No. of packed coils with Package Nos.
c) Gross Weight
d) Net Weight
e) Port of loading
f) Port of Discharge
g) Name of the Ocean Vessel

h) Grade & Thickness of Core Material

i) Any other information as mentioned on the body of packed coils

17.4.6. For those bidders, who have no in-house core-cutting facility, they should mention the names of at least three sub-vendors to whom they intend to assign their core-cutting. Such sub-vendors should have been approved by other Electricity Board/Electrical Utilities and accredited by some internationally recognized certification body like ISO-9000 etc. to ensure that a minimum quality parameters & tolerance are maintained. The experience, the details of core-cutting facilities finishing & testing facilities etc. as available which such sub-vendors should be clearly out-lined in the bid.

17.4.7. On award of Contract the TM is to assign the core-cutting to such sub- vendors for which approval is to be given by OPTCL.

17.4.8. The laminations shall be free of all burrs and sharp projections. Each sheet shall have insulation coating, resistant to the action of hot oil.

17.4.9. The insulation structure for the core to bolts and core to clamp plates shall be such as to withstand 2000 V DC voltage for one minute.

17.4.10. The completed core and coil shall be so assembled that the axis and the plane of the outer surface of the core assembly shall not deviate from the vertical plane by more than 25 mm.

17.4.11. All steel sections used for supporting the core shall be thoroughly shot or sand blasted, after cutting, drilling and welding.

17.4.12. The final assembled core with all the clamping structures shall be free from deformation and shall not vibrate during operation.

17.4.13. The core clamping structure shall be designed to minimize eddy

current loss.

17.4.14. The frame work and clamping arrangements shall be securely earthed.

17.4.15. The core shall be carefully assembled and rigidly clamped to ensure adequate mechanical strength.

17.4.16. Oil ducts shall be provided, where necessary, to ensure adequate cooling inside the core. The welding structure and major insulation shall not obstruct the free flow of oil through such ducts.

17.4.17. The design of magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or to the earth clampingstructure and production of flux component at right angle to the plane of the lamination, which may cause local heating. The supporting frame work of the cores shall be so designed as to avoid the presence of pockets, which would prevent complete emptying of the tank through the drain valve or cause trapping of air during filling.

17.4.18. The construction is to be of bolt less core type. The core shall be provided with lugs suitable for lifting the complete core and coil assembly. The core and coil assembly shall be so fixed in the tank that shifting will not occur during transformer short circuits.

17.4.19. The temperature gradient between core & surrounding oil shall be maintained less than 20 deg. Centigrade. The manufacturer shall demonstrate this either through test (procurement to be mutually agreed) or by calculation.

17.5. Internal Earthing

17.5.1 All internal metal parts of the transformer, with the exception of individual lamination and the individual clamping plate shall be earthed.

17.5.2 The top clamping structure shall be connected to the tank by a copper strap. The bottom clamping structure shall be earthed by one or more of the following methods:

a) By connection through vertical tie-rods to the top structure.

b) By direct metal to metal contact with the tank base.

c) By a connection to the structure on the same side of the core as the main earth connection to the tank.

17.5.3 The magnetic circuit shall be connected to the clamping structure at one point only and this shall be brought out of the top cover of the transformer tank through a suitably rated insulator. A disconnecting link shall be provided on transformer tank to facilitate disconnections from ground for IR measurement purpose.

17.5.4 Coil clamping rings of metal at earth potential shall be connected to the adjacent core clamping structure on the same side as the main earth connections.

17.6. Winding

17.6.1 Winding shall be subjected to a shrinking and seasoning process, so that no further shrinkage occurs during service. Adjustable devices shall be provided for taking up possible shrinkage in service.

17.6.2 A low voltage windings for use in the circular coil concentric winding shall be wound on a performed insulating cylinder for mechanical protection of the winding in handling and placing around the core.

17.6.3 Winding shall not contain sharp bends which might damage the insulation or produce high dielectric stresses. No strip conductor wound on edge shall have width exceeding six times the thickness.

17.6.4 Materials used in the insulation and assembly of the windings shall be insoluble, non-catalytic and chemically inactive in the hot

transformer oil and shall not soften or otherwise be affected under the operating conditions.

17.6.5 In no case varnish or other adhesive be used which will seal the coil and prevent evacuation of air and moisture and impregnation by oil.

17.6.6 Winding and connections shall be braced to withstand shocks during transformer short circuit.

17.6.7 Permanent current carrying joints in the windings and leads shall be welded or brazed. Clamping bolts for current carrying parts inside oil shall be madeof oil resistant material which shall not be affected by acidity in the oil. Steel bolts, if used, shall be suitably treated.

17.6.8 Terminals of all windings shall be brought out of the tank through bushingsfor external connections.

i) The completed core and coil assembly shall be dried in vacuum at not more than 0.5 mm of mercury absolute pressure and shall be immediately impregnated with oil after the drying process to ensure the elimination of air and moisture within the insulation. Vacuum may be applied in either vacuum over or in the transformer tank.

ii) The winding shall be so designed that all coil assembles of identical voltage ratings shall be interchangeable and field repairs to the winding can be made readily without special equipment. The coils shall have high dielectric strength.

iii) Coils shall be made of continuous smooth high grade electrolytic copper conductor, shaped and braced to provide for expansion and contraction due to temperature changes.

iv) Adequate barriers shall be provided between coils and core and between high and low voltage coil. End turn shall have additional protection against abnormal line disturbances.

v) The insulation of winding shall be designed to withstand voltage stress arising from surge in transmission lines due to atmospheric or transient conditions caused by switching etc.

vi) For Winding insulation, only Double Paper Covered insulation is acceptable with laying in opposite direction to each other and each paper must have overlapping more than 25% of its width.

vii) Kraft paper and Pressboard should be made of pure Cellulose from soft wood pulp manufactured from sulphate process. No additive, adhesive or coloring matter shall be present.

viii) Kraft paper and Pressboard should be of class A (105°C) insulation material.

ix) Kraft paper self-adhesive tape to be used for bonding of insulating paper layer, spanner and paperboards that are immersed in the oil filled transformer.

x) Winding shall be suitable for connection of reactors or capacitors which would be subjected to frequent switching. All the windings shall be capable of withstanding stresses that may be caused by such switching.

xi) Primary and secondary windings shall be constructed from high-conductivity (copper conductors), Double Paper Covered (DPC) copper conductor.

xii) The insulation between core and bolts and core and clamps shall withstand 2.5 kV for one minute.

xiii) Tapping shall not be brought out from inside the coil or from intermediate turns and shall be so arranged as to preserve as far as possible magnetic balance of transformer at all voltage ratios.

xiv) Magnitude of impulse surges transferred from HV to LV windings by electromagnetic induction and capacitance coupling shall be limited to BIL of LV winding.

xv) The current density adopted in all winding shall not exceed 2.4 A/mm². The total net cross sectional area of the strip conductors for calculating current density for each winding shall be obtained after deducting the copper area lost due to rounding up of the sharp edges at the rectangular conductors.

17.6.9 INSULATING PAPER AND INSULATING PRESS BOARD :

i) The bidder shall submit characteristics along with make for all the type of insulation papers and Pressboards to be used with the offer.

ii) Inter layer insulation both for HV and LV windings shall be

Epoxy diamond dotted Kraft paper and compressed pressboard of reputed make (subject to approval of TPCODL).

iii) For Winding insulation, only Double Paper Covered insulation is acceptable with laying in opposite direction to each other and each paper must have overlapping more than 25% of its width.

iv) Kraft paper and Pressboard should be made of pure Cellulose from soft wood pulp manufactured from sulphate process. No additive, adhesive or coloring matter shall be present.

v) Kraft paper and Pressboard should be of class A (105°C) insulation material.

vi) All spacers, axial wedges / runners used in windings shall be made of pre-compressed solid pressboard.

vii) All axial wedges/runners shall be properly milled to dovetail shape so that they pass through the designed spacers freely.

viii) Insulation shearing, milling and punching operations shall be carried out in such a way, that there should not be any burr, sharp edges and dimensional variations.

ix) Kraft paper self-adhesive tape to be used for bonding of insulating paper layer, spanner and paperboards that are immersed in the oil filled transformer.

x) Below required values could be verified if required at any stage of the inspection and it should fulfill the requirement as per below table

Characteristics	**Kraft Paper**	**Pressboard (all Sizes)**
1. Dimension	As specified by bidder with $\pm$5% tolerance.	As specified by bidder with tolerance as per IS1576.
2. Apparent Density	>0.80 g/cm^3	as per IS1576 w.r.t Thickness
3. pH of Aqueous extract	6-8%	6-8%

4. Electrical strength i) in air ii) In Oil	 7KV/mm ----------	 12KV/mm 35KV/mm
5. Ash content	Maximum 1%	Maximum 0.7
6. Moisture content	Maximum 8%	Maximum 8%
7. Oil absorption	----------	Minimum 9%

Bidder has to submit the test certificates as per IS-9335, IS-1576 for all type of insulating materialscovering above stated parameters along with below parameters during stage inspection:

1. Substance (Grammage) (g/m3)
2. Compressibility
3. Tensile strength
4. Conductivity of water extract
5. Shrinkage in air
6. Flexibility
7. Cohesion between plies1.
8. Elongation
9. Air permeability
10. Tear index
11. Heat stability

17.7. Insulating Oil

17.7.1 Transformer oil shall be as per IS 16659 / IEC 62770/ IS 335

17.7.2 The quantity of oil required for the first filling of the transformer and its full specification shall be stated in the bid. The bidder shall quote the price of transformer complete with all fittings, accessories and new transformer oil required for first filling plus **10% extra oil**. The extra quantity of oil shall be supplied in non-returnable drums along with the oil required for the radiator banks.

17.7.3 The design and materials used in the construction of the transformer shall be such as to reduce the risk of development of acidity in the oil.

17.7.4 The contractor shall warrant that oil furnished is in accordance with the following specifications.

SL. No	Characteristic	Requirement	Method of Test
1	Appearance	Bright & Clear	Visual
2	Density at 20°C	0.89 g/cm³ Max	IS:1448
3	Kinematic Viscosity at 100°C Max	27 CST	IS:1448
4	Flash Point	136°C	IS:1448
6	Pour Point Max.	-6°C	IS:1448
7	Neutralization Value (Total Acidity) Max.	0.03 mg KOH/gm	IS:335
8	Dielectric strength Breakdown (voltage) Min.	72.5 KV	IS:6792
9	Dielectric dissipation factor tan delta at 100°C	0.03 Max	IS:6262
10	Water content Max:	Less than 25ppm	IS:2362

17.1. Valves

17.1.1 Valves shall be of forged carbon steel up to 50mm size and of gun metal or of cast iron bodies with gun metal fittings for sizes above 50mm. They shall be of full way type with screwed ends and shall be opened by turning counterclockwise when facing the hand wheel. There shall be no oil leakage when the valves are in closed position.

17.1.2 Each valve shall be provided with an indicator to show the open and close positions and shall be provided with facility for padlocking in either open or close position. All screwed valves shall

be furnished with pipe plugs for protection. Padlocks with duplicate keys shall be supplied along with the valves.

17.1.3 All valves except screwed valves shall be provided with flanges having machined faced drilled to suit the applicable requirements. Oil tight blanking plates shall be provided for each connection for use when any radiator is detached and for all valves opening to atmosphere. If any special radiator valve tools are required the contractor shall supply the same.

17.1.4 Each transformer shall be provided with following valves on the tank:

a) Drain valves located as to completely drain the tank.
b) Two filter valves on diagonally opposite corners of 50mm size.
c) Oil sampling valves not less than 8mm at top and bottom of main tank.
d) One15mm air release plug.
e) Valves between radiators and tank.
f) Drain and filter valves shall be suitable for applying vacuum as specified inthe specifications.

17.8. Accessories

17.8.1 Bushing

a) All porcelain used in bushings shall be homogeneous, non-porous, uniformly glazed to brown colour and free from blisters, burns and other defects.
b) Stress due to expansion and contraction in any part of the bushing shall not lead to deterioration.
c) Bushing shall be designed and tested to comply with the applicable standards.
d) Liquid oil filled bushings shall be equipped with liquid level indicators and outlet for sampling and draining the liquid. The angle of inclination tovertical shall not exceed 30 degree.
e) Oil in oil filled bushings shall meet the requirements of the transformer oil standards.
f) Bushing rated for 400A and above shall have non-ferrous flanges and hardware.

g) Fittings made of steel or malleable iron shall be galvanized.

h) Bushing shall be so located on the transformers that full flashover strength will be utilized. Minimum clearances as required for the BIL shall be realized between live parts and live parts to earthed structures.

i) All applicable routine and type tests certificates of the bushings shall be furnished for approval.

j) Bushing shall be supplied with bi-metallic terminal connector/ clamp/ washers suitable for fixing to bushing terminal and OPTCL's specified conductors. The connector/clamp shall be rated to carry the bushing rated current without exceeding a temperature rise of 55^0C over an ambient of 50^0C. The connector/clamp shall be designed to be corona free at the maximum rated line to ground voltage.

k) Bushing of identical voltage rating shall be interchangeable.

l) The insulation class of high voltage neutral bushing shall be properly coordinated with the insulation class of the neutral of the low voltagewinding.

m) Each bushing shall be so coordinated with the transformer insulation that all flash over will occur outside the tank.

17.8.2 Terminal Arrangement

a) Both HV and LV side terminals of Power transformer shall be through Cable Box-Complete enclosed.

b) The cable box shall be suitable for cable termination kits and shall be self-supporting, weather proof, air filled type, complete with all hardware such as gland plate, brass glands, tinned copper lugs, armour clamps etc.

c) Surge protection to be provided at both HV and LV terminals.

d) NCT to be provided at neutral bushing of Transformer.

17.8.3 Protection & Measuring Devices

17.9.2.1 Oil Conservator Tank

a) The Conservator tank shall have adequate capacity between highest and lowest visible levels to meet the requirement of expansion of the total cold oil volume in the transformer and cooling equipment.

b) The conservator tank shall be bolted into position so that it can be removed for cleaning purpose.

c) The conservator shall be fitted with magnetic oil level gauge with low level electrically insulated alarm contact.

d) Plain conservator fitted with silica gel breather.

17.9.2.2 Pressure Relief Device

The pressure relief device provided shall be of sufficient size for rapid release of any pressure that may be generated in the tank and which may result in damage of the equipment. The device shall operate at a static pressure of less than the hydraulic test pressure of transformer tank. It shall be mounted direct on the tank. A pair of electrically insulated contact shall be provided for alarm and tripping.

17.9.2.3 Buchholz Relay

A double float type Buchholz relay shall be provided. Any gas evolved in the transformer shall collect in this relay. The relay shall be provided with a test cock suitable for a flexible pipe connection for checking its operation. A copper tube shall be connected from the gas collector to a valve located about 1200mm above ground level to facilitate sampling with the transformer in service. The device shall be provided with two electrically independent potential free contacts, one for alarm on gas accumulation and the other for tripping on sudden rise of pressure.

17.9.2.4 Temperature Indicator

a) Oil Temperature Indicator (OTI) (PRECIMEASURE MAKE, Micro Switch Type) :

The transformers shall be provided with a Micro switch contact type thermometer with 150mm dial for top oil temperature indication. The thermometer shall have adjustable, electrically independent potential free alarm and trip contacts. Maximum reading pointer and resetting device shall be mounted in the local control panel. A temperature sensing element suitably located in a pocket on top oil shall be furnished. This shall be connected to the

OTI by means of capillary tubing. Accuracy class of OTI shall be ±1% or better. Two Nos. electrical contacts capable of operating at 5A at 230 volt, AC supply.

- Model:-ML-1031H,Dial Type with embedded PT-100 Sensor in the sensing Bulb with external CCU with PSU (Model: 2220R2) having PT-100 sensor input
- Temp Range:- 0-150 degC
- 02 Nos. of Micro switches
- Capillary Length:- 6 meters

b) Winding Temperature indicator (WTI) (PRECIMEASURE MAKE,Micro switch type) :

A device for measuring the hot spot temperature of the winding shallbe provided. It shall comprise the following:

i) Temperature sensing element
ii) Image Coil
iii) Micro switch contacts
iv) Auxiliary CTS, if required, to match the image coil, shall be furnished and mounted in the local control panel.
v) 150 mm dial local indicating instrument with maximum reading pointer mounted in local panel and with adjustable electrically independent ungrounded contacts, besides that required for control of cooling equipment, one for high winding temperature alarm and one for trip.
vi) Calibration device.
vii) Two number electrical contact each capable of operating at 5A at 230 volt, AC supply.
viii) Model:-ML-1031H,Dial Type with embedded PT-100 Sensor in the sensing Bulb with external CCU with PSU (Model: 2220R2) having PT- 100 sensor input
ix) Temp Range:- 0-150 degC
x) 02 Nos. of Micro switches
xi) Capillary Length:- 6 meters

17.8.4 Oil Preservation Equipment

a) Oil Sealing

The oil preservation shall be diaphragm type oil sealing in conservator to prevent oxidation and contamination of oil due

to contact with atmospheric moisture. The conservator shall be fitted with a dehydrating filter breather. It shall be so designed that.

i) Passage of air is through a dust filter & silica gel
ii) Silica gel is isolated from atmosphere by an oil seal
iii) Moisture absorption indicated by a change in colour of the crystals of the silica gel can be easily observed from a distance.
iv) Breather is mounted not more than1400mm above ground level.

17.9. Marshalling Box

a) Sheet steel, weather, vermin and dust proof marshalling box fitted with required glands, locks, glass door, terminal board, heater with switch, illumination lamp with switch, water- tight hinged and padlocked door of a suitable construction shall be provided with each transformer to accommodate temperature indicators, terminal blocks etc. The box shall have slopping roof and the interior and exterior painting shall be in accordance with the specification. Padlock along with duplicate keys shall be supplied for marshalling box. The degree of protection shall be IP-55or better.

b) The schematic diagram of the circuitry inside the marshalling box be prepared andfixed inside the door under a propane sheet.

c) The marshalling box shall accommodate the following equipment:

i) Temperature indicators
ii) Space for accommodating Control & Protection equipment in future for thecooling fan (for ONAN type cooling may be provided in future).
iii) Terminal blocks and gland plates for incoming and outgoing cables.

All the above equipments except (iii) shall be mounted on panels and back of panel. Wiring shall be used for inter-connection. The temperature indicators shall be so mounted that the dials are not more than 1600mm above the ground level and the door(s) of the compartment(s) shall be provided with glazed window of adequate size. The transformer shall be erected on a plinth which shall be 2.5 feet above ground level.

d) To prevent internal condensation, a metal clad heater with thermostat shall be provided. The heater shall be controlled by a MCB of suitable rating mounted in the box. The ventilation louvers, suitably padded with felt, shall also be provided. The louvers shall be provided with suitable felt pads to prevent ingress of dust.

e) All incoming cables shall enter the kiosk from the bottom and the gland plate shall not be less than 450mm from the base of the box. The gland plate and associated compartment shall be sealed in suitable manner to prevent the ingress of moisture from the cable trench.

f) The control connection, wiring etc. shall be as per this specification.

17.10. Tap Changer

17.10.1 On-load tap-changers with Transformer Monitoring Unit (TMU).(preferred make:- ABB, Siemens, Eberle)

Each transformer shall be provided with an on-load tap-changer connected to the high voltage winding. The on-load tap-changer shall be capable of withstanding the voltages described earlier and shall comply with the requirements of IEC-214, latest revision. It's tapping range, number of steps and tap positions shall be as specified. OLTC shall be able to do automatic / parallel operations through Transformer Monitoring Unit (TMU).

Adequate access for personnel shall be provided for inspection and maintenance. The guaranteed interval between maintenance periods for the diverter switch shall be 10 years or 50,000 operations. It shall not be possible for oil in the diverter switch compartment to come in contact with the oil in the main transformer tank.

The tap-changer shall be driven by a motor operated mechanism incorporating a stored energy device which shall ensure that once a change of tap begins it is completed and so shall ensure that the mechanism does not fail in an intermediate position on loss of the supply voltage to the motor. The motor shall be rated for 400/230V, 50 Hz and shall operate satisfactorily at any voltage between 85% and 110% of rated voltage.

A tap-changer mechanism box with hinged door and mounted on the

transformer tank at a convenient height shall contain all electrical and mechanical parts associated locally with control of the tap-changer. Remote tap-changer controls shall also be provided at a transformer control panel (one per transformer, to be supplied under this contract) in the control room.

Facilities for electrical raise and lower operation (Control switch or push button) as well as mechanical operation shall be provided as the tap-change mechanism box. An interlock shall be provided which shall interrupt the electric supply to the drive motor when the manual mechanical operating device is engaged. The motor drive control shall be such that on initiation of a tap-change operation by means of a control switch or push-button the tap- changer shall complete its movement form one service position to an adjacent one irrespective of whether or not the control switch or push button has been operated continuously during the running time or motor drive. Another operation shall only be possible when the previous operation has been completed, the control switch or push button has been released and the control system is again in the rest position.

The tap-changer arrangement shall be such that a command to raise tap- numbers shall result in an increase in the secondary voltage with constant voltage applied to the high voltage winding.

An under and over voltage monitoring relay fed with line voltage from the owner's voltage transformers on the low voltage side of the transformer and capable of being set in a continuously variable range from 90% to 115% normal voltage (110V) shall be used to give visual and audible signals at the remote tap change control panel if the LV voltage lies above or below preset values.

Limit switches shall be provided to prevent over-running of the tap-change mechanism. These shall be directly connected in the motor circuit. In addition mechanical end stops shall be fitted to prevent over-running of the mechanism under any conditions. A counter shall be provided to indicate the number of tap-change operations that

have been taken place.

A mechanical tap-position indicator shall be provided and it shall be visible from ground level through a window in the door of the mechanism box. Position transmitter e.g. dial switches shall be provided to:

a) Signal tap position to the control cabinet in the control room.
b) Signal “out of step” under parallel operating conditions.

A Remote/Local switch shall be provided at the mechanism box to select either remote or local operation. When this switch is turned to the Remote position control shall be passed to the control cabinet in the control room TMU. It should be possible to use only one control, i.e. Local or Remote.

With TMU,it shall be possible to operate a transformer tap-changer independently or in parallel with the tap-changers of other similar transformers in the same substation in either a “master” or “follower” mode. In addition, when operating independently or in parallel in the master mode, it shall be possible to have manual operation by means of control switch, push button or, (in future) automatic operation by means of an automatic voltage regulating relay. Contacts shall be provided for future SCADA control of the tap-changer and for reporting of the tap position and mode of control to the SCADA system.

The paralleling scheme shall use the in-step principle and shall have provision for operating singly or in paralleling any combination. It shall be possible for any transformer in a group to be selected as either the master or follower for that group when operating in parallel. Each transformer control panel shall therefore have a manual/automatic control switch or push buttons, independent/ master/follower control switch or push buttons as well as “raise” and “lower” control switches or push buttons. Interlock shall be provided to avoid independent operation when the transformers are running in parallel. There should not be any out-of-step during such operation.

The control scheme shall be capable of extension to cater for the total number of transformers to be installed in any future development of

the substation. The control mode selected shall be indicated on the front of the control cabinet.

Each transformer shall have a miniature circuit breaker (MCB) on the AC distribution cabinet through which the 400/230V, 50 Hz supply to its tap- changer and temperature controls is passed. Separate MCB's shall be provided at the mechanism box for protection of the motor and control circuits. The control circuits shall operate at 110V single phase, to be supplied from a transformer having a ratio of 230/55-0-55 V, with the center point earthed through a removable link mounted in the marshalling box or tap-changer mechanism box.

Each tap-changer mechanism box shall be fitted with an anti-condensation space heater (230V AC) controlled by a humidistat with variable range. A lamp for illumination purposes controlled by a door switch shall be provided. Solar gain can give rise to high temperature within a mechanism box. Adequate ventilation shall be provided to ensure that all equipment contained therein shall operate satisfactorily under these conditions. Ten percent spare terminals shall be provided in each mechanism box.

The tap changer mechanism box shall be out door, weather proof type, dust, vermin and damp proof with a degree of protection of IP 54 of IEC 529 or IS 13947 equivalent.

A terminal block with terminals rated for 10A continuous current, 650V grade of molded insulating materials shall be provided for panel wiring and external connection.

Transformer shall be compatible for Operation along with Tap Changer Control and Transformer Monitoring Unit (TMU). Supply of TMU is in scope of Bidder.

All contacts should be SCADA compatible and suitable for connection to TMU.

TMU shall be fitted in transformer panel.

17.10.2 Nitrogen Injection Drain & Stir System (Include this is spec)

I. Fire prevention and extinguishing system shall work on the oil drain, nitrogen injection and stir method. The system shall operate during internal fault in transformer or external fire on transformer, which includes fire due to bursting of transformer bushing and Fire in OLTC tank.

II. Fire detector provided on the transformer shall take minimum time for detection of fire and initiate the fire protection system on receipt of other required signals.

III. System shall operate on station's DC auxiliary supply (48 VDC). The system shall be capable of working in Auto/Remote Electrical/Local manual modes.

IV. Provision shall be available to keep the system "ISOLATED" /"OUT OF SERVICE" which is necessary for preventing any mal-operation during transformer maintenance.

V. The protection system shall be compatible of being hooked on to the SCADA or fire alarm system. Suitable spare contacts shall be made available for operation of fire system. System using PLC shall be only considered.

VI. Fire protection system shall operate in Auto mode under two logic:

a) In Transformer Explosion prevention Logic it shall operate on receipt of minimum three positive feedback signals, namely differential relay, pressure relief valve or rapid pressure rise relay or Buchholz relay and electrical isolation of transformer through master trip relay or HV & LV circuit breaker in series to avoid any mal-operation of system .

b) In Transformer Fire Prevention logic, Fire protection system shall operate in Auto mode on receipt of minimum three positive feedback signals, namely fire detector, pressure relief valve or rapid pressure rise relay or Buchholz relay / OSR (in case of fire in OLTC and electrical isolation of transformer through master trip relay or HV & LV circuit breaker in series to avoid any mal-operation of system.

c) Provision shall be made in system so that any of the above two logic can be disabled by operator from local panel only.

d) Supply and installation of Rapid Pressure Rise Relay shall be in the

scope of the bidder.

VII. Fire protection system shall operate in Remote electrical mode on receipt of signal for electrical isolation of transformer and by operating switch provided in a box which shall be accessible only after breaking the glass cover on control panel.

VIII. The Local manual operating system shall be used only in case if the system fails in Auto mode/ Remote electrical mode/ power failure. System if kept in manual mode must be clearly visible by a different alarm / LED.

IX. The system shall start operation in auto or remote electrical or local manual, initially draining a pre- determined quantity of oil from the tank top through outlet valve to reduce the tank pressure and simultaneously closing Isolation valve in the conservator line and then inject nitrogen gas with appropriate flow rate at high pressure from lower side of the tank through inlet valves to create stirring action and reduce the temperature of top oil surface below flash point to extinguish the fire.

X. Isolation valve in the conservator line shall operate mechanically on transformer oil flow rate with electrical signal for monitoring on control panel. However in case of bursting of transformer bushing conservator oil should be isolated from main transformer tank without any additional signal to operate isolation valve.

XI. Provision shall be available so that in case of accidental leakage of Nitrogen, the same should not affect the operation of Transformer

XII. The system shall have built in facility for monitoring or display of the following.

a. Open /Close status of valves.

b. Healthiness of all sensors.

c. Operation of PRV

d. Healthiness of control cable

e. Healthiness of control supply

I. Provision shall be available for annunciation (along with audible alarm) and a mimic panelof the following.

a. Detection of fire due to external causes

b. Low nitrogen pressure.
c. System initiated
d. Tank pressure beyond the set limit
e. Operating signal cable faulty.
f. Operation of conservator isolation valve (PNRV)
g. Supply Failure

II. However, bidder shall confirm whether it is advisable to initiate the system even whentransformer is not electrically isolated due to stuck breaker problem etc.

III. The system shall have built-in-on-line testing facility, which will be operable without affectingthe functioning of the transformer.

IV. All valves used in system shall be stainless steel ball / butterfly type and of Legris make or equivalent as per the purchaser's approval. Limit switches shall be provided wherever required.

V. The connecting cables shall be fire retardant low smoke (FRLS) armored cable. Cables passing along the top of the transformer shall be the fire survival (FS) type.

VI. The Pipe Line used for the system shall be of Class 'C' type.

VII. All the hardware used in the system shall be stainless steel.

VIII. Limit switches used in the panel shall be of Schmersal make or equivalent as per the purchaser's approval.

IX. Control cable gland used in system shall be of Lapp, Germany make or equivalent as per the purchaser's approval.

X. Fire extinguishing cubicle shall be of 3mm thick CRCA sheet with PU painting and IP 55 enclosure protection class and shall accommodate nitrogen gas cylinder of adequate capacity and associated accessories like regulator, high pressure tubing etc.

XI. The remote control panel, to be mounted inside the control room shall accommodate the necessary control units, operating switches push buttons etc. and also alarm annunciation unit.

XII. The bidder shall, furnish the complete details including bill of materials of the fire prevention and extinguishing system offered. The list of all accessories including FRLS, fire survival cable, pipes, valves, sensors, control cubicle, nitrogen gas cylinder etc. shall be listed out and furnished in the offer.

XIII. The bidder shall ensure that fire prevention and extinguishing system

offered is full proof and reliable. Installation, testing and commissioning of the fire protection system shall also be in the successful bidder's scope.

XIV. Bidder shall ensure that fire prevention and extinguishing system shall not affect the normal operation of power transformer.

XV. Fire protection scheme to the power transformer should have authentic certification regarding performance similar to one issued by LAPEM (MEXICO)/TAC/RDSO /any other approved standard laboratory.

XVI. Similar units offered by bidder shall be in successful operation for a minimum period of two years.

XVII. The bidder shall also furnish performance certificate for similar systems in proof of thesatisfactory operation.

XVIII. NIDS is to be supplied with transformer unless specified elsewhere in the Bidding document.

XIX. Drawing shall be prepared as per the layout and OGA of the transformer to avoid any major fabrication at site. Complete drawing and GTP should be submitted for approval.

XX. Bidder shall also ensure overall product & installation quality.

XXI. In all conditions transformer shall have provision for future implementations of NIDS.

XXII. In any condition OEM (PTR) guarantee shall remain the same as mention in clause no. 11 of this specification.

17.11. Fittings And Accessories

The following fittings and accessories shall be provided on the transformers:

i) Conservator with isolating valves, oil filling hole with cap and drain valve. The conservator vessel shall be filled with constant oil pressure diaphragm oil sealing system.

ii) Magnetic type oil level gauge (150mmdia.) with low oil level alarm contacts.

iii) Prismatic/toughened glass oil level gauge.

iv) Silica gel breather with oil seal and connecting pipe complete with first fill of activated silica gel or Alumina mounted at a level of 1300mm above ground level.

v) A double float type Buchholz relay with isolating valve. Bleeding

pipe and a testing cock, the test cock shall be suitable for a flexible (pipe connection for checking its operation).

vi) A 5 mm dia. Copper pipe shall be connected from the relay test cock to a valve located at a suitable height above ground level to facilitate sampling of gas with the transformer in service. Interconnection between gas collection box and relay shall also be provided. The device shall be provided with two electrically independent ungrounded contacts, one for alarm on gas accumulation and the other for tripping on sudden oil surge. These contacts shall be wired up to transformer marshalling box. The relay shall be provided with shut off valve on the conservator side as well as on the tank side

vii) Pressure relief devices (including pressure relief valve) and necessary air equalizer connection between this and the conservator with necessary alarm and trip contacts.T-6 type for main tank & T-4 type for OLTC.

viii) Air release plugs in the top cover

ix) Inspection cover, access holes with bolted covers for access to inner ends of bushing etc.

x) Winding temperature (hotspot) indicating device for local mounting complete in all respects. Winding temperature indicator shall have three set of contacts to operate at different settings:
   a) To provide winding temperature high alarm.
   b) To provide temperature too high trip.

xi) Dial thermometer with pocket for oil temperature indicator with one set ofalarm and one set of trip contacts and maximum reading pointer.

xii) Lifting eyes or lugs for the top cover, core and coils and for the completetransformer.

xiii) Jacking pads.

xiv) Haulage lugs.

xv) Protected type mercury/ alcohol in glass thermometer and a pocket to housethe same.

xvi) Top and bottom filter valves on diagonally opposite ends with padlockingarrangement on both valves.

xvii)Top and bottom sampling valves.

xviii)Drain valve with padlocking

arrangement.

xix) Rating and connection diagram plate.

xx) Two numbers tank earthing terminals with associated nuts and bolts forconnections to OPTCL's grounding strip.

xxi) Bi-directional flagged rollers with locking and bolting device.

xxii) Marshalling Box(MB)

xxiii) Shut off valve on both sides of flexible pipe connections between radiator bankand transformer tank.

xxiv) Cooling Accessories:

a) Requisite number of radiators provided with:-

- One shut off valve on top
- One shut off valve at bottom
- Air release device on top
- Drain and sampling device at bottom
- Lifting lugs.

b) Air release device and oil drain plug on oil pipe connectors

xxv) Terminal marking plates for Current Transformer and Main Transformer

xxvi) On-Load Tap Changer.

xxvii) Oil Preservation Equipment.

xxviii) Oil Temperature indicator

NOTE:- i) The fittings listed above are indicative and any other fittings which are generally required for satisfactory operation of the transformer are deemed to be included in the quoted price of the transformer.

ii) The contacts of various devices required for alarm and trip shall be potential free and shall be adequately rated for continuous, making and breaking current duties as specified.

17.12. Control connections and instrument and wiring terminal board andfuses

i) Normally no fuses shall be used anywhere instead of fuses MCB's (both in AC & DC circuits) shall be used. Only in cases where a MCB cannot replace a fuse due to system requirements, a HRC fuse can be accepted.

ii) All wiring connections, terminal boards, fuses MCB's and links shall be suitable for tropical atmosphere. Any wiring liable to be in contact with oil shall have oil resisting insulation and the bare ends

of stranded wire shall be sweated together to prevent seepage of oil along the wire.

iii) Panel connections shall be neatly and squarely fixed to the panel. All instruments and panel wiring shall be run in PVC or non-rusting metal cleats ofthe compression type. All wiring to a panel shall be taken from suitable terminal boards.

iv) Where conduits are used, the runs shall be laid with suitable falls, and the lowest parts of the run shall be external to the boxes. All conduit runs shall be adequately drained and ventilated. Conduits shall not be run at or belowground level.

v) When 400 volt connections are taken through junction boxes or marshalling boxes, they shall be adequately screened and 400 volts Danger Notice must be affixed to the outside of the junction boxes or marshalling box. Proper colour code for Red, Yellow, Blue wires shall be followed.

vi) All box wiring shall be in accordance with relevant ISS. All wiring shall be of stranded copper (48strands) of 1100 Volt grade and size not less than 2.5 sq.mm.

vii) All wires on panels and all multi-core cables shall have ferrules, for easy identifications, which bear the same number at both ends, as indicated in the relevant drawing.

viii) At those points of interconnection between the wiring carried out by separate contractors, where a change of number cannot be avoided double ferrules shall be provided on each wire. The change of numbering shall be shown on the appropriate diagram of the equipment.

ix) The same ferrule number shall not be used on wires indifferent circuits on the same panels.

x) Ferrules shall be of white insulating material and shall be provided with glossy finish to prevent the adhesion of dirt. They shall be clearly and durably marked in black and shall not be affected by dampness or oil.

xi) Stranded wires shall be terminated with tinned Ross Courtney terminals, claw washers or crimped tubular lugs. Separate washers shall be suited to the size of the wire terminated. Wiring shall, in

general, be accommodated on the sides of the box and the wires for each circuit shall be separately grouped. Back of panel wiring shall be arranged so that access to the connecting items of relays and other apparatus is not impeded.

xii) All circuits, in which the voltage exceeds 125 Volts, shall be kept physically separated from the remaining wiring. The function of each circuit shall be marked on the associated terminal boards.

xiii) Where apparatus is mounted on panels, all metal cases shall be separately earthed by means of stranded (48No.) copper wire of strip having a cross section of not less than 2.5 sq.mm where strip is used, the joints shall be sweated. The copper wire shall have green coloured insulation for earth connections.

xiv) All wiring diagram for control and relay panel shall preferably be drawn as viewed from the back and shall show the terminal boards arranged as in services.

xv) Terminal block rows should be spaced adequately not less than 100mm apart to permit convenient access to external cables and terminations.

xvi) Terminal blocks shall be placed with respect to the cable gland (at a minimum distance of 200 mm) as to permit satisfactory arrangement of multi core cable tails.

xvii) Terminal blocks shall have pairs of terminals for incoming and outgoing wires. Insulating barrier shall be provided between adjacent connections. The height of the barriers and the spacing between terminals shall be such as to give adequate protection while allowing easy access to terminals. The terminals shall be adequately protected with insulating dust proof covers. No live metal shall be exposed at the back of the terminal boards. CT terminals shall have shorting facilities. The terminals for CTs should have provision to insert banana plugs and with isolating links.

xviii) All interconnecting wiring, as per the final approved scheme between accessories of transformer and marshalling box is included in the scope of this specification and shall be done by the Transformer supplier.

xix) The schematic diagram shall be drawn and fixed under a transparent prospane sheet on the inner side of the marshalling box cover.

xx) To avoid condensation in the Marshalling Box, a space heater shall beprovided with an MCB and thermostat.

xxi) Suitable LED Light shall be provided in the Marshalling Box for lightningpurpose.

17.13. Radio interference and noise level

Transformers shall be designed with particular care to suppress at least the third and fifth harmonic voltages so as to minimize interference with communication circuits. Transformer noise level when energized at normal voltage and frequency shall be as per NEMA stipulations.

18.0 INSPECTION AND TESTING

i) The Contractor shall carry out a comprehensive inspection and testing programme during manufacture of the transformer. This is however, not intended to form a comprehensive programme as it is contractor's responsibility to draw up and carry out such a programme duly approved by OPTCL.

ii) The contractor shall carry out type tests and routine tests on the transformers.

iii) Only one no. of transformer of each rating will be subjected to type test. The charges for conducting each of type tests shall be included in the bid price and no separate type test charges shall be paid. The OPTCL reserves the right to conduct any or all type tests at CPRI/National Govt. Approved Laboratory, if the type tests were not conducted earlier on transformers of the same rating and design at the cost of the firm.

iv) The pre-shipment checks shall also be carried out by the contractor.

v) The requirements on site tests are as listed in the specifications.

vi) Certified test report and oscillograms shall be furnished to OPTCL /Consultants for evaluation as per the schedule of distribution of documents. The Contractor shall also evaluate the test results and rectify the defects in the equipment based on his and OPTCL's evaluations of the tests without any extra charges to OPTCL. Manufacturer's Test Certificates in respect of all associated auxiliary and ancillary equipment shall be furnished.

vii) The bidder shall state in his proposal the testing facilities available at his works. Incase full testing facilities are not available, the bidder

shall state the method proposed to be adopted so as to ascertain the transformer characteristics corresponding to full capacity.

18.1 Inspection

i) Tank and Conservator

a) Inspection of major welding portions.

b) Crack detection of major strength weld seams by dye penetration test.

c) Check deformation of tank by vacuum & pressure test.

d) Check correct dimensions between wheels, demonstrate turning of wheels,through 90^0 and further dimensional check.

e) Leakage test of the conservator & radiators

ii) Core

a) Sample testing of core materials for checking specific loss, properties,magnetization characteristics and thickness.

b) Check on the quality of varnish if used on the stampings.

c) Check on the amount of burrs.

d) Visual and dimensional check during assembly stage.

e) Check on complete core for measurement of iron loss, determination ofmaximum flux density

f) Visual and dimensional checks for straightness and roundness of core,thickness of limbs and suitability of clamps

g) High voltage DC tests (2KVforoneminute) between cores and clamps.

iii)Insulating Material

a) Sample check for physical properties of materials

b) Check for dielectric strength

c) Check for the reaction of hot oil on insulating materials

iv)Winding

a) Sample check on winding conductorfor mechanical and electricalconductivity

b) Visual and dimensional checks on conductor for scratches, dent mark etc.

c) Sample check on insulating paper for PH value, electric strength.

d) Check for the bonding of the insulating paper with conductor.
e) Check and ensure that physical condition of all materials taken for windings issatisfactory and free of dust.
f) Check for absence of short circuit between parallel strands.

v) Checks Before Drying Process

a) Check condition of insulation on the conductor and between the windings.
b) Check insulation distance between high voltage connections, between high voltage connection cables and earth and other live parts.
c) Check insulating distances between low voltage connections and earth andother parts
d) Insulating test for core earthing.

vi)Check during Drying Process

a) Measurement and recording of temperature and drying time during vacuumtreatment.
b) Check for completeness of drying

vii) Assembled Transformer

a) Check completed transformer against approved outline drawing, provision forall fittings, finish level etc.
b) Jacking test on the assembled transformer

viii) Oil

a) All standard tests in accordance with IS: 335 shall be carried out onTransformer oil sample before filling in the transformer.

ix)Test Report for bought out items

The contractor shall submit the test reports for all bought out/sub contracted itemsfor approval.

a) Buchholz relay
b) Sudden pressure rise relay on Main Tank
c) Winding temperature indicators(forTXcapacity12.5MVA)
d) Oil temperature indicators
e) Bushings

f) Bushing current transformers in neutral

g) Marshalling box

h) On Load Tap changer

i) Any other item required to complete the works.

j) Porcelain, bushings, bushing current transformers, wherever provided, winding coolers, control devices, insulating oil and other associated equipment shall be tested by the contractor in accordance with relevant IS. If such requirement is purchased by the contractor on a sub-contract, he shall have them tested to comply with these requirements

18.2 Factory Tests

i) All standards routine tests in accordance IS: 2026 with dielectric tests corresponding as per latest amendments to IS: 2026 shall be carried out.

ii) All auxiliary equipment shall be tested as per the relevant IS. Test certificates shallbe submitted for bought out items.

iii) High voltage withstand test shall be performed on auxiliary equipment and wiringafter complete assembly.

iv) Following additional routine tests shall also be carried out on each transformer:

a) Magnetic Circuit Test Each core shall be tested for 1 minute at 2000 Volt DC

b) Oil leakage test on transformer

18.2.1 Type Test

The transformer shall be subjected to the following type tests particularly Short circuit and Impulse withstand tests at CPRI/National Govt. approved Laboratory at the discretion of OPTCL, if these tests were not conducted on the transformers of the offered design and rating at the cost of the manufacturer.

a) Tan delta measurement and capacitance of each winding to earth (with all other windings earthed) & between all windings connected together to earth.

b) Measurement of Zero sequence impedance.

c) Temperature Rise Test

d) Short Circuit Test

e) Tank Vacuum test
f) Tank Pressure Test
g) Lightning impulse withstand test for line and neutral terminal
h) Measurement of acoustic noise level.

The above type tests will be conducted by the supplier at their own cost, if the design/test result of the type-tested transformer differs from those of the offeredtransformer as per their bid.

18.2.2 Stage inspection

The supplier shall offer the core, windings and tank of each transformer for inspection by the OPTCL's representative(s). During stage Inspection, all the measurements like diameter, window height, leg centre, stack width, stack thickness, thickness of laminations etc. for core assembly, conductor size, Insulation thickness, I.D., O.D, winding height, major and minor insulations for both H.V and L.V windings, length, breadth, height and thickness of plates of Transformer tank, the quality of fittings and accessories will be taken/ determined. The supplier can offer for final inspection of the transformers subject to clearance of the stage Inspection report by the OPTCL.

18.2.3 Routine Tests

Transformer routine tests shall include tests stated in latest issue of IS:2026(Part–1). These tests shall also include but shall not be limited to the following:

a) Measurement of winding DC resistance.
b) Voltage ratio on each tapping and check of voltage vector relationship.
c) Impedance voltage at all tapings
d) Magnetic circuit test as per relevant ISS or CBIP manual or latest standardbeing followed.
e) Measurement of Load losses at normal tap and extreme taps.
f) No load losses and no load current at rated voltage and rated frequency, also at 25% to 125% of rated voltage in steps.
g) Absorption index i.e. insulation resistance for 15seconds and 60 seconds (R60/R15) and polarization index i.e. Insulation Resistance for 10minutes and one minute (R10mt/ R1mt) before

and after the high voltage tests.

h) Induced over voltage withstand test.
i) Separate source voltage withstand test.
j) Tan delta measurement and capacitance of each winding to earth (with all other windings earthed) & between all windings connected together to earth before and after the high voltage tests.
k) Measurement of zero sequence impedance
l) Tests on On-load tap changer (fully assembled on transformer) as per IEC: 214/1976 and BS:4571/1970.
m) Auxiliary circuit tests
n) Oil BDV tests
o) Measurement of neutral unbalance current which shall not exceed 2% ofthe full rated current of the transformer.
p) Magnetic balance test
q) Measurement of partial discharge
r) Leakage test.

Three (3) sets of certified test reports and oscillographs shall be submitted for evaluation prior to dispatch of the equipment. The contractor shall also evaluate the test results and shall correct any defect indicated by his and OPTCL's evaluation of the tests without charge to OPTCL.

18.3 Tank Tests

18.3.1. Oil leakage Test

The tank and oil filled compartments shall be tested for oil tightness completely filled with air or oil of viscosity not greater than that of insulating oil conforming to IS:335 at the ambient temperature and applying a pressure equal to the normal pressure plus 35kN/m^2 measured at the base of the tank. The pressure shall be maintained for a period of not less than 12 hours of oil and one hour for air and during that time no leak shall occur.

18.3.2. Pressure Test

Where required by the OPTCL, one transformer tank of each size together with its radiator, conservator vessel and other fittings shall

be subjected to a pressure corresponding to twice the normal head of oil or to the normal pressure plus 35 kN/m² whichever is lower, measured at the base of the tank and maintained for one hour.

18.3.3. Vacuum Test

One transformer tank of each size shall be subjected to the vacuum pressure of 60 mm of mercury. The tanks designed for full vacuum shall be tested at an internal pressure of 3.33 kN/m^2 (25 mm of mercury) for one hour. The permanent deflection of flat plates after the vacuum has been released shall not exceed the value specified in C.B.I.P. Manual on Transformers (Revised 1999) without affecting the performance of the transformer.

18.4 Pre-Shipment Check At Manufacturers Works

a) Check for proper packing and preservation of accessories like radiators, bushings, explosions vent, dehydrating breather, rollers, buchholz relay, control cubicle connecting pipes and conservator etc.
b) Checkforproperprovisionofbracingtoarrestthemovementofcoreandwi ndingassemb ly inside the tank.
c) Gas tightness test to conform tightness.

18.5 Inspection And Testing At Site

The Engineer authorized from OPTCL along with the contractor's site engineer shall carry out detailed inspection covering are as right from the receipt of material up to commissioning stage. An indicative programme of inspection as envisaged by the Engineer is given below.

i) **Receipt and Storage Checks**

a) Check and record conditions of each package visible parts of the transformers etc. for any damage.
b) Visual check of core and coils before filling up with oil and also checkcondition of core and winding in general.

ii) **Installation Checks**

a) Inspection and performance testing of accessories like tap changers etc.
b) Check choking of the tubes of radiators
c) Test on oil samples taken from main tank top and bottom and cooling system. Samples should be taken only after the oil has

been allowed to settle for 24 hours.

d) Check the whole assembly for tightness, general appearance etc.
e) Oil leakage tests.

iii) **Pre-Commissioning Tests**

After the transformer is installed, the following pre-commissioning tests andchecks shall be done before putting the transformer in service.

a) Dry out test
b) Insulation Resistance Test
c) DC Resistance measurement of windings
d) Ratio test on all taps
e) Phase relationship test (Vector grouping test)
f) Buchholz relay alarm & surge operation test
g) Low oil level (in conservator) alarm
h) Temperature Indicators
i) Marshalling kiosk
j) Protective relays
k) Magnetizing current
l) Tests on OLTC

iv) **The following additional checks shall be made:**

a) All oil valves are in correct position closed or opened as required
b) All air pocket are cleared.
c) Thermometer pockets are filled with oil.
d) Oil is at correct level in the bushing, conservator, diverter switch & tank etc.
e) Earthing connections are made.
f) Colour of Silica gel is blue.
g) Bushing arcing horn is set correctly and gap distance is recorded.
h) CT polarity and ratio is correct

18.6 PERFORMANCE

The performance of the transformer shall be measured on the following aspects.

a) The transformer shall be capable of being operated without danger on any tapping at the rated KVA with voltage variations and ± 10% corresponding to the voltage of the tapping.
b) Radio interference and Noise Level

c) The transformer shall be designed with particular attention to the suppression of third and fifth harmonics so as to minimize interference with communication circuits.

18.7 FAULT CONDITIONS

a) The transformer shall be capable of withstanding for five (5) seconds without damages any external short circuit to earth

b) Transformer shall be capable of withstanding thermal and mechanical stresses conveyed by symmetrical or asymmetrical faults on any winding. This shall be demonstrated through calculation as per IS: 2026.

c) Transformer shall accept, without injurious heating, combined voltage and frequency fluctuation which produce the 125% over fluxing condition for one minute and 140% for 5 seconds.

Certified test report and oscillograms shall be furnished to the OPTCL /Consultant for evaluation as per the schedule of distribution of documents. The Contractor shall also evaluate the test results and rectify the defects in the equipment based on his and OPTCL's evaluations of the tests without any extra charges to OPTCL. Manufacturer's Test Certificates in respect of all associated auxiliary and ancillary equipment shall be furnished.

The bidder shall state in his proposal the testing facilities available at his works. Incase full testing facilities are not available, the bidder shall state the method proposed to be adopted so as to ascertain the transformer characteristicscorresponding to full capacity testing.

18.8 WITNESSING OF TESTS AND EXCESSIVE LOSSES

a) OPTCL and or his representative reserve the right to witness any or all test or to waive tests at its sole discretion.

b) OPTCL reserves the right to reject the Transformer, if, losses exceed the maximum specified as per Clause No 2. SPECIFIC TECHNICAL REQUIREMENTS (STANDARD CONDITIONS), item-35 & 36 of this specification or if, temperature rise of oil and winding exceed the values specified at item — 26 of the above clause.

19.0 CAPITALISATION OF LOSSES AND LIQUIDATED DAMAGES FOR EXCESSIVE LOSSES

Sl. No	Transformer Rating	Maximum No Load Lossin kW	Maximum Copper Lossin kW
1	33/11 kV, 12.5 MVA	5.5	4.5

NOTE:-There shall be no positive tolerance to above losses. Capitalization of lossesshall not be factored in the comparative statement for selection of vendors.

20.0 SPARE PARTS

In case the manufacturer goes out of production of spare parts, then he shall make available the drawings of spare parts and specification of materials at no extra costto OPTCL to fabricate or procure spare parts from other sources.

Mandatory Spare: The suppliers shall provide the following mandatory spares free of cost one set each for every transformer supplied.

a) H.V. Bushing with Stud –1No
b) L.V. Bushing with Stud –1No
c) H.V. Bimetallic Conductor – 1 No.
d) L.V. Bimetallic Connector – 1 No

The supplier shall include the price of such mandatory spares in his price bid or else it will be presumed that the prices of such spares are included in the prices of transformers.

21.0 INSTRUCTION MANUAL

Eight sets of the instruction manuals shall be supplied at least four (4)weeks before the actual dispatch of equipment. The manuals shall be in bound volumes and shall contain all the drawings and information required for erection, operation and maintenance of the transformer. The manuals shall include amongst other, the following particular:

a) Marked erection prints identifying the components, parts of the transformer as dispatched with assembly drawings.
b) Detailed dimensions, assembly and description of all auxiliaries.
c) Detailed views of the core and winding assembly, winding connections and tap changer construction etc. These drawings are required for carrying out overhauling operation at site.
d) Salient technical particulars of the transformer.

e) Copies of all final approved drawings
f) Detailed O&M instructions with periodical checklists.

22.0 COMPLETENESS OF EQUIPMENT

All fittings and accessories, which may not be specifically mentioned in the specification but which are necessary for the satisfactory operation of the transformer, shall be deemed to be included in the specification and shall be furnished by the supplier without extra charges. The equipment shall be complete in all details whether such details are mentioned in the specification or not, without any financial liability to OPTCL under any circumstances.

23.0 TOOLS AND TACKLES

All the necessary tools and tackles required for normal operation &maintenance of thetransformers shall be supplied by the Contractor.

24.0 COMMISSIONING

The equipments shall be commissioned as per CBIP manual, IS: 10028 and manufacturer's recommendations. All the related drawings and manuals shall be pre- requisite for release of final payment.

25.0 NON COMPLIANCE SCHEDULE

On this schedule the bidder shall provide a list of noncompliance with this specification, documenting the effects that such noncompliance is likely to have on the equipment's life and operating characteristics. Each Non Compliance shall refer to the relevant clause of the specification. Where there are no deviations from specifications, the bidder shall so indicate by stating "No deviations" in this schedule.

26.0 TEST CERTIFICATES SCHEDULE

On this schedule a list of the test certificates included with the bid shall be provided. The list should include type test certificates and sample routine test reports. Each certificate listed shall be referred to the relevant specification clause and item ofequipment to which the test applies.

GUARANTEED TECHNICAL PARTICULARS FOR 33kV POWER TRANSFORMER

Sl. No.	Description	Bidder's offer
1	Name and address of the Manufacturer	

a)	Transformer	
b)	HV & LV Bushings	
c)	Bimetallic connectors	
d)	Transformer Oil	
e)	On load tap changer	
f)	Instruments	
g)	Neutral Bushing CTs	
2	Service (Indoor / Outdoor)	
3	Normal continuous rating in kVA under site conditionsat all taps :	
a)	HV winding (kVA)	
b)	LV winding (kVA)	
4	Rated Voltage	
a)	HV winding (kV)	
b)	LV winding (kV)	
5	Rated frequency (Hz)	
6	No. of phases	
7	Type of transformer	
8	Connections	
a)	HV winding	
b)	LV winding	
9	Connections symbols	
a)	HV – LV	
10	Tappings	
a)	Range	
b)	Number of steps	
c)	Position of tapping on HT winding for high voltagevariation	
11	Reference ambient temperatures	
a)	Maximum ambient air temperature (°C)	
b)	Maximum daily average ambient temperature (°C)	
c)	Minimum ambient air temperature(°C)	
d)	Maximum yearly weighted average ambienttemperature (°C)	
12	Maximum temperature rise over ambient temperature	

a)	In oil by thermometer (°C)	
b)	In winding by resistance measurement (°C)	
Sl. No.	Description	Bidder's offer
c)	Limit for hot spot temperature for which the transformer is designed (°C)	
d)	Type and details of winding hot spot temperature detector (°C).	
e)	Temperature gradient between windings and oil (°C).	
f)	Type of maximum winding temperature indicator (°C).	
13	Voltage to earth for which the star point will be insulated	
14	Cooling type	
15	Losses	
a)	Fixed (Iron) losses of 3 phase Transformer (kW) at rated voltage & rated frequency	
b)	Load losses at rated current at principal Tap at 75°C (kW)	
16	Max. Current density in winding at rated current for normal tap position	
a)	HV winding (Amps/ sq.mm.)	
b)	LV winding (Amps / sq.mm.)	
17	Impedance voltage at rated current , frequency and at 75°C expressed as percentage of rated voltage at :-	
a)	Principal (normal) tap (%)	
b)	Highest tap (%)	
c)	Lowest tap (%)	
18	Reactance at rated current & frequency as percentage of rated voltage at:	
a)	Principal (normal) tap	
b)	Highest Tap	
c)	Lowest Tap	
19	Resistance at 75º C	
a)	H.V. winding at normal tap position	
b)	L.V. winding	
	Resistance voltage drop at 75º C winding	

c)	temperature expressed as percent of rated voltage (%)	
i)	Principal/ normal tap	
ii)	Highest tap	
iii)	Lowest tap	
20	Capacitance on open circuit conditions	
21	Insulation level	
a)	Separate source power frequency voltage withstand	
i)	HV winding (kV rms)	
ii)	LV winding (kV rms)	
Sl. No.	Description	Bidder's offer
b)	Induced over voltage withstand	
i)	HV winding (kV rms)	
ii)	LV winding (kV rms)	
c)	Full wave lightning impulse withstand voltage	
i)	HV winding (kV peak)	
ii)	LV winding (kV peak)	
d)	Power frequency high voltage tests	
i)	Test voltage for one minute withstand test on high voltage windings (induced)	
ii)	Test voltage for one minute withstand test on low voltage windings	
iii)	Test voltage for one minute withstand test on neutral end of low voltage windings	
e)	Lightning impulse withstand tests	
i)	Impulse test on high voltage winding 1.2/50 µ sec full wave withstand (kV peak)	
ii)	Impulse test on low voltage winding 1.2/50 µ sec full wave withstand (kV peak)	
iii)	Wave form for impulse test	
22	No load current, no load loss, no load power factor at normal ratio and frequency (Amp/ kW/ P.F.)	
a)	10 percent of rated voltage	
b)	25 percent of rated voltage	
c)	50 percent of rated voltage	
d)	85 percent of rated voltage	

e)	100 percent of rated voltage	
f)	105 percent of rated voltage	
g)	110 percent of rated voltage	
h)	112.5 percent of rated voltage	
i)	115 percent of rated voltage	
j)	120 percent of rated voltage	
k)	125 percent of rated voltage	
23	Efficiency at 75º C at unity power factor	
a)	Full load	
b)	75% load	
c)	50% load	
d)	25% load	
24(a)	The minimum percentage of load at which the transformer will run at maximum efficiency (%)	
b)	Maximum efficiency of the transformer	
25	Regulation at full load at 75º C	
a)	At unity power factor (%)	
b)	At 0.8 power factor (lagging) (%)	
Sl. No.	Description	Bidder's offer
26	Core data	
a)	Grade of core material used	
b)	Thickness of core plate lamination (mm)	
c)	Whether core laminations are of cold rolled grain oriented	
d)	Details of oil ducts in core	
i)	Whether in the plane & at right angle to the plane of winding	
ii)	Across the plane of lamination	
e) i)	Insulation of core lamination	
ii)	Insulation of core plates	
iii)	Type of core joints	
27	Flux density	
a)	Designed maximum flux density at normal tap at rated voltage and rated frequency (Tesla)	
b)	Operating continuous flux density (Tesla)	
i)	at normal tap	

ii)	at maximum tap	
iii)	at minimum tap	
c)	Designed maximum operating flux density which the transformer can withstand for one minute at normal tap (Tesla)	
d)	Designed maximum operating flux density which the transformer can withstand for five seconds at normal tap (Tesla)	
28	Inter-Tap insulation	
a)	Extent of extreme end turns reinforcement	
b)	Extent of end turns reinforcement	
c)	Extent of turn adjacent to tapping reinforced	
d)	Test voltage for 10 seconds 50Hz inter-turn insulation test on (a)	
e)	Test voltage for 10 seconds 50Hz inter-turn insulation test on (b)	
f)	Test voltage for 10 seconds 50Hz inter-turn insulation test on (c)	
29	Windings:	
a)	Material	
b)	Type of windings:	
i)	HV windings	
ii)	LV windings	
c)	Insulation of HV windings	
d)	Insulation of LV windings	
e)	Insulation between HV & LV windings	
Sl. No.	Description	Bidder's offer
30	Continuous rating under following conditions:	
a)	At 40ºC ambient air temp. at site	
b)	At 30ºC ambient air temp. at site	
c)	At 20ºC ambient air temp. at site	
31	Transformer Tank	
a)	Material	
b)	Thickness	
i)	Top	
ii)	Sides	
iii)	Bottom	
c)	Details of painting	

i)	Inner surface	
ii)	Outer surface	
32	Dimensions of 3 phase transformers:	
a)	Max. Height to top of bushings (mm)	
b)	Overall length (mm)	
c)	Overall breadth (mm)	
33	Weight data of transformer components : (Tolerance + 5%) (approximate values not allowed)	
a)	Core excluding clamping (Kg)	
b)	Core with clamping (Kg)	
c)	HV winding insulated conductor (Kg)	
d)	LV winding Insulated conductor (Kg)	
e)	Coils with insulation (Kg.)	
f)	Core and windings (Kg)	
g)	Weight of steel (Kg)	
h)	Fittings and accessories (Kg)	
i)	Oil required for first filling including 10% extra (ltrs / Kg)	
	i)Oil in main tank (Ltrs)	
	ii)Oil in the conservator (Ltrs)	
	iii)Oil in the radiators (Ltrs)	
	iv)Oil in the OLTC (Ltrs.)	
	v)Overall total quantity of oil with 10% extra oil for first filling (ltrs / Kg)	
j)	Transportation weight excluding accessories (Kg)	
k)	Shipping details	
i)	Weight of heaviest package (Kg.)	
ii)	Dimension of largest package (Kg)	
l)	Untanking weight (Kg)	
m)	Total weight of transformer with oil and fittings (Kg)	
Sl. No.	Description	Bidder's offer
34	Bushing data :	

a)	Type of bushing insulator	
i)	HV	
ii)	LV	
iii)	Neutral	
b)	Material of bushing (inner part / outer part)	
c)	Weight of bushing insulator (Kg.)	
d)	Quantity of oil in one bushing (lt.)	
e)	Minimum dry withstand & flash over power frequency voltage of bushing (kV)	
f)	Minimum wet withstand & flash over power frequency voltage of bushing (kV)	
g)	Minimum withstand & flashover impulse level (kV)	
h)	Voltage rating (kV)	
i)	Current rating (Amps.)	
j)	Thermal Short Time current & Duration	
k)	Rated Dynamic current & its duration	
l)	Cantilever with stand loading	
m)	Clearance in oil	
	i)phase to phase (mm)	
	ii)phase to earth (mm)	
n)	Creepage distance in oil & air (mm)	
o)	Minimum level of immersing / medium (oil) (mm)	
p)	Maximum pressure of immersing medium (oil) Kg/ cm^2	
q)	Free space required at top for removal of bushings (mm)	
r)	Angle of mounting	
35	Details of CT to be provided in the neutral for REF protection.	
a)	Outdoor bushing type	
b)	No. of cores and their function	
c)	Location (Line / Neutral)	
d)	Current rating for various cores (Primary / Secondary)	
e)	VA burden / Knee Point voltage (Core wise)	
f)	Magnetising current at half knee point voltage. (mA)	

g)	Classification (PS class) core wise	
h)	Test voltage	
i)	Construction details	
36	Conservator (Main Transformer and OLTC)	
a)	Total volume of the Conservator (Cub mtr / Ltr.)	
Sl. No.	Description	Bidder's offer
b)	Volume of the conservator between the highest and lowest level (Cubic mtr. / Ltrs)	
37	Calculated time constants for natural cooling	
38	Type of axial coil supports :	
a)	HV winding	
b)	LV winding	
39	Details of On Load tap changer	
a)	Make	
b)	Type	
c)	Rating	
i)	Rated Voltage	
ii)	Rated current	
iii)	Step voltage	
iv)	Number of steps	
d)	Whether Diverter switch provided with gas vent and buchholz relay (Yes / No)	
e)	Whether a separate oil surge relay with trip contacts provided (Yes / No)	
f)	Pressure relief valve	
g)	Details of motor device unit housed in kiosk / mounted on tap changer	
h)	Whether Remote control panel provided with Control scheme for simultaneous operation of Tap changer when transformers are running in parallel and independent control when in independent operation.	
i)	Details of equipment in the OLTC kiosk	
j)	Details of OLTC panels	

	i)automatic tap changer relay	
	ii)literature of all the relays	
	iii)dimensions of OLTC, Panel L x B x H	
	iv)thickness of sheet	
	v)degree of protection	
	vi)details of equipment supplied	
40	Dispatch details :	
a)	Approx. mass of heaviest Package (Kg)	
b)	Approx. dimensions of largest Package	
	i)Length (mm)	
	ii)Breadth (mm)	
	iii)Height (mm)	
41	Un-tanking height (mm)	
42	Bimetallic connectors HV / LV	
a)	Normal current rating (A)	
b)	Short time current rating (A)	
Sl. No.	Description	Bidder's offer
c)	Tensile strength (Kg)	
d)	Maximum temperature limit	
e)	Dimensional sketch enclosed indicating tolerances (Yes/No)	
f)	Minimum clearance (mm)	
	i)Phase to phase	
	ii)Phase to Earth	
43	CORE ASSEMBLY :-	
a)	Core diameter (mm)	
b)	Core window height (mm)	
c)	Core leg centre (mm)	
d)	Gross core cross – sectional area (m^2)	
e)	Total height of core (mm)	
f)	Details of top end frame	
g)	Details of Bottom end frame	
h)	Details of clamp plate (material, thickness, insulation)	
i)	Total core weight (Kg)	

j)	Core loss, basing on core loss graph at operating flux density (rated voltage and rated frequency) (kW)	
k)	Core stacking factor	
l)	Net core area (Sq.m)	
m)	Margin towards corner joints, cross-fluxing, dielectric loss (kW)	
n)	Total core loss at rated voltage and rated frequency (kW)	
o)	Describe location / method of core grounding	
p)	Details of core- belting	
i)	Material , grade and type	
ii)	Width	
iii)	Thickness	
iv)	Fixing method	
44	DETAILS OF WINDING	
a)	Type of winding	
b)	Material of the winding conductor	
c)	Maximum current density of windings at rated current and conductor area	
d)	Whether windings are pre-shrunk ?	
e)	Whether adjustable coil clamps are provided for HV and LV windings ?	
f)	Whether steel rings are used for the windings ? If so, whether these are split ?	
Sl. No.	Description	Bidder's offer
g)	Whether electrostatic shields are provided to obtain uniform voltage distribution in the windings ?	
h)	Winding Insulation (Type & Class)	
i)	Insulating material , used for	
i)	H.V winding	
ii)	LV winding	
iii)	Tapping connection	
j)	Insulating material used between	
i)	L.V and H.V winding	
ii)	Core & L.V winding	
k)	H.V to H.V winding between phases	

l)	Type of axial supports	
i)	H.V winding	
ii)	L.V winding	
m)	Type of radial supports	
i)	H.V winding	
ii)	L.V winding	
n)	Maximum allowable torque on coil clamping bolts	
o)	Clamping ring details	
i)	Thickness of ring mm	
ii)	Diameter of ring mm	
iii)	No. & size of pressure screw	
p)	Bare conductor size (mm^2)	
i)	HV	
ii)	LV	
q)	Insulated conductor size (mm^2)	
i)	HV	
ii)	LV	
r)	No. of conductor in parallel (Nos.)	
i)	HV	
ii)	LV	
s)	No. of turns / phase	
i)	HV	
ii)	LV	
t)	No. of discs / phase	
i)	HV	
ii)	LV	
u)	No. of turns / Disc	
i)	HV	
ii)	LV	
v)	Gap between discs (mm)	
i)	HV	
Sl. No.	Description	Bidder's offer
ii)	LV	
w)	Inside diameter (mm)	
i)	HV	
ii)	LV	

x)	Outside diameter (mm)	
i)	HV	
ii)	LV	
y)	Axial height after shrinkage (mm)	
i)	HV	
ii)	LV	
z)	D.C Resistance	
i)	L.V winding at 75°C (Ohms)	
ii)	H.V winding at normal tap at 75°C (Ohms)	
iii)	H.V winding at highest tap at 75°C (Ohms)	
iv)	H.V winding at lowest tap at 75°C (Ohms)	
v)	Total I^2R losses at 75°C for normal tap (kW)	
vi)	Total I^2R losses at 75°C for highest tap (kW)	
vii)	Total I^2R losses at 75°C for lowest tap (kW)	
viii)	Stray losses including eddy current losses in winding at 75°C (kW)	
	i)Normal tap position	
	ii)Highest tap position	
	iii)Lowest tap position	
	iv)Any special measures, taken to reduce eddy current losses and stray losses. Mention in details	
ix)	Load losses at 75°C (I^2 R + Stray)	
	i)Normal tap position (kW)	
	ii)Highest tap position (kW)	
	iii)Lowest tap position (kW)	
x)	Details of special arrangement, provided to improve surge voltage distribution in the windings.	
45	DETAILS OF TANK :	
a)	Material of Transformer tank	
b)	Type of tank	
c)	Thickness of sheet (No approximate value to be mentioned)	

	i) Sides (mm)	
	ii) Bottom (mm)	
	iii) Cover (mm)	
	iv) Radiators (mm)	
d)	Inside dimensions of main tank (No approximation in dimensions to be used)	
	i) Length (mm)	
Sl. No.	Description	Bidder's offer
	ii) Breadth (mm)	
	iii) Height (mm)	
e)	Outside dimensions of main tank (No approximation in dimensions to be used)	
	i) Length (mm)	
	ii) Breadth (mm)	
	iii) Height (mm)	
f)	Vacuum recommended for hot oil circulation (torr / mm of Hg)	
g)	Vacuum to be maintained during oil filling in transformer tank (torr / mm of Hg)	
h)	Vacuum to which the tank can be subjected without distortion (torr / mm of Hg)	
i)	No. of bi-directional wheels provided	
j)	Track gauge required for the wheels	
	i) Transverse axis	
	ii) Longitudinal axis	
k)	Type and make of pressure relief device and minimum pressure at which it operates (Kpa)	
46	CONSERVATOR :-	
a)	Thickness of sheet (mm)	
b)	Size (Dia x length) (mm)	
c)	Total volume (Litres)	
d)	Volume between the highest and lowest visible oil levels (Litres)	

CHAPTER-E8
AC AND LT DISTRIBUTION BOX
WITH MCCB

TABLE OF CONTENTS

1. SCOPE:

This specification covers the technical requirements of design, manufacture, testing at manufacturer's works, packing, forwarding, supply and unloading at site/store and performance of 415Volts ACDB with all accessories and necessary training for trouble free & efficient performance.

It is not the intent to specify completely herein all the details of tech design and construction of material. However, the material shall conform to practices consistent with sound environmental management and local statues. It is also expected that equipment shall comply in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation in manner acceptable to the TPCODL, who will interpret the meanings of drawings and specification and shall have the power to reject any work or material which, in his judgment is not in accordance therewith. The offered material shall be complete with all components necessary for their effective and trouble-free operation. Such components shall be deemed to be within the scope of Bidder's supply irrespective of whether those are specifically brought out in this specification and/or the commercial order or not.

2. APPLICABLE STANDARDS:

The equipment covered by this specification shall unless otherwise stated, be designed, manufactured and tested in accordance with latest editions of the following Standards /IEC and shall conform to the regulations of local statutory authorities.			
a)	IS 13947 / IEC 60947	:	Specification for Low voltage Switchgear and Control gear
b)	IS 2705	:	Current transformer
c)	IS 694-1990	:	PVC insulated cables for working voltage upto and including 1100V
d)	IS 2629-1985	:	Recommended practice for Hot Dip Galvanizing of Iron & Steel.
e)	IS 2633-1986	:	Tests for uniformity of zinc coating
f)	IS 5578-1984	:	Guide for marking of insulated conductors
g)	IS 11353-1985	:	Guide for uniform system of marking and identification of conductors and apparatus terminals.
h)	IEC 60060	:	High-voltage test techniques
i)	IEC 61010-1	:	Safety requirement for electrical equipment for measurement and laboratory use.
j)	IEC 62052–11	:	Electricity metering equipment (a.c.) – General requirements, tests and test conditions
k)	IEC 62053–22	:	Static meters for active energy (Class 0.2 S and 0.5 S)
l)	IS 14697	:	AC Static Transformer Operated Watt-hour and Var-hour Meters, Class 0.2S and 0.5 S - Specification
m)	IS 12063 / IEC 60529	:	Classification of degrees of protection provided by enclosures of electrical equipment
n)	IS 8623	:	Specification for Low-Voltage Switchgear and Control gear Assemblies
o)	IEC 60664	:	Insulation co-ordination within low voltage systems including clearances & creepage distances for equipment.
p)	IS 14772-2000	:	General requirements for enclosures for accessories for household and similar fixed electrical installation.

3.CLIMATIC CONDITIONS:

1	Maximum ambient temperature	50 deg C
2	Max. Daily average ambient temp	35 deg C
3	Min Ambient Temperature	0 deg C
4	Maximum Humidity	95%
5	Average Annual Rainfall	150cm
6	Average No. of rainy days per annum	120
7	Altitude above MSL not exceeding	1000m
8	Wind Pressure	300 Km/hr
9	Earthquakes of an intensity in horizontal direction	equivalent to seismic acceleration of 0.3g
10	Earthquakes of an intensity in vertical direction	equivalent to seismic acceleration of 0.15g (g being acceleration due to gravity)

4.GENERAL TECHNICAL REQUIREMENTS:

S.No	Description	Requirement
4.1	**Switchgear panel**	
4.1.1	Architecture	Metal-clad air insulated
4.1.2	Normal service condition	Indoor
4.1.3	No. of Phases	Three
4.1.4	Rated Voltage	415 V
4.1.5	Rated Frequency	50 Hz
4.1.6	Rated Impulse withstand voltage	8 kVP
4.1.7	Rated Insulation Voltage	690 V

4.1.8	Main Bus bar continuous rated current	400A
4.1.9	Bus bar material & Current density	Aluminum, 1.0 A/sqmm
4.1.10	Degree of protection for enclosure / for meters	IP 54 / IP 5X or equivalent to completely protect against dust ingress
4.1.11	Temperature Rise	The maximum permissible temperature rise for bus bar and terminals shall be 45° C and 65° C at an ambient temperature not exceeding 40° C.

S.No.	Description	Requirement					
4.2	Item / Panel reference	Incomer	Bus-Coupler	Outgoings			
4.2.1	Circuit Breaker Type/Rating (A)	MCCB 250 A	MCCB 250 A	TPN MCB 100A	63A	32A	16A
4.2.2	Quantity (Nos.)	2	1	1	2	4	10
4.2.3	No of poles	3					1
4.2.4	Type of release	TMD as well as E/f protection	Thermal magnetic release (TMD)				Only magnetic
4.2.5	O/L Releases setting	80% - 100%					-
4.2.6	Rated Voltage	400V					230V
4.2.7	Rated ultimate short circuit breaking capacity (Icu)	50KA		35KA			20KA
4.2.8	Rated service short circuit breaking	100% of Icu		50% of Icu			50% Icu

	capacity (Ics)						
4.2.9	Utilization Category	A					
4.2.10	Rated Insulation Voltage	690V					500V
4.2.11	Rated Impulse withstand voltage	8kVP					6kVP
4.2.12	1.1KV Al. XLPE cables (sq mm)	4CX300/ 150	-	4Cx50	4Cx25	4Cx25	2Cx10
4.2.13	Cast Resin type CT (3Nos)-Ratio, Burden	250/5A 15VA, Cl-0.5S	-	-	-	-	-
4.2.14	**Auxiliary Voltages**						
a)	For Spring charging motor	230V AC	230V AC	Not Applicable			
b)	For closing & trip coil.						
c)	For anti-condensation heaters	230V AC					
4.2.15	**Remote Control**	Required	Required	Not Required			
4.2.16	**Metering**	Multi-function meter	Not Required				
4.2.17	**Panel Illumination and space heating**	To be provided by the Bidder in each Cable alley					
4.2.18	**Feeder Description Name plate**	To be provided by the Bidder for each feeder					

5. GENERAL CONSTRUCTION:

5.1 SWITCHGEAR

a) The switchgear panel shall be of sheet steel construction and shall be dust and vermin proof and shall be suitable for indoor installation. The panels shall be of Metal Clad compartmentalized, free standing, continuous from rear, modular type. The switchgear panels shall be rigid without using any external bracing. The switchboard panels should comply with relevant IS/IEC and revision thereof and shall be designed for easy operation maintenance and further extension. Bus bar, metering, circuit breaker chamber, cables and cable box chamber should have proper access for maintenance, proper interlocks should be provided. Metal enclosed switchgear shall be so designed that normal service, inspection and maintenance operations including visual checking of phase sequence, earthing of connected cables, locating of cable faults, voltage tests on connected cables can be carried out safely.

b) Panels shall have structural steel frame-work enclosed on all sides by CRCA sheet steel of minimum thickness as specified below:

- Frame : 2 mm
- Doors & Covers : 2 mm
- Removable gland plate : 3 mm

c) Panels shall consist of a front portion with equipment mounted on it and wiring access from rear. All doors, cut-outs and removable covers shall be gasketed all round by neoprene cork gaskets. Each panel section shall be provided with thermostat controlled space heater with ON/OFF switch. CFL Lamp shall be provided with door switch for each panel for cubicle interior illumination.

d) Panels shall be mounted and bolted to a common base channel of height 75mm. The channel in turn shall be fixed to the foundation bolts at site. All foundation equipment, anchor bolts etc. including the supporting channel shall be furnished by successful bidder in advance for completion of Civil Works prior to dispatch of panels. The bottom plates of the panels shall be fitted with removable gland plates of not less than 3mm in thickness, for fixing the cable glands, the size of which shall suit the purchaser's external cables to the panels.

e) Height of the panel should be limited to 2100mm. Each Indicating instruments and meters shall be at a suitable height so that the lettering on the dials can be easily read. Control switches/push buttons shall be conveniently located for ease of operation. The centre lines of the switches, push buttons and indicating lamps shall not be at a height more than 1800mm also shall not be less than 300mm that of the lowest unit. MCB with neutral link shall be provided at the panel for incoming AC supplies. Push buttons shall be made of non-hygroscopic material. All other insulators shall also be made of non-hygroscopic material.

f) All components of the same rating and construction which may be needed to be replaced shall be interchangeable. If there are removable parts with different ratings and if parts are interchangeable within the assembly of metal enclosed switchgear and control gear, any possible combination of removable and fixed parts shall withstand the rated insulation level specified for fixed parts concerned. While making the general arrangement, consideration will be given to the place of sectionalizing to select the location where the minimum electrical connections are transferred from one section to other section.

g) All the components of a module will be mounted on a component plate using machine screws and taped holes (except the components mounted on the door) to ensure vibration free operation. Circuit breakers shall be mounted such that they are accessible from the front of the panel. These components plates should be fixed with bolts for easy replacements. Standardization will be adopted while making these plates so that the component plates of the same size modules can be changed from one module to other.

h) Auto Changeover facility shall be implemented and provided in ACDB between two incomers (Between Local Transformer Supply source and Duplicate supply source), bus coupler. Local transformer supply shall be considered as default supply. If local transformer supply gets failed then Duplicate supply source MCCB shall switched ON automatically i.e auto changeover. But when Local transformer supply gets restored, then auto changeover to local transformer source shall operates i.e. default source shall be of local transformer. Necessary delay timer to be provided for such kind of auto changeover to enhance safety factor. SCADA operations shall not intervene in the Auto operations and shall be separately provided. ACDB shall have provision for SCADA compatibility.

i) Interlocks between different components shall be provided for safety and ease of operation. The withdrawal or engagement of only incomer and bus coupler circuit breaker shall be impossible unless it is in open position. All instruments shall be non-draw-out type and safeguard in every respect from damages. The operation of a circuit breaker shall be impossible when it is in closed position. It shall be impossible to close the incoming and bus coupler circuit breaker in service position unless it is connected to auxiliary circuit.

j) The rear of the ACDB shall have bolted covers in sections except cable chamber. Single line diagram for power distribution and wiring diagram for power and control shall be provided inside the panel. All retaining catches, screws and bolts for doors and covers shall be hot dip galvanized screws and bolts shall be captive. All hardware for the complete equipment including foundation bolts, lifting lugs & cable termination lugs etc. shall be supplied along with the panels.

k) All LT design shall ensure conformity to IEC-60947. The supplier shall submit Type Test report from CPRI/ERDA to prove the above. Auxiliary and control equipment installed on the panel shall be suitably protected against disruptive discharge from main circuit. Buses shall be insulated with insulating sleeves, wherever bare conductor is employed. The switchgear panel shall withstand 50KA for 1 sec.

l) Degree of Protection for the enclosure shall be IP54 and that of partitions shall be IP4X. Compartment shall have its own front located, outward opening lockable hinged door with concealed hinges and bolted back cover. The door shall have interlocking facility with the MCCB or its handle such that the door can be opened only if the MCCB is in 'OFF' position. De-interlocking arrangement shall also be provided. Partitions of metal-clad switchgear and control gear shall be metallic and earthed.

m) Control supply in individual bay shall to be distributed through MCBs of suitable rating for individual control function like:

- Trip Circuit (Only for I/Cs & B/C)
- Close Circuit (Only for I/Cs & B/C)
- Spring charging circuit (Only for I/Cs & B/C)

- Heating and Lighting Circuit

n) MCB shall be rated for 10kA short circuit rating. It shall be quick make, quick break, and independent manual type with trip free feature. MCB shall have the following:

- Over current protection
- ON/OFF Trip position indicators Auxiliary contact block (Wherever required)

o) Wherever CB contacts are to be multiplied, latch type relay shall be used for contact multiplication. Auxiliary contact multiplier relays shall be reputed make and selected on the basis of continuous current carrying capacity and rated voltage. The fluctuation in voltage level shall be accounted for (+/-) 10% continuously.

p) Each switchgear panel shall have 20% spare terminals. All equipment mounted on front side of panel shall have individual nameplates with equipment designation engraved. The termination links for cables shall be segregated in vertical plane. The bidder shall deliver to site completely assembled, wired, tested panels and only the interconnecting cables shall be connected at site.

q) Cable entry arrangement shall be from bottom and suitable for 1.1KV XLPE armored external cables of sizes as mentioned in the specification. Removable CRCA gland plate of 3mm with cable holes to suit the cable sizes and with 2mm neoprene type gasket of non-inflammable and insulating vermin proof material shall be provided. A minimum distance of 250mm will be provided between the gland plate and the nearest terminal for proper dressing and termination of the cable.

5.2 Circuit Breaker

a) The circuit breaker shall be MCCB. The I/Cs and B/C MCCBs shall be strictly withdraw able type, rest MCCBs / MCBs shall be fixed type and Electrical & Mechanical interlocks shall be provided for only incomers & bus couplers. Detail scheme shall be finalized during engineering. Comprehensive interlocking system to prevent any dangerous or inadvertent operation shall be provided. The spare contact of breakers, Local/ Remote switches to be wired up to the terminals.

b) The CB shall be spring operated, motor charged, and manually released spring closing mechanism with three pole simultaneous operations. The speed of closing operation shall be independent of the hand-operating lever. The indicating device shall show the OPEN and CLOSE position of breaker visible from front of the cubicle. The spring charging time of the motor shall not exceed 15 seconds.

5.3 BUS BARS

a) Bus bars and all other electrical connections between various components shall be made of Aluminium of rectangular cross-section with current density of 1 A/mm2, shall be suitable for 3 phase, 4 wire, 400 volts 50 Hz AC supply and have a fault withstanding capacity of 50 KA for 1 second. The bus bars shall be insulated with heat shrinkable and colour coded insulating sleeves, except at the points of connections. The Main bus bar shall be of ample capacity to carry the rated current of 400A continuously without excessive heating and for adequately meeting the thermal and dynamic stresses in the case of short circuit in the system. Neutral Bus bar shall have a rating of not less than that of the associated phase bus bars. All bus bars shall be rigidly and firmly mounted and shall be capable of withstanding short circuit stresses and vibrations. The bus bars shall be extensible on both sides depending upon layout.

b) Minimum electrical clearances shall be maintained between phases, neutral and body as per relevant IS however the minimum clearance between phase to phase and phase to ground shall be 25.4mm & 19.4mm respectively.

c) The Bus bars shall run in a separate bus bar chamber using suitable Bus bar support of non-hygroscopic, non-combustible, material such as DMC/ SMC at sufficiently close intervals to prevent bus bar sag. All bus bar joints shall be provided with high tensile steel bolts (electro plated with suitable metal such as Nickel/ Cadmium), spring washer and nuts so as to ensure good contact. Alternatively, electroplated/ tinned brass bolts shall be used. The joints shall be formed with fish-plates on either side of bus bar to provide adequate contact area. Bus supports shall be provided on either side of joints. Max. Unsupported distance from the joints and between two supports shall not exceed 450mm.

5.4 CURRENT TRANSFORMER

The Current transformer shall be Epoxy Cast resin type and rated for 50KA (1 Sec) with details as given in GTP. The CT control wiring shall be of 4 mm2 multi stranded copper wire with 1.1KV insulation grade. Al CTs shall be designed to carry continuously a current of 120% of the rated current.

5.5 METERING, INSTRUMENTATION AND CONTROL DEVICES

5.5.1 MEASURING INSTRUMENTS

3-phase, 4-wire LT CT operated static multifunction meter with associated CT's (400/5 A, Class 0.5S, 15 VA) shall be provided for only incomers to record Current reading (Range 0-400A), voltage reading (Range 0-500V) and energy consumption. The multifunction meter shall necessarily have RS 485 Modbus serial port for communication with Purchaser SCADA.

All meters shall be of flush mounting type with 96x96 sq. mm. The meter shall be enclosed in a dust tight housing providing IP5X or an equivalent provision to completely protect it against dust ingress, and shall protect in a way that performance doesn't get effected due to small dust also. The design and manufacture of the meters shall ensure the preventing of fogging of instrument glass. Instrument meters shall be sealed in such a way that access to the measuring element and to the accessories within the case shall not be possible. Inbuilt selector switches shall be provided to be used on three phase supply.

The make of Energy meter & CT shall be duly approved by the Purchaser.

5.5.2 INDICATING LAMPS

The indicating lamps used in the panel will be pleasant looking, LED type indicating lamps in round shape and suitable for continuous operation at 85% to 110% of their rated voltage. They shall be provided with suitable series resistor and the bulb shall be replaceable from the front of the panel.

The selection of the colours of the indicating lamps will be as follows:

- Red – MCCB ON
- Green – MCCB OFF
- Amber – MCCB TRIP
- Red, Yellow and Blue for incoming 3-ph supply indication

The various feeders shall be assigned the indicating lamps as mentioned:

- I/Cs – ON, OFF, TRIP and 3-ph supply indications
- B/C – ON, and OFF indications only
- O/Gs – ON indication only

All color caps shall be similar and interchangeable and all LEDs shall be of same type and ratings. The LED lamps shall be furnished 20% in excess of actual numbers required and color caps shall be furnished 10% in excess of actual numbers used for each color

5.5.3 SELECTOR SWITCHES

Selector switches shall be of non-hygroscopic rotary type with enclosed contacts adequately rated for the purpose intended (min. acceptable rating is 10A continuous at 240V AC).
It shall be provided with escutcheon plates clearly marked to show the following three positions first one for 'LOCAL' second 'REMOTE' and the third being the 'OFF' position. Selector switches shall be provided with pistol grip type handles and shall be of the maintained contact stay put type.

5.6 PANEL WIRING

a) Panels shall be supplied completely wired internally to equipment and terminal blocks and ready for the Purchaser's external cable connections at the terminal blocks. The control wiring will be done with PVC single core flexible copper wires and properly dressing all the wires either in a PVC duct of liberal size or bunched together by PVC strapping taps and thereafter fastened to steel members of the panel. When panels are arranged to be mounted adjacent to each other all inter-panel wiring and connections between panels shall be provided by the Bidder.

b) All wiring shall be carried out with 1100 V grade, single core stranded copper conductor wires with PVC insulation. Extra flexible wires shall be used for wiring of devices mounted on moving parts such as swinging panels and doors. The minimum size of the stranded copper conductor used for panel wiring shall be as follows:

- CT circuits : 4mm2 per lead
- All circuits except CT circuits : 2.5mm2 per lead

c) Interconnections to adjacent panels shall be brought out to a separate set of terminal blocks located near the slots or holes meant for taking the interconnecting wires. Arrangements shall permit easy inter-connections to adjacent panels at site and wires for this purpose shall be provided by the bidder looped and bunched properly inside the panels. The unused instrument space on the front or rear of the panels shall be kept clear of wiring, to facilitate addition of devices without rewiring associated portion of

the panels

d) Wire terminations shall be made with solder less crimping type of (ring type lugs for all CT and pin type lugs for other circuits) tinned copper lugs which firmly grip the conductor and insulation. Insulated sleeves shall be provided at all the wire terminations. Printed type PVC ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of all the control, instrumentation, and protection wiring. Ferrules shall fit tightly on the wires and shall not fall off when the wire is disconnected

e) Internal wiring to be connected to external equipment shall terminate on terminal blocks. The terminal blocks for CTs shall be provided with test links and isolating facilities. The CT terminal blocks shall be provided with short circuiting and earthing facilities. Switchgear shall have 20% terminals as spare terminals in each panel & should be uniformly distributed in all the blocks.

f) The Power interconnections shall be carried out by means of bolted connections with washers. The wiring shall be terminated by using crimping sockets. Under no circumstances the wiring should be under any kind of stress for which sufficient length of control wiring should be provided.

5.7 TERMINAL BLOCKS

a) The terminal blocks shall be 1100 V grade, 10 Amps rated, one piece moulded, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts and identification strips. Markings on the terminal strips shall correspond to wire numbers on the wiring diagrams. The terminal blocks shall be fully enclosed with easily removable covers and made of moulded non-inflammable plastic material.

b) All spare contacts of the panel mounted equipment and devices shall be wired up to terminal blocks. All the TB's shall be of single Decker type. ASB shall be provided with potential free contacts for Mains ON, I/C 1 ON, I/C 1 OFF, I/C 2 ON, I/C 2 OFF, B/C ON & B/C OFF etc. for Purchaser's SCADA. Supplier will provide wiring of these contacts up to terminal block in ASB.

5.8 SPACE HEATERS

a) Strip type space heaters of adequate capacity shall be provided inside each panel to prevent moisture condensation on the wiring and panel mounted equipment. Space heaters shall be rated for 240 V, 1 phase, 50 Hz supply. Heaters inside the panels shall not be mounted close to the wiring or any panel mounted equipment. Heaters shall be complete with miniature circuit breaker on phase and link on the neutral of the heater supply.

b) An adjustable type thermostat shall be provided in the heater control circuit with temperature range of 0-90^0 C.

5.9 INTERIOR LIGHTING

Each panel shall be provided with a 8W, 230V, 1-Ph, 50Hz CFL for the interior illumination of the panel during maintenance. The fitting shall be complete with switch-fuse unit and the switching of the fitting shall be controlled by the respective panel door switch.

5.10 POWER & CONTROL SUPPLIES

The ASB shall be provided with necessary arrangement for receiving, distributing, isolating and fusing of AC supply for various control, signaling, lighting and space heater circuits

5.11 CABLE TERMINATION ACCESSORIES

The purchaser's external cable connections will be terminated on the terminal blocks provided in the control panel. All necessary cable terminating accessories such as gland plates, cable glands, crimp type tinned copper lugs, supporting clamps and brackets, wiring troughs and gutters etc. for cables shall be included in the bidder's scope of supply

5.12 LABELS

a) All equipment mounted on front and rear side as well as equipr mounted inside the panels shall be provided with individual labels equipment designation. Also on the top of each Bay on front as well as side, large and bold nameplates shall be provided for Bay designa

b) All front mounted equipment feeders shall be provided, at the rear also individual labels engraved with tag numbers corresponding to the c shown in the panel internal wiring to facilitate easy tracing of the wi

c) Labels both external & internal shall be made on non-rusting m preferably Aluminum anodized one. Labels shall have white letters on b background. The lettering size shall be 6 mm for panel designation minimum 3mm for device labels. The label designations shall be subje the Purchaser's appro

d) Each switch shall bear clear inscription identifying its function 'BREAKER' '52A' etc. Similar inscription shall also be provided on e device whose function is not otherwise defined. If any switch device doe bear this inscription, separate name plate giving its function shall provided for it. Switch shall also have clear inscription for each posi indication e.g. 'Local-Remote-Off', 'ON-OFF', 'R-Y-B-OFF' ETC. Each and meter shall be prominently mar

- 16A TP – For lighting & 1-Ph supply loads.
- 32A TP – For Battery charger, Sump pump, Station Lightings, C&R pa etc.
- 63A TP – For Transformer cooler supply, Yard lighting etc.
- 100A TP – For Oil Filter machine etc.

5.13 EARTHING

a) All panels shall be equipped with a separate earth bus securely fixed along with the inside base of panels. When several panels are mounted adjoining each other, the earth bus shall be made continuous. Provision shall be made for future extension of the earth bus. Provision shall be made on the earth bus bars of the end panels for connecting the same to the earthing grid.

b) An earthing conductor of 50x6 mm2 Al. (minimum) shall be provided extending the whole length of switchgear and control gear to sustain the Rated short time withstand current. Every equipment mounted in the panel shall be directly earthed to this earth bus by distinct connections.

c) The earth bus shall be located at sufficient height from the gland plate and shall not be removable from the outside of the cubicle. Door earthing shall also be provided with bolted lugs. The earth bus shall be identified by means of the sign I marked on the outer surface of ASB in a legible and indelible manner on the both side.

5.15 GALVANISING

a) All galvanizing shall be carried out by the hot dip process, in accordance with Specification ISO: 1460 or IS: 2629 amended to date. However, high tensile steel nuts, bolts and spring washers shall be electro - galvanized to service condition four. The zinc coating shall be smooth, continuous and uniform. It shall be free from acid spots and shall not scale, blister or be removable by handling or packing. There shall be no impurities in the zinc or additives to the galvanic bath, which could have a detrimental effect on the durability of the zinc coating.

b) After galvanizing no drilling or welding shall be performed on the galvanized parts of the equipment except that nuts may be threaded after galvanizing.

c) To avoid the formation of white rust, galvanized material shall be stacked during transport and stored in such a manner as to permit adequate ventilation. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanization. The galvanized steel shall be subjected to tests as per IS-2633 and BS: 729 amended to date.

5.16 REMOTE MOITORING AND CONTROL PHILOSOPHY

a) The multi-function meter shall necessarily have RS 485, MODBUS protocol for communication with purchaser's SCADA such that remote monitoring of its parameters is possible.
b) Contacts of O/G breaker for ON/OFF/TRIP indication status shall be wired up to the terminals.

6.0 NAME PLATE & MARKING

a. Manufacture's name and address.
b. Rated Voltage & Frequency
c. Rated normal current in Amps.
d. Serial No.
e. TPCODL
f. No. of Relevant Standard
g. Month & Year of Manufacture
h. Guarantee Period
i. Purchase Order No. & Date

7.0 TESTS

All the Routine and acceptance tests shall be carried out in accordance with the relevant IS/IEC standards. All routine/acceptance tests shall be witnessed by the TPDDL/it's authorized representative. All the components of ASB shall have been tested for Routine/acceptance and Type tests as per the relevant standards. All Type tests as per latest IS / IEC shall have been carried out as per relevant IS/IEC. Following tests shall be necessarily conducted on the equipment and its components as specified in IEC 62271-200:

7.1 TYPE TESTS

a) Tests to prove the capability of the main and earthing circuits to be subjected to the rated peak and the rated short-time withstand currents.
b) Dielectric tests
c) Temperature rise test
d) Degree of protection test
e) Short circuit making & breaking capacities

7.2 ROUTINE TESTS

a) Dimensional and visual check for damages.
b) All main/auxiliary bus bars joints, wire terminations, nuts & bolts shall be checked and tightened
c) Mechanical operational tests
d) Test of auxiliary electrical devices
e) Dielectric tests
f) Measurement of resistance of main circuit.
g) Verification of clearance & creepage distances
h) Verification of correct wiring and continuity of protective circuit
i) Suitable injection tests for all measuring instruments to establish accuracy of calibration.
j) Tests after erection on site.

8.0 TYPE TEST CERTIFICATE

The Bidder shall furnish the type test certificates for the tests as mentioned above as per the corresponding standards. All the tests shall be conducted at CPRI/ERDA or any other International Laboratory as per the relevant standards. Type tests shall have been conducted in certified Test laboratories during the period not exceeding 5 years from the date of opening the bid. In the event of any discrepancy in the test reports, i.e. any test report not acceptable or any/all type tests (including additional type tests, if any) not carried out, same shall be carried out without any cost implication to TPCODL

9.PRE-DISPATCH INSPECTION:

The material shall be subject to inspection by a duly authorized representative of the TPCODL. Inspection may be made at any stage of manufacture at the discretion of the purchaser and the equipment, if found unsatisfactory as to workmanship or material, the same is liable to rejection. Bidder shall grant free access to the places of manufacture to TPCODL's representatives at all times when the work is in progress. Inspection by the TPCODL or its authorized representatives shall not relieve the bidder of his obligation of furnishing equipment in accordance with the specifications. Material shall be dispatched after specific MDCC (Material Dispatch Clearance Certificate) is issued by TPCODL.

Following documents shall be sent along with material.

a)Test reports

b)MDCC issued by TPCODL

c)TPCODL Invoice in duplicate

d)Packing list

e)Drawings & catalogue

f)Guarantee / Warrantee card

g) Delivery Challan

h)OtherDocuments (as applicable).

10. INSPECTION AFTER RECEIPT A STORE:

The material received at TPCODL store will be inspected for acceptance and shall be liable for rejection, if found different from the reports of the pre-dispatch inspection and one copy of the report shall be sent to Project Engineering department.

11. GUARANTEE:

Bidder shall stand guarantee towards design, materials, workmanship & quality of process/ manufacturing of items under this contract for due and intended performance of the same, as an integrated product delivered under this contract. In the event any defect is found by the Purchaser up to a period of at least 36 months from the date of commissioning or 48 months from the date of last supplies made under the contract whichever is later, (the time scale of 12/24 months could be enhanced subject to mutual agreements). Bidder shall be liable to undertake to replace/rectify such defects at its own costs, within mutually agreed period, and to the entire satisfaction of the Purchaser, failing which the Purchaser will be at liberty to get it replaced/rectified at Bidder's risks and costs and recover all such expenses plus the Purchaser's own charges (@ 20% of expenses incurred), from the Bidder or from the "Security cum Performance Deposit" as the case may be. Bidder shall further be responsible for 'free replacement' for another period of THREE years from the end of the guarantee period for any 'Latent Defects' if noticed and reported by the Purchaser.

12. PACKING AND TRANSPORT:

Supplier shall ensure that all material covered by this specification shall be prepared for rail/road transport (local equipment) and be packed in such a manner as to protect it from damage in transit. The bidder shall provide instructions regarding handling and storage precautions to be taken at site.

13.TENDER SAMPLE:

Not Required

14. QUALITY CONTROL:

The bidder shall submit QAP indicating the various stages of inspection, the tests and checks which will be carried out on the material of construction, components during manufacture and bought out items and fully assembled component and equipment after finishing. As part of the plan, a schedule for stage and final inspection within the parameters of the delivery schedule shall be furnished. The Purchaser's engineer or its nominated representative shall have free access to the manufacturer’s/sub-supplier's works to carry out inspections.

15. TESTING FACILITIES:

Supplier/ Manufacturer shall have adequate in house testing facilities for carrying out all routine tests & acceptance tests as per relevant Indian standards.

16. MANUFACTURING FACILITIES:

The successful bidder shall submit the bar chart for various manufacturing activities clearly elaborating each stage, with quantity. This bar chart should be in line with the Quality assurance plan submitted with the offer.

17. SPARES, ACCESSORIES AND TOOLS

Required As Applicable

18. DRAWINGS AND DOCUMENTS:

Following drawings and documents shall be prepared based on TPCODL specifications and statutory requirements and shall be submitted with the bid:

a) Completely filled-in-Technical parameters.
b) General description of the equipment and all components including brochures.
c) General arrangement drawings
d) Single line diagram and wiring diagram with terminal block details.
e) Technical details for ASB, switchgear, lamps, meters etc.
f) Calculation for sizing of bus bars.
g) Bill of material
h) Experience List
i) Type test certificates
j) Manufacturing schedule and test schedule

Drawings / documents to be submitted after the award of the contract are as under:

S. NO.	Description	For Approval	For Review Information	Final Submission
1	Technical Parameters	√		√
2	General Arrangement drawings	√		√
3	Single Line Diagram	√		√
4	Schematic Diagram	√		√
5	Foundation Plan & loading details	√		√
6	Bill Of Material	√		√
7	Manual/Catalogues/drawings for -HRC fuses, lamps etc.		√	
8	Installation Instructions		√	√
9	Instruction for Use		√	√
10	Transport/ Shipping dimension drawing		√	√
11	QA &QC Plan	√	√	√
12	Routine, Acceptance & Type Test Certificates	√	√	√

Bidder shall subsequently provide four (4) complete sets of final drawings, one of which shall be auto positive suitable for reproduction, before the dispatch of the equipment. Soft copy (Compact Disk CD) of all the drawing, GTP, Test certificates shall be submitted after the final approval of the same to purchaser.
All the documents & drawings shall be in English language.
Instruction Manuals: Bidder shall furnish two softcopies (CD) and four (4) hard copies of nicely bound manuals (In English language) covering erection and maintenance instructions and all relevant information and drawings pertaining to the main equipment as well as auxiliary devices.

19.0 SCHEDULE- "A" GUARANTEED TECHNICAL PARTICULARS: <u>To be Furnished by Bidder</u>

S.No.	PARTICULARS	UNITS	AS FURNISHED BY BIDDER
1	**SWITCHBOARD**		
a)	Design Architecture		
b)	Dimensions - WXDXH	mm	
c)	Rated Voltage	V	
d)	Rated Frequency	Hz	
e)	Rated impuse withstand voltage	kVP	
f)	Rated Insulation Voltage	V	
g)	System Earthing		
h)	Material of sheet		
i)	Thickness of enclosure sheet	mm	
j)	Thickness of doors/covers sheet	mm	
k)	Thickness of gland plate	mm	
l)	Paint shade		
m)	Degree of protection		
n)	Total weight	kg	
o)	Cable entry		
p)	Max. operating height from ground level	mm	
q)	Min. operating height from ground level	mm	

2	**CIRCUIT BREAKER**		
a)	Standard		
b)	Rated Voltage	V	
c)	Rated Current	A	
d)	Rated Ultimate Short circuit breaking capacity (Icu)	kA	
e)	Rated Service Short circuit breaking capacity (Ics)	% of Icu	
f)	Rated Insulation voltage	V	
g)	Rated Impulse withstand voltage	kV	
h)	Temperature rise	deg C	
3	**CURRENT TRANSFORMER**		
a)	Type		
b)	Short circuit withstand capacity	kA	
c)	Make of CT's		
4	**BUSBAR**		
a)	Material of bus bar		
b)	Bus bar insulation		
c)	Max current Density of bus bar	A/sqmm	
d)	Current rating of phase bus bars	A	
e)	Current rating of neutral bus bar	A	
f)	Temperature Rise	Deg C	
g)	Short Circuit withstand current	kA	
5	**CONTROL & METERING**		
a)	Multifunction Meter		
b)	Current rating	A	
c)	Voltage rating	V	
d)	Energy measurement provision		
e)	RS 485 modbus serial port provision		
f)	Remote control provision of I/Cs & B/Cs		
6	**OTHERS**		
a)	Auxiliary voltage for coils and motors	V	
b)	Local / Remote switch		

c)	Indication Lamps for CBs status		
d)	MCB for AC		
e)	MCB for Space heating		
f)	Panel anti-condensation heater with therostat		
g)	Panel illumination CFL with limit switch		
7	**MAKES**		
a)	MCCB		
b)	MCB		
c)	Multifunction Meters		
d)	CTs		
e)	Indication Lamps		

20. SCHEDULE “B” DEVIATIONS:
(TO BE ENCLOSED WITH TECHNICAL BID)

All deviations from this specification shall be set out by the Bidders, clause by Clause in this schedule. Unless

specifically mentioned in this Schedule, the tender shall be deemed to confirm the purchaser's specifications:

SL. No	Clause No.	Details of deviation with

CHAPTER-E9
CONTROL CABLE

TABLE OF CONTENTS

TECHNICAL SPECIFICATION FOR CONTROL CABLES

1.0 SCOPE

This specification covers the manufacturing, testing and performance requirements of PVC, unarmoured , copper, control cables for installation in substations.

The material offered shall be procured from short listed vendor at **E-26** and shall have been successfully type tested during last five years on the date of bid opening. The front page of type test report showing the evidence of successful type test of the items asked for in this Specification shall be uploaded with the signature of bidder. The full text of the type test report is to be submitted at the time of signing the agreement or within one month of LOA.

The control cables shall conform in all respects to highest standards of engineering, design, workmanship in accordance to this specification and the latest revisions of relevant standards, mentioned below.

2.0 STANDARDS

IEC / ISO	Indian Standard	Title
IEC 811	IS-18-10810:1982	Testing cables
IEC 502	IS - 1554:1988 (part1)	PVC Cables 1100V
IEC 227	IS - 5819:1970	Short circuit ratings for PVC cables
IEC 228	IS-8130:1984	Conductors for insulated cables
IEC 540	IS - 5831: 1984	Test Methods for insulation and sheaths ofelectric cables and cords
IEC 287		Calculation of the continuous current rating ofcables

In the case of conflict, the order of precedence shall be

i) Indian Standards

ii) IEC

3.0 TECHNICAL DETAILS

3.1 1.1kV Polyvinyl Chloride (PVC) Insulated Cables

All control cables to be used shall be un- armored PVC type. The outer sheath of control cable shall be Polyvinyl chloride (PVC) type ST-2 of IS 5831.

3.2 Rated Voltage And Temperature

Control and Panel Wiring Cables (PVC insulated)

The conductor shall be of round stranded plain copper wires complying with IS - 8130:1984/IEC 228.

N.B. - Conductor screening not required in this case.

3.3 Insulation

The insulation shall be of Polyvinyl Chloride (PVC) compound. 'Heat Resisting' Type C for the Control and Panel Wiring cables. Both shall conform to the requirements of IS - 5831: 1984.

Type of Insulation	Normal Continuous Operation	Short Circuit Operation
Heat Resisting	85°C	160°C

The PVC insulation shall be applied by extrusion and the average thickness of insulationas specified in IS — 1554 (part 1): 1988.

The insulation shall be applied so that it fits closely on to the conductor and it shall bepossible to remove it without damage to the conductor.

Insulation Screening not required.

Core Identification and Laying up of Cores.

In multi-core cables, the cores shall be laid up together with a suitable lay as recommended in IS - 1554 (Part 1): 1988. The layers shall have successive right and left hand lays with the outermost layer having a right hand lay.

3.4 Inner Sheath

The laid up cables shall be covered with an inner sheath made of thermoplastic material(PVC) applied by extrusion.

The thickness of the sheath shall conform to IEC 502/IS - 1554: 1988. Single core cables shall have no inner sheath.

The outer serving shall incorporate an effective anti-termite barrier and shall be capable of withstanding a l0kV DC test voltage for five minutes after installation and annually thereafter.

Current ratings shall be calculated in accordance with IEC 287 "Calculation of the continuous current rating of cables with 100% load factor".

3.5 Conductor Sizes

The following shall be used for Control and Panel Wiring:

The No. of Cores & Sizes of the Control Cable shall be 4 Core, 7 Core, 10 Core and 19 Core etc. The size of each shall be 2.5 sq mm flexible Copper Wires. There shall be one single core copper cable of 16 sq mm size. All panel wiring shall be done by 2.5 sq.mm fo CT, PT, CVT, and 4 sq.mm AC & DC Supply and connection from CT secondary to metes.

3.6 Cable Drum Length

The cable shall be supplied in 500 metre lengths or more but with prior approval for the owner.

4.0 CABLE IDENTIFICATION

The manufacturer’s and Owner’s name or trade mark, the voltage grade, cable designation and year of manufacture shall be indented or

embossed along the whole length of the cable. The indentation or embossing shall only do on the outer sheath. The alphanumerical character size shall be not less than 20% of the circumference of the cable and be legible.

5.0 SAMPLING OF CABLES

5.1 Lot

In any consignment the cables of the same size manufactured under essentially similar conditions of production shall be grouped together to constitute a lot.

5.2 Scale of Sampling

Samples shall be taken and tested from each lot to ascertain the conformity of the lot to specification.

5.3 Sampling Rates

The number of samples to be selected shall be as follows:

Number of drums inthe Lot	Number of Drums to betaken as samples	Permissible number ofdefective drums
Up to 25	3	0
26 to 50	5	0
51 to 100	8	0
101 to 300	13	1
301 and above	20	1

The samples shall be taken at random. In order to achieve random selection the procedure for selection detailed in IS - 4905: 1968 shall be followed.

6.0 NUMBER OF TESTS AND CRITERION FOR CONFORMITY

Suitable lengths of test samples shall be taken from each of the selected drums. These samples shall be subjected to each of the acceptance tests. A test sample shall be classed as defective if it fails

any of the acceptance tests. If the number of defective samples is less than or equal to the corresponding number given in the lot shall be declared as conforming to the requirements of acceptance test.

7.0 TESTS ON 1.1 KV PVC INSULATED CONTROL CABLE

7.1 Type Tests

Certification of type tests already completed by independent test laboratories shall be presented with the bid for each cable type. These tests shall be carried out in accordance with the requirements of IS - 8130: 1984/IEC 502, IS - 5831:1984/IEC 540 and IEC 811 unless otherwise specified. Type testing of 33kV, 11kV and 1.1 kV cables shall includethe following:

a) Tests on conductor

   i) Annealing test (copper)-IS-8130: 1984/IEC 502

   ii) Resistance test- IS-8130: 1984/IEC 502

b) Tests for thickness of insulation and sheath- IS-5831:1984/IEC 540

c) Physical tests for Insulation

   i) Tensile strength and elongation at break- IS-5831:1984/IEC 540

   ii) Ageing in air oven- IS-5831:1984/IEC 540

   iii) Hot test- IS-5831:1984/IEC 540

   iv)Shrinkage test-IS-5831:1984/IEC 540

   v) Water absorption (gravimatic)- IS-5831:1984/IEC 540

d) Physical tests for outer sheath

   i) Tensile strength and elongation at break- IS-5831: 1984/IEC 540

   ii) Ageing in air oven-IS-5 831: 1984/IEC 540

   iii) Shrinkage test-IS-5831: 1984/IEC 540

iv) Hot deformation-IS-5831: 1984/IEC 540

v) Loss of mass in air oven-IS-5831: 1984/IEC540

vi) Heat shock-IS-5831: 1984/IEC540

vii) Thermal stability-IS-5831: 1984/IEC540 and IS-5831: 1984

e) Insulation resistance test-IS-8130: 1984/IEC502

f) High voltage test-As per IS / IEC

g) Flammability test-As per IS / IEC

Tests e) and f) are only applicable to screened cables.

7.2 Acceptance Tests

The following shall constitute acceptance tests:

a) Tensile test (aluminium)

b) Annealing test (copper)

c) Wrapping test

d) Conductor resistance test

e) Test for thickness of insulation and sheath

f) Hot set test for insulation*

g) Tensile strength and elongation at break test for insulation and outer sheath Highvoltage test

h) Insulation resistance (volume resistivity) test.

i) PVC insulation only

** test to be completed on full drum of cable

7.3 Routine Tests

Routine tests shall be carried out on all of the cable on a particular order. These tests shall be carried out in accordance with the requirements of IS - 8130: 1984/IEC 502 and IS - 5831:1984/IEC 540

unless otherwise specified.

The following shall constitute routine tests.

a) Conductor resistance test
b) High voltage test

* Test to be completed on full drum of cable

7.4 Optional Tests

Cold impact test for outer sheath (IS-5831-1984), which shall be completed at the discretion of the Project Manager and at the same time as test at low temperature for PVC as stipulated in the section on special tests.

7.5 Special Tests

Special tests shall be carried out at the Project Manager's discretion on a number of cable samples selected by the Project Manager from the contract consignment. The test shall be carried out on 10% of the production lengths of a production batch of the same cable type, but at least one production length. Special tests shall be carried out in accordance with the requirements of IEC 502 and IEC 540 unless otherwise specified.

The following special tests shall be included:

a) Conductor Examination (IEC-228)
b) Check of Dimensions
c) Test at low temperature for PVC

8.0 DETAILS OF TESTS

8.1 General

Unless otherwise stated, the tests shall be carried out in accordance with the appropriate part of IS-10810/IEC502:1994 and the additional requirements as detailed in this specification.

8.2 Bending Test

The diameter of the test cylinder shall be 20 (d +D) ± 5% for single core cables and 15 (d+D) ± 5% for multicores, where D is the overall

diameter of the completed cable in millimeters and d is the diameter of the conductor. After completing the bending operations, the test samples shall be subjected to partial discharge measurements in accordance with the requirements of this specification.

8.3 Dielectric Power Factor Test

For cables of rated voltage 1.1 kV and above. The measured value of tan δ at up shall not exceed 0.004 and the increment of tan δ between 0.5 up and 2 up shall not be more than 0.002.

8.4 Heating Cycle Test

The sample which has been subjected to previous tests shall be laid out on the floor of the test room and subjected to heating cycles by passing alternating current through the conductor until the conductor reaches a steady temperature 10°C above the maximum rated temperature of the insulation in normal operation. After the third cycle the sample shall subjected to a dielectric power factor as a function of voltage and partial discharge test.

8.5 High Voltage Test

8.3.1 For Type/ Acceptance Test

The cable shall withstand, without breakdown, at ambient temperature, an ac voltage equal to 3Uo, when applied to the sample between the conductor and screen/ armour (and between conductors in the case of unscreened cable). The voltage shall be gradually increased to the specified value and maintained for a period of 4 hours.

If while testing, interruption occurs during the 4 hour period the test shall be prolonged by the same extent. If the interruption period exceeds 30 minutes thetest shall be repeated.

8.3.2 For Routine Test

Single core screened cables, shall withstand, without any failure, the test voltages given in this specification for a period of five minutes between the conductor and metallic screen.

Single core unscreened cables shall be immersed in water at room temperature for one hour and the test voltage then applied for 5 minutes between the conductorand water.

Multicore cables with individually screened cores, the test voltage shall be applied for 5 minutes between each conductor and the metallic screen or covering.

Multicore cables without individually screened cores, the test voltage shall be applied for 5 minutes in succession between each insulated conductor and all the other conductors and metallic coverings, if any.

When a DC voltage is used, the applied voltage shall be 2.4 times the power frequency test voltage. In all instances no breakdown of the insulation shall occur.

8.6 Flammability Test

The period for which the cable shall burn after the removal of the flame shall not exceed 60 seconds and the unaffected portion (uncharged) from the lower edge of the top clamp shall be at least 50mm.

9.0 CONTROL / LV WIRING ACCESSORIES

9.1 Terminations

Control wire terminations shall be made with solder less crimping type and tinned copper lugs which firmly grip the conductor. Insulated sleeves shall be provided at all the wire termination. Engraved core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the

wire and shall not fall off when the wire is disconnected from terminal blocks. All wires directly connected to trip circuit breaker or device shall be distinguished by the addition of red coloured unlettered ferrule. Numbers 6 and 9 shall not be included for ferrules purposes except where underlined and identified as 6 and 9.

LVAC cable terminals shall be provided with adequate size crimp type lugs. The lugsshall be applied with the correct tool, which shall be regularly checked for correct calibration. Bi-metallic joints between the terminals and lugs shall be provided where necessary.

Terminals shall be marked with the phase colour in a clear and permanent manner.

A removable gland plate shall be provided by the contractor at every cable entry to mechanism boxes, cabinets and kiosks. The Contractor shall be responsible for drilling the cable gland plate to the required size.

10.0 GENERAL PARTICULARS AND GUARANTEES

The control cables shall comply in all respects with the requirements of this specification. However, any minor departure from the provisions of the specification shall be disclosedat the time of bidding in the Deviation Schedule in this document.

The GTP for Battery charger shall be as chapter-**E23** .

11.0 PACKING AND SHIPPING

11.1 Packing

The cable shall be wound on strong drums or reels capable of withstanding all normal transportation and handling.

Each length of cable shall be durably sealed before shipment to prevent ingress of moisture. The drums, reels or coils shall be lagged or covered with suitable material to provide physical protection for the cable during transit and during storage and handling operations.

In the case of steel drums adequate precautions shall be taken to prevent damage being caused by direct contact between the cable sheath and the steel. These precautions shall be subject to the approval of the Project Manager.

If wooden drums are used then the wood shall be treated to prevent deterioration from attack by termites and fungi.

Each drum or reel shall carry or be marked with the following information:

a) Individual serial number
b) Owner's name
c) Destination
d) Contract Number
e) Manufacturer's Name
f) Year of Manufacture
g) Cable Size and Type
h) Length of Conductor (meters)
i) Net and Gross Mass of Conductor (kg)
j) All necessary slinging and stacking instructions
k) Destination
l) Contractor's name
m) Name and address of Contractor's agent in Orissa
n) Country of origin

The direction of rolling as indicated by an arrow shall be marked on a flange.

11.2 Storage

The site selected for the storage of cable drums shall be well drained and preferably have a concrete/firm surface which will prevent the drums sinking into the ground or being subjected to excess water thus causing flange rot.

All drums shall be stood on battens, in the upright position, and in such a manner to allow sufficient space between them for adequate air circulation. During storage the drums shall be rotated 90° every three months. In no instances shall the drums be stored "flat" on their flanges or one on top of each other.

CHAPTER-E10

33KV UG XLPE CABLE

TABELS OFCONTENTS

1. SCOPE:

This specification covers technical requirements of design, manufacture, testing at manufacturer's works, packing, forwarding, supply and unloading at site/store, performance of 33 kV XLPE Armoured cable for trouble free and efficient operations.

Inclusive Sizes:-

3 CORE CABLE	1 CORE CABLE
3CX 95 sq.mm	1C X 400 sq.mm
3C X 300 sq.mm	1C X 630 sq.mm.
3C X 400 sq.mm	1C X 1000 sq.mm.

2. APPLICABLE STANDARDS:

The equipment covered by this specification shall unless otherwise stated, be designed, manufactured and tested in accordance with the latest editions of the following Indian, International Standards and shall conform to the regulations of the local authorities:

IS 7098 (Part 2)	Cross-linked Polyethylene (XLPE) insulation for Cables
IS 8130	Conductors for insulated electrical cables and flexible cords
IS 10418	Specification for Drums for Electric cables
IEC 60228	Conductor for insulated cables

IS 3975	Low carbon galvanized steel wires, formed wires and tapes for armoring of cables
IS 5831	Specification for PVC insulation sheath for electric cables
IEC-60811	Test methods for insulations and sheaths of electric cables and cords.
ASTM D 6097	Standard test method for relative resistance to vented water tree growth in Solid Dielectric insulating materials
ICEA T 31-610	Test method for conducting longitudinal water penetration resistance tests on blocked conductors
IS 10810	Methods of tests for cables
IS 4905	Methods for random sampling
IS 4984	High density polyethylene pipes for water supply
IS 2530	Methods of test for polyethylene moulding materials and polyethylene compounds
IS 4826	Specification for hot dipped galvanized coatings on round steel wires
IS 5:2007	Colours for ready mixed paints and enamels

ASTM 2863	Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
IEC 60754	Apparatus and procedure for the measurement of the amount of halogens evolved during the combustion of materials taken from electric or
IEC-60502 (Part-2)	Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um = 1.2 kV) up to 30 kV (Um = 36 kV) - Part 2: 22 kV Cables for rated voltages from 6 kV (Um = 7.2 kV) up to 30 kV (Um= 36 kV).
IEC 332	Test on electric cables on the fire conditions
ASTM 2843	Standard Test Method for Density of Smoke from the Burning or Decomposition of Plastics

3. CLIMATIC CONDITIONS OF THE INSTALLATION:

1	Maximum ambient temperature	50 deg C
2	Max. Daily average ambient temp	35 deg C
3	Min Ambient Temperature	0 deg C
4	Maximum Humidity	95%
5	Average Annual Rainfall	150cm
6	Average No. of rainy days per annum	120
7	Altitude above MSL not exceeding	1000m
8	Wind Pressure	300 Km/hr
9	Earthquakes of an intensity in horizontal direction	equivalent to seismic accelerati on of 0.3g
10	Earthquakes of an intensity in vertical direction	equivalent to seismic acceleration of 0.15g (g being acceleration due to gravity)

4. GENERAL TECHNICAL REQUIREMENTS:

S. No.	Description	Requirement	
		3 CORE CABLE	1 CORE CABLE
1	Voltage grade	33 kV (Earthed system)	
2	Max System voltage	36 kV	
3	Frequency	50 Hz	
4	Variation in frequency	+/- 5%	
5	Conductor	Watertight Stranded Aluminum (compacted circular)	
6	Conductor screen	Semi conducting tape and screen	
7	Insulation	XLPE	
8	Insulation screen	Shall have three layers:	Shall have three layers:
9		a)Bonded Semiconducting, b)Semiconducting water swellable tape, c)Metallic copper tape	a)Bonded Semiconducting,b) Semiconducting water swellable tape, c)Metallic copper tape d)Polyester transparent tape over copper screen
10	Coreidentification strip	Beneath copper screen	NA
11	Inner sheath	Pressure Extruded PVC ST-2 with PP fillers	Extruded PVC ST-2

12	Armour	GI wire round binded with rubberized cotton binding tape	Aluminum wire binded by rubberized cotton tape
13	Outer sheath	PVC ST-2 FRLSH type of colour 'Yellow Lemon shade' code: 355 as per IS 5:2007	

5.0 GENERAL CONSTRUCTION:

The cross linked polyethylene insulated (XLPE) 33 kV Cable Dry cured & water cooled shall be manufactured and tested strictly in accordance with the Indian Standard IS 7098 (Part – 2)/ Relevant IEC/ International standards and its latest amendments.

All material used in the manufacturing of cables shall be new and shall be selected as the best available for the intended use.

The rating factors for variation in ground and air temperature, depth of laying, thermal resistivity of soil and different laying configuration of cables shall be provided by the Bidder.

5.1 Conductor

S.No.	Parameter	Require				
1	Conductor	As per IS				
2	Class	Class				
3	Material	Plain Aluminium, grade H2/H4				
4	Shape	Stranded Compacted Circular				
5	Nominal size of conductor mm2	95	300	400	630	1000
6	Min. number of strands	15	30	53	53	30

7	Max. DC resistance @ 20 deg C (Ohm/km)	0.32	0.1	0.0778	0.0469	0.0291
8	Conductor Short circuit current rating for 1 second	9 kA	28.3kA	37.7 kA	59.4 kA	94.3 kA
9	Min. weight of conductor (kg/km/core)	244	780	1080	1650	2600
10	Longitudinal water sealing of conductor	a) Non-conductive water swellable yarn/ tape/ combination of both shall be provided in between interstices of the conductor. b) Also, this water swellable tape and yarn shall be compatible to withstand conductor continuous temperature of 90 deg C and short circuit temperature of 250 deg C without any decay. c) It shall not affect the electrical conductivity of the conductor.				

11	Cleanliness and uniformity	a) Before stranding, the cross-section of the Aluminium conductor shall be circular, and shall have uniform smooth surface, free from sharp edges and free from any defects. b) Stranded Conductor shall be free from oil traces & aluminum dust. Conductor (after stranding) shall be super cleaned

12	Conductor jointing	Not acceptable in any strand or in any conductor after it is stranded.
13	Raw material supplier	Conductor raw material shall be procured from reputed suppliers viz., BALCO/ HINDALCO/ NALCO/ Vedanta only.
14	Diameter of conductor	To be specified by bidder

5.2 Conductor Screen:

S. No.	Parameter	Requirement
1	Material	1st layer: Semi-conducting tape 2nd layer: Semi-conducting compound
2	Configuration	1st layer: Semi-conducting tape shall be applied over conductor with nominal thickness of 0.2 mm. 2nd layer: Semi-conducting compound screen shall be applied through triple extrusion process.
3	Min. thickness	Minimum thickness of semi-conducting compound screen shall be 0.5 mm at any point of measurement.

4	Resistivity	Resistivity of semiconducting conductor screen shall not exceed 1000 Ω-m
5	Uniformity on interfacial region	Interfacial region between conductor screen and insulation shall be uniform. Protrusion/ convolution/ other defects are not acceptable in the region.
6	Raw material supplier	Semiconducting compound shall be procured from reputed raw material suppliers viz.,Dow/Borealis/Hanwa only

5.3 Insulation:

S. No.	Parameter	Requirement
1	Material and extrusion process	XLPE insulation shall be applied through CCV/VCV line by triple extrusion process with 'Dry Curing' and 'Water Cooling'.
2	Raw material supplier	a) XLPE compound shall be procured from reputed raw material suppliers viz., Dow/Borealis/Hanwa only. b) Both XLPE and semi conductive compounds shall be used from same raw material supplier.

3	Thickness and Eccentricity	a) Nominal thickness shall be 8.8 mm. b) Minimum thickness shall be 7.82 mm at any point of measurement. c) Eccentricity of insulation shall not exceed 10%.
4	Thermal stability	The insulation properties shall be stable under thermal conditions arising out of continuous operation at conductor temperature of 90 deg. C rising momentarily to 250 deg. C under short circuit conditions.
5	Cleanliness and uniformity	Interfacial region between insulation and insulation screen shall be uniform. Protrusion/convolution/ other defects are not acceptable. Core shall be free from void and contamination.

5.4 Insulation Screen & Core identification strip:

Sl. No.	Parameter	Requirement
1	Material	a) 1st layer : Semi-conducting compound b) 2nd layer: Semi-conducting water swellable tape c) 3rd layer: Annealed copper tape
2	Configuration	a) 1st layer: Non-Metallic Part: Extruded Insulation semiconducting screen shall be bonded type. Resistivity shall not exceed 500 Ω-meter. Surface of insulation screen shall be smooth, free from cavity/ nicks/scratches/ other visible defects. Min. thickness shall be 0.5 mm at any point of measurement. b) 2nd layer: Water Swellable tape: Semi-conducting water swellable tapes shall be applied over non-metallic screen. Minimum thickness of water swellable shall be 0.3 mm and minimum overlapping shall be 15%. Core identification strip: <u>For 3 Core Cable</u> Each of the three core identification strips shall be applied longitudinally beneath copper screen. Width of the coloured strip shall be 7-10 mm. <u>For 1 Core Cable</u> NA

		c) 3rd layer: Metallic Part: Annealed copper tape, helically wound over the water swellable tape with minimum 15% overlap. Minimum thickness shall be 0.045 mm at any point of measurement.
3	Raw material supplier	Semiconducting compound shall be procured from reputed raw material suppliers viz., Dow/Borealis/Hanwa only
4	Diameter of cores	To be specified by bidder
5	Weight of cores/km (approx.)	To be specified by bidder
6	Weight of copper tape/km (approx.)	To be specified by bidder

5.5 Fillers:

Sl. No.	Parameter	Requirement
		3 Core Cable
1	Material	Virgin Polypropylene fibers of natural colour
2	Configuration	Virgin Polypropylene fibers shall be tightly filled in empty space as fillers.

5.6 Inner Sheath:

Sl. N	Parameter	Requirement	
		3 CORE CABLE	**1 CORE CABLE**
1	Material	Black coloured Polyvinyl chloride (PVC) type ST-2 compound	
2	Configuration	The laid up cores shall be provided with pressure extruded Polyvinyl chloride (PVC) type ST-2 compound conforming to IS5831 with latest amendments. Pressurized extrusion is required to remove any gaps remaining in between the fillers and to make the cable as circular as possible. It shall be applied to fit closely on to the laid up cores and shall be possible to remove easily without causing any damage to the underlying insulated cores and screens.	Extruded PVC ST-2 type conforming to IS: 5831. It shall be applied to fit closely and shall be possible to remove easily without causing any damage to the underlying insulated cores and screens.

3	Raw material supplier	PVC compound shall be procured from reputed raw material suppliers viz., Shakun, Kalpana, KLJ, DCM ShriRam. PVC compound from cable manufacturer shall be considered only after factory evaluation for the same.		
4	Min. thickness At any point of measure ment	3 CORE CABLE		
		95 sq.mm.	300 sq.mm.	400 sq.mm.
		0.7 mm	0.7 mm	0.7
		1 CORE CABLE		
		400 sq.mm.	630 sq.mm.	1000 sq.mm.
		0.5 mm	0.6 mm	0.7 mm

5.7 Armour:

Sl. No.	Parameter	Requirement	
		3 CORE CABLE	**1 CORE CABLE**
1	Material	Low carbon annealed hot dipped galvanized round steel wires	H4 Grade Aluminium wires
2	Compliance to Standard	It shall comply with the requirements of IS 3975 along with latest amendments. Hot dipped galvanizing layer shall be uniform on low carbon annealed steel wires. Zinc coating shall be 290 g/m2 as per IS 4826:1979.	It shall comply with the requirements of IS 8130 along with latest amendments.

<table>
<tr><td rowspan="6">3</td><td rowspan="6">Nominal Dimensions</td><td colspan="3">3 Core cable</td></tr>
<tr><td>95 sq.mm</td><td>300 sq.mm</td><td>400 sq.mm.</td></tr>
<tr><td>3.15 (GI Wire)</td><td>4.00 (GI Wire)</td><td>4.00 (GI Wire)</td></tr>
<tr><td colspan="3">1 Core cable</td></tr>
<tr><td>400 sq.mm</td><td>630 sq.mm</td><td>1000 sq.mm</td></tr>
<tr><td>2 mm (Aluminum</td><td>2.5 mm (Aluminum</td><td>3.15 mm (Aluminum wire)</td></tr>
<tr><td rowspan="6">4</td><td rowspan="6">Approx. Armor Short circuit rating in kA for 1 sec</td><td colspan="3">3 Core cable</td></tr>
<tr><td>95 sq.mm</td><td>300</td><td>400 sq.mm.</td></tr>
<tr><td>9</td><td>20</td><td>20</td></tr>
<tr><td colspan="3">1 Core cable</td></tr>
<tr><td>400 sq.mm</td><td>630 sq.mm</td><td>1000 sq.mm</td></tr>
<tr><td>20</td><td>20</td><td>20</td></tr>
<tr><td></td><td></td><td colspan="3">Fault current for the armour with mimimum 90 % coverage.</td></tr>
<tr><td>5</td><td>Jointing in the armour wires</td><td colspan="3">Not acceptable in any armour wire</td></tr>
<tr><td>6</td><td>Laying of armour</td><td colspan="3">The armor wires shall be applied as closely as practicable. Shall not be less than 90% of total circumference.</td></tr>
<tr><td>7</td><td>Binding</td><td colspan="3">The rubberized cotton binding tape shall be applied to bind the armor wires such that it shall not affect the electrical properties of the armor wires and the overall cable.</td></tr>
<tr><td>8</td><td>Weight of armor</td><td colspan="3">To be furnished by Bidder</td></tr>
</table>

9	Raw material supplier	Steel armour shall be procured from reputed raw material suppliers viz., TATA Steel, Jindal Steel, SAIL only.	Aluminium armour shall be procured from reputed raw material suppliers viz., BALCO/HINDALCO/NALCO/ Vedanta Only.

5.8 Outer Sheath

Sl.No.	Parameter	Requirement		
1	Material	Polyvinyl chloride (PVC) ST-2 FRLSH type compound with 'lead napthenate' additive		
2	Configuration	Polyvinyl chloride (PVC) ST-2 FRLSH type compound with 'lead napthenate' additive as 'termite & rodent repellent' applied by extrusion process.		
3	Min. Thickness at any point of measurement	3 CORE CABLE		
		95 sq.mm	300 sq.mm	400 sq.mm.
		2.68 mm	3.0 mm	3.0 mm
		1 CORE CABLE		
		400	630 sq.mm	1000 sq.mm
		2.04 mm	2.36 mm	2.52 mm

4	Colour	Yellow Lemon color, colour code: 355 as per IS 5:2007.
5	Surface uniformity	Surface of outer sheath shall be free from cavity/ nicks/ other visible defects.
6	Raw material supplier	PVC compound shall be procured from reputed raw material suppliers viz., Shakun, Kalpana, KLJ, DCM ShriRam. PVC compound from cable manufacturer shall be considered only after factory evaluation for the same.
7	Weight of outer sheath/km	To be provided by bidder

5.9 Sealing End Cap:

S.No.	Parameter	Requirement
1	Material	Adhesive coated polyolefin heat shrinkable
2	Configuration	Adhesive coated polyolefin heat shrinkable end cap shall be provided at both ends of the cable.
3	Additional requirements	2 nos. additional cable end caps shall be provided with each drum and placed in the drum.

5.10 Other Requirements:

S.No.	Parameter	Requirement
1	Overall diameter of cable	To be provided by bidder
2	Weight of Overall cable	To be provided by bidder

6. MARKING:

Steel drums shall be provided. Drum shall be free from sharp edges and visual defect. Stencil plate on one flange side of the drum and laminated paper sheet on other side flange of drum. Cable length on one drum shall be 250 meters max. +/- 5%.

I. Following details shall be provided on flanges of drum:

a) Manufacturer's name
b) Type of Cable
c) Size of Cable d) Voltage Grade
e) Length of the cable on the drum

f) Direction of the rotation of the drum g) Gross mass
h) Country of manufacture

i) Year and month of manufacturer
j) Purchase Order no.
k) Drum No.

II. Following details shall be embossed on the outer sheath: At interval of every 1 meter, following details to be embossed: i) TPCODL
ii) Manufacturer name
iii) Month & Year of Manufacture
iv) Voltage grade
v) Size of the cable
vi) Purchase Order no.
vii) Cable code

Note:- Sequential meter marking shall be printed.

7. TESTS:

The bidder shall be required to submit complete set of the following test reports along with the offer: -

7.1 ACCEPTANCE TESTS

Test on Conductor

a. Conductor resistance test

b. Test for non-conductivity of water swellable tape/yarn of conductor

c. Visual inspection for conductor cleanliness

d. Conductor water penetration test

Test on Conductor Screen

a. Thickness of semi-conducting tape over conductor

b. Test for conductivity of semi-conducting tape over conductor

c. Resistivity of extruded semi-conducting conductor screen

d. Thickness of extruded semi-conducting conductor screen

Test on Insulation

Tensile strength & Elongation at break (before ageing)

a. Insulation thickness

b. Eccentricity and Ovality of insulation

c. Hot set test

d. Volume resistivity

e. Void & contamination test on core (by silicon oil dip method)

f. Surface smoothness of insulation

Test on Insulation Screen

a. Resistivity of insulation screen

b. Thickness of insulation screen

c. Visual inspection for any convolution/ protrusion between conductor screen and XLPE insulation, XLPE insulation and insulation screen

d. Thickness & % Overlapping of semi-conducting water swellable tape

e. Thickness & % Overlapping of copper tape

Test on Inner Sheath

a. PVC thickness

b. Colour of inner sheath

Test on Armour (For 3 Core)

a) Tensile test

b) Mass of zinc coating

c) Uniformity of zinc coating

d) Adhesion test

e) Diameter and no. of wires

f) Coverage %

Test on Armour (For 1 Core)

a) Tensile test

b) Wrapping test

c) Resistance test

d) Diameter and no. of wires

e) Coverage %

Test on Outher sheath

a) Thickness
b) Tensile strength and Elongation at break (before ageing)
c) Colour of outer sheath
d) Surface uniformity of outer sheath (on full drum)/ shall be free from any damage- void, nick, cavity
e) Presence of lead napthenate in PVC outer sheath
f) Flammability test
g) Oxygen index
h) Temperature index
i) Acid gas generation
j) Smoke density

Test on Complete Cable

a. Partial discharge test

b. High voltage test

c. Raw material consumption verification

7.2 ROUTINE TESTS

a) Conductor resistance test
b) Partial discharge
c) High voltage test with power frequency
d) Resistance test for Aluminium armour

7.3 TYPE TESTS

Tests on Conductor

a) Conductor resistance test
b) Conductor water penetration test

Tests on Insulation

i. Tensile strength & Elongation at break (before ageing)

ii. Ageing in air oven

iii. Tensile strength & Elongation at break

iv. Tests for thickness of insulation

v. Eccentricity and Ovality of insulation

vi. Hot set test

vii. Shrinkage test

viii. Gravimetric test (Water absorption)

ix. Volume resistivity/ Insulation Resistance

Tests on Inner Sheath

a) PVC thickness

Tests on Extruded semi-conducting screen

- Volume resistivity test of conductor screen
- Volume resistivity test of core screen

Tests on Outer Sheath (PVC)

i. Flammability test for outer sheath

ii. Thickness

iii. Tensile strength and Elongation at break (before ageing)

iv. Tensile strength and Elongation at break (after ageing)

v. Variation due to ageing

vi. Loss of mass test

vii. Shrinkage test

viii. Hot deformation test

ix. Heat shock test

x. Thermal stability test

xi. Flammability test

xii. Oxygen index

xiii. Temperature index

xiv. Acid gas generation

xv. Smoke density

Tests on Armour for 3 Core Cable

a) Tensile test

b) Torsion test

c) Wrapping test

d) Resistance test

e) Mass of zinc coating

f) Uniformity of zinc coating

g) Adhesion test

Tests on Armour for 1 Core Cable

a. Tensile test

b. Torsion test

c. Wrapping test

d. Resistance test

Tests on complete cable

i. Partial discharge test

ii. Thermal ageing test

iii. Bending test

iv. Dielectric power factor test

v. High voltage test

vi. Heat cycle test

vii. Impulse withstand test

Additional Tests

a) Raw material consumption

b) Colour coding identification over copper screen (for 3C cable)

c) Sequential marking check
d) Cable drum length verification

e) Packaging of cable on cable drum

f) Weight of conductor/km

g) Diameter of Conductor

h) Weight of XLPE insulation plus semiconducting screen (of conductor & insulation)/ km

i) Diameter over core

j) Weight of core

k) Weight of copper tape/km

l) Diameter over innersheath

m) Weight of armour/ km

n) Cable sealing end caps

o) Weight of outer sheath/ km
p) Diameter of complete cable

8 TYPE TEST CERTIFICATES:

The Bidder shall furnish the type test certificates for the tests as mentioned above as per the corresponding standards. All the tests shall be conducted at CPRI / ERDA as per relevant IS.Type tests should have been conducted in certified Test laboratories during the period not exceeding 10 years from the date of opening the bid.

9. PRE-DISPATCH INSPECTION:

The material shall be subject to inspection by a duly authorized representative of the OPTCL. Inspection may be made at any stage of manufacture at the discretion of the purchaser and the equipment, if found unsatisfactory as to workmanship or material, the same is liable to rejection. Bidder shall grant free access to the places of manufacture to OPTCLL's representatives at all times when the work is in progress. Inspection by the OPTCL or its authorized representatives shall not relieve the bidder of his obligation of furnishing equipment in accordance with the

specifications. Material shall be dispatched after specific MDCC (Material Dispatch Clearance Certificate) is issued by OPTCL.

Following documents shall be sent along with material.

a) Test reports
b) MDCC issued by OPTCL
c) OPTCL Invoice in duplicate
d) Packing list
e)Drawings & catalogue
f)Guarantee / Warrantee card
g) Delivery Challan
h)Other Documents (as applicable).

10. INSPECTION AFTER RECEIPT AT STORE:

The material received at OPTCL, Odisha store will be inspected for acceptance and shall be liable for rejection, if found different from the reports of the pre-dispatch inspection and one copy of the report shall be sent to Engineering department.

11. GUARANTEE:

Bidder shall stand guarantee towards design, materials, workmanship & quality of process/ manufacturing of items under the contract for due and intended performance of the same, as an integrated product delivered under this contract. In the event any defect is found by the Company up to a period of 60 months from the date of commissioning or 72 months from the date of last supplies made under the contract, whichever is earlier, supplier shall be liable to undertake to replace/rectify such defects at his own costs. within mutually agreed timeframe, and to the entire satisfaction of the Company, failing which the Company will be at liberty to get it replaced/rectified at supplier's risks and costs and recover all such expenses plus the Company's own charges (@ 20% of expenses incurred), from the supplier or from the "Security cum Performance Deposit" as the case may be.

12. PACKING:

a)Standard length of Cable: The cable shall be supplied in continuous standard length of 250 (3 cores) & 500 (Single core) running meters with +/- 5% tolerance.

b)Filling condition: Drum shall not be overfilled.

c) Cable drum: The cable shall be wound on non-returnable steel drums without any extra cost to OPTCL as per IS 10418 and its latest amendments.

d)Sealing of cable ends: The ends of the cable shall be sealed by means of heat shrinkable polyolefin end caps. Additional 2 nos. end caps shall be provided with each drum.

e)Requirements for Cable drums: Cable drums shall be so constructed as to have required mechanical strength so that the drum flanges and other components do not break during transport, in actual use or in storage. The flanges and the outside surface of the barrel shall be free from protruding materials/projections/ unevenness/ sharp edges that can damage the cable or hands of the operator during rotation of drums.

A metal preservation shall be applied to the entire drum.

f) Bottom end of cable should be clamped on drum by jute or nylon rope.

g) All ferrous metal parts used shall be treated with a suitable rust free finish or coating to avoid rusting during transit or storage. The drums shall withstand normal handling and transport.

h) Rail/ Road transportation: The bidder shall ensure that the equipment covered under this specification shall be prepared for rail/road transport in a manner so as to protect the equipment from damage in transit.

i) Packaging shall be as per climate change perspective. Cable wound on cable drum shall be covered by recyclable PVC sheet for dust proof.

13. TENDER SAMPLE:

Not Applicable

14. QUALITY CONTROL:

The bidder shall submit QAP indicating the various stages of inspection, the tests and checks which will be carried out on the material of construction, components during manufacture and bought out items and fully assembled component and equipment after finishing. As part of the plan, a schedule for stage and final inspection within the parameters of the delivery schedule shall be furnished. The Purchaser's engineer or its nominated representative shall have free access to the manufacturer's/sub-supplier's works to carry out inspections.

15. TESTING FACILITIES:

Supplier/ Manufacturer shall have adequate in house testing facilities for carrying out all routine tests & acceptance tests as per relevant Indian standards.

16. MANUFACTURING FACILITIES:

The successful bidder shall submit the bar chart for various manufacturing activities clearly elaborating each stage, with quantity. This bar chart should be in line with the Quality assurance plan submitted with the offer.

17. SPARES, ACCESSORIES AND TOOLS

Not applicable.

18. DRAWINGS AND DOCUMENTS:

Following drawings and documents shall be submitted in line with the requirement of Tender specifications:

a) Completely filled in Schedule "A" Guaranteed Technical

Particulars & Schedule "B" Deviations

b)Work Experience details

c)Type test certificates.

d) Drawing 1 set of Hard Copy & Soft copy PDF File containing complete information about manufacturing.

19. SCHEDULE- "A" GUARANTEED TECHNICAL PARTICULARS:

Bidder to submit clause wise compliance.

20. SCHEDULE "B" DEVIATIONS:

(TO BE ENCLOSED WITH TECHNICAL BID)

All deviations from this specification shall be set out by the Bidders, clause by Clause in this schedule. Unless specifically mentioned in this Schedule, the tender shall be deemed to confirm the purchaser's specifications:

SL. No	Clause No.	Details of deviation with justifications

CHAPTER-E11

11KV UG XLPE CABLE

TABLES OF CONTENTS

1. SCOPE:

This specification covers technical requirements of design, manufacture, testing at manufacturer's works, packing, forwarding, supply and unloading at site/store, performance of 11 kV XLPE ARMOURED cable, for trouble free and efficient operations.
Inclusive sizes:-

3 CORE CABLE	1 CORE CABLE
3C X 95 sq.mm.	1C X 400 sq.mm.
3C X 120 sq.mm.	
3C X 150 sq.mm.	1C X 630 sq.mm.
3C X 300 sq.mm.	
3C X 400 sq.mm.	1C X 1000 sq.mm.
3C X 400 sq.mm. (co-extruded cable)	

2. APPLICABLE STANDARDS:

The equipment covered by this specification shall unless otherwise stated, be designed, manufactured and tested in accordance with the latest editions of the following Indian, International Standards and shall conform to the regulations of the local authorities:

IS 7098 (Part 2)	Cross-linked Polyethylene (XLPE) insulation for Cables
IS 8130	Conductors for insulated electrical cables and flexible cords
IS 10418	Specification for Drums for Electric cables
IEC 60228	Conductor for insulated cables

IS 3975	Low carbon galvanized steel wires, formed wires and tapes for armoring of cables
IS 5831	Specification for PVC insulation sheath for electric cables
IEC-60811	Test methods for insulations and sheaths of electric cables and cords.
ASTM D 6097	Standard test method for relative resistance to vented water tree growth in Solid Dielectric insulating materials
ICEA T 31-610	Test method for conducting longitudinal water penetration resistance tests on blocked conductors
IS 10810	Methods of tests for cables

IS 4905	Methods for random sampling
IS 4984	High density polyethylene pipes for water supply
IS 2530	Methods of test for polyethylene moulding materials and polyethylene compounds
IS 4826	Specification for hot dipped galvanized coatings on round steel wires
IS 5:2007	Colours for ready mixed paints and enamels
ASTM 2863	Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)

IEC 60754	Apparatus and procedure for the measurement of the amount of halogens evolved during the combustion of materials taken from electric or optical fiber cable constructions
IEC-60502 (Part-2)	Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um = 1.2 kV) up to 30 kV (Um = 36 kV) - Part 2: 22 kV Cables for rated voltages from 6 kV (Um = 7.2 kV) up to 30 kV (Um= 36 kV).
IEC 332	Test on electric cables on the fire conditions
ASTM 2843	Standard Test Method for Density of Smoke from the Burning or Decomposition of Plastics

3. CLIMATIC CONDITIONS OF THE INSTALLATION:

1	Maximum ambient temperature	50 deg C
2	Max. Daily average ambient temp	35 deg C
3	Min Ambient Temperature	0 deg C
4	Maximum Humidity	95%
5	Average Annual Rainfall	150cm
6	Average No. of rainy days per annum	120
7	Altitude above MSL not exceeding	1000m

8	Wind Pressure	300 Km/hr
9	Earthquakes of an intensity in horizontal direction	equivalent to seismic acceleration of 0.3g
10	Earthquakes of an intensity in vertical direction	equivalent to seismic acceleration of 0.15g (g being acceleration due to gravity)

4. GENERAL TECHNICAL REQUIREMENTS:

S. No.	Description	Requirement	
		3 CORE CABLE	1 CORE CABLE
1	Voltage grade	11 kV (Earthed system)	
2	Max System voltage	12 kV	
3	Frequency	50 Hz	
4	Variation in frequency	+/- 5%	
5	Conductor	Watertight Stranded Aluminum (compacted circular)	
6	Conductor screen	Semi conducting tape and screen	
7	Insulation	XLPE	
8		Shall have three layers:	Shall have three layers:

9	Insulation screen	a) Bonded Semiconducting, b) Semiconducting water swellable tape, c) Metallic copper tape	a) Bonded Semiconducting, b) Semiconducting water swellable tape, c) Metallic copper tape d) Polyester transparent tape over copper screen
10	Core identification strip	Beneath copper screen	NA
11	Inner sheath	Pressure Extruded PVC ST- 2 with PP fillers	Extruded PVC ST-2
12	Armour	GI wire round binded with rubberized cotton binding tape	Aluminum wire binded by rubberized cotton tape
13	Outer sheath	PVC ST-2 FRLSH type of colour 'Crimson Red shade' code: 355 as per IS 5:2007	
14	Outer sheath (for co-extruded cable)	3 CORE CABLE	1 CORE CABLE
		a) Inner layer: HDPE ST-7, Crimson Red shade b) Outer sheath: HDPE ST-7, Black colour	NA

5. GENERAL CONSTRUCTION:

The cross linked polyethylene insulated (XLPE) 11 kV Cable (Dry cured & water cooled) shall be manufactured and tested strictly in accordance with the Indian Standard IS 7098 (Part – 2)/ Relevant IEC/International standards and its latest amendments.

All material used in the manufacturing of cables shall be new and shall be selected as the best available for the intended use.

The rating factors for variation in ground and air temperature, depth of laying, thermal resistivity of soil and different laying configuration of cables shall be provided by the Bidder.

5.1 Conductor

Sl.No.	Parameter	Requirement						
1	Conductor	As per IS 8130						
2	Class	Class II						
3	Material	Plain Aluminium, grade H2/H4						
4	Shape	Stranded Compacted Circular						
5	Nominal size of conductor mm2	95	120	150	300	400	630	1000

6	Min. number of strands	15	15	15	30	53	53	30
7	Max. DC resistance @ 20 deg C (Ohm/ km)	0.32	0.25	0.206	0.1	0.08	0	0.03
8	Conductor Short circuit current rating for 1 second	9 kA	11.3kA	14.2kA	28.3kA	37.7 kA	59.4 kA	94.3 kA
9	Min. weight of conduct or (kg/km/ core)	244	308	390	780	1080	1650	2600

10	Longitudinal water sealing of conductor	a) Non-conductive water swellable yarn/ tape/ combination of both shall be provided in between interstices of the conductor. b) Also, this water swellable tape and yarn shall be compatible to withstand conductor continuous temperature of 90 deg C and short circuit temperature of 250 deg C without any decay. c) It shall not affect the electrical conductivity of the conductor.

11	Cleanliness and uniformity	a) Before stranding, the cross-section of the Aluminium conductor shall be circular, and shall have uniform smooth surface, free from sharp edges and free from any defects. b) Stranded Conductor shall be free from oil traces & aluminum dust. Conductor (after stranding) shall be super cleaned c) Traces of aluminum dust on conductor or conductor screen shall not be acceptable.
12	Conductor jointing	Not acceptable in any strand or in any conductor after it is stranded.
13	Raw material supplier	Conductor raw material shall be procured from reputed suppliers viz., BALCO/ HINDALCO/ NALCO/ Vedanta only.
14	Diameter of conductor	To be specified by bidder

5.2 Conductor Screen:

Sl. No.	Parameter	Requirement
1	Material	1st layer: Semi-conducting tape 2nd layer: Semi-conducting compound
2	Configuration	1st layer: Semi-conducting tape shall be applied over conductor with nominal thickness of 0.2 mm. 2nd layer: Semi-conducting compound screen shall be applied through triple extrusion process.
3	Min. thickness	Minimum thickness of semi-conducting compound screen shall be 0.5 mm at any point of measurement.
4	Resistivity	Resistivity of semiconducting conductor screen shall not exceed 1000 Ω-m
5	Uniformity on interfacial region	Interfacial region between conductor screen and insulation shall be uniform. Protrusion/ convolution/ other defects are not acceptable in the region.

6	Raw material supplier	Semiconducting compound shall be procured from reputed raw material suppliers viz.,Dow/Borealis/Hanwa only

5.3 Insulation:

Sl.	Parameter	Requirement
1	Material and extrusion process	XLPE insulation shall be applied through CCV/VCV line by triple extrusion process with 'Dry Curing' and 'Water Cooling'.
2	Raw material supplier	a) XLPE compound shall be super cleaned and procured from reputed raw material suppliers viz., Dow/Borealis/Hanwa only. b) Both XLPE and semi conductive compounds shall be used from same raw material supplier.
3	Thickness and Eccentricity	a) Nominal thickness shall be 3.6 mm. b) Minimum thickness shall be 3.14 mm at any point of measurement. c) Eccentricity of insulation shall not exceed 10%.

4	Thermal stability	The insulation properties shall be stable under thermal conditions arising out of continuous operation at conductor temperature of 90 deg. C rising momentarily to 250 deg. C under short circuit conditions.
5	Cleanliness and uniformity	Interfacial region between insulation and insulation screen shall be uniform. Protrusion/convolution/ other defects are not acceptable. Core shall be free from void and contamination.

5.4 Insulation Screen & Core identification strip:

Sl	Parameter	Require
1	Material	a) 1st layer : Semi-conducting compound
2	Configuration	a) 1st layer: Non-Metallic Part: Extruded Insulation semiconducting screen shall be bonded type. Resistivity shall not exceed 500 Ω-meter Min. thickness shall be 0.3 mm at any point of measurement. b) 2nd layer: Water Swellable tape: Semi-conducting water swellable tapes shall be applied over non-metallic screen. Minimum thickness of water swellable shall be 0.3 mm and minimum overlapping shall be 15%. Core identification strip: <u>3 CORE CABLE:-</u> Each of the three core identification strips shall be applied longitudinally beneath copper screen. Width of the coloured strip shall be 7-10 mm. <u>1 CORE CABLE:-</u> <u>NA</u> c) 3rd layer: Metallic Part: Annealed copper tape, helically

		wound over the water swellable tape with minimum 15% overlap. Minimum thickness shall be 0.045 mm at any point of measurement.
3	Raw material supplier	Semiconducting compound shall be procured from reputed raw material suppliers viz., Dow/Borealis/Hanwa only
4	Diameter of cores	To be specified by bidder
5	Weight of cores/km (approx.)	To be specified by bidder
6	Weight of copper tape/km (approx.)	To be specified by bidder

5.5 Fillers:

SI	Parameter	Requirem	
		3 CORE	1 CORE
1	Material	Virgin Polypropylene fibers of natural colour	NA
2	Configuration	Virgin Polypropylene fibers shall be tightly filled in empty space as fillers.	

5.6 Inner Sheath:

Sl. No.	Parameter	Requirement				
		3 CORE CABLE				1 CORE CABLE
1	Material	Black coloured Polyvinyl chloride (PVC) type ST-2				
2	Configuration	The laid up cores shall be provided with pressure extruded Polyvinyl chloride (PVC) type ST-2 compound conforming to IS: 5831 with latest amendments. Pressurized extrusion is required to remove any gaps remaining in between the fillers and to make the cable as circular as possible. It shall be applied to fit closely on to the laid up cores and shall be possible to remove easily without causing any damage to the underlying insulated cores and screens.				Extruded PVC ST-2 type conforming to IS: 5831. It shall be applied to fit closely and shall be possible to remove easily without causing any damage to the underlying insulated cores and screens.
3	Raw material supplier	PVC compound shall be procured from reputed raw material suppliers viz., Shakun, Kalpana, KLJ, DCM ShriRam. PVC compound from cable manufacturer shall be considered only after factory evaluation for the same.				
4	Min. thickness At any point of measurement	3 CORE CABLE				
		95 sq.mm.	120 sq.mm	150 sq.mm	300 sq.mm	400 sq.mm.
		0.6 mm	0.6 mm	0.6 mm	0.7 mm	0.7 mm
		1 CORE CABLE				

		400 sq.mm.	630 sq.mm.	1000 sq.mm.
		0.4 mm	0.5 mm	0.6 mm

5.7 Armour:

Sl. No.	Parameter	Requirement				
		3 CORE CABLE		1 CORE CABLE		
1	Material	Low carbon annealed hot		H4 Grade Aluminium wires		
2	Compliance to Standard	It shall comply with the requirements of IS 3975 along with latest amendments. Hot dipped galvanizing layer shall		It shall comply with the requirements of IS 8130 along with latest amendments.		
3	Nominal Dimensions	3 Core cable				
		95 sq.mm	120 sq.mm	150 sq.mm	300 Sq.mmm	400 sq.mm.
		2.5 (GI Wire)	2.5 (GI Wire)	2.5 (GI Wire)	3.15 (GI Wire)	4.00 (GI Wire)
		1 CORE				
		400		630	100 sq.mm	
		2 mm (Aluminum wire)		2 mm (Aluminum wire)	3.15 mm (Aluminum wire)	
		3 Core cable				

<table>
<tr><td rowspan="6">4</td><td rowspan="6">Approx. Armor Short circuit rating in kA for 1 sec</td><td>95 sq.m</td><td>120 sq.m</td><td>150 sq.mm</td><td>300 sq.mm</td><td>400 sq.mm</td></tr>
<tr><td>9</td><td>12</td><td>15</td><td>15</td><td>15</td></tr>
<tr><td colspan="5">1 CORE CABLE</td></tr>
<tr><td>400 sq.mm</td><td colspan="2">630 sq.mm</td><td colspan="2">1000 sq.mm</td></tr>
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<tr><td colspan="5">Fault current for the armour with mimimum 90 % coverage.</td></tr>
<tr><td>5</td><td>Jointing in the armour wires</td><td colspan="5">Not acceptable in any armour wire</td></tr>
<tr><td>6</td><td>Laying of armour</td><td colspan="5">The armor wires shall be applied as closely as practicable. Shall not be less than 90% of total circumference.</td></tr>
<tr><td>7</td><td>Binding</td><td colspan="5">The rubberized cotton binding tape shall be applied to bind the armor wires such that it shall not affect the</td></tr>
<tr><td>8</td><td>Weight of</td><td colspan="5">To be furnished by Bidder</td></tr>
<tr><td>9</td><td>Raw material supplier</td><td colspan="2">Steel armour shall be procured from reputed raw material suppliers viz., TATA Steel, Jindal Steel, SAIL only.</td><td colspan="3">Aluminium armour shall be procured from reputed raw material suppliers viz., BALCO/HINDALCO/NALCO/Vedanta Only.</td></tr>
</table>

5.8 Outer Sheath (for Normal cable)

<table>
<tr><th>Sl.No.</th><th>Parameter</th><th>Requirement</th></tr>
<tr><td>1</td><td>Material</td><td colspan="5">Polyvinyl chloride (PVC) ST-2 FRLSH type compound with 'lead napthenate' additive</td></tr>
<tr><td>2</td><td>Configuration</td><td colspan="5">Polyvinyl chloride (PVC) ST-2 FRLSH type compound with 'lead napthenate' additive as 'termite & rodent repellent' applied by extrusion process.</td></tr>
<tr><td rowspan="5">3</td><td rowspan="5">Min. Thickness at any point of measurement</td><td colspan="5">3 CORE</td></tr>
<tr><td>95 sq.mm</td><td>120 sq.mm</td><td>150 sq.mm</td><td>300 sq.mm</td><td>400 sq.mm.</td></tr>
<tr><td>2.2 mm</td><td>2.2 mm</td><td>2.36 mm</td><td>2.84 mm</td><td>3.0 mm</td></tr>
<tr><td colspan="5">1 CORE</td></tr>
<tr><td colspan="2">400 sq.mm</td><td colspan="2">630 sq.mm</td><td>1000</td></tr>
<tr><td colspan="2">1.72 mm</td><td colspan="2">1.88 mm</td><td>2.2 mm</td></tr>
<tr><td>4</td><td>Colour</td><td colspan="5">Crimson Red color, colour code: 540 as per IS 5:2007.</td></tr>
<tr><td>5</td><td>Surface uniformity</td><td colspan="5">Surface of outer sheath shall be free from cavity/ nicks/ other visible defects.</td></tr>
<tr><td>6</td><td>Raw material supplier</td><td colspan="5">PVC compound shall be procured from reputed raw material suppliers viz., Shakun, Kalpana, KLJ, DCM ShriRam.
PVC compound from cable manufacturer shall be considered only after factory evaluation for the same.</td></tr>
<tr><td>7</td><td>Weight of outer sheath/km</td><td colspan="5">To be provided by bidder</td></tr>
</table>

5.9 Outer Sheath (for Co extruded 3C Cable)

S.No	Parameter	Require
1	Inner layer	HDPE ST-7, Crimson red of colour code 540, Minimum thickness at any point of measurement – 3 mm
2	Outermost layer	HDPE ST-7, Black colour, Nominal Thickness at any point of measurement – 2 mm. Carbon content shall be as per IS 7098
3	Surface uniformity	Surface of outer sheath shall be free from cavity/ nicks/ other visible defects.
4	Raw material supplier	HDPE shall be procured from reputed raw material suppliers viz., Shakun, Kalpana, KLJ, SCJ Plastics, and Borealis only.
5	Weight of outer sheath/km	To be provided by bidder
6	Weight of HDPE/km	To be provided by bidder

5.10 Sealing End Cap:

S.No	Parameter	Requirement
1	Material	Adhesive coated polyolefin heat shrinkable
2	Configuration	Adhesive coated polyolefin heat shrinkable end cap shall be provided at both ends of the cable.
3	Additional requirements	2 nos. additional cable end caps shall be provided with each drum and placed in the drum.

5.11 Other Requirements:

S.No.	Parameter	Requirement
1	Overall diameter of cable	To be provided by bidder
2	Weight of Overall cable	To be provided by bidder

6. MARKING:

Steel drums shall be provided. Drum shall be free from sharp edges and visual defect. Stencil plate on one flange side of the drum and laminated paper sheet on other side flange of drum. Cable length on one drum shall be 250 meters max. +/- 5%.

I. Following details shall be provided on flanges of drum:

i. Manufacturer's name
ii. Type of Cable
iii. Size of Cable
iv. Voltage Grade
v. Length of the cable on the drum
vi. Direction of the rotation of the drum
vii. Gross mass
viii. Country of manufacture

ix. Year and month of manufacture
x. Purchase Order no.
xi. Drum No.

II. Following details shall be embossed on the outer PVC Jacket (For normal Cable)

& HDPE layer (for co-extruded cable) :

Embossing may be clearly visible. At interval of every 1 meter, following details to be embossed:

i) TPCODL
ii) Manufacturer's name
iii) Month & Year of Manufacturing
iv) Voltage grade
v) Size of the cable
vi) Purchase Order no.
vii) Cable code

Note: - Sequential meter marking shall be printed.

7. TESTS:

The bidder shall be required to submit complete set of the following test reports along with the offer: -

7.1 ACCEPTANCE TESTS

Test on Conductor

- Conductor resistance test
- Test for non-conductivity of water swellable tape/yarn of conductor
- Visual inspection for conductor cleanliness
- Conductor water penetration test

Test on Conductor Screen

- Thickness of semi-conducting tape over conductor
- Test for conductivity of semi-conducting tape over conductor
- Resistivity of extruded semi-conducting conductor screen

- Thickness of extruded semi-conducting conductor screen

Test on Insulation

- Tensile strength & Elongation at break (before ageing)
- Insulation thickness
- Eccentricity and Ovality of insulation
- Hot set test

Volume resistivity

- Void & contamination test on core (by silicon oil dip method)
- Surface smoothness of insulation

Test on Insulation Screen

- Resistivity of insulation screen
- Thickness of insulation screen
- Visual inspection for any convolution/ protrusion between conductor screen and XLPE

  insulation, XLPE insulation and insulation screen
- Thickness & % Overlapping of semi-conducting water swellable tape
- Thickness & % Overlapping of copper tape

Test on Inner Sheath

- PVC thickness
- Colour of inner sheath

Test on Armour (For 3 Core)

- Tensile test
- Mass of zinc coating
- Uniformity of zinc coating
- Adhesion test
- Diameter and no. of wires
- Coverage %

Test on Armour (For 1 Core)

- Tensile test
- Wrapping test
- Resistance test
- Diameter and no. of wires
- Coverage %

Test on Outer sheath (for Normal cable)

- Thickness
- Tensile strength and Elongation at break (before ageing)
- Colour of outer sheath
- Surface uniformity of outer sheath (on full drum)/ shall be free from any damage- void,nick, cavity
- Presence of lead napthenate in PVC outer sheath
- Flammability test
- Oxygen index
- Temperature index
- Acid gas generation
- Smoke density

Test on Outher sheath (for 3 Core extruded cable) INNER LAYER

- Thickness
- Tensile strength and Elongation at Break (before ageing)
- Colour

OUTER LAYER

- Thickness
- Tensile strength and Elongation at Break (before ageing)
- Carbon Content
- Colour
- Surface uniformity of outer sheath (on full drum)/ shall be

free from any damage- void, nick, cavity

Test on Complete Cable

- Partial discharge test
- High voltage test

7.2 ROUTINE TESTS

i) Conductor

resistance test ii)

Partial discharge

iii) High voltage test with

power frequency iv)

Resistance test for Aluminium

armour

7.3 TYPE TESTS

Tests on Conductor

- Conductor resistance test
- Conductor water penetration test

Tests on Insulation

- Tensile strength & Elongation at break (before ageing)
- Ageing in air oven
- Tensile strength & Elongation at break
- Tests for thickness of insulation
- Eccentricity and Ovality of insulation
- Hot set test
- Shrinkage test
- Gravimetric test (Water absorption)
- Volume resistivity/ Insulation Resistance

Tests on Inner

Sheath

- PVC thickness

Tests on Extruded semi-conducting screen

- Volume resistivity test of conductor screen
- Volume resistivity test of core screen

Tests on Outer Sheath (PVC)

- Flammability test for outer sheath
- Thickness
- Tensile strength and Elongation at break (before ageing)
- Tensile strength and Elongation at break (after ageing)
- Variation due to ageing
- Loss of mass test
- Shrinkage test
- Hot deformation test
- Heat shock test
- Thermal stability test
- Flammability test
- Oxygen index
- Temperature index
- Acid gas generation
- Smoke density

Tests on Outer Sheath - HDPE ST 7 (for Co-extruded cable)

- Thickness
- Tensile strength and Elongation at break (before ageing)
- Tensile strength and Elongation at break (after ageing)
- Shrinkage test
- Carbon Black Content

Tests on Armour for 3 Core Cable

- Tensile test
- Torsion test
- Wrapping test
- Resistance test
- Mass of zinc coating
- Uniformity of zinc coating
- Adhesion test

Tests on Armour for 1 Core Cable

- Tensile test
- Torsion test
- Wrapping test
- Resistance test

Tests on complete cable

- Partial discharge test
- Thermal ageing test
- Bending test
- Dielectric power factor test
- High voltage test
- Heat cycle test
- Impulse withstand test

Additional Test (To be checked by Inspector)

- Raw material consumption
- Colour coding identification over copper screen (for 3C cable)
- Sequential marking check
- Cable drum length verification
- Packaging of cable on cable drum
- Diameter over outermost sheath of co-extruded cable
- Weight of outer sheath of co-extruded cable/ km
- Weight of total HDPE of co-extruded cable/ km

8. TYPE TEST CERTIFICATES:

The Bidder shall furnish the type test certificates for the tests as mentioned above as per the corresponding standards. All the tests shall be conducted at CPRI / ERDA as per relevant IS. Tests should have been conducted in certified Test laboratories during the period not exceeding

10 years from the date of opening the bid. In the event of any discrepancy in the test reports, i.e. any test report not acceptable, same shall be carried out without any cost implication to TPCODL.

9. PRE-DISPATCH INSPECTION:

The material shall be subject to inspection by a duly authorized representative of the TPCODL. Inspection may be made at any stage of manufacture at the discretion of the purchaser and the equipment, if found unsatisfactory as to workmanship or material, the same is liable to rejection. Bidder shall grant free access to the places of manufacture to TPCODL's representatives at all times when the work is in progress. Inspection by the TPCODL or its

authorized representatives shall not relieve the bidder of his obligation of furnishing equipment in accordance with the specifications. Material shall be dispatched after specific MDCC (Material Dispatch Clearance Certificate) is issued by TPCODL.

Following documents shall be sent

along with material.

a) Test reports

b) MDCC issued by TPCODL

c) TPCODL Invoice in

duplicate

d) Packing list

e) Drawings & catalogue

f) Guarantee /

Warrantee card

g) Delivery Challan

h) Other Documents (as applicable).

10. INSPECTION AFTER RECEIPT AT STORE:

The material received at TPCODL, Odisha store will be inspected for acceptance and shall be liable for rejection, if found different from the reports of the pre-dispatch inspection and one copy of the report shall be sent to Engineering department.

11. GUARANTEE:

Bidder shall stand guarantee towards design, materials, workmanship & quality of process/ manufacturing of items under the contract for due and intended performance of the same, as an integrated product delivered under this contract. In the event any defect is found by the Company up to a period of 60 months from the date of commissioning or 72 months from the date of last supplies made under the contract, whichever is earlier, supplier shall be liable to undertake to replace/rectify such defects at his own costs. within mutually agreed timeframe, and to the entire satisfaction of the Company, failing which the Company will be at liberty to get it replaced/rectified at supplier's risks and costs and recover all such expenses plus the Company's own charges (@ 20% of expenses incurred), from the supplier or from the "Security cum Performance Deposit" as the case may be.

12. PACKING:

a) Standard length of Cable: The cable shall be supplied in continuous standard length of 250 (3 cores) & 500 (Single core) running meters with +/- 5% tolerance.

b) Filling condition: Drum shall not be overfilled.

c) Cable drum: The cable shall be wound on non-returnable steel drums without any extra cost to

TPCODL as per IS 10418 and its latest amendments.

d) Sealing of cable ends: The ends of the cable shall be sealed by means of heat shrinkable polyolefin end caps. Additional 2 nos. end caps shall be provided with each drum.

e) Requirements for Cable drums: Cable drums shall be so constructed as to have required mechanical strength so that the drum flanges and other components do not break during transport, in actual use or in storage. The flanges and the outside surface of the barrel shall be free from protruding materials/projections/ unevenness/ sharp edges that can damage the cable or hands of the operator during rotation of drums.

A metal preservation shall be applied to the entire drum.

f) Bottom end of cable should be clamped on drum by jute or nylon rope.

g) All ferrous metal parts used shall be treated with a suitable rust free finish or coating to avoid rusting during transit or storage. The drums shall withstand normal handling and transport.

h) Rail/ Road transportation: The bidder shall ensure that the equipment covered under this specification shall be prepared for rail/road transport in a manner so as to protect the equipment from damage in transit.

i) Packaging shall be as per climate change perspective. Cable wound on cable drum shall be covered by recyclable PVC sheet for dust proof.

13. TENDER SAMPLE:

Not Applicable

14. QUALITY CONTROL:

The bidder shall submit QAP indicating the various stages of inspection, the tests and checks which will be carried out on the material of construction, components during manufacture and bought out items and fully assembled component and equipment after finishing. As part of the plan, a schedule for stage and final inspection within the parameters of the delivery schedule shall be furnished. The Purchaser's engineer or its nominated representative shall have free access to the manufacturer's/sub-supplier's works to carry out inspections.

15. TESTING FACILITIES:

Supplier/ Manufacturer shall have adequate in house testing facilities for carrying out all routine tests & acceptance tests as per relevant Indian standards.

16. MANUFACTURING FACILITIES:

The successful bidder shall submit the bar chart for various

manufacturing activities clearly elaborating each stage, with quantity. This bar chart should be in line with the Quality assurance plan submitted with the offer.

17. SPARES, ACCESSORIES AND TOOLS

Not applicable.

18. DRAWINGS AND DOCUMENTS:

Following drawings and documents shall be submitted in line with the requirement of Tender specifications:

a) Completely filled in Schedule "A" Guaranteed Technical Particulars & Schedule "B" Deviations

b) Work Experience details c) Type test certificates.

d) Drawing 1 set of Hard Copy & Soft copy PDF File containing complete information about

manufacturing.

19. SCHEDULE- "A" GUARANTEED TECHNICAL PARTICULARS:

Bidder to submit clause wise compliance.

20. SCHEDULE "B" DEVIATIONS:
(TO BE ENCLOSED WITH TECHNICAL BID)

All deviations from this specification shall be set out by the Bidders, clause by Clause in this schedule. Unless specifically mentioned in this Schedule, the tender shall be deemed to confirm the purchaser's specifications:

SL. No	Clause No.	Details of deviation with justifications

CHAPTER-E12
CABLE TERMINATIONS

TABLE OF CONTENTS

TECHNICAL SPECIFICATIONS FOR HEAT SHRINKABLE CABLE JOINT KITSFOR CABLE TERMINATIONS

1.0 GENERAL

The term heat shrink refers to extruded or molded polymeric materials which are cross linked to develop elastic memory and supplied in expanded or deformed size or shape. The manufacturer of kits besides stating the properties of each component of the kit as indicated below and as per the detailed specifications should also state the source of origin of each component viz; whether locally manufactured or imported in raw material form and processed. The manufacturing activity carried out on each component should be stated. Also, in case the kit is assembled with components imported from two or more foreign suppliers, the manufacturers should give documentary proof supported by the foreign manufacturers confirming that the kit assembled utilizing components of different suppliers are guaranteed by them.

2.0 QUALIFYING EXPERIENCE

The kits should have satisfactory performance record in India in excess of 5 years Supported with proof of customers having had satisfactory use of these kits in excess of 5years.

3.0 HEAT SHRINKABLE MATERIAL

The heat shrinkable material component used in the joint shall have been produced in a systematic procedure as follows:

a) The required materials shall be mixed and extruded into the required shape and then cross- linked by irradiation or any other appropriate chemical process. The components are then warmed and stretched by a predetermined amount and allowed to cool in the extruded shape. The cross-linking shall create a memory and when heated again, the same shall come back to its original shape at which it was cross-linked. Heat shrinkable tubes can be reduced to 30% of its expanded dimension by heating.

b) The volume resistivity of the sleeves shall be 10^8 ohm-cm and the

dielectric constant of around 15 to 30. The limiting temperature shall not be less than 100°C for longer duration and 250°C for one minute.

4.0 TYPE TEST REPORTS

The terminations should have been subjected to all the type tests and type test reports not later than 5 years on the day of Bid opening shall be furnished for verification. The front page of type test report showing the evidence of successful type test of the items asked for in our Tender Specification can be uploaded with the signature of bidder. The full text of the type test report is to be submitted at the time of signing the agreement or within one month of LOA.

If required, OPTCL will do the type test. The transportation charges to type test laboratory and type test charges shall be borne by OPTCL. But if there is significant

design difference between the one tested and are to be supplied, the cost of such testto Contractor's account.

5.0 ELECTRICAL CLEARANCES

The electrical clearances required for a Indoor/Outdoor termination is shall be as perstandards.

6.0 COMPRESSION TYPE TUBULAR TERMINAL ENDS

The materials used in the terminals shall be Aluminum of grade 19501 conforming to IS 5082 - Specifications for wrought aluminum and aluminum alloys bars, rods, tubes and sections for electrical purposes and copper as per relevant IS. The finish inside the barrel shall either be suitably roughened throughout the crimping length of terminal end or provided with suitable greasebased compound with abrasive action. Edges and corners shall be free from burrs and sharp edges. The terminals shall meet the requirements of IS 8309 - Specification for Compression type tubular terminal ends for aluminum conductors of insulated cables.

7.0 JOINT KITS

The requirements contained in a typical joint Kit are as follows:

a) Heat shrinkable type
b) Stress control tubing where necessary
c) Ferrule insulating tubing for joints.
d) Conductive cable break outs for terminations, non tracking, erosion
e) Weather resistant tubing both outer / inner
f) Non tracking erosions and weather resistant outdoor sheds in case ofterminations
g) High permittivity mastic wedge Insulating mastic.
h) Aluminum/Copper crimping lugs of ISI specification.
i) Tinned copper braids
j) Wrap around mechanical protection for joints.
k) Cleaning solvents, abrasive strips.
l) Plumbing metal.
m) Binding wire etc. adequate in quantity and dimensions to meet the service and testconditions.
n) The kit shall contain a leaflet consisting of detailed installation instructions and shallbe properly packed with shelf life of over 3 years.

8.0 LIST OF MANUFACTURERS

The bidders can offer the above equipment from manufactures as per the Vender list (Chapter - **E25**) only.

9.0 PROPERTIES OF JOINTING KIT COMPNENTS

The manufacturer of kits besides stating the properties of each component of the kit as indicated below and as per the detailed specifications given in Enclosures-I(A), I(B) & I(C) should also state the source of origin of each component in raw material form and processed. The manufacturing activity carried out on each component should be stated.

10.0 PERFORMANCE TESTING

Cable termination Kit shall have been type tested during last 5 years. If required further, type test will be done at CPRI/ERDA/NABL accredited Laboratory. The type test charges and transportation charges to type test laboratory shall be borne by OPTCL. But if there is significant design difference between the one tested and the material to be supplied, the cost of such test shall be to the Contractor's account.

Test sequence				
Sl. No.	**Test Sequence**		**Test Voltage**	**Test results shall be as follows**
1	Impact a wedge shaped weight of 4kghaving a 900 angle with a 2 mm radius shall be dropped freely 6 timesfrom a height of 2.0M. On to the sample. The drops shall be distributed over the length of the joint and at right angles to the axis of the joint. (Electricity Council Engg.C.81)			No visual damage
2	AC voltage withstand(IEC Pub 60)	1 min	35 kV	Shall withstand satisfactoril y
			Indoor -75 kV	

		sheath or screen		

Test sequence				
Sl. No.	**Test Sequence**		**Test Voltage**	**Test results shall be as follows**
4	Load Cycling	63 cycles, 5 hrs heating, 3hrs cooling conductor temperature screened : 75^0 C	15 kV	-do-
5	Thermal shortcircuit	1 Sec. symmetrical fault with sheath temp. as per cableSpec.		-do-
6	Load Cycling	Repeat	15 kV	-do-
7	A/C voltage withstand	4 hrs	24 kV	-do-
8	Impulse voltage withstand	Repeat	Indoor -75 kV Outdoor-95 kV	- do-
9	D/C voltage withstand	30 Min.	48 kV	-do-
10	Humidity indoor termination	Conductivity 800M/h S/Cm., 100 hrsspray rate 0.41/Cu.	7.5 kV	-do-

11	Dynamic short circuit(VDE 0278)	63 kA		-do-
12	Salt frog outdoor terminations	224 Kg/m^3	7.5 kV	-do-

ENCLOSURE – I (A)

MATERIAL SPECIFICATION FOR HEAT SHRINKABLE TUBING

Test	**Test Method**	**Requirement**				
		Non-Tracking Tubing	**Stress Control Tubing**	**Ferrule insulating tubing**	**Clear insulating tubing**	**Inner Outer tubing forJoint**
Tensile Strength	ISO 37	8 N/mm^2 Min.	14 N/mm^2 Min.	10 N/mm^2 Min.	12 N/mm^2 Min.	14 MPa Min.
Ultimate Elongation	ISO 37	300 % Min.	250 % Min.	300 % Min.	200 % Min.	500 % Min.
Accelerated Ageing 168 Hrs. at 120˚C	ISO 188					
Tensile Strength	ISO 37 Min.	7.5 N/mm^2 Min.	13 N/mm^2 Min.	10 N/mm^2 Min.	12 N/mm^2 Min.	14 MPa Min.
Ultimate Elongati	ISO 37	200 % Min.	130 % Min.	300 % Min.	200 % Min.	300 % Min.

on						
Thermal Endurance	IEC 216	110° C Min.	90° C Min.	105° C Min.	110° C Min.	120° C Min.
Electric Strength	IEC 243	Wall Elec. Thkn. Strn. (Normal) kV/CM	-	Wall Elec. Thkn. Strn. (Normal) kV/CM	Wall Elec. Thkn. Strn. (Normal) kV/CM	100 kV/CM Min.
		3.0 100 mm. Min.		3.0 100 mm. Min.	*1.3 100 mm. Min.	
Volume Resitivity	IEC 93	1 × 108 OHM-CM Min.	5 × 10 1° OHM-CM Min.	1 × 10 13 OHM-CM Min.	1 × 10 16 OHM-CM Min.	1 × 10 12 OHM-CM Min.
Dielectric	IEC 250	5.0 Max.	15.0 Min.	5.0 Max.	3.5 Max.	5.0 Max.
Test	**Test Method**	**Requirement**				
		Non-Tracking Tubing	**Stress Control Tubing**	**Ferrule insulating tubing**	**Clear insulating tubing**	**Inner Outer tubing forJoint**

Tracking and erosion resistance	ASTM D2303	No tracking erosion to top surface or flame failure after: 1 HR at 2.5 kV 1 HR at 2.75 kV 1 HR at 3.0 kV 20 Mins at 3.25kV	-	kA 3C		kA 1
Water absorption	ISO/R62 Procedure A	1 % Max. AFT. 14 days at (23 ± 2)°C	1 % Max. AFT. 14 daysat (23 ± 2)°C	1 % Max. AFT. 14 days at (23 ± 2)°C	0.5 % Max. AFT.14 days at (23 ± 2)° C	0.2 % Max.AFT. 14 days at (23 ± 2)° C
Resistanceto liquids	ISO 1817					
Transforoil to VDE0370 immersion & days at (23 ± 2)°C						
Tensile Strength	ISO 37	5 N/mm2 Min.	13 N/mm2 Min.	7.5 N/mm2Min.	-	14 MPa Min.
Ultimate Elongation	ISO 37	250 % Min.	250 % Min.	250 % Min.	-	300 % Min.

ENCLOSURE – I (B) MATERIAL SPECIFICATION FOR HEAT SHRINKABLE MOULDED PARTS			
Test	**Test Method**	**Requirement**	
		Sheds	**Conductive Break-outs**
Tensile Strength	ISO 37	8 N/mm^2	9 N/mm^2
Ultimate Elongation	ISO 37	300 % Minimum.	230%
Accelerated Ageing 168 Hrs. at 120ºC	ISO 188		
Tensile Strength	ISO 37	7.5 N/mm^2 Minimum.	9 N/mm^2 Minimum.
Ultimate Elongation	ISO 37	200 % Minimum.	150 % Minimum.
Thermal Endurance	IEC 216	110ºC Minimum.	105ºC Minimum.
Electric Strength	IEC 243	Wall Elec.Thkn. Strn. (Normal) KV/CM	-
		<3.0 100 mm. Minimum.	
Volume Resistivity	IEC 93	1×10^{13} OHM-CM Minimum.	200 OHM-CM Max.
Dielectric constant	IEC 250	5.0 Maximum.	-
Tracking and erosion resistance	ASTM D2303	No tracking erosion totop surface or flame failure after: 1 HR at 2.5 kV 1 HR at 2.75 kV 1 HR at 3.0 kV	-

		20 Mins. at 3.25 kV	
Water absorption	ISO/R 62Procedure A	1 % Max. AFTER. 14 days at (23 ± 2)º C	1 % Max. AFTER. 14days at (23 ± 2)ºC
Resistance to liquids	ISO 1817		
Transformer oil to VDE 0370 immersion & daysat (23 ± 2)ºC			
Tensile Strength	ISO 37	5 N/mm^2 Minimum.	7.5 N/mm^2 Minimum.

ENCLOSURE – I (B)
MATERIAL SPECIFICATION FOR HEAT SHRINKABLE MOULDED PARTS

	Ultimate Elongation	ISO 37	250 %Minimum.	150 % Minimum.

ENCLOSU
RE- I(C)

MATERIAL SPECIFICATION FOR HEAT SHRINKABLE ADHESIVE/SEALANTS			
Test	**Test Method**	**Requirement**	
		Black Insulator Mastic	**Sealant break-outand sheds**
Softening Point	ASTM E28	$(115 \pm 10)^0$ C	
Electric Strength	IEC 243	130 kV/CM Min.	80 kV/CM Min.
Volume resistivity	IEC 93	1 X 10 14 OHM-CM Min.	

Water absorption	ISO/R 62 Procedure A	1 % Max. AFT. 1 day at (23 ± 2)0 C	1 % Max. AFT. 1 day at(23 ± 2)0 C
Corrosive effect 16Hrs. at 121^0 C	AST M D2671 Method-B	No corrosion	
Adhesive peel strength substrate 2/1	as detailed in master Spec.	-	
			Below- 300 C
NTR/ NTR			25N/25 mm Min.
NTR/ CON			20N/25 mm Min.
NTR/ AL			20N/25 mm Min.
NTR/ Pb			20N/25 mm Min.
T.E.R.T	AST M D2303	-	No tracking erosion to top surface or flame failure after:1 HR at 2.0 kV 1 HR at 2.5 kV 1 HR at 2.75 kV

CHAPTER-13
BATTERY & BATTERY CHARGER

TABLE OF CONTENTS OF BATTERY & BATTERY CHARGER
PART – A (48V VRLA TYPE STORAGE BATTERY)

Specification.....

Part – B (Charger For 24 V,150AH,VRLABatteries)

TECHNICAL SPECIFICATION FOR 48V VRLA TYPE STORAGE BATTERY

1.0 SCOPE

Supply, installation and commissioning of 48V VRLA type storage Battery along with Battery charger. It shall have 4nos. of 12V battery & 150AH capacity. The materials offered shall be procured from short listed vendor at **E-25** and shall have been successfully Type Tested during last five years on the date of bid opening. The Type Test reports shall be submitted along with the bid.

2.0 STANDARDS

The equipment shall comply in all respects with the latest edition of relevant Indian Standard Specifications and IEC except for the modifications specified herein.

Ref. IS	Description
IS 266-1993	Battery grade Sulphuric Acid
IS-1885 [Part-8] / 1986	Electro technical vocabulary: Part- 8-Secondary cells & batteries

BS-46290 (Part-4) / 1997	British standard specification for lead acid type valve regulated sealed type batteries
IEC 896-2/1995	Stationary lead-acid batteries, general requirements and methods of test (part-2, valve regulated types)
IS 1146-1981	Rubber and plastic container for lead acid storage batteries
IS 1069-1993	Water for storage batteries
IEC60896-21 & IEC60896-22 of 2004.	Valve Regulated Types - Methods Of Test Valve Regulated Types - Requirements
IS:15549	Stationary Regulated Lead Acid Batteries
IS 3116-2002	Sealing compound for lead acid batteries
IS 8320-2000	General requirements and methods of tests for lead acid storage batteries
ANSI, IEEE STD 450/1987	IEEE recommended practice for maintenance, testing and replacement of large lead storage batteries for generating stations and sub-stations.

3.0 INSTALLATIONS

Batteries shall be installed at indoor.

4.0 DETAILS OF SPECIFICATIONS OF VRLA TYPE

(48V)Battery:

The batteries shall be made of closed type lead acid cells with VRLA Type (48V) plates manufactured to conform to IS:15549 of 2005, IEC60896-21 & IEC60896-22 of 2004.

Capacity

The capacity of the batteries shall be as follows :

a) Voltage - 48V

b) Output at 27°C- 150AH at 10 hrs. discharge rate.

The batteries shall normally remain under 'floating' condition with the 'trickle' charger supplying the continuous load. However, the batteries shall be capable of supplying the following loads under emergency conditions without any assistance from the chargers and without their terminal voltage falling below 43V [90% of rated voltage].

Stage emergency:-15A for 3 hours for lighting.

The number of cells for 48V batteries shall be so chosen that for the nominal floating voltage of the cells, the battery voltage shall be 51.85V and for the minimum [discharged condition] voltage of the cells, the voltage of the battery shall not be less than 43.2 V, while the assigned rating of the battery bank cannot lowered below its rated voltage of 48V. It shall have 4nos. of 12V battery & 150AH capacity.

5.0 DESIGN AND CONSTRUCTIONAL DETAILS

5.1 Plates:

Positive plates shall be made of flat pasted type using lead-cadmium antimony alloy for durability, high corrosion resistant, maintenance free, long life both in cyclicas well as in float applications.

Negative plates shall be heavy duty, durable flat plate using lead calcium alloy pasted box grid. Negative plates shall be designed to match the life of positive plates and combination of negative and positive plates shall ensure long life,durability and trouble free operation of battery.

PLC (programmable logic control) operated equipment should be deployed for preparation of paste to ensure consistency in paste quality. Conventional/manual type of paste preparation is not allowed.

5.2 Container and Lid:

The containers and lids shall be made of a special grade polypropylene copolymer plastic material. They shall be sufficiently robust and not liable to deformation under internal operating pressures and within the temperature range naturally encountered, leak proof, non-absorbent and resistant to the acid with low water vapour permeability.

The container shall be made up of a special grade polypropylene copolymer material, which should be of flame-retardant. The container shall be enclosed in epoxy coated steel trays. The steel trays shall be so designed as to make both vertical and horizontal stacking of cells / batteries possible. The surface of the container shall be free from blisters, rough spots, scales, blow holes and other imperfections or

deformations. The cell plates shall be suspended without touching the bottom of the container. It shall provide enough sediment space so that the plates can shed their active material without shorting the plates in the cell during the expected life of the battery without cell cleaning. The plastic container shall conform to all the requirements as mentioned in IS 1146. The covers shall be furnished with acid spray proof vent plugs. The cell post polarity shall be marked on the cover. The electrolyte level lines for upper and lower limits shall be marked on all four sides of each container.

5.3 Separators:

The separators shall be of synthetic material conforming to the latest edition of IS- 6071-1986. These shall permit free flow of electrolyte and would not be affected by the chemical reaction inside the cell and shall last for indefinite time. The internal resistance factor of the separators shall assure high discharge characteristics underall operating conditions. Proper arrangement to keep end plates in position shall be furnished by the bidder along with his offer.

5.4 Electrolyte:

The electrolyte shall be prepared from the battery grade Sulphuric acid conforming to IS-266-1993 and shall have a specific gravity of 1.2 at 27^0C. The Sulphuric acid of battery grade shall be colorless liquid. The concentrated Sulphuric acid on dilution with an equal volume of distilled water shall be free from suspended matter and other visible impurities. The Sulphuric acid shall meet the requirements of columns — 4 and 5 Table —1 of IS-266-1993. VRLA battery does not require any elelectrolyte top up.

5.5 Plate Group Bar with Terminals:

The plate group bar with terminals shall conform to IS-1652-1991. The positive and negative terminals shall be clearly marked for easy identification. The legs of the plates of like polarity shall be connected to the load, turned to a horizontal group bar having an upstanding terminal post adopted for connection to the external circuit. The group bars shall be sufficiently strong to hold the plates in position.

5.6 Buffers/Spring:

Suitable buffers/springs shall be provided in the cells to keep the end plates inposition. These shall have adequate length and strength.

5.7 Cell Lids:

Lids used with sealed or closed type cells shall be of glass, plastic or ebonite and shall be provided with vent plugs. Terminal post shall be suitably sealed at the lid to prevent escape of acid spray, by means of rubber grommets, sealing compound or other suitable device. The positive and negative terminal posts shall be clearly and indelibly marked for easy identification. Sealing compound shall conform to IS 3116.

5.8 Water:

Water used for preparation of electrolyte and also to bring the level of electrolyte to approximately correct height during operation/testing shall conform to relevant standards.

5.9 Venting Device:

Safety valve vent plugs shall be provided in each cell. They shall be explosion resistant, self-resealing and pressure regulating type. They shall not allow gas (air) to enter into the cell but shall allow gas to escape from the cell above a certain internal pressure, which does not lead to deformation or other damage to the cell.

- The vent plug used shall be explosion resistant and self re-sealing pressure regulating type. Vent plug shall be such that it cannot be opened without proper tool.
- The valve shall be so designed that it operates at a pressure between 0.14 Kg / Sq. mm to 0.63 Kg / Sq. mm to release the excess gas and reseal automatically as soon as the gas pressure within the cell drops to atmospheric value.
- All the cells shall be subjected to pressure test upto 0.7 Kg / Sq. mm.
- The self-discharge rate at room temperature shall not be more than 5 % of the capacity of each battery per month.
- Each valve opening shall be covered with flame barrier capable in preventing the ingress of flame into the cell interior when the valve opens and hydrogen / oxygen gas mixture is released.

5.10 Marking:

Acid level line shall be permanently and indelibly marked around on all thecontainers.

The following information shall be indelibly marked on the outside surface of eachcell:

a) Manufacturer's name, type and trade mark.
b) Nominal voltage.
c) AH capacity at 10 hours rate with specified end cell voltage.
d) Cell number.
e) Upper and lower electrolyte level in case of transparent containers.
f) Type of positive plate.
g) Type of container.
h) Date of manufacture [month and year] or [week and year].

5.11 CONNECTORS:

Bars tinned copper lead connectors shall be employed for Inter-cell and inter-row, inter-tier connections. However, the tee-off connection from the battery unit shall be made with acid resisting cables of suitable size. A suitable terminal box along with acid-resisting cable shall be provided by the Contractor for this purpose. The connectors shall preferably be of bolted type and the bolts and nuts shall be of similar material as that of connectors and shall be provided with corrosion resisting lead coating. The connectors shall be of sufficient cross-section to withstand all the working conditions including one minute discharge rate as well as short circuit conditions.

a) Lead coated connection hardware such as bolts, nuts etc. 5% extra, or any otherconnector suitable for VRLA type Battery.
b) Ampere-hour Meter [10 hour discharge rate] of 100 –150 AH range-1 no.
c) Any other accessories, not specified but required for installation, satisfactoryoperation and maintenance of batteries for a period of 5 [five] years.

5.12 Fastners:-

Bolts, nuts and washers for connecting the cells shall be effectively lead-coated to prevent corrosion. Where it is not possible to bolt the cell terminals directly to assemble a battery, separate lead-coated copper or

aluminum connectors of suitable size shall be provided to join the cells.

5.13 STAND AND BATTERY RACKS:

The cells shall be supported on insulated rack fixed with pads and with adequate clearances between the adjacent cells. The battery racks shall be made of best quality material having the features of rodent proof, rust proof, sustainable to saline/coastal environments with at least three (3) coating of anti-acid paint of approved shade. Racks shall be rigid, numbering tags for each cell shall be attached on the racks. Bidder is responsible for replacement of the battery rack if any damage/deterioration found during the warranty period.

6.0 MAXIMUM SHORT CIRCUIT CURRENT

The Bidder shall state the maximum short circuit current of each battery along with the safe duration in seconds which it can withstand. Methods, proposed to be adopted for protecting batteries from the short circuit conditions should also be stated to avoid damage to the battery and loss to the associated equipment.

7.0 CHARGING

The bidders shall state whether an equalizing charge is recommended for the battery. If so, the equalizing charge voltage, current, duration and the interval between the equalizing charging shall be specified in the Data sheet. Bidder shall also indicate the requirements for boost charging.

8.0 LIFE

The minimum guaranteed life span of the battery should not less than 5 years. The bidder shall quote in his offer the guaranteed life of the battery when operating under the conditions specified.

9.0 INSTRUCTION MANUALS

Fifteen sets of instruction manuals for installation, commissioning, charging and maintenance instruction shall have to be furnished.

10.0 TESTS

10.1. TYPE TESTS:

The bidder shall submit the Type Test reports along with the drawing for

approval for the following type tests, conducted as per relevant IS within Seven years from the date of opening of the bid from CPRI/ERDA/Government Laboratories as per the relevant IS/IEC ,failing which the offer is liable forrejection.

a) Verification of constructional requirements.
b) Verification of dimensions.
c) Test for capacity.
d) Test for retention of charge.
e) Endurance Test.
f) Ampere-hour and watt-hour efficiency test.
g) Test for voltage during discharge.
h) Acid retension capability test on separators
i) Wicking test on separators
j) Test on vent seal operation
k) Test for oxygen recombination efficiency

If the Type Test report [s] does/do not meet the requirements as per this specification, OPTCL at its discretion may ask the Contractor to conduct the above type tests [s] at the Contractor's cost in the presence of OPTCL's representative without any financial liability to OPTCL.

10.2. ACCEPTANCE TESTS:

Following shall constitute the acceptance tests which shall be test witnessed by theOwner's representative at the works of the manufacturer at the cost of supplier.

a) Verification of marking.
b) Verification of dimensions.
c) Test for capacity for 10 hours discharge rate along with the Test for voltage duringdischarge.
d) Ampere-hour and watt-hour efficiency test.

10.3. The Owner may at his discretion undertake test for capacity and voltage duringdischarge after installation of the battery at site without any extra cost.

10.4. The Contractor shall arrange for all necessary equipments including the

variable resistor, tools, tackles and instruments. If a battery fails to meet the guaranteed requirement, OPTCL shall have the option of asking the Contractor to replace the same within 15 [fifteen] days from the date of declaring the same to beinsufficient/failed/not as per the specification.

11.0 DRAWINGS / DOCUMENTS

The tenderer shall submit the following drawings / documents within one month ofplacement of LOA.

a) General battery arrangement, proposed size of individual and over all dimensionsalong with sectional views showing all connections etc.
b) Pamphlets and technical literature giving detailed information of the batteriesoffered.

The Contractor shall submit the following drawings / documents in two copies forapproval. :-

a) Lay out details of the batteries.
b) OGA and cross-sectional details for battery cells.
c) Instruction manuals for initial charging and subsequent charging.
d) Technical data, curves etc.

12.0 GUARANTEED TECHNICAL PARTICULARS

The Guaranteed Technical Particulars, as called for in the chapter-**E23** shall befurnished along with the drawing for approval.

13.0 DEVIATION FROM SPECIFICATION

All deviations from the specification shall be separately listed, in the absence of which it will be presumed that the provisions of these specifications are complied with by the tenderer.

CHARGER FOR 48 V, 150AH VRLA BATTERIES

15Amp single phase Charger (Float Cum Boost Charger) suitable for 48V, 150 AH, Maintenance Battery Type VRLA.

1.0 BRIEF DESCRIPTION

Charging equipment comprising of a Float cum Boost (15 Amp for Float & 25Amp for Boost Charger) suitable for 48V DC, 150 AH, Maintenance free VRLA Battery charger, is required to meet the D.C. power requirement of the sub-station under normal conditions, i.e., when AC auxiliary power supply is available and also to keep all the cells in the state of full charge. The float charger shall supply the continuous DC load at the bus bars in addition to keeping, batteries floated in a healthy condition. In case of failure of A.C. mains or sudden requirement of additional DC power, the battery shall meet the demand as the battery shall be connected in parallel with the charger. After the battery has discharged to a considerable extent, it shall be fully recharged by the 'boost' charger unit in a short period so as to prepare it for the next emergency. Even during the 'boost' charging of the battery, the continuous DC load at the bus shall be met by the trickle-charging unit. The 'boost' charging unit shall however be provided with suitable control arrangement to function as a stand-by for float charging unit in case of necessity. Input to Charger shall be 220V AC supply.

2.0 ARRANGEMENTS

2.1 Trickle (Float) Charger :

The trickle charger shall have arrangement for regulation of D.C. output voltage by:-

a) automatic voltage regulation system.
b) Shall be of thyristor control type with both 'auto/manual' control arrangement.

2.2 Quick (Boost) Charger:

The quick charger shall be similar type as trickle charging equipment, but shall have the following features.

a) Shall be provided with control arrangement for 'auto/manual' current regulationfeatures, necessary for quick charging.
b) Shall also have 'auto/manual' voltage control arrangement for use when thecharger will be utilized as a trickle charger.

2.3 The 'Trickle' and 'Quick' charger shall be self-supporting cubicle type with front panels hinged and suitable for mounting instruments, incoming A.C (3-ph) circuit breaker with thermal and instantaneous releases relays, contactors and control switches etc. The panels shall have access from the backside also. These cubicles shall also house transformers, rectifiers and other equipment's, accessories, as stipulated in this specification.

3.0 DESIGN AND CONSTRUCTION DETAILS

3.1 The 'trickle' charger and 'quick' charger shall be complete with silicon controlled rectifier units, dry type air-cooled transformers, control electronics, smoothing filtersetc. suitable for operation from 220V ± 10%, 50 Hz (-5%, +3%), 1-ph A.C. supply. The

Charger output shall be stabilized to ± 1% of set value for ± 10% input voltagevariations and 0-100% load variation.

3.2 The battery charger shall have full-wave, Half-controlled thyristor controlled bridge rectifier circuit. The charger output voltage shall suit the battery offered. The float voltage shall be adjustable from 80% to 115% of nominal voltage. The boost voltage shall be adjustable from 80% to 135% of nominal voltage. Ripple voltage shall be less than 3% RMS voltage.

3.3 Each float charger shall be capable of floating each cell of the battery bank at the specified voltage and supplying specified float current continuously under normal system operation.

3.4 Under normal operation, the float charger shall be supplying the DC load current andat the same time trickle charge the station battery. When the battery voltage goes down considerably, automatic transfer arrangement shall be provided such that the battery is disconnected from the float charger and gets connected to the Boost charger. However, when battery is on boost charge, DC load shall be fed from the float charger. In addition, means shall be provided to ensure interruption free

availability of control power from the battery whenever there is a power failure irrespective of whether the battery is on boost charge or float charge.

3.5 The selection of electronic components shall be used on ambient temperature of 50°C. and shall be of worst-case design to ensure continuous and trouble free service. The control electronics shall be built on plug in type glass epoxy printed circuit boards of modular design.

3.6 The maximum temperature, attained by any part of trickle charger and quick charger, when in service at site under continuous full load conditions shall not exceed the permissible limits as fixed by relevant standards and as corrected to site condition.

4.0 CHARGER PANEL

4.1 Charger Panels shall be rigid, self-supporting structures, completely assembled and totally enclosed cubicle type construction, made out of structural steel members with sheet steel-coverings.

4.2 The enclosure of the charger shall be made of CRCA sheet steel of thickness not less than 3 mm for load bearing members, 2 mm for door and non-load bearing members and 3 mm for gland plates. Panels shall be offered with base frame of 3.0 mm thick CRCA sheet, painted black all around, suitable for bolting/ welding/ grouting on to the foundation. Gaskets on doors and inter panel gaskets shall be of neoprene rubber.

4.3 The panel shall have hinged front and back doors with concealed type hinged locksand latches.

4.4 The panel shall have adequate cross –ventilation arrangement to avoid any undue rise in temperature.

4.5 All equipment's and wiring used in the panel shall be tropicalised dust proof and vermin-proof.

4.6 Power wiring for the chargers shall be done with 1.1KV grade, heavy duty, single core, stranded copper conductor PVC insulated cables or suitable

sized PVC sleeved copper bus bars. Control wiring for the charger shall be done with 1.1 KV grade PVC insulated copper wires of cross section 2.5 sq. mm for all control connection. Wire of
2.5 sq. mm cross section shall be used for control bus. All control wiring shall be ferruled.

4.7 Necessary terminals for grounding the panel with two separate earthings shall be arranged for bottom entry and suitable cable glands shall be provided for the cables.

4.8 Each charger panel shall incorporate all the necessary controls, Indications, interlocks, protective devices and timing features to ensure any operation.

4.9 Provision shall be made with necessary contact / relays for annunciation in the event of alternating current power failures to the charger and automatic shutdown of the charger by over-voltage / current devices. Annunciation shall however be prevented when the charger is manually shutdown or when A.C. power supply is momentarily interrupted for adjustable period of 1 to 5 seconds.

4.10 The float and equalizer charging rates shall both be adjustable from the front of the charger control panel. Each charger shall be protected against any damage from over voltage/ load currents and shall be so designed that it can continuously deliver at least rated current output without operation of the protective over-load device for abnormal conditions of low battery voltage down to 38.4V (80%) of the rated voltage. But the chargers shall be disconnected from A.C. input supply through an over-voltage relay, if the input voltage exceeds 10% of the rated voltage of the equipment. Necessary selector switches for 'Trickle Charging' and 'Quick charging' shall be provided. There shall be 'make before break' type blocking Diodes and other equipments to be shown in the drawing or otherwise found necessary for charging or otherwise found necessary for charging the battery without increasing the voltage beyond safe value across the load shall also be supplied by the tenderer.

4.11 The rectifier units of the chargers shall be capable of supplying an impulse load of 6/7 times its rated capacity. The trickle charger in conjunction with automatic voltage regulators shall have drooping characteristics, So as to transfer the load beyond its capacity to the battery.

4.12 The incoming and outgoing circuits shall be provided with MCCBs with static releases for overload, short circuit and earth fault protections. The incoming power supply to the chargers will be from two sources with a facility of changeover switch. The change over facility shall be provided in the charger itself.

4.13 The battery circuit shall be provided with HRC fuse protection over a suitably rated load break isolator switch and reverse protection circuits.

4.14 Input volt meter and ammeter shall be of digital type and shall be 96 x 96 mm. Square. These meters shall be of accuracy class not less than 1.0 and shall be of flush mounting type with required PTs and CTs and selector switches. Output voltmeter shall be digital and ammeter shall be moving iron type and shall be 96 x 96 mm square. These meters shall be of accuracy class not less than 1.0 and shall be flush mounting type. The ammeter shall be centre zero type for measurement of charging and discharging current from the battery.

4.15 Cluster LED lamps for indicating 'Input on' condition and 'Output on' condition, float status on / off, boost status on / off etc. shall be provided. Annunciation with audiovisual alarms shall be provided for the following.

a) Input mains failure.
b) Input phase failure.
c) Input fuse failure.
d) Rectifier fuse failure.
e) Filter fuse failure
f) DC over voltage
g) DC under voltage
h) Output fuse failure
i) Charger over-load
j) Earth leakage

k) Alarm supply fuse failure
l) Charger trip
m) Output MCCB tripped
n) AC under voltage
o) Battery low condition

ACCEPT, TEST AND RESET push buttons shall be provided. 20% spare annunciationwindows shall be provided.

4.16 Any other item(s), not stipulated in this specification, but required for installation, operation and maintenance of the battery charger is / are included in the scope of supply without any extra charge to OPTCL.

5.0 TESTS

5.1. Type Tests :

The bidder shall submit the Type Test reports along with the drawing for approval for the following type tests conducted on float cum boost charger as per relevant IS and IEC within five years from the date of opening of the bid and test-witnessed by any Government Department / Government undertaking, failing which the offer is liable for rejection.

a) Measurement of voltage regulation / AVR regulation
b) Efficiency and power factor measurement test
c) Temperature rises test so as to determine the temperature rise of SCR, Transformer primary, Secondary and core, Diode, capacitor, choke and cabinetetc.
d) Measurement of insulation resistance.

i) AC input to earth.
ii) AC input to DC output.
iii) DC output to earth
iv) Test for rectifier transformer.
v) DC voltage current characteristic
vi) High Voltage Tests.
vii) Determination of regulation
viii) Measurement of ripple
ix) Reverse leakage test.

5.2. Acceptance Tests :

Followings shall constitute the Acceptance tests which shall be tested by the Owner's representative at the works of the manufacturer at the cost of the supplier (both for FC cum BC) for each charger. No sampling is allowed.

i) Measurement of voltage regulation / AVR Regulation
ii) Efficiency and power factor measurement
iii) Temperature rise test so as to determine the temperature rise of SCR, Transformer primary, secondary and core, diode, capacitor, choke and cabinet etc.
iv) Measurement of insulation resistance.
v) AC input to earth
vi) AC input to DC output
vii) DC output to earth
viii) Test for rectifier transformer (all relevant tests as per corresponding ISS)
ix) DC voltage current characteristic
x) High voltage tests.
xi) Determination of regulation.
xii) Measurement of ripple
xiii) Tests for indications and alarms as per this specification
xiv) Tests for indicating instruments.
xv) Determination of system set points.
xvi) Soft start test

N.B. :The supplier shall provide arrangements for monitoring the temperature across the elements, as stipulated above, continuously during the temperature rise test without disconnection of any of the temperature measuring devices across the hottest spot of each of the above elements.

All other tests, as may be necessary to ensure that all equipment's are satisfactory shall also be carried out. In addition to the above tests, manufacturer's test certificates, vendor's test certificates for different equipment's, accessories, instruments etc. shall be submitted, whenever required by the Owner.

6.0 DRAWINGS / DOCUMENTS

The tenderer shall submit the following drawings / documents for approval.

a) OGA of the battery chargers
b) General layout with overall dimensions
c) Electrical schematic diagram showing connections and controls.
d) Leaflets and technical literature giving detailed information of the panels offered.

The contractor shall submit the following drawings / documents in 7 (seven) copies within 15 (fifteen) days from the date of issue of the purchase order for Owner's approval.

a) OGA of the battery chargers.
b) General layout with overall dimensions marked alongwith sectional viewsshowing cable entry position etc.
c) Rating calculations for transformer, rectifiers, diode, capacitor, inductor etc.
d) Detailed schematic and connection and control wiring diagram for all theequipments.
e) Complete bill of materials.
f) Technical excerpts on operation.
g) The circuit diagram of charger including circuit diagrams of all cards to facilitatethe maintenance of chargers.

7.0 GUARANTED TECHNICAL PARTICULARS

The Guaranteed Technical Particulars of this specification shall be furnished along with the tender. Any tender, lacking complete information in this respect is likely to be rejected.
The GTP for Battery charger shall be as chapter-**E23** .

8.0 DEVIATION FROM SPECIFICATION

All deviations from the specification shall be separately listed in the technical deviation sheet, in the absence of which it will be presumed that the provisions of these specifications are complied with by the tenderer.

N.B.: Besides the above general technical requirements, all other stipulations, as enumerated in this technical specification shall be followed. Any deviation should be clearly brought out with clear explanation.

Any extra feature/ equipment/ instrument as necessary for

operation and performance of the battery charger for the 48V battery set as per this specification shall be provided without any extra cost to OPTCL.

CHAPTER-14
DC DISTRIBUTION BOARD

TABLE OF CONTENTS

1. SCOPE:

This specification covers the technical requirements of design, manufacture, testing at manufacturer's works, packing, forwarding, supply and unloading at site/store SMPS based Battery Charger with DCDB and VRLA Battery of 48 Volts with all accessories/components for trouble free operation.

It is not the intent to specify completely herein all the details of tech design and construction of material. However, the material shall conform to practices consistent with sound environmental management and local statues. It is also expected that equipment shall comply in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation in manner acceptable to the TPCODL, who will interpret the meanings of drawings and specification and shall have the power to reject any work or material which, in his judgment is not in accordance therewith. The offered material shall be complete with all components necessary for their effective and trouble-free operation. Such components shall be deemed to be within the scope of Bidder's supply irrespective of whether those are specifically brought out in this specification and/or the commercial order or not.

2. APPLICABLE STANDARDS:

The material covered by this specification shall unless otherwise stated be designed, constructed and tested in accordance with latest revisions of relevant Indian Standard and shall conform to the regulations of local statutory authorities.

Sl.No	IEC/IS	Description
1	IS:3895/1966	Specification for the rectifier equipment
2	IS: 1248	Specification for Indicating instrument.
3	IS:375 /1963	Specification for wiring
4	IS: 4540/1968	Specification for Mono crystalline semiconductor rectifier Assemblies
5	IS:13947/ 1993	Specification for Air Break Switch/Contactor
6	IS: 8828/1993	Specification for Miniature circuit breaker

7	IS:6619	Safety code for semiconductor rectifier Equipment

8	IS:2147	Degree of protection for cubicle
9	IS 6619: 1972	Safety Code for Semi-conductor Rectifier Equipment
10	UL 1564	UL Standard for Safety Industrial Battery Chargers
11	IEC 61000-4-17	Electromagnetic compatibility (EMC) – Part 4-17: Testing and measurement techniques – Ripple on DC input

3. CLIMATIC CONDITIONS:

1	Maximum ambient temperature	50 deg C
2	Max. Daily average ambient temp	35 deg C
3	Min Ambient Temperature	0 deg C
4	Maximum Humidity	95%
5	Average Annual Rainfall	150cm
6	Average No. of rainy days per annum	120
7	Altitude above MSL not exceeding	1000m
8	Wind Pressure	300 Km/hr
9	Earthquakes of an intensity in horizontal	equivalent to seismic acceleration of
10	Earthquakes of an intensity in vertical direction	equivalent to seismic acceleration of 0.15g (g being acceleration

TPCODL service area has heavy saline conditions along the coast and High cyclonic Intensity winds with speed up to 300 Kmph. The atmosphere is generally laden with mild acid, dust in suspension during the dry months, and is subjected to fog in cold months.

4. GENERAL TECHNICAL REQUIREMENTS:

Sl.No	Description	Units	Requirement for 48V Battery Charger
1	Manufacturer Name		To be provided by Bidder
2	Type & Designation (if any)		To be provided by Bidder
3	System DC voltage	V	48
4	**Input AC Voltage**		
a.	FC	V	415V ±10% 3 phase, 4wire, 50Hz + 5%
b.	FCB	V	415V ±10% 3 phase, 4wire, 50Hz + 5%
5	Frequency	Hz	50
6	Ampere/hour capacity	Ah	VRLA 100Ah or 150Ah
7	**Battery Charger Ratings**		
a.	FC	A	40 or 60
b.	FCB	A	40 or 60
8	**No. of Modules**		
a.	FC	N+1	
b.	FCB	N+1	
9	Number of cells	Nos.	to be noted by the bidder in line with the applicable battery
10	Nominal Voltage	V	48
11	Output Voltage adj.	V	to be provided by the bidder
12	**Performance Parameters**		
a.	Voltage Ripple	mV	< 200 mV
b.	Efficiency		Better than 90%
c.	Operating Temp.		$-5^{o}C$ to $+60^{oC}$

d.	Power factor at 50% and 100% load		0.99 @ 50-100% load
13	Soft Start time		to be provided by the bidder
14	Load Regulation (Voltage)`		±1%
15	**Regulation:**		
a.	Output voltage over shoot/under shoot when charger is switched on		to be provided by the bidder
b.	DC output voltage over shoot for a step change in AC voltage 165V to 260V single phase		to be provided by the bidder
c.	DC output voltage for a step load change of 25% to 100%		to be provided by the bidder
16	**Float Charger**		
a.	Rating	A	to be provided by the bidder
b.	Float voltage per cell	V	to be provided by the bidder
c.	Float voltage (for Battery Bank)	V	As per application required for VRLA Battery
d.	Maximum Float charging current	V	to be provided by the bidder
17	**Float cum Boost Charger:**		
a.	Rating	A	to be provided by the bidder
b.	Boost voltage per cell	V	to be provided by the bidder
c.	Boost voltage (for Battery Bank)	V	As per application required for VRLA Battery
d.	Maximum Boost charging current	A	to be provided by the bidder
18	Protection for Control circuit		Control circuit :MCB
19	**Construction Details:**		
a.	Colour Shade		Shade RAL 7032
b.	Paint Thickness	Micron	80-100 micron
c.	Thickness of CR sheet steel	MM	3 mm for load bearing parts & 2mm for others
d.	Cable Entry		Bottom
20	Degree of Protection		IP-42

21	Recommended clearance on rear side		to be provided by the bidder
22	Recommended clearance on front side		to be provided by the bidder
23	Overall Maximum Dimensions:(W X D X H)		W X H X D: 1800 X 1900 X 800 mm
24	Mounting Type		Free standing floor mounting, Indoor
25	**DC DISTRIBUTION BOARD**		
a.	Feature of DCDB feeder ON/OFF status monitoring through controller display		Yes
b.	Feature of DCDB earth fault monitoring through controller display		Yes
c.	Incoming feeder comprising of copper bus bar double pole DC MCCB - 300 A	Qty	1 No
d.	Outgoing feeder comprising of double pole 25A MCB	Qty	12 Nos
e.	Moving coil DC voltmeter of size 96sq.mm with HRC fuse 0-300V	Qty	1 No
f.	Moving coil DC ammeter of size 96sq.mm; 0-150A	Qty	1 No
g.	220V/200A Copper bus bar (size to be mentioned by bidder)		Copper bus bar
26	Dropper Diode scheme		Yes
27	Surge Protection Device (SPD) class		Type-1
28	Earthing bus bar		25x3 sq. mm tinned copper
29	Cooling		Speed regulated Fan cooled
30	Digital leakage current Indicator		Yes
31	Lamp indication to be provided whether battery charger is running on Float mode or Boost Mode		Yes
32	**Alarm Annunciation:**		
a.	Load voltage high		Yes
b.	Over voltage, under voltage or output fail.		Yes
c.	Mains out of range		Yes

d.	System Over Load		Yes
e.	Mains ON / Battery Discharge		Yes
f.	Temperature Compensation fail		Yes
g.	Battery Fail or No Battery		Yes
h.	Battery Isolated from the load		Yes
i.	DC Earth Leakage		Yes
j.	Input MCCB Trip/Off		Yes
k.	FC & FCB Output MCCB Trip/Off		Yes
l.	DCDB Incomer MCCB Trip/Off		Yes
m.	Rectifier Module fail		Yes
33.	**Controller shall have display feature consisting of following features:**		
a.	Float Voltage		Yes
b.	Boost Voltage		Yes
c.	Float Current		Yes
d.	Boost Current		Yes
e.	Load Voltage		Yes
f.	Load Current		Yes
g.	Battery Voltage		Yes
h.	Battery Current		Yes
i.	DC Earth Leakage		Yes

5. GENERAL CONSTRUCTION:

The battery chargers of 48V/40Amp in N+1 configuration with ultimate capacity 80 Amp shall be of SMPS type suitable for both VRLA Batteries. The system shall consist of a Distribution/Switching/Alarms arrangement (DSA) and Float /Boost Rectifier-cum-Chargers (FC/FCB) in a rack.

It shall employ modular configuration for flexible provision of DC Power. It shall employ menu driven Micro Processor Controlled Techniques for DSA as well as module for control, monitoring and alarm to achieve better reliability of the system. The SMPS battery chargers shall be capable of continuous operation with float voltage for VRLA Batteries while supplying the constant DC load. The SMPS battery chargers shall have constant voltage characteristics throughout the range (from zero to full load) at the floating value of the voltage so as to keep the batteries fully charged but without harmful overcharge.

The system shall employ a modular configuration to provide flexibility in view the future load requirements of DC power. All factory wiring for the rack shall be for the ultimate capacity so that only plugging of FR/FC module shall enhance the DC power plant output. The modules shall be accommodated in a rack.

Following are the major components which should be considered in float charger:

SNo	Component Name	Float C	Float Cum
1	Triple pole ON/OFF AC Molded Case Circuit Breaker (MCCB 50kA) for the AC incoming of the FC or FCB Charger with alarm contact for annunciation.	1 No.	1 No.
2	LED type pilot lamps with series resistors to indicate AC mains `ON' condition	3 Nos.	3 Nos.
3	Double wound impregnated naturally air cooled three phase mains transformer necessary secondary tapes for achieving required control DC output voltage.	1 No.	1 No.
4	Three phase, full wave, fully controlled rectifier bridge comprising of MOSFETs/IGBTs liberally rated, mounted on heat sinks and complete with resistor/condenser network for surge suppression, with rectifier MCBs & its trip alarm indication	1 No.	1 No.
5	Filter circuit comprising of smoothing choke and condenser with MCBs for condenser & its trip alarm indication	1 No.	1 No.
6	Electronic controller to stabilize the DC output voltage of the float charger as per battery cell voltage for input voltage variation of ±10% from 415V, frequency variation of ±5% from 50 Hz and simultaneous DC load variation of 0-100% and also complete with load limiting circuit to droop the float charger output voltage upon overloads to enable the Battery to take	1 No.	1 No.
7	Dropper diode selector switch with minimum three positions along bypass scheme in case voltage reaches to one specified level.	as per battery design	
8	Auto/Manual selector switch for selecting the mode of operation of float charger	1 No.	1 No.
9	Potentiometers for setting DC output voltage in the Auto Mode and for adjusting the voltage in the Manual Mode	1 set of two Nos.	1 set of two Nos.
10	The float charger DC output current measurement	1 No	1 No
11	The float charger DC output voltage measurement.	1 No	1 No
12	Double pole ON/OFF DC Molded Case Circuit Breaker (MCCB 10KA) for the float charger Output With alarm contact for annunciation	1 No	1 No1
13	Float Charger Blocker diode with suitable heat sink	1 set	1 set

14	DC `ON' indicating LED type pilot lamp	1 No.	1 No.
15	Float charger DC under voltage Sensing	1 No.	1 No.
16	Float charger DC over voltage Sensing	1 No.	1 No.
17	Auxiliary AC contactor to be interlocked with the DC contactor on the positive bus		1 No.
18	Constant current/ Constant voltage selector switch to select the Boost/ Float mode of operation for the Float cum Boost charger		1 No.
19	DC contactor with power `NC' contact interlocked with the AC Auxiliary Contactor of the float cum boost charger so that whenever the float cum Boost charger operated in its constant current Mode, the contact of DC Contactor on the positive bus bar opens out thus	1 No.	1 No.
20	Silicon blocking diode connected in series to the N^{th} cell of the Battery Bank to maintain continuity in the DC supply even during the second power failure during boost charging of the battery.	2 Nos	2 Nos
21	The charge/ discharge current of Battery	1 No.	1 No.
22	Double pole ON/OFF DC MCB with lock and key for connecting the discharge resister for periodical 10Hr discharge	1 No.	1 No.
23	The Battery voltage to be measure of MU1000C or equivalent for SCADA compatibility	1 No.	1 No.
24	Earth fault sensing	1 No.	1 No.
25	Battery DC Voltage low Sensing	1 No.	1 No.
26	Battery DC Voltage high sensing	1 No.	1 No.
27	Digital meters : - AC Moving iron Voltmeter of size 96 Sq.mm. with suitable selector switch & HRC fuses	1 Set	1 Set
28	Digital meters :- AC Moving iron ammeter of size 96 Sq.mm. with suitable current transformer & selector Switch	1 Set	1 Set
29	AC mains under/over voltage circuit solid state sensing type	1 No.	1 No.
30	Space heater (80W) with Thermostat with MCB	1 No.	1 No.
31	Cubicle Lamp of LED type with an ON/OFF switch and a fuse	1 No.	1 No.

21	The charge/ discharge current of Battery	1 No.	1 No.
22	Double pole ON/OFF DC MCB with lock and key for connecting the discharge resister for periodical 10Hr discharge	1 No.	1 No.
23	The Battery voltage to be measure of MU1000C or equivalent for SCADA compatibility	1 No.	1 No.
24	Earth fault sensing	1 No.	1 No.
25	Battery DC Voltage low Sensing	1 No.	1 No.
26	Battery DC Voltage high sensing	1 No.	1 No.
27	Digital meters :- AC Moving iron Voltmeter of size 96 Sq.mm. with suitable selector switch & HRC fuses	1 Set	1 Set
28	Digital meters :- AC Moving iron ammeter of size 96 Sq.mm. with suitable current transformer & selector Switch	1 Set	1 Set
29	AC mains under/over voltage circuit solid state sensing type	1 No.	1 No.
30	Space heater (80W) with Thermostat with MCB	1 No.	1 No.
31	Cubicle Lamp of LED type with an ON/OFF switch and a fuse	1 No.	1 No.

33	Alarm Annunciation a) Load voltage high b) Over voltage, under voltage or output fail. c) Mains out of range d) System Over Load e) Mains ON/Battery Discharge f) Temp. Compensation fail g) Battery Fail or No Battery h) Battery Isolated from the load i) DC Earth Leakage j) I/P MCCB Trip/Off	1 No.	1 No.

33	Alarm Annunciation a) Load voltage high b) Over voltage, under voltage or output fail. c) Mains out of range d) System Over Load e) Mains ON/Battery Discharge f) Temp. Compensation fail g) Battery Fail or No Battery h) Battery Isolated from the load i) DC Earth Leakage j) I/P MCCB Trip/Off k) FC & FCB O/P MCCB Trip/Off l) DCDB Incomer MCCB Trip/Off m) Rectifier Module fail All alarm circuits shall be provided with suitable delay to ensure that they do not operate to transient. Every alarm, condition shall be accompanied with an audio alarm with audio cut off facility. Potential free contacts two (one for alarm and one redundant) shall be provided for extension Of alarms to centralized	1 No.	1 No.
34	Microprocessor based Digital Controller form to suit SCADA Compatibility through Mod Bus or Supporting Protocol. Controller shall have display feature consisting of following features: Float Voltage Boost Voltage Float Current Boost Current Load Voltage Load Current Battery Voltage Battery Current DC Leakage	1 No.	1 No.
35	Digital leakage current Indicator	1 No.	1 No.
36	Lamp indication to be provided whether battery charger is running on Float mode or Boost Mode.	1 No.	1 No.
37	Any item not specifically mentioned, but required for efficient working of the equipment	As applicable	As applicable

DC Distribution Board :

The DCDB shall be floor mounting, integral to battery charger panel. Non compartmentalized, separate partition shall be provided between battery charger and DCDB. It shall have Moving coil DC voltmeter of size 96 sq.mm with HRC fuse 0-300V and Incoming Feeder 300A DC, Copper Bus-bar, MCCB: 1 No., Outgoing Feeder 25A DC MCB 12 Nos. with Feeder 'ON' LED indication. Battery bank shall be connected to battery charger MCCB/CB, therefore MCCB/CB to be considered in Battery charger for

battery bank connection for safe disconnection of battery bank in case of O&M activity.

General Features:

1. The Float charger, Float cum Boost charger with other Components and Integral DCDB shall be housed in a common cubicle with separate compartments for float & boost charger and for DCDB.

2. The Chargers shall be indoor, floor mounted, self-supporting sheet metal enclosed cubicle type. The Bidder shall supply all necessary base frames, anchor bolts and hardware. The Charger shall be fabricated using cold rolled sheet steel shall not less than 1.6 mm and shall have folded type of construction. The panel frame shall be fabricated using cold rolled sheet steel of thickness not less than 3.0 mm (for load bearing members). Removable undrilled gland plates of at least 3.0 mm sheet steel and lugs for all cables shall be supplied by the Bidder. The lugs for cables shall be made of electrolytic copper with tin coat. The Charger shall have sufficient vermin proof. Ventilation louvers shall be backed with fine brass wire mesh.

3. All the door mounted equipment as well as equipment mounted inside the cabinet shall be provided with individual riveted /life lasting adhered labels with equipment description engraved.

4. All doors and covers shall be fitted with EPDM gaskets. The Chargers shall have hinged double leaf doors provided on front and/or backside for adequate access to the Charger internals. All the Charger cubicle doors shall be properly earthed. The degree of protection of Charger enclosure shall be at least IP-42.

5. Battery Charger shall be provided with earth bus bar of tinned copper flat, having minimum cross section 25x3 Sq. mm flat securely fixed along with base and provision on both the sides of earth bus for connecting TPCODL's earthing grid.

6. Redundancy arrangement for input AC supply: Dual source provision to be considered in battery charger. MCCB for individual source to be considered.
7. Conformal coating on all electronics components to be considered.
8. All indicating instruments, control & selector switches and indicating lamps shall be mounted on the front side of the Charger.
9. Electronic equipment shall be of modular design consisting of plug in modules in standard 19 inches metallic racks with metallic card guides. The cards should be provided with proper handles. Card to card wiring should be preferably through a mother board. Unplanned jumpering and track modifications are not permitted. Mechanical interlocks to prevent wrong insertion of cards should be provided. Each card shall have its junction and test points

identified. Maintenance aids such as extension printed wiring boards and jumper leads shall be provided.

10. The layout of Charger components shall be such that their heat losses do not give rise to excessive temperature within the Charger panel surface. Operating temperature range shall be minus 5°C to plus 60°C. Location of the electronic modules will be such that temperature rise of the location, in no case, will exceed 10°C above ambient air temperature outside the Charger.

11. The electronic control circuitry should have built in feature of soft start so that whenever the charger is switched on, the output voltage should increase gradually.

12. The float section of the charger shall be compatible to operate in auto (fully automatic) as well as manual mode with a provision of selection through Auto/Manual switch and all related components & scheme.

13. Normally the float charger shall operate in parallel with the 48 V, battery set and the load. The float charger shall supply the DC loads of the sub-station and also provide the trickle charge for keeping the battery set floating totalling up to full capacity. For this condition, the float charger shall be designed to trickle charge all the cells between 48 Volts to 55 Volts and supply DC load of the sub-station, keeping the load bus-bar voltage approximately at rated voltage of DC load components by using dropper diodes.

14. The boost charger and the float charger shall be so interlocked electrically that during boost charging of the battery, the float charger will supply the DC constant load without supplying to the battery, and at the same time will be in parallel with the battery through a reverse current blocking diode at a suitable tapping. One DC contactor may be incorporated which shall get engaged through N/C contact of the contactor on AC side of the boost charger. In case of failure of AC supply, this contactor shall connect the entire battery supply to the load through one of its N/O contacts automatically without any interruption of DC supply even of a momentary nature. Under no circumstances the voltage across lower tapped terminals shall exceed (+) 10% or fall below (-) 15% of the rated voltage.

15.Suitable Surge protection Devices must be used for voltage surge protection.

16.**Charger Output**: Suitable ripple filtering circuits shall be provided to give a smooth DC output. The ripple content, without the battery connected shall be limited to less than 3% on resistive load. The DC output shall be free from switching surges, transients, etc.

17.**Locking facilities shall be provided as following:**

(a.) For locking Trickle/Boost selector switch in the trickle position only. This would be used for having key mechanical interlock between Trickle/Boost selector switch and isolator in D.C. distribution board which is being procured separately by the Owner.

(b.) The Charger enclosure door locking requirements shall be met by the application of padlocks. Padlocking arrangement shall allow ready insertion of the padlock shackle but shall not permit excessive movement of the locked parts with the padlock in position.

WIRING:

- Each Charger shall be furnished completely wired up to power cable lugs and terminal blocks ready for external connection. The power wiring shall be carried out with 1.1KV grade PVC insulated copper cables conforming to IS:1554 (Part-I). The control wiring shall be of 1.1KV grade PVC insulated stranded copper conductors of 2.5sq.mm. Conforming to IS: 694. Control wiring terminating at electronic cards shall not be less than 1.0 sq. mm. Control terminal shall be suitable for connecting two wires with 2.5 sq.mm. Stranded copper conductors. All terminals shall be numbered for ease of connections and identification. At least 20% spare terminals shall be provided for circuits. The wiring shall have fire resistant (FRLSH) properties.

- Power and control wiring within panels shall be kept separate. Any terminal or metal work which remains alive at greater than 415 V, when panel door is opened, shall be fully protected by shrouding. All hardware such as screws nuts, studs, washers shall be of brass and no ferrous parts shall be used in electrical circuitry control / power.

- An air clearance of at least ten (10) mm shall be maintained throughout all circuits, except low voltage electronic circuits, right up to the terminal lugs. Whenever this clearance is not available, the live parts should be insulated or shrouded.

AC Terminations:

- The input terminal should be single phase or three phases as the case may be cleared marked as R Y B and N and for AC three phase, L and N for AC single phase.AC input termination shall be suitably protected against the accidental touch/contact with the working staff for their protection and shall also have clear and prominent be “Danger” marking.

- Screening shall be provided between AC and DC components to prevent accidents. The AC input connection to the rectifier module shall be by means of locking type plug and socket arrangement.

All the connection between distribution and modules shall be through proper rated cables only. Fuses and circuit breakers for each modules shall be easily accessible and properly rated.

DC Terminations:

The output of each rectifier in the negative load shall be taken through full rated ISI marked MCBs. All the AC, DC control & alarm cabling shall be supplied with the rack. All DC +ve and - ve leads shall be clearly marked

Battery Temperature Compensation:

The charger shall be provided with the appropriate circuitry to interface with the temperature probe assembly. With the probe, the charger shall automatically compensate gassing and constant voltage setting inversely proportional to the probe's temp/ battery ambient temp.,

so that over charging at high temperature and under charging at low temperature can be prevented.

MCB:

Suitable rated MCBs are to be considered. MCB rating shall be chosen by the Bidder depending on the circuit requirement. All MCBs in the chargers shall be monitored. MCB OFF/failure annunciation shall be provided on the OFF/failure of any MCB.

Blocking Arrangements:

Blocking arrangement shall be provided in the positive pole of the output circuit of the charger to prevent current flow from the DC battery into the charger.

Radio Interference:

The equipment shall be efficiently screened against interference to radio and also other communication equipment, which may be installed in the same building. All sources of noise shall be filtered if necessary with suppressors generally in accordant with relevant standards.

Additional Features Required:

The SMPS modules should be hot swappable modules.

- The spare modules should be easily replaced without any shut downs & there should be no downtime of the system.
- Despite a breakdown in the Monitoring unit or disturbances on bus, system stability should not affect.
- Less voltage drop in the output. (as per voltage regulation)
- Selective over voltage shut down
- Provision for Battery Capacity Test.
- No requirement of additional hardware for changing of parameters at site.
- Settable Time delay & hysteresis for each alarm
- Event history records (min. 100 records storage) with time stamp for fault analysis
- Remote monitoring of parameters
- DCDB feeder ON & OFF status monitoring through controller display feature should be available.
- DCDB individual feeder earth fault monitoring through controller display feature to be added

Following are the minimum mandatory signal requirement for DCDB signals for ADMS (SCADA):

Measurement signals:

1. DC load voltage
2. Load current
3. Float Current
4. Float cum Boost Current

Alarm signals:

1. DC earth Leakage
2. UV Alarm
3. OV Alarm
4. Main-1 Ac fail
5. Main-2 AC fail
6. FC Charger fail
7. FCBC charger fail
8. Major card/components failure

Battery Charger with DCDB shall be integrated with TPCODL SCADA over Modbus-RTU or TCP/IP protocol. If any kind of software required for configuration, then same to be supplied by the bidder. It shall be noted that voltage exact value to be mapped in SCADA. No calculation formula is acceptable. Vendor shall depute their service engineer during installation and commissioning stage for required checks and assist TPCODL in commissioning of Battery Charger.

Service Level Agreement:

1. Bidder shall have all facilities necessary for testing, repairing & failure analysis of the system.

2. Spare parts for repairs should be available ex-stock at bidder's works.

3. Manufacturer Service person availability within 4 hrs from the issue reporting time. Issue shall be reported by TPCODL either via telephonically or email.

4. Vendor shall provide detailed root cause analysis of the fault within 15 days from the date of occurrence of the fault/ failure.

5. Any spare part replacement, testing and its commissioning to be done by the vendor only, without any price implication to the TPCODL.

6. MARKING:

Name Plate:

Battery Charger shall be provided with durable and legible nameplates containing all technical parameters mounted on the front side of charger. Name plate for Battery Charger shall be embossed with "PO no. with date", "PROPERTY OF TPCODL, Odisha

"MATERIAL CODE", along with the following information :

1. Name of manufacturer.
2. Serial Number
3. Rated voltage
4. Rated normal current in Amps.
5. Year & Month of Manufacture.
6. Warrantee Period
7. Applicable IS/IEC

Following points needs to be painted on the front side and shall be visible. Background shall be in yellow color. (Front: Arial; size: 100; Polyurethane paint shall be used. Board formation shall be 100x200 mm)

Equipment Description- ……
Rating- …….. Make- ……..
S.no- ……
YOM- ……
Equipment ID. -……..
Assetno- ……

7. TESTS:

The bidder shall be required to submit complete set of the following test reports along with the offer:

7.1 ROUTINE and ACCEPTANCE TESTS:

i) Visual Inspection & Dimensions
ii) Checking of Wiring & Continuity of Circuits
iii) Ripple content measurement
iv) No load test
v) Load test with voltage regulation
vi) Insulation Resistance
vii) Efficiency tests
viii) Auto/Manual operation test
ix) Alternating Current Measurement
x) Auxiliary Devices
xi) Temperature rise test
xii) Operational Tests for Protection, Alarm, Indication
xiii) HV test

7.2 TYPE TESTS

xiv) Voltage regulation test
xv) Power losses in rectifier assemblies
xvi) Measurement of
Efficiency xvii) Temperature
Rise Test xviii) Degree of
Protection Test xix) HV Test
xx) Insulation Resistance
xxi) Test for Protection Device
xxii) Measurement of power Factor
xxiii) Automatic Voltage regulator operation

8. TYPE TEST CERTIFICATES:

The Bidder shall furnish the type test certificates for the tests as mentioned above as per the corresponding standards. All the tests shall be conducted at **CPRI/ERDA/Third Party** as per relevant IS. Type tests should have been conducted in certified Test laboratories during the period not exceeding 5 years from the date of opening the bid. In the event of any discrepancy in the test reports, i.e. any test report not acceptable, same shall be carried out without any cost implication to TPCODL.

9. PRE-DISPATCH INSPECTION:

The material shall be subject to inspection by a duly authorized representative of the TPCODL. Inspection may be made at any stage of manufacture at the discretion of the purchaser and the equipment, if found unsatisfactory as to workmanship or material, the same is liable to rejection. Bidder shall grant free access to the places of manufacture to TPCODL's representatives at all times when the work is in progress. Inspection by the TPCODL or its authorized representatives shall not relieve the bidder of his obligation of furnishing equipment in accordance with the specifications. Material shall be dispatched after specific MDCC (Material Dispatch Clearance Certificate) is issued by TPCODL.

Following documents shall be sent along with material.

a) Test reports
b) MDCC issued by TPCODL
c) TPCODL Invoice in duplicate
d) Packing list
e) Drawings & catalogue
f) Guarantee / Warrantee card
g) Delivery Challan
h) Other Documents (as applicable).

10. INSPECTION AFTER RECEIPT AT STORE:

The material received at TPCODL store will be inspected for acceptance and shall be liable for rejection, if found different from the reports of the pre-dispatch inspection and one copy of the report shall be sent to Project Engineering department.

11. GUARANTEE:

Bidder shall stand guarantee towards design, materials, workmanship & quality of process/manufacturing of items under the contract for due and intended performance of the same, as an integrated product delivered under this contract. In the event any defect is found by the Company up to a period of 60 months from the date of commissioning or 66 months from the date of last supplies made under the contract, whichever is earlier, bidder shall be liable to undertake to replace/rectify such defects at his own costs, within mutually agreed timeframe, and to the entire satisfaction of the Company, failing which the Company will be at liberty to get it replaced/rectified at bidder's risks and costs and recover all such expenses plus the Company's own charges (@ 20% of expenses incurred), from the supplier or from the " Security cum Performance Deposit" as the case may be. Bidder shall further be responsible for 'free replacement' for another period of THREE years from the end of the guarantee period for any 'Latent Defects' if noticed and reported by the Company.

12. PACKING AND TRANSPORT:

Supplier shall ensure that all material covered by this specification shall be prepared for rail/road transport (local equipment) and be packed in such a manner as to protect it from damage in transit. The bidder shall provide instructions regarding handling and storage precautions to be taken at site.

13. TENDER SAMPLE:

Not Required

14. QUALITY CONTROL:

The bidder shall submit QAP indicating the various stages of inspection, the tests and checks which will be carried out on the material of construction, components during manufacture and bought out items and fully assembled component and equipment after finishing. As part of the plan, a schedule for stage and final inspection within the parameters of the delivery schedule shall be furnished. The Purchaser's engineer or its nominated representative shall have free access to the manufacturer's/sub-supplier's works to carry out inspections.

15. TESTING FACILITIES:

Supplier/ Manufacturer shall have adequate in house testing facilities for carrying out all routine tests & acceptance tests as per relevant Indian standards.

16. MANUFACTURING FACILITIES:

The successful bidder shall submit the bar chart for various manufacturing activities clearly elaborating each stage, with quantity. This bar chart should be in line with the Quality assurance plan submitted with the offer.

17. SPARES, ACCESSORIES AND TOOLS

Mandatory Spares:

Following spares to be provided by the bidder without any extra price implications a) Surge Protection Device (SPD) – 1 nos.

b) Indicating Lamps – 5 nos.

One no. display Controller shall be supplied as spare whenever more than 4 no. of battery chargers procured in the same tender.

Maintenance Spares:

The bidder shall submit a list of spares recommended for maintenance for 3 years of smooth and trouble free operation along with item wise price.

18. DRAWINGS AND DOCUMENTS:

Following drawings and documents shall be submitted in line with the requirement of Tender specifications:

a) Completely filled in Schedule “A” Guaranteed Technical Particulars & Schedule “B” Deviations

b) Work Experience details

c) Type test certificates.

d) Drawing 1 Set of Hard Copy & Soft Copy PDF File containing complete information about manufacturing.

19. SCHEDULE- "A" GUARANTEED TECHNICAL PARTICULARS:

Sl.No	Description	Units	Requirement	To Be Furnished By Bidder
1	Manufacturer Name			
2	Type & Designation (if any)			
3	System DC voltage	**V**	**48**	
4	Input AC Voltage			
a.	FC	**V**	415V ±10% 3 phase, 4wire, 50Hz + 5%	
b.	FCB	**V**	415V ±10% 3 phase, 4wire, 50Hz + 5%	
5	Frequency	**Hz**	**50**	
6	Ampere/hour capacity	**Ah**	**VRLA 100Ah or 150Ah**	
7	Battery Charger Ratings			
a.	FC	**A**	**40 or 60**	
b.	FCB	**A**	**40 or 60**	
8	No. of Modules			
a.	FC	**N+1**		
b.	FCB	**N+1**		
9	Number of cells	Nos.	to be noted by the bidder in line with the	
10	Nominal Voltage	**V**	**48**	
11	Output Voltage adj.	**V**	to be provided by the bidder	
12	**Performance Parameters**			
a.	Voltage Ripple	mV	< 200 mV	
b.	Efficiency		Better than 90%	
c.	Operating Temp.		$-5^{O}C$ to $+60^{OC}$	

d.	Power factor at 50% and 100% load		0.99 @ 50-100% load	
13	Soft Start time		to be provided by the bidder	
14	Load Regulation (Voltage)`		±1%	
15	Regulation:			
a.	Output voltage over shoot/under shoot when charger is switched on		to be provided by the bidder	
b.	DC output voltage over shoot for a step change in AC voltage 165V to 260V single phase		to be provided by the bidder	
c.	DC output voltage for a step load change of 25% to 100%		to be provided by the bidder	
16	Float Charger			
a.	Rating	**A**	to be provided by the bidder	
b.	Float voltage per cell	**V**	to be provided by the bidder	
c.	Float voltage (for Battery Bank)	**V**	As per application required for VRLA Battery	
d.	Maximum Float charging current	**V**	to be provided by the bidder	
17	Float cum Boost Charger:			
a.	Rating	**A**	to be provided by the bidder	
b.	Boost voltage per cell	**V**	to be provided by the bidder	
c.	Boost voltage (for Battery Bank)	**V**	As per application required for VRLA Battery	
d.	Maximum Boost charging current	**A**	to be provided by the bidder	
18	Protection for Control circuit		Control circuit :MCB	
a.	Rating	**A**	to be provided by the bidder	
b.	Boost voltage per cell	**V**	to be provided by the bidder	
c.	Boost voltage (for Battery Bank)	**V**	As per application required for VRLA Battery	
d.	Maximum Boost charging current	**A**	to be provided by the bidder	

19	Construction Details:			
a.	Colour Shade		Shade RAL 7032	
b.	Paint Thickness	**Micron**	80-100 micron	
c.	Thickness of CR sheet steel	**MM**	3 mm for load bearing parts & 2mm for others	
d.	Cable Entry		Bottom	
20	Degree of Protection		IP-42	
21	Recommended clearance on rear side		to be provided by the bidd	
22	Recommended clearance on front Side		to be provided by the bidd	
23	Overall Maximum Dimensions:(W X D X H)		W X H X D: 1800 X 1900 X 800 mm	
24	Mounting Type		Free standing floor mounting, Indoor	
25	DC DISTRIBUTION BOARD			
a.	Feature of DCDB feeder ON/OFF status monitoring through controller display		Yes	
b.	Feature of DCDB earth fault monitoring through controller		Yes	
c.	Incoming feeder comprising of copper bus bar double pole DC MCCB - 300 A	**Qty**	1 No	
d.	Outgoing feeder comprising of double pole 25A MCB	**Qty**	12 Nos	
e.	Moving coil DC voltmeter of size 96sq.mm with HRC fuse 0-300V	**Qty**	1 No	
f.	Moving coil DC ammeter of size 96sq.mm; 0-150A	**Qty**	1 No	

g.	48V/200A Copper bus bar (size to be mentioned by		Copper bus bar	
26	Dropper Diode scheme		Yes	
27	Surge Protection Device (SPD) class		Type-1	
28	Earthing bus bar		25x3 sq. mm tinned copper	
29	Cooling		Speed regulated Fan cooled	
30	Digital leakage current Indicator		Yes	
31	Lamp indication to be provided whether battery charger is running on Float mode or Boost Mode		Yes	
32	Alarm Annunciation:			
a.	Load voltage high		Yes	
b.	Over voltage, under voltage or output		Yes	
c.	Mains out of range		Yes	
d.	System Over Load		Yes	
e.	Mains ON / Battery Discharge		Yes	
f.	Temperature Compensation fail		Yes	
g.	Battery Fail or No Battery		Yes	
h.	Battery Isolated from the load		Yes	
i.	DC Earth Leakage		Yes	
j.	Input MCCB Trip/Off		Yes	
k.	FC & FCB Output MCCB Trip/Off		Yes	
l.	DCDB Incomer MCCB Trip/Off		Yes	
m.	Rectifier Module fail		Yes	
33.	Controller shall have display feature consisting of following features:			
a.	Float Voltage		Yes	
b.	Boost Voltage		Yes	
c.	Float Current		Yes	
d.	Boost Current		Yes	
e.	Load Voltage		Yes	
f.	Load Current		Yes	
g.	Battery Voltage		Yes	

h.	Battery Current		Yes	
i.	DC Earth Leakage		Yes	

20. SCHEDULE "B" DEVIATIONS:
(TO BE ENCLOSED WITH TECHNICAL BID)

All deviations from this specification shall be set out by the Bidders, clause by Clause in this schedule. Unless

specifically mentioned in this Schedule, the tender shall be deemed to confirm the purchaser's specifications:

SL. No	Clause No.	Details of deviation with justifications

CHAPTER-15
5KW SOLAR POWER PLANT

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1.0 STANDARDS

Applicable BIS /Equivalent IEC Standards / MNRE Specifications for Solar

Sl. No	Equipment /Material	Standard
1	Crystalline Silicon Terrestrial PV modules poly/ mono	IEC 61215/ IS14286
2	Solar PV module safety qualification requirements	IEC 61730 (P1 – P2)
3	PV modules to be used in a highly corrosive atmosphere (Nearby Chemical factories, Coastal areaetc,) must qualify Salt Mist corrosion Testing	IEC 61701/ IS 61701
4	Earthing	IS 3043: 1987
5	Switches/ Circuit Breakers/Connectors	IEC 60947 Part I,II, III /IS 60947 Part I,II, III / EN 50521
6	Junction Boxes/ Enclosures for Charge Controllers/Luminaries	IP 65 (for outdoor)/ IP 21 (for indoor)As per IEC 529
7	Cables	IEC 60227 / IS 694 IEC 60502 / IS 1554 (part I & II)
8	Overall PVC insulation for UV protection	IEC 69947
9	Lightning protection System (LPS)	BS EN/IEC 62305

2.0 SOLAR PV MODULES

1	Type	Crystalline silicon – Poly or Mono
2	Module Efficiency	>= 15.2%. I-V curve of the sample module should be Submitted
3	Fill factor	>= 70%

4	Power warranty	25 years limited warranty on power output & 5 yearsproduct warranty
5	Performan ce Warranty	Should not be less than 90% of designed nominal powerat the end of 10 years and 80% of designed nominal power at the end of 25 years.
6	Module frame	Anodized aluminum, Non-corrosive and electrolyticallycompatible mounting structure
7	Mounting structure	M.S. mounting structure with Hot dip Galvanized having70 microns thickness
8	Module minimum rated power	The nominal power of a single PV module shall be >=300Wp
9	RF Identification tagfor each solar module	Must be able to withstand environmental conditions and last the life of the solar module and shall be kept inside the module laminate
10	RF Identification tagdata	a) Name of the manufacturer of PV Module b) Name of the Manufacturer of Solar cells c) Month and year of the manufacture(separately forsolar cells and module) d) Country of Origin (separately for solar cellsand module) e) I-V curve for the module f) Wp, Im, Vm and FF for the module g) Unique Serial No and Model No of the module h) Date and year of obtaining IEC PV modulequalification certificate i) Name of the test lab issuing IEC certificate j) Other relevant information on traceability of solar cells and module as per ISO 9000 standard

3.0 MOUNTING STRUCTURE

Sl No	Particulars	Specifications
1	Wind velocity withstandingcapacity	As per the Building codes
2	Structure material	Structural materials shall be made of corrosion resistant and electrolytic ally compatible with the materials used in the module frame, its fasteners,and nuts and bolts. Hot dip galvanized steel with galvanization thickness of minimum 70 microns or Aluminum with the same standards.
3	Bolts, nuts, fasteners, panel mounting clamps	Stainless steel SS304
Sl No	**Particulars**	**Specifications**
4	Mounting arrangement forflat roofs	The mounting structures shall be erected to achieve required slope from north to south to havea maximum solar PV output efficiency throughout the year. The minimum height on lower side of the lean toroof (on southern side) shall be 2.5 Mtrs. Structures shall be mounted on the building roofwith Removable concrete ballast made of Pre- fabricated PCC (1:2:4), M20. The mounting structures shall be made of M.S. with Hot dip galvanized steel with galvanization minimum thickness of 70 micron

		or Aluminum with the same standards.
5	Installation	The structures shall be designed for simple mechanical on-site installation
6	Minimum distance betweenroof edge and mounting structure (Horizontal Clearance)	>= 0.60 m
7	Minimum clearance betweenlowest part of panel and mounting structure (Vertical Clearance)	Shall not be less than 100mm
8	Access for panel cleaningand maintenance	All solar panels must be accessible from the top for cleaning and from the bottom for access to the junction box
9	Panel tilt angle	North – south orientation with a fixed tilt angle depending on location (south facing)

4.0 ARRAY JUNCTION BOX

4.1 The array junction boxes made of Thermo-Plastic are to be free of dust, vermin and waterproof. The terminals shall be connected to copper bus-bar arrangement of proper sizes made of tinned copper flats. The arrayjunction boxes will havesuitable cable entry points fitted with cable glands of appropriate sizes for both incoming and outgoing cables.

4.2 Technical Specification – Junction Boxes:

Sl. No	Particulars	Specifications
1	Material	Dust, Vermin & Water proof Thermoplastic
2	Hardware SS 304	Cable Gland Thermoplastic
3	Protection	IP 65 enclosures with transparent covers with Surge Protection Device (SPD) Class-I/II, DC Fuse withholder and string disconnect or

5.0 SURGE PROTECTION DEVICE

5.1 Internal surge protection shall consist of three MOV/GDT (glass discharge tube) type arrestors connected from +ve and –ve terminals to earth (via Y arrangement) for higher withstand of the continuous PV-DC voltage during earth fault condition. SPD shall have safe disconnection and short circuit interruption arrangements through integrated DC inbuilt bypass fuse (parallel) which should get tripped during failure mode of MOV, extinguishing DC arc safely in order to protect the installation against fire hazards.

5.2 Nominal discharge current (In) shall be minimum of 10kA with max. Discharge current (I_{max}) of 20kA with discharge time of 8/20 micro seconds.

a) A surge protection device in each sub-array line shall be provided to prevent thehigh current transients from entering into the DC bus.
b) It must be with DC disconnect switch and DC fuses positive side shall have avoltage rating of 1000V DC and current rating as required.

6.0 DC DISTRIBUTION BOX

6.1 DC distribution box shall be mounted close to the solar grid inverter. The DC distribution box shall be of thermos-plastic IP65 DIN rail mounting type and shallcomprise the following components and cable terminations:

a) 2/3 pole DC circuit breaker
b) DC surge protection devise (SPD) class 2 as per IEC 60364-5-53.
c) Cable termination glands for DC cables from DC combiner box and grid inverter.

6.2 The bus bars shall be made of copper of adequate size.

7.0 AC DISTRIBUTION BOX

7.1 AC Distribution Panel Board (ACDPB) shall control the AC power from PCU/ inverter and should have necessary surge arrestors. Interconnection from ACDB to mains at LT Bus bar while in grid tied mode.

7.2 An AC distribution box shall be mounted close to the solar grid inverter. The AC distribution box shall be of wall / rail mounting type and shall comprise of following components:

a) 2 pole / 4 pole AC circuit breaker.
b) AC surge protection device (SPD), class 2 as per IEC 60364-5-53. Suitable cabletermination glands for cable from inverter and electrical distribution board.

7.3 A manual disconnect switch beside automatic disconnection to grid would have to be provided to ensure physical isolation for enabling the utility personal to carry out any maintenance. This manual switch shall have the locking provision.

7.4 All switches and the circuit breakers, connectors should conform to IEC 60947, part I,II and III/ IS60947 part I, II and III.

7.5 The changeover switches, cabling work should be undertaken by the bidder as part of the project.

7.6 All the Panel's shall be metal clad, totally enclosed, rigid, floor mounted, air - insulated, cubical type suitable for operation on three phase / single phase, 415 or 230 volts,50Hz

7.7 All indoor panels will have protection of IP54 or better. All outdoor panels will have protection of IP65 or better.

7.8 Should conform to Indian Electricity Act and rules

8.0 DC and AC CABLES

8.1 All Cables shall confirm to relevant IS/ IEC standards.

8.2 For the DC cabling, XLPE insulated and PVC sheathed, UV stabilized single core flexible copper cables shall be used. Multi-core cables shall not be used. Only FRLS copper wires of appropriate size and of reputed make shall have to be used.

8.3 For the AC cabling, PVC or XLPE insulated and PVC sheathed single or multi-core flexible copper cables shall be used. Outdoor AC cables shall have a UV-stabilized outer sheath.

8.4 The total voltage drop on the cable segments from the solar PV modules to the solar grid inverter shall not exceed 2.0%.

8.5 The total voltage drop on the cable segments from the solar grid inverter in the roof of third floor to the building A.C. distribution board in the ground floor shall not exceed 2.0%.

8.6 Cabling shall be carried out as per IE Rules.

8.7 Cable Ends: All connections are to be made through suitable cable/lug/terminals;crimped properly & with use of Cable Glands.

8.8 Cable Marking: All cable/wires are to be marked in proper manner by good qualityferule or by other means so that the cable can be easily identified.

8.9 All cable schedules with cable sizes /layout drawings and design aspect of the cablesizes have to be got approved from the KRCSS prior to installation.

8.10 All cable tests and measurement methods should confirm to IEC 60189.

8.11 Multi Strand, annealed high conductivity copper conductor PVC type 'A' pressureextruded insulation.

8.12 Overall PVC insulation for UV protection and confirm to IEC 69947.

8.13 Armoured cable shall be used for underground cable laying

9.0 EARTHING PROTECTION

9.1. A minimum of two separate dedicated and interconnected earth electrodes must beused for equipment earthing both on DC side and AC side.

9.2. An additional dedicated earth electrode shall be provided to Surge Protection Device.

9.3. Earthing shall be done in accordance IS 3043-1987, provided that earthing conductors shall have a minimum size of 6.0 sq.mm copper wire or 10 sq.mm aluminum wire or 6mmx25 mm hot dip galvanized iron flat. Unprotect aluminum or copper-clad aluminum conductors shall not be used for final underground connections to earth electrodes.

9.4. The earth electrodes shall have a pre-cast concrete enclosure with a removal lid for inspection and maintenance. The entire earthing system shall comprise non-corrosive components.

10.0 GRID INVERTER

10.1 Inverter/PCU shall be non- Transformer string inverters, grid tied in nature, shall consist of MPPT controller. Inverters shall be decided based on array design/suitable rating in case of string design, associated control and protection devices etc. all integrated into PCU. It shall provide necessary protections for Grid Synchronization. The Inverters should convert DC power produced by SPVmodules in to AC power and must synchronizeautomatically its AC output to the exact AC Voltage and frequency of Grid.

10.2 The DC energy produced has to be utilized to maximum and supplied to the bus for inverting to AC voltage to extract maximum energy from solar

array and provides 3-ph, 400V AC/ (+10% to — 10%), 50+/ -1.5 Hz with total harmonic voltage distortion less than 3% to synchronize with local grid.

10.3 The Inverters shall be of very high quality having efficiency not less than 97% and shallbe capable of running in integrated mode.

10.4 Degree of protection of the indoor Inverters shall be at least IP-42 and that of outdoorat least IP-65.

10.5 Built in with data logging to remotely monitor plant performance through external PC shall be provided.

10.6 The Inverters should be designed to be completely compatible with the SPV array voltage and Grid supply voltage.

10.7 The dimension, weight, foundation details etc. of the PCU shall be clearly indicated in the detailed technical offer.

10.8 The PCU shall be capable of complete automatic operation, including wake-up, synchronization & shut down independently& automatically.

10.9 Both AC & DC lines shall have suitable fuses & surge arrestors and Bidder to allowsafe start up and shut down of the system. Fuses used in the DC circuit should be DC rated.

10.10 Inverters/PCU shall operate in sleeping mode when there will no power connected.

10.11 The inverter should be capable of injecting the reactive power to the grid in case of requirement.

10.12 PCU shall be capable to synchronize independently & automatically with grid power line to attain synchronization and export power generated by solar plant to grid.

10.13 The PCU shall be capable of operating in parallel with the grid utility service and shall be capable of interrupting during faults.

10.14 The PCU shall be able to withstand an unbalanced load conforming to IEC standard (+/-5% voltage) and relevant Indian electricity condition. The PCU shall include appropriate self- protective and self-diagnostic features to protect itself and the PV array from damage in the event of PCU component failure or from parameters — beyond the PCU's safe operating range due to internal or external causes. The self- protective features shall not allow signals from the PCU front panel to cause the PCUto be operated in a manner which may be unsafe or damaging. Faults due to malfunctioning within the PCU, including commutation feature, shall be cleared by the PCU protective devices and not by the existing site utility grid service circuit breaker.

10.15 The Inverter shall go to shutdown/standby/sleep mode, with its contacts open, under the following conditions before attempting an automatic restart after an appropriatetime delay.

a) When the power available from the PV array is insufficient to supply the lossesof the PCU, the inverter shall go to standby/shutdown/sleep mode.

b) The PCU control shall prevent excessive cycling of shut down duringinsufficient solar radiance.

10.16 Operation outside the limits of power quality as described in the technical data sheet should cause the power conditioner/inverter to disconnect the grid. Additional parameters requiring automatic disconnection are

a) Over current
b) Earth fault
c) In each of the above cases, tripping time should be less than a few seconds.

11.0 BILL OF MATERIAL

Sl. No	Item	Quantity
1	Polycrystalline Solar PV Modules (16 panels of 320Wp with tolerance of rated power is +2.5Wp)	5,120Wp
2	5kVA Grid tied inverter	1 No
3	Module mounting structure	Lot
4	MCB Enclosure & Array junction box	1 No
5	AC Synchronizing panel	1 No
6	Solar DC/AC copper cable, cable trays, connectorsand all miscellaneous materials required for stringing& synchronizing	LS
7	3 Earth pits for AC/DC/Lightning arrestor andinterconnecting strips	Lot
8	Lightning arrestor	1 No
9	Remote monitoring system	1 No

CHAPTER-16

CCTV SURVEILANCE SYSTEM

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1.0 IP THERMAL CAMERA WITH INTEGRATED FIXED ENCLOSURE

a) The fixed thermal IP and analog system shall provide an integrated thermal imaging device in an environmental enclosure.

b) The fixed thermal IP and analog system shall provide a native digital image from the image sensor to the IP video stream.

c) The fixed thermal IP and analog system shall consist of an uncooled, sun-safe amorphous silicon micro bolometer, long-wavelength infrared (LWIR) camera capable of 384 x 288 and 240 x 184 resolution formats.

d) The fixed thermal IP and analog system shall provide a temporal Noise EquivalentTemperature Difference (NETD) below 50mK at f/1.0. It shall be capable of the multiple display formats including white hot, black hot, and rainbow.

e) The fixed thermal IP and analog system shall be conformant to the ONVIF v1.02 and support open architecture best practices with a published API available to third-party network video recording and management systems.

f) The fixed thermal IP and analog system shall offer input voltage of 24 VAC and 24VDC.

g) The fixed thermal IP and analog system shall provide a built-in heater/defroster and sun shroud. It shall meet NEMA Type 4X and IP66 standards.

h) Thermal Camera Optics

Detector	Sun-safe, uncooled micro bolometer, amorphous silicon
Array Format	384 x 288 or 240 x 184

Pixel Size	384 x 288 240 x 184 25 µm
Effective Resolution	110, 592 (384 x 288) 19, 200 (240 x 184)
Spectral Response	7.5 to 13.5 µm, LWIR
Normalizati onSource Video	Internal shutter (offset only), 0.3 second video freezeduring shutter wink
Temporal NETD	50mK at f/1.0
Display Formats	White hot, black hot, and rainbow
Video Output	NTSC/PAL, IP

a) The fixed thermal IP and analog system shall support two simultaneous, configurable video streams. MJPEG, JPEG and H.264 compression formats shall be available for primary and secondary streams with selectable Unicast and Multicast protocols. The streams shall be configurable in a variety of frame rates, bit rates, and group of pictures (GOP) structures.

b) The fixed thermal IP and analog system shall use a standard Web browser interface for remote administration and configuration of camera parameters.

c) The fixed thermal IP and analog system shall provide a 100Base-TX network portfor live streaming F to a standard Web browser.

d) The fixed thermal IP and analog system shall support standard IT protocols.

e) The fixed thermal IP system shall provide integrated video analytics with theability to provide hardware and software alarms based on the analytic behaviors. Analytics shall include:

i) **Adaptive Motion:** Detects and tracks objects that enter a scene and then triggers an alarm when the objects enter a user-defined zone. This behavior is primarily used in outdoor environments with light traffic to reduce the number of false alarms caused by environmental changes.

ii) **Camera Sabotage:** Detects contrast changes in the field of view. An alarm is triggered if the lens is obstructed with spray paint, a cloth, or a lens cap. Any unauthorized repositioning of the camera also triggers an alarm.

iii) **Loitering Detection:** Identifies when people or vehicles remain in a defined zone longer than the user-defined time allows. This behavior is effective in real-time notification of suspicious behavior around ATMs, stairwells, and school grounds.

iv) **Object Counting:** Counts the number of objects that enter a defined zone or cross a tripwire. This behavior might be used to count the number of people at a store entrance/exit or inside a store where the traffic is light. This behavior is based on tracking and does not count people in a crowded setting.

v) **Stopped Vehicle:** Detects vehicles stopped near a sensitive area longer thanthe user-defined time allows. This behavior is ideal for airport curbside drop- offs, parking enforcement, suspicious parking, traffic lane breakdowns, and vehicles waiting at gates.

f) The fixed thermal IP and analog system shall meet or exceed the followingspecifications:

i) **Video Specifications**

Video Encoding	H.264 High, Main, or Base profiles; MJPEG, and JPEG
Video Streams	Up to 2 simultaneous streams; the second stream is variablebased on the setup of the primary stream

Frame Rate	Up to 30, 25, 24, 15, 12.5, 12, 10, 8, 7.5, 6, 5, 4,3, 2.5, 2, 1 (dependent upon stream configuration)
Available Resolutions	384 x 288 and 240 x 1084
Supported Protocols	TCP/IP, UDP/IP (Unicast, Multicast IGMP), UPnP, DNS, DHCP, RTP, RTSP, NTP, IPv4, IPv6, SNMP, QoS, HTTP, HTTPS, LDAP (client), SSH, SSL, SMTP, FTP, and
Users	
Unicast	Up to 20 simultaneous users depending on resolution settings (2guaranteed streams)
Multicast	Unlimited users H.264
Security Access	Password protected
Software Interface	Web browser view and setup
Open API	API or ONVIF v1.02

ii) **Electrical Specifications**

Port	RJ-45 connector for 100Base-TX, auto MDI/MDI-X
Cabling Type	Cat5 or better for 100Base-TX
Input Power	24 VAC or 24 VDC
Input Power Range	+15%, –20%
Power Consumption	
24VAC	1.51 A, 39.90 VA (35 W)
24VDC	1.26 A, 86.10 VA (85 W) 3.21 A (85 W)

Current Consumption	<750 mA nominal; <1.2 A maximum
Local Storage	Micro SD
Alarm Input	N.O. switch, N.C. switch, or 1 kΩ; supervised
Alarm Output	0 to 32 VDC maximum, 100 mA maximum
Audio	Bidirectional, half duplex; line level/external microphone input; 600ohm differential, 1 Vp-p maximum signal level
Compression	G.711 PCM, 64 kbps

i) **Physical Specifications**

Construction	Aluminum
Finish	Gray polyester powder coating
Environment	Indoor/outdoor
Operating Temperature	–40° to 50°C (–40° to 122°F)
Latching	2 captive Torx™ screws
Cable Entry	2 adjustable 0.5-inch NPT liquid-tight glands

ii) **Lens Specifications**

384 x 288	Lens (mm)	F-Number	FOV (H/V/D)
	14.25	1.2	39° x 29° x 48°

iii) **Certifications/ Ratings / Patents**

1) CE, Class A
2) FCC, Class A

3) UL Listed
4) C-Tick
5) Meets NEMA Type 4 and IP66 standards
6) Shock and Vibration, Meets NEMA TS 2; IEC613736-8,-9,-10
7) ONVIF

2.0 TECHNICAL DETAIL FOR PTZ DOME CAMERA

SL. No	Specification	Paramet er
20X, 2Mpx High speed PTZ Dome Camera		
1	Image sensor	1/3-inch CMOS Sensor
2	Resolution	1920 X 1080
SL. No	Specification	Parameter
3	Dynamic Range	60dB
4	White balance Range	2,500° to 8,000°K
5	Signal to Noise Ratio	50dB
6	Electronic Shutter Range	1 ~ 1/8,000 sec
7	Minimum Illumination	Color (200 ms) 0.08 lux ; Mono (200 ms) 0.015 lux
8	Lens	4.3 mm (wide) ~ 86.0 mm (tele)
9	Optical Zoom	20X
10	Digital Zoom	12X
11	Horizontal Angle of View	55.4° (wide) ~ 2.9° (tele)
12	Iris Control	Auto iris
13	Active Noise Filtering	Yes
14	Presets	128 preset
15	Tours	16
16	Preset Accuracy	Pan ±0.1°; Tilt ±0.05°
17	Auto flip feature	Yes
18	Audio	Embedded with stream 1 and stream 2 G.711 A-law/G.711 U-law

19	Supported Protocols	TCP/IP, UDP/IP (Unicast, Multicast IGMP), UPnP, DNS, DHCP, RTP, RTSP, NTP, IPv4, IPv6, SNMP v2c/v3, QoS, HTTP, HTTPS, LDAP (client), SSH, SSL, SMTP, FTP, and 802.1x (EAP), GB28181
20	Local Storage	Up to 32GB onboard Micro SD, SDHC Compatible
21	Analytics	Motion Detection and Camera Sabotage
22	Pan Movement	360° continuous pan rotation
23	Tilt Movement	+1° to –90°
Sl. No	**Specification**	**Parameter**
24	Preset Speed	Pan 430°/sec; Tilt 200°/sec
25	Variable Manual Speed	Pan 0.1°/sec to 100°/secTilt 0.1°/sec to 50°/sec
26	Ports	RJ-45 connector for 100Base-TX; AutoMDI/MDI-X; Auto negotiate/manual setting
27	Alarms	4 X inputs and 1 X output
28	Input Power	24 VAC; 50 VA
29	Operating Temperature	-40 to 50deg C
30	Operating Humidity	20% to 80% (non condensing)
31	Housing	Aluminum Housing with PolycarbonateBubble
32	Environmental Protection	Ingress for Water & Dust - IP66 orhigher
33	Vandal Proof Certification	IK10 or higher

34	ONVIF Compliant	ONVIF Profile S and Profile Gconformant
35	Certificates	• CE, Class A • FCC, Class A • UL/ cUL Listed • C-Tick • NEMA TS-2 (Temp.) para 2.2.7.3 -2.2.7.7 • KCC* • ONVIF Profile S and Profile GConformant† • Meets Type 4X enclosure and IP66standards when installed properly

Note : The Camera should be connected to the DCU which in turn will be connected tothe SCADA system.

CHAPTE-E17
SUB-STATION & CONTROL ROOMLIGHTING

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PART-A SUB-STATION & CONTROL ROOM LIGHTING

PART-B LED FIXTURE

TECHNICAL SPECIFICATION FOR SUB-STATION & CONTROL ROOM LIGHTING

1.0 GENERAL

The scope comprises design, engineering,supply, installation, testing andcon

a) Complete installation and lighting fixtures complete with lamps, supports andaccessories for indoor and outdoor. Switchyard GI octagonal poles etc.

b) Ceiling fans complete with electronic regulators, accessories.

c) Lighting panels and lighting poles complete with distribution boxes.

d) Galvanized rigid steel conduits and fittings, lighting PVC Cables GI Earth wire receptacles, switchboards, switches, junction boxes, pull out boxes complete with accessories.

e) Any other items required to complete the indoor and outdoor lighting in complete shape.

The details of area to be illuminated are given below along with the required lux levels.

Areas to be lit and required lux levels

Area	Lux
Control Room	350
Battery Room	100
Entrance lobby	150
Corridor and landing	150
Switchyard - Main equipment	50
Switchyard - general equipment and balance	30

Street/Road	30

Contractor shall submit detailed calculation for verifying that the required lux levels willbe attained by the proposed lighting system.

Any material, cables, wire, conduits, fittings, accessories etc. whether mentioned specifically or not but required for installation of lighting fixtures are included in the scope of Contractor.

2.0 SYSTEM DESCRIPTIONNormal lighting - AC

AC lights will be connected to AC lighting panels. All the lights connected to the AC lighting system in different areas will be connected to the main lighting distribution boards to be supplied.

3.0 LIGHTING FIXTURES

Fixture shall conform to latest IS/IEC and its latest amendment.

All fixtures shall be designed for minimum glare. The finish of the fixtures shall be such that no bright spots are produced either by direct light source or by reflection.

All lighting fixtures shall be complete with required lamps such as LED (to be fitted inside switch yard), & LED light (adopt as per Govt. norms for energy efficiency) for indoor lighting.

LED lamp fixtures shall be complete with all necessary wiring and accessories such as ballasts, ignitors, power factor improvement capacitors etc. if required. These shall be mounted in the fitting assembly only. The Contractor shall indicate starting time of these lamps to attain full light output. Curves for starting

characteristics with varying supply voltage etc. are to be furnished by the Contractor.

Flood lighting shall have suitable base plate/frame for mounting on structural steel member.

Each fixture (other than bulk head fixtures) shall have terminal blocks suitable for 2.5 mm² stranded flexible copper conductor. The internal wiring should be completed by the manufacturer and terminated on the above terminal blocks. The Contractor shall specifically furnish details of internal size of wires and type of insulation. The terminal blocks shall be as specified under General Equipment and Substation Accessories (GESA) section of this Specification.

Each lighting fixture shall be provided with an Earthing terminal suitable for connection to 16 SWG GI Earthing conductors. All metal or metal enclosed parts of the housing shall be suitably constructed so as to ensure satisfactory Earthing continuity throughout the fixture up to the Earthing terminal. The mounting facility and conduit knock-outs for the fixtures shall be provided and shall be suitable for 20mm conduit entry. On completion of manufacture, all surfaces of the fixtures shall be thoroughly cleaned and degreased. The fixtures shall be free from scale, rust, sharp edges and burrs.
The housing shall be stove-enamelled or vitreous enamelled or anodised aluminium as indicated in the specification of the relevant fixture.

All enamel finishing shall have a minimum thickness of 2 mils for outside surface and
1.5 mils for inside surface. The finish shall be non-porous and free from blemishes, blisters and fading.

The surface shall be scratch resistant and shall show no sign of cracking or flakingwhen bent through 90 degrees. over 1.5 inch

die mandrel.

All light reflecting surfaces shall have optimum light reflecting coefficient so as toensure the overall light output as specified.

The different types of lighting fixtures to be provided shall be to the approval of theOPTCL.

REMARKS: ALL THE LAMPS TO BE USED INSIDE & OUTSIDE THE SUB-STATION AREA SHALL BE OF "LED" ONLY. BIDDERS ARE ADVISED TO QUOTE ACCORDIN

4.0 ACCESSORIES

4.1 Reflectors

The reflectors shall be manufactured from sheet steel or aluminium more applicable of not less than 22 SWG thicknesses. They shall be securely fixed and of captive type.

4.2 Lamp holders

Lamp holders shall preferably be for LED lamps etc. Holders shall be designed and manufactured in accordance with relevant standard to give long and satisfactory service.

4.3 Lamps

The LED lamps to be supplied shall conform to IS 9974. LED lamps shall be suitable for use in any position. Restrictions, if any, shall be clearly stated. The lamps shall be capable of withstanding small vibrations with out breakage of connections at lead-in wires and filament electrodes.

The constructional features of LED lamps for special applications shall be clearly brought out in the bid.

Type test reports from NABL of required LED fixtures to be submitted along with the offer.

5.0 RECEPTACLES

All receptacles shall be of cast steel or aluminium, heavy duty type, suitable for fixing on wall or column and complete with

individual switch.

In general the receptacles to be installed are of the following types:

a) 15A, 240V, 2 pole, 3 pin type with third pin grounded, metal clad with gasket having cable gland entry suitable for 2 core 16 mm² PVC armoured cable and a metallic cover fixed to it with a metallic chain. Receptacles shall be suitable for installation in moist location and/or outdoor. The switch shall be of rotary type. Receptacles shall be housed in an enclosure made out of 2mm thick GI sheet with hinged doors with padlocking arrangements. Door shall be lined with good quality gaskets. This shall conform to IP 55.

b) 5A and 15A, 240V, 3 pin type with third pin grounded, suitable for flush mounting. The switch shall be of piano key type and shall be flush mounted.

63A, 415V, 3 phase, 4 pin interlocked plug and switch with earthing contacts. Other requirements shall be same as type RO. The receptacle shall be suitablefor 3½ core 35mm² / 3½ core 70mm² aluminium conductor cable entry and shall also be suitable for loop-in-loop-out connection of cables of identical size. Receptacle shall be suitable for outdoor application. Receptacles shall be housed in a box made out of 2mm thick GI sheet, with hinged door with padlocking arrangement. Door shall be lined with good quality gaskets. This shallconform to IP 55.

6.0 LIGHTING POLES

The Contractor shall supply, the following types of hot dip galvanised GI Octagonal lighting poles for one fixture.

Lighting poles shall be complete with fixing brackets and junction boxes. Junction boxes should be mounted above ground level at 1 mtr height from the ground.

The lighting poles shall be steel hot dip galvanized.

The galvanised sheet steel junction box for lighting poles shall be completely weather proof conforming to IP 55 and provided with a lockable door and HRC fuse mountedon a fuse carrier and fuse base assembly. The terminals shall be stud type andsuitable for two nos.16mm^2 cables. Necessary arrangement for cable glands along with supply of double compression glands are included in Contractor's scope.

Wiring from junction box at the bottom of the pole (minimum height from the bottom of the pole shall be 1.0mtrs) to the fixture at the top of the pole shall be 2.5 mm^2 wire.

7.0 LIGHTING WIRES & CABLES

The wiring used for lighting shall be of 1100V grade, PVC insulated cable of standard products of reputed manufacturers.

The conductor sizes for wires used for point wiring beyond lighting panels shall be single core 4mm², 6mm² and 10mm² stranded aluminium wires and 2.5mm² stranded copper wire.

The wires used for connection of a lighting fixture from area rest junction box or for loop-in loop-out connection between two fluorescent fixtures shall be single core copper stranded conductor, 1100V grade flexible PVC insulated cords, unsheathed, conforming to IS 694 with nominal conductor cross sectional areas of 2.5mm^2.

The Contractor's scope covers supply of all wiring, cabling

and accessories.The wires shall be colour coded as

follows:

- Red for R – Phase
- Yellow for Y – Phase
- Blue for B – Phase
- Black for Neutral

- White for DC (Positive)
- Grey for DC (Negative*)*

8.0 TESTS AND TEST REPORTS

Manufacturer's NABL test certificates shall be submitted for the fixtures and accessories. Type test certificates shall be furnished along with the bid.

9.0 LIGHTING SYSTEM INSTALLATION WORKS

9.1 General

In accordance with the specified installation instructions as shown on manufacturer's drawings or as directed by Project Manager. Contractor shall supply, erect, install, test and put into commercial use all the electrical lighting equipment included in the contract. Equipment shall be installed in a neat, workman like manner so that it is level, plumb, square and properly aligned and oriented. Tolerances shall be as established in manufacturer's drawings or as stipulated by Project Manager.

The Contractor shall prepare the lighting layout and erection drawings and obtain the Project Manager's approval before commencing the erection works.

9.2 Flood lights

Contractor shall install flood lights on switchyard structures to be erected inside switchyard. The GI structural are also suitable for protection from lightening by providing spikes cones at all the column peak. Proper design in this respect to be carried out along with numbers of such towers required. Plotting of lightening protection area showing details of equipment installed in switch yard. A platform provided in the mast tower shall be used for fixing of lighting fixtures.

Fixtures shall be mounted on galvanised making use of shop provided holes or by suitable clamps. No cutting or drilling of

galvanised structure is permitted.

The Contractor shall mount the assembled fittings and install necessary cabling.

9.3 Lighting fixtures for flood lights

Flood lights shall be mounted on steel base facing the tentative direction shown on drawings. Fixing holes shall be provided with slot to turn the fixture by approximately 5 degrees on both sides. Bolts shall be finally tightened with spring washer. The Contractor shall supply and install the steel base, channels, angles etc. for fixing the flood light on the flood light towers. Terminal connection to the flood light shall be through flexible conduits, and these flexible conduits shall be included in the installation rate of fixture itself.

The scope of Contractor shall include the supply of necessary brackets and sundry material, for installation of lighting fixtures.

9.4 Lighting panels

Lighting panels shall be erected at the locations to be indicated in the approved drawings.

Necessary foundations and/or supporting structures for all outdoor type lighting panels and necessary supporting structures for indoor lighting panels shall be provided by the Contractor.

10.0 FOUNDATION AND CIVIL WORKS

All foundations civil works shall be included in the Contractor's scope of work. Civil works shall be in accordance with the relevant part of this specification.

11.0 GROUNDING

All lighting panels, junction boxes, fixtures, conduits etc. shall be grounded in compliance with the provision of I.E. Rules.

Ground connections shall be made from nearest available station

ground grid. Allconnections to ground grid shall be done by arc welding.

Lighting panels shall be directly connected to ground grid by two 50 x 6mm GI flats.

A continuous ground conductor of 16 SWG GI wire shall be connected to each panel ground bus. All junction boxes, lighting fixtures shall be connected to this 16 SWG ground conductor.

All lighting poles shall be earthed as per standard. 16 SWG GI wire shall be taken upto junction box from the lighting fixture.

12.0 TESTING AND COMMISSIONING

On completion of erection work, the Contractor shall request OPTCL to undertake the inspection as required by this Specification.

The OPTCL shall arrange for joint inspection of the installation for completeness and correctness of the work. Any defect pointed out during such inspection shall be promptly rectified by the Contractor.

The installation shall be tested and commissioned in the presence of the Contractor and OPTCL.

The Contractor shall provide all men, material and equipment required to carry out the tests.

All rectification, repairs or adjustment work found necessary during inspection, testing and commissioning shall be carried out by the Contractor, without any extra cost tothe Employer.

The Contractor shall measure and furnish to the Project Manager, the actual lux levelin all the areas of the substation to prove compliance to this specification.

**** Armoured PVC cables are to be used for the switch yard lighting and any other out door lighting system.**

**** For indoor lighting ,each fixture shall be controlled by one switch.**

**** Minimum two nos 5Amp multi purpose power sockets with switch are to be provided in each switch.**

***** Contractor to furnish the design details for the locations (like Switch yard area, Control room building area, Gate etc), which can be adopted after approval from OPTCL. Design to be carried out as per the LUX level indicated at the beginning of this chapter.**

TECHNICAL SPECIFICATION FOR LED FLOOD

1.0 GENERAL DESCRIPTION

LED Flood Light luminaries of 240V, AC, 50 Hz , suitably decided the wattage of the lamp (to be decided after detail Engineering) in Single piece High Pressure Die Cast Aluminium alloy Housing having high conductivity acting as heat sink, with Powder coating with suitable colour with distortion free, clear, Heat Resistant Toughened UV stabilized Glass in the front fixed to the die cast Aluminium frame which shall be fixed to the housing with high quality long lasting Neoprine Rubber gasket duly impregnated with insecticide and water repellant chemical on the periphery of lamp compartment by means of stainless steel screws to render it dust proof, water proof and vermin proof and having minimum IP-65 Protection conforming to IS:10322 (part-2) — 1982.

Note:The capacity LED Luminary is to be suitably decided after conducting the detail Engineering for the locations, where these Luminaries are to be used. The Locations are generally in EHV grade Sub-station switch yard area, Control Room Building etc. Details design for adoption of LED Luminary system to be furnished for review of

design and its acceptance. Latest practice of adoption of these system are to be strictly followed.

2.0 TRAINING

Train the staff on Hardware/Software, installation, commissioning and maintenance of the Luminaries at different locations (Different Sub-stations).

3.0 TECHNICAL SPECIFICATIONS

The LED Luminaries are as per the following parameters

1	LED Lumens for 20 watt	2000 Lumens
2	LED Lumens for 120 watt	12000 Lumens
3	Life span as per LM70 (@70%) light output	>50000 Hrs. or Better
4	Lux at centre at height of 4.5 meter	>150 LUX or Better
5	Uniformity Ratio (Emin./Emax.) (mounted at 4.5m height @90º Angle)	>0.35 or Better
6	Luminary Efficacy	>100 lumens/watt
7	Control of Distribution	Fully Cut off
8	Driver current (With Constant Current Driver)	<100mA/LED or Better
9	**Electronic** Efficiency @ 230V	**>85%or Better**
10	Beam angle of the Luminary	> 120° or Better
11	Color Temperature of LEDs	6500K to 7500K or Better
12	P/N junction temperature (High thermal conduction must be achieved by silicon heatconducting greases as adhesive	<85 ºC or Better
13	Luminary Body Temperature	The Body Temperature shall be <(Ambient+35º C) even after continuous

		burning of Luminary for 24 Hrs.or Better
14	Color Rendering Index(CRI)	>70 or Better
15	Weight	Preferably less weight & may be of Maximum up to 4 Kgs (comfortably can be carried and fixed)
B	ELECTRICAL	
1	AC Input Voltage Range	100V TO 270V AC
2	AC Input frequency (The LED circuitry shall function at an operating frequency that must be greater than 120 Hz to prevent perceptible flicker to the unaided eye over the entire voltage range specified above.)	47 ~ 53Hz
3	Power Factor (Source PowernFactor varies from 0.5 Lag to 0.5 Lead)	> 0.95 or Better
4	Luminary Wattage variance at 100 V to 270 V	± 10%
5	Luminary Lux Levels Variance at 100 V to 270 V	± 5%
6	Total Harmonic Distortion(THD)	< 15% or Better
7	Electrical Connection System	3 wire system (Phase, Neutral & Gnd)
8	System of earthing (The luminaries offered shall conform to Level-1 classification)	Solidly grounded
9	There shall be electrical isolation between input and output circuitsof the driver.	
C	**MECHANICAL**	

1	Construction of Casing	High Pressure Die Cast Aluminum. Should be durablefor extreme climatic conditions.
2	Finish	Powder Coating and gray/black color and should be durable.The colour should not fade in extreme climateconditions.
3	Heat Sink type (It shall be designed insuch a way that the heat generated within the LED source is efficiently dissipated to the surrounding atmosphere without abnormal rise in temperature. Any debris build up shall not degrade heat dissipation performance of the luminaries.	Aluminium Metal Core PCB
4	Lamp Cover	Toughened Glass or any suitable material which can be used in the extreme climate and should be durable.
5	Gross Weight and Dimensions (LxW xT) mm of Luminaries (Efforts shall be made to keep the overall outer dimensions as minimum as possible with out compromising on the performance,mainly thermal management of the luminary)	
6	Heat Dissipating Area (Luminary Rating wise)	
7	IP Level –Minimum IP 65	

4.0 DETAILED TECHNICAL SPECIFICATION

I. Electrical Characteristics of LED 23 Watt:

PARAMETER	DRIVER RESULT
Input Voltage	160 -300 V AC
Rated Power	23Watt
Maximum Power	23Watt

Efficiency	>100%
Power Factor	>0.9
Voltage Harmonics (THD)	<5%
Current Harmonics (THD)	<10%

II. Operating Conditions:

Operating Frequency	100kHz to 200KHz
Operating Temperature Range	0°C to +70°C
Storage Temperature Range	0°C to 125°C
Humidity	95% RH

III. LED Details:

Led Make	Osram/Cree/Philips Luminied/GE
No Of LED's	12
Led Viewing Angle	120º by using reflector
Colour Temperature	Cool White (5500K to 6500K)
Luminous Flux	>2300 Lumens
Life Span	> 50,000 Hours
Colour Rendering Index	>70 Ra

IV. LED Luminary Details:

Body	Alluminium Body
Heat Sink	Optimized thermal design to ensure maximum life to LED. The Heat sink grade aluminium has the highest surfacearea for efficient heat diffusion and the entire

	luminary with Aluminium acts as heat sink.
Dust and Water protection	IP 65 Standards

V. Protection Parameters:

Over-Current Protection	Inbuilt
Short-Circuit Protection	Inbuilt
Over-Voltage Protection	Inbuilt
Over-Temperature Protection	135 °C
Dust and Water Protection	IP 65
Lightning Protection	Inbuilt

5.0 120W LED FLOOD LIGHT

5.1 Features

a) Optical
- Optical pattern meets all standard of Light Standards.
- Uniform illuminance distribution.

b) Power
- Switched mode constant current power supply.
- Over-heat, Over-voltage, Over-current protections are provided.
- Lightning Protection provided.

c) Thermal
- Luminaries surface temperature is 48°C @ Ta=30°C, the temperaturevariation is controlled under 5°C.
- Junction temperature is controlled at 70°C @ Ta=30.
- Overheat protection will operate to adjust as the LED module surfacereaches 80°C.

d) Luminaire
- Optimized thermal design to ensure maximum life to LED. The Heat sink grade aluminium has the highest

surface area for efficient heat diffusion and the entire luminary with Aluminium acts as heat sink.

- Dust and water protection design meeting IP65 standards.
- Super-high luminaire efficacy.

5.2 DETAILED TECHNICAL SPECIFICATION

I. Electrical Characteristics

PARAMETER	PROMPT DRIVER RESULT
Input Voltage	160 -300V AC
Rated Power	120W
Maximum Power	140W
Efficiency	>85%
Power Factor	>0.9
Voltage Harmonics (THD)	<5%
Current Harmonics (THD)	<10%

II. Operating Conditions

Operating Frequency	100kHz to 200KHz
Operating Temperature Range	0°C to +70°C
Storage Temperature Range	0°C to 125°C
Humidity	95% RH

III. LED Details

Led Make	As per approved vendor
No of LED's	48-70
Led Viewing Angle	120º by using reflector
Colour Temperature	Cool White (5500K to 6500K)
Luminous Flux	>12000 Lumens
Life Span	> 50,000 Hours
Colour Rendering Index	>70 Ra

IV. LED Luminary Details:

Body	Aluminium Die casting Body
Heat Sink	Optimized thermal design to ensure maximum life toLED. The Heat sink grade aluminium has the highest surface area for efficient heat diffusion and the entire luminary with Aluminium acts as heat sink.
Protection	IP 65 Standards for Dust and Water

V. Protection Parameters:

Over-Current Protection	Inbuilt
Short-Circuit Protection	Inbuilt
Over-Voltage Protection	Inbuilt
Over-Temperature Protection	135 °C

Dust and Water Protection	IP 65
Lightning Protection	Inbuilt

NOTE:

The contractor has to design the requirement as per the lux level indicated above & the said quantity if exceeding the minimum recommended quantity the contractor has to supply the quantity as required as per the design and should not be less than the minimum recommended quantity. Minimum Nos of fittings recommended are as below:

Outside Control Room:

1) 120W LED – 9nos. /Substation

Inside Control Room:

1) 20W LED – 36 sets

CHAPTER-E18

SUBSTATION EARTHING SYSTEM

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SUB-STATION EARTHING

1.0 EARTHING

Earth mat design to be carried out referring to the IEEE-Std 80 before implementation of the same. Design shall be based on the soil resistivity. The measurement of the soil resistivity is to be taken before the representative of Owner by using a latest 4-port Digital Earth Tester duly calibrated having validity period. The design of Earth mat to be furnished by the Contractor for approval of the Owner.

The material offered shall be procured from short listed vendor at **E-27** and shall have been successfully Type Tested during last five years on the date of bid opening. The Type Test reports shall be submitted along with the bid.

2.0 GUIDE LINE

Soil Resistivity test of the Substation location to be carried out and the values to be used for earth mat Design /sizing Calculation. Touch and step potential voltages to be kept below the specified value in satandard IEEE-80. Equipotential bonding and earthihing for sofecticated electronic quipments to be dond following IEEE-80 standard.

The Earth mat conductor shall be of 75x10 mm GI flats and it shall be laid in both the directions in the Switchyard and the gap between each conductor shall not be more than 2(two) Mtr. However, this gap may be further reduced depending on the design.

Earth risers should be of 50x6 mm GI flats. All equipment & metal parts of the Sub-station should be connected with main earth grid by using 50x6 GI flats at two different places. The main earth grid should be laid not less than 600 mm below the finished ground level. The lap welding should not less than 150 mm. The welding of joints should be done after removal of Zinc by using Blow lamps. Welding should be done in all four sides and should be double layer continuous. Before taking up the second layer welding the deposited flux should be removed. During welding the two flats should be tightened properly by using 'C 'clamps. Immediately after welding two layers of anti-corrosive paints should be painted over the welded portion along with two coats of Black bituminous paints. Before back filling of earth trenches the welded portion should be covered by wrapping with bituminous tape properly and also jointing portion should be covered with PCC (1:3:6) mix. The backfilling of earth pits and trenches should be done with powered loam soil mixed with Bentonite powder (10:1) mix.

All equipment, steel structures etc. should be connected with main earth mat at two points and with separate risers from the main earth mat. All equipment, structures, spikes (if any) should be connected individually with individual Pipe electrodes and again should be connected with main earth grid at two separate places. The Neutral of Power Transformer should be connected with two separate Pipe electrodes and again connected with main earth electrodes at two separate places. The separation distance between each Pipe electrodes should not be less than 3 mts. The back filling of Pipe electrodes should be done in layer of Charcoal, loam soil mixed with Bentonite powder. The value of earth resistance should be less than 0.5 ohm with above arrangement. Where there is possibility of not achieving the earth resistance value, special type of earthing device (chemically treated) can also be used to achieve the desired value.

There should be a closely spaced earth grid of size 1.5 mts x 1.5mts by using 75 mm x 10mm GI flat near the transformers. In Sub-station the diameter of Pipe electrode should not be less than 100 mm dia (NB), heavy gauge GI Pipe (perforated). The Flange (50x6) mm GI flat should be welded in all sides with Pipe electrode. In each face of Flange there should be two nos. of 17.5 mm hole to accommodate 16 mm GI Bolt & nut with spring washer.

Provision of watering to earth pits (Water hydrant) shall have to be provided by using conduit pipe arrangement. The pipes are be connected to the water source provided in the S/s. Each earth pits having pipe electrodes should be provided 250 mm Brick wall chambers duly plastered on all the side with Cast Iron cover Slab. The size of the chamber shall be 450x450x600mm.

3.0 G.I. Flat (75x 10 mm) & G.I.Flat (50 x 6 mm)

The specification covers supply and testing of Galvanized Steel flat for Earthing arrangements.

SL. NO.	TECHNICAL PARTICULARS	DESIRED VALUE
1	Relevant Standard	IS: 2062, IS: 2633, IS: 2629, TPCO-OTH-010.
2	Grade of Steel	E 250 A (As per IS: 2062)
3	Minimum Tensile Strength	410 N/mm^2
4	Yield Stress	250 N/mm^2
5	Percentage Elongation (Min.) at Gauge Length	23%
6	Bend Test (Internal Dia)	Min-2t
7	Mass of Zinc Coating	705 gm/m^2 (TPCODL Standard)
8	Zinc Coating Thickness	100 microns (TPCODL Standard)
9	Engraved Marking (Punching before galvanisation)	TPCODL, Manufacture's name or trademark, Year of Manufacturing.

3.1 APPLICABLE STANDARDS

Materials shall conform to the latest applicable Indian standards / International standards.

Sl. No.	Standard No.	Title
1	IS:2062 Grade 'A' Quality	Specification for M.S. Channel and M.S. Flat
2	IS:2062	Chemical and Physical Composition of material
3	IS:1852	Rolling and Cutting Tolerances for Hot Rolled Steel products
4	IS 2633	Methods for testing uniformity of coating of zinc coated articles
5	IS 4759	Hot-dip zinc coatings on structural steel and other allied products
6	IS 6745	Method for determination of mass of zinc coating on zinc coated iron and steel articles

3.2 INSPECTION AND TEST CERTIFICATE

The Inspection shall be made as per GCC of Volume-I and Chapter E2 of Volume – II of Tender

Specification.

The routine & acceptance tests shall be in accordance with the latest version of the relevant Indian Standard.

All conductors buried in earth or in concrete or above the ground level shall be galvanized steel. Galvanized steel shall be subject to four one minute dips in copper sulphate solution as per IS:2633/1922).

The materials to be supplied will be subject to inspection and approval by the Owner's representatives before dispatch unless otherwise waived. Inspection before dispatch shall not, however, relieve the Contractor of his responsibility to supply the steel section strictly in accordance with the ISS.

The representative of Owner shall pick up samples at random from the GI Flats offered for carrying out Routine tests as per specified IS. The representative shall make visual inspection on each & every GI flats. **The Owner reserves the right to reject the material if the same is found defective at destination**.

3.3 METHOD OF GALVANISING

Sl. No.	Tests	For GI Flat
1	Dip test	6 dips of 1 min each
2	Mass of Zinc coating	705 gm/sqm, 100 microns

Pre dispatch inspection shall be performed to witness following tests:

i) Freedom from defects,
ii) Verification of dimensions
iii) Galvanization tests
iv) Mechanical tests
v) Chemical composition tests

These tests are to be performed and certified at Govt. recognized laboratory.
MS flat shall conform to IS 2062 & its latest amendments for steel & Galvanization as per IS 4759 & its Latest amendments.
The flat shall be coated with Zn98 Zinc grade.
The minimum Zinc coating shall be 610 gm/sqm for thickness more than 5 mm and 460 gm/sqm for item thickness less than 5 mm.

3.4 Earth Electrode (100 mm Dia. GI having gauge perforated pipe as per IS)

4.1 Scope

This specification provides for Supply of Earthing Device (**Heavy Duty**) (100x3000 mm), as per enclosed Drawing.

4.2 APPLICABLE STANDARDS

The Earthing Device must be made out of 100 mm (Heavy Gauge- No minus Tolerance is allowed on Wall thickness) Hot Dip G.I. Pipe (as per IS: - 1239,m Part-1, 1990 of reputed Make – (i.e. **SAIL / RINL/JINDAL/TATA)** & 3.0 mtrs length tapered finished smooth at one end for a length of 75 mm & Clamp at the other end.

Staggered drills hole of 12mm Dia. at an interval of 150mm shall be made before galvanization.

The GI Earthing Clamp/ Strip (C -Clamp Type) is to be of 50mm width, 6mm thickness & flange length of 65 mm in each side. This should be suitable for termination of 4 nos. of GI Flat earth electrodes. The Clamp/ Strip & Earthing pipe after fabrication will be hot dip galvanized confirming to IS: 2629/85 with latest amendments. The clamp shall have two holes in both sides suitable for 16 mm GI Bolts & Nuts. There shall be provision of funnel for pouring water through pipes. The height of the funnel shall be such that the watering will be better. Provision of reduced of GI pipe to be converted to the main GI earth pipe & on the top of the funnel is to be provided.

SL. No	TECHNICAL PARTICULAR	DESIRED VALUE
1	Diameter of earthing Pipe	100 mm dia
2	Standard	IS 1239
3	Material	GI Pipe
4	Make	JINDAL /TATA
5	Class	Heavy
6	Outdoor diameter	113.1 mm min. to 115 mm max.
7	Wall thickness	5.4 mm
8	% of Elongation	20
9	Tensile strength	320 N/mm²
10	Length of pipe earthing	3000 mm
11	Dimensions of holes	
12	Centre of hole	150 mm
13	Tolerance on dimensions/weight	+/-5 %

14	Galvanizing shall confirm	IS: 2633, IS: 2629, TPCO-OTH-010.
15	Dimension of clamp	50 x 6 GI flat

TYPE TEST:-

The Bidder shall furnish the type test certificates for the tests as mentioned above as per the corresponding standards. All the tests shall be conducted at **CPRI / ERDA / Other Government Labs** as per relevant IS. Type tests should have been conducted in certified Test laboratories during the period not exceeding 5 years from the date of opening the bid. In the event of any discrepancy in the test reports, i.e. any test report not acceptable, same shall be carried out without any cost implication to TPCODL.

7.1 ACCEPTANCE TESTS

i) Visual Inspection
ii) Verification of Dimensions
iii) Tensile Strength
iv) Bend Test
v) Hot Dip galvanizing
vi) Determination of mass of Znic coating on Znic coated iron and steel

7.2 ROUTINE TESTS

Same as Acceptance Test

7.3 TYPE TESTS

i) Visual Inspection
ii) Verification of Dimensions
iii) Tensile Strength
iv) Bend Test
v) Hot Dip galvanizing
vi) Determination of mass of Znic coating on Znic coated iron and steel

CHAPTER-19

OPTICAL SMOKE AND HEAT DETECTIONSYSTEM

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1.0 ADDRESSABLE MULTI SENSOR (OPTICAL & THERMAL) DETECTOR

The Optical & Thermal (combined) detector shall confirm to the relevant standardshaving the following features

a) The detector shall be UL approved.
b) It shall have smoke sensitivity of 1.9 +/- 0.6 %/ft.
c) The detector should have fixed temperature rating of 57 deg C and rate of rise of 11.1◦C/min.
d) The multi detector shall be loop powered and addressed by DIP switches.
e) All the detectors shall have a visible dual blinking LED to indicate the healthiness/ trouble/ alarm condition of the detector. The LED shall be located in such a way that it shall be visible 360º.
f) It shall possess false alarm immunity and a superior signal to noise ratio.
g) It shall be capable of supporting style 7 wiring.
h) It shall have inbuilt drift compensation facility.
i) In case of a failure, panel shall allow to replace the detector with the same typewithout the need of additional programming.
j) The detector shall change sensitivity settings based on day/night mode or withschedules based on the programming.
k) The detector shall have at least 3 levels of sensitivity settings.

2.0 ADDRESSABLE OPTICALSMOKE DETECTOR

The Optical Detector shall confirm to the relevant standards having the followingfeatures:-

a) Detector shall be UL approved
b) It shall have smoke sensitivity of 1.9 +/- 0.6 %/f
c) The Detector shall be loop powered and addressed by DIP switches
d) All the detectors shall have a visible dual blinking LED to indicate the healthiness/ trouble/ alarm condition of the detector. The LED shall be located in such a way that it shall be visible from the 360º.
e) It shall be capable of supporting style 7 wiring.
f) It shall have inbuilt drift compensation facility.
g) In case of a failure, panel shall allow to replace the detector with the same typewithout the need of additional programming.

h) The detector shall change sensitivity settings based on day/night mode or withschedules based on the programming.
i) The detector shall have at least 3 levels of sensitivity settings.

3.0 ADDRESSABLE HEAT DETECTOR

The Heat Detector shall confirm to the relevant standards having the followingfeatures:-

a) Detector shall be UL approved.

b) The detector should have fixed temperature rating of 57 deg C and rate of rise of 11.1◦C/min.
c) The Detector shall be loop powered and addressed by DIP switches.
d) All the detectors shall have a visible dual blinking LED to indicate the healthiness/ trouble/ alarm condition of the detector. The LED shall be located in such a way that it shall be visible from the 360º.
e) It shall possess False alarm immunity and a superior signal to noise ratio.
f) It shall be capable of supporting style 7 wiring.
g) In case of a failure, panel shall allow to replace the detector with the same type without the need of additional programming.

4.0 STANDARD BASE

a) The base shall be UL Listed
b) The base shall be common for PHOTO, THERMAL AND MULTI SENSOR.
c) Terminals of base shall be rust resistant.
d) The base shall have separated in and out terminals.
e) The base shall have terminals to connect remote indicator

5.0 ADDRESSABLE MODULES

5.1 Control Module (CM)

a) The Control Module shall be UL listed.
b) The CM shall have LED indication to show the status.
c) The CM shall provide a output activating notification devices and operateddevices **as suitable for the sub-station**.
d) It shall have a capability of handling at least 1A & **as suitable for the sub-**

station

to integrate with third party system.

e) The CM shall be capable of powering through the auxiliary source and shall supervise the auxiliary power. The CM shall communicate faults and troubles related to the NACs, power supply to the panel.
f) The CM shall be addressed by means of dip switches.
g) The CM shall be loop powered.

5.2 Monitor Module (MM)

a) Monitor Module shall be UL Listed.
b) The MM shall have LED indication to show the status.
c) The MM shall have supervised monitoring circuit.
d) The MM shall monitor potential free NO contact
e) The MM shall be addressed by means of dip switches.
f) The MM shall be loop powered.

5.3 Relay Module (RM)

a) The Relay Module shall be UL Listed.
b) The RM shall provide two dry potential free contacts for activating a variety ofauxiliary devices and other firefighting / ventilation equipment.
c) The RM shall have contact rating of 2A @30V DC, 0.5 @125 VAC
d) The RM shall be addressed by means of dip switches.
e) The RM shall have LED for status indication.
f) The RM shall be loop powered.

5.4 Isolator Module/ Base

Isolator module/ base shall be part of the loop. These modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC Style 6 (Class A) or Style 4 (Class B branch). The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit on the SLC loop segment or branch. At least one isolator module shall be provided for each floor or protected zoneof the building. If a wire-to-wire short occurs, the isolator module shall automatically open-

circuit (disconnect) the SLC. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section. The isolator module shall not require any address setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.

5.5 Addressable Zone Interface Module (ZIM)

a) The zone Interface module (ZIM) will facilitate connection of conventionaldetectors in the same circuit /loop consisting of addressable detectors.
b) The ZIM shall be capable of powering the detectors through the auxiliary sourceand shall supervise the IDC power supply.
c) The ZIM shall communicate alarm and troubles related to detector and powersupply to the Panel.
d) The ZIM shall allow resetting conventional detectors from the panel.
e) The ZIM shall be addresses by means of dip switches.
f) The ZIM shall have LED for status indication.
g) The ZIM shall be capable to connect at least 16 Devices.

5.6 Manual Call Points (MCP)

The Manual call points (MCP) shall conform to the relevant standards having thefollowing features:-

a) MCP shall be resettable Type.
b) MCP shall be either surface mounted or flush mounted.
c) Each addressable MCP will comprise of an electronic circuit built in to it toprovide addressing capability.
d) MCP shall be addressable by Dip switch.
e) The MCP shall have a LED to indicate Alarms

5.7 Sounder

The Sounder shall conform to the relevant standards having the following features:-

a) The Sounder shall be a Conventional sounder. (Bidder shall consider external power supply, cable, conduits, modules required for activating externally powered sounders.)

b) The sounder shall have audibility level of 90dB and the volume shall be adjusted from the Fire Alarm Panel.
c) The sounder shall have the capability of being tested from the FACP.

6.0 GRAPHIC MONITORING SOFTWARE

a) The Graphic Software shall provide both Alarm Management and systemmaintenance tool.
b) The Graphic software shall have all the system information available on a singlescreen allowing quick assessment and full control over the fire alarm system.
c) The Graphic software shall able to access the individual device and zones status.
d) The Graphic software shall be connected to a single panel or series of thenetworked panels.
e) The Graphic software shall have a 3access level for the software access security.
f) Building Evacuation, Alarm Silencing and Reset shall be available to any users with suitable security clearance.
g) The Graphics software can be configured to provide a schematic overview of the overall site, individual floor plans and even individual rooms. Each plan is independently named and can be configured to show all devices as installed on the site.
h) The graphics software shall have event log details with a complete history of the activity of the fire system. All major control actions are recorded with date, time, user and an Optional comment field. Entries are colour coded to help easy Identification of specific types of events.
i) SCADA compatibility should be considered for the above system as the sub- station is a smart s/s.

7.0 CABLES/CONDUICTS

All cables/conduits to be laid on wall, ceiling and on the hangers wherever necessary and as directed by the authority with required hardware. The cables shall be armored PVC twisted 1.5 sq mm multi strand insulated, copper conductor, conforming to IS: 1554 and shall be of specified make.

The cables shall be properly terminated and labeled.

1. Manufacturer recommended : Hochiki / Apollo / Notifier / Ravel / Siemens
2. INSPECTION & TESTING:

The following are mandatory tests to be carried out:

a) Commissioning Test

Commissioning of the entire installation shall be done in the presence of the Purchaser and / or its representative. All necessary instrumentation, equipment, materials andlabour shall be provided by the Contractor.
The Contractor shall record all tests and system calibrations and a copy of these results shall be retained on site in the system Log Book.

b) Functional Test

The FACP shall be checked for basic tests such as visually checking input voltage and current. All zones/Loop one by one shall be de-wired to check for fault signal indication in the FACP. 100% testing of all sensors, MCP, Sounders to be carried out as a part of functional checks.

The power source shall be cut off and checked for standby supply from the batteries. After six hours the FACP source shall be switched on to check for auto switch over to the mains module.

Test shall be conducted for AC fail, charger fail, DC fail, Battery disconnect or battery fail. In all such cases the relevant LED should glow and the piezo sound shall also give sound output.

Reference: NFPA 72 (National Fire Alarm and Signal Code)

CHAPTER-E20
CONSTRUCTION OF CONTROL ROOM-CUM- SWITH GEAR ROOM

TABLE OF CCONTENTS

TECHNICAL SPECIFICATION for CIVILWORK FOR SUBSTATIONS

1.0 ERECTION WORK

1.1 CIVIL WORKS

Civil works includes the following items:

The scope shall generally covers design, engineering, erection, testing and commissioning of all civil works at each substation. The scope includes Construction of Control room-cum- Switch gear room along with site clearance, soil investigation, switchyard dressing and leveling, Boundary Wall, fencing, cable trenches along with covers, cable trench crossings of road and rails, sump pits, marshaling box/control cubicle foundations, Equipment foundations, roads, drains, transformer foundations and gravel filling, firewalls, control room building, switchyard gate and other items not specifically mentioned here but required for the commissioning of substation shall be deemed to be included in the scope of this Specification. All civil works shall also satisfy the General Technical Clauses specified in other sections of this specification and as detailed below.

Excavation, pile drilling, dewatering, carriage of excavated earth, plain cement concrete (PCC), casting of reinforced cement concrete (RCC) foundations, super- structures for sub- station structures, equipment supports, their control cubicles, bus post supports, lighting poles and panels, brick and stone masonry, cable trenches, pipe trenches with necessary pre cast RCC removable covers, with lifting facility(In every 5th slab) and sump pits, cable supports and their embedment in cable trenches and cable trench crossings road or rail track with backfilling complete as per drawings approved by OPTCL, shall be carried out by the contractor. The cable trenches inside the control room shall be provided with GI chequered plate with angle stiffeners at the bottom for mechanical strength and painting there of as per the standard practice.

The Contractor shall furnish all designs, (unless otherwise specified) drawings, labour, tools, equipment, materials, temporary works, constructional plant and machinery, fuel supply, transportation and all other incidental items not shown or specified but as may be required for complete performance of the Works in accordance with approved drawings, specifications and as per direction of the Engg In-charge.

The work shall be carried out according to the design/drawings furnished in the specifications or supplied to the contractor by the Engg In-charge. For all buildings, structures, foundations etc. necessary layout, levels and details have been furnished by the owner keeping in view the functional requirement of the plant and facilities and providing enough space and access for operation, use and maintenance based on the input provided by the Engg In-charge . Certain requirements are indicated in this specification for guidance purposes only. However, the Bidder shall quote according to the complete requirements.

2.0 SOIL INVESTIGATION

General

The Contractor shall perform a detailed soil investigation to arrive at sufficiently accurate general as well as specific information about the soil profile/strata and the necessary soil parameters of the site in order that the foundations of the various structures specified in the tender specification can be adopted. Foundation systems adopted by the contractor shall ensure that relative settlement shall be as per provision in IS 1904 and any latestIS and other Indian Standards.

A report to the effect will be submitted by the Contractor for the Engg In-charge specific approval giving details regarding his assumed data for Civil structures design.

Any variation in soil data shall not constitute a valid reason for any additional cost and shall not affect the terms and condition of the Contract. Nothing extra what so ever shall be paid to the Contractor on account of any variation in subsoil properties /or conditions. Tests must be conducted under all the critical locations i.e. Control room building & transformer

location etc. However, some of the soil parameters for substations have tobe determined and submitted to Engg In-charge .

2.1 EXCAVATION AND BACKFILL

Excavation and backfill for foundations shall be in accordance with the relevant Code. Back filled materials in the pit to be levelled maximum up to a height of 200-250 mm and then to be compacted to 150mm after sprinkling of required quantity of water.

Whenever water table is met during the excavation, it shall be dewatered and water table shall be maintained below the bottom of the excavation level during excavation, concreting and back filling.

2.2 ROCK EXCAVATION

The rock to be excavated shall be classified under the following categories:

2.2.1 Ordinary rock

Rock which does not require blasting, wedging or similar means for excavation is considered as ordinary rock.. This may be quarried or split with crowbars or pickaxes and includes lime stone, sand stone, hard laterite, hard conglomerate and reinforced cement concrete below ground level. It will also include rock which is normally hard requiring blasting when dry but can be excavated without blasting, wedging or similar means when wet. It may require light blasting for loosening materials, but this will not any way entitle the material to be classified as hard rock.

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2.2.2 Hard Rock (Blasting prohibited)

This shall cover any hard rock requiring blasting as described in above but where blasting is prohibited for any reason and excavation has to be carried out by chiselling, wedging. drilling or any other approved method.

2.2.3 Authority for classification

The classification of excavation shall be decided by the Engg In-charge and his decision shall be final and binding on the Contractor.

2.2.4 Excavations for foundations and other purposes

Excavations shall be of the minimum sizes where not specified in the specifications, necessary for the proper construction of the works, and excavations shall not be kept open for periods longer than that reasonably required to construct the works. The Contractor shall take all precautions necessary to ensure that the bottoms of excavations are protected from deterioration and that the excavations are carried out in such a manner that adjacent foundations, pipes or such like are not undermined, damaged or weakened in any way. Any excavation taken out below the proper level without approval shall be made good at the expense of the Contractor using concrete or other material as directed.

2.2.5 Support of excavations

The Contractor shall be responsible for the stability of the sides of the excavations. Excavation surfaces shall be close timbered or sheeted, planked and strutted as and when necessary during the course of the work and shall ensure the safety of personnel working within them. If any slips occur, they shall, as soon as practicable, be made good in an approved manner at the expense of the Contractor. Shoring shall not be removed until the possibility of damaging the works by earth pressure has passed. No payment for shoring or timber left in shall be made, unless agreed in writing by the Engg In-charge .

2.3 WORKS TO BE IN DRY

All excavations shall be kept free from water and the Contractor shall take whatever action is necessary to achieve this. Pumping, hand dewatering and other means necessary to maintain the excavations free from water shall be at the expense of the Contractor, and carried out in an approved manner.

2.4 BACKFILL

As soon as possible after the permanent foundation works are sufficiently hard and have been inspected and approved, backfill shall be placed where necessary and thoroughly consolidated in layers not exceeding two hundred (200) millimetres in depth.

On completion of structures, the earth surrounding them shall be accurately finished to the line and grade as shown on the drawings. Finished surfaces shall be free of irregularities and depressions.

The soil to be used for back filling purposes shall be from the excavated earth or from borrowed pits, as directed by the Engg In-charge .

2.5 DISPOSAL OF SURPLUS

Surplus excavated material not required or not approved for backfilling shall be loaded and deposited either on or off site as directed. The Contractor shall not delay disposal of surplus material after receipt of instructions from the Engg In-charge .

2.6 REQUIREMENT FOR FILL MATERIAL UNDER FOUNDATIONS

The thickness of fill material under the foundations shall be such that the maximum pressure from the footing, transferred through the fill material and distributed onto the original undisturbed soil will not exceed the allowable soil bearing pressure of the original undisturbed soil.

Where compacted fill is required it shall consist of suitable sand, or other selective inorganic material, RRHG mixed with sand subject to approval by the Engg In-charge . The filling shall be done with locally available sand. The filled in sand shall be kept immersed in water for sufficient time to ensure compaction, if so desired by the Engg In- charge .

3.0 SITE LEVELLING

3.1 Scope

The contractor shall furnish all labour, equipment and materials required for complete performance of the work in accordance with the drawings, specification and direction of the Engg In-charge .Contour survey of proposed sub-station area including the control room area has to be done by taking levels at an interval of two meters in both the ways in the presence of the Engineer-in-charge or his representative. The detail contour survey should be traced over the tracing graph paper and submitted to the Engineer-in- charge for approval.

3.2 General Requirement

The material required for site surfacing/gravel filling shall be free from all types of organic materials and shall be of standard approved quality, and as directed by theEngg In-charge .

The Contractor shall furnish and install the site surfacing to the lines and grades as shown in the drawing and in accordance with the requirements and direction of the Engg In-charge . The soil of the entire switchyard area shall be levelled before placing the site surfacing/gravel fill material. After all the structures and equipment have been erected and accepted the site shall be maintained to the lines and grades indicated in the drawing and rolled or compacted with suitable water sprinkling to form a smooth and compact surface condition, which shall be matching with finished ground level of the switchyard area. After due compaction of the surface of the entire switchyard area shall be provided with plain cement concrete of 75 mm thickness (1:4:8) mix. after proper compaction. Care shall be taken for proper gradient for easy discharge of storm water.

After the PCC is applied and surface prepared to the required slope and grade a base layer of uncrushed/crushed broken gravel of 20 mm nominal size shall be spread, rolled and compacted to a thickness 100 mm. The 20 -40 mm. nominal size (for both layers) shall pass 100% through IS sieve designation 37.5 mm and nothing through 16.0 mm. ISsieve.

Engg In-charge by no means shall relieve the contractor of their contractual obligations as stipulated in General Conditions of Contract.

4.0 SITE DRAINAGE

4.1 General

Adequate site drainage system by M20 grade RCC. The surfaces of the site shall be sloped to prevent the ponding of water.

The Contractor shall ensure that water drains are away from the site area and shall prevent damage to adjacent property by this water. Adequate protection shall be given to site surfaces, roads, ditches, culverts, etc., to prevent erosion of material by water.

The drainage system shall be adequate without the use of cable trenches.

All manholes deeper than 1.2 m shall be provided with galvanised GI. foot rests. Foot rests shall be of 20 mm GI. square bars.

Invert of the drainage system shall be decided in such a way that the water can easily be discharged above the High Flood Level (HFL) outside substation boundary at suitable location and approved by Engg In-charge . Pumping of drainage water, if required, shall be provided by Contractor.

The Contractor shall locate the outfall point outside the substation vicinity and thesubstation storm drainage must be connected to this point.

The drainage scheme and associated drawings, if required, supersiding the drawing provided in the specification, shall be subject to approval of the Engg In-charge. In such a case the payment will be made on prorate basis for different items of work.

4.2 Excavation and backfill

Trench excavations for drains shall be carried out with the minimum disturbanceto adjacent ground and in such a way that existing or new work shall not be undermined. No backfill shall be placed until it has been inspected, tested and approved. Backfill shall be carefully placed by hand tools and rammed in layers not exceeding one hundred (100) millimetres thick in a manner which will not cause

damage.

5.0 SEWAGE SYSTEM

A sewage system shall be provided for all utility buildings including the Control room building and other auxiliary buildings.

The Contractor shall construct suitable septic tank and soak pit for the discharge of effluents. Sewers shall be constructed as per the provision made in the price schedule (BOQ).

6.0 ROADS AND CULVERTS

The approach road to the S/s and the roads inside the S/s shall be RCC (M20 Grade) in accordance to the drawing provided in the specifications and details below.

CONCRETE ROAD:

The concrete road shall consists of the following items.

i. Boulder & sand packing to a depth of 200mm.
ii. 100mm thick concerete PCC (M10 Grade).
iii. 200mm thick RCC (M20 Grade).

7.0 TRANSFORMER FOUNDATION, RAIL TRACK

The transformer foundation should be designed for 12.5 MVA Power transformer shall be of RCC, M20 (1:1½:3 mix) grade (as per the indicative drawing enclosed). The 90 lb rails shall be first quality manganese steel as per Indian Railway specification T-12-64.

The station transformer has to be mounted on prefabricated RCC (M20grade) foundation as per the drawing.

8.0 RMU FOUNDATION

Prefabricated RCC with M20 grade concrete foundation structure for 33kV and 11kV RMUs as per specification and approved drawing.

9.0 OIL RECOVERY SYSTEM

An oil recovery system shall be provided for all transformers (containing insulating oilor any flammable or polluting liquid) in order to avoid spread of fire by the oil, and for environmental protection by providing suitable

common Oil sum pit of RCC (with M20 Grade concrete) of size (1.6x1.6x2.3)meter for Transformer, with 250mmDia Hume Pipe connecting to the oil collection pits of the transformers for Drainage of oil/water.

10.0 FIRE PROTECTION (BAFFLE) WALLS

Fire protection walls shall be provided between two power Transformers. Fire wall column shall be RCC (with M20 Grade concrete) and the walls are of fire resistant Fly ash Bricks). Painting of the walls as per direction of the Engineer in charge

11.0 BOUNDARY WALL/ COMPOUND WALL

The boundary wall shall be as per the drawing and the quantity mentioned in the bidprice schedule (BOQ).

boundary-wall (with RCC column & beam with M-20 Grade concrete) along the property line of the sub-station. Brick works rested on RCC Beam and RCC Column & footings , including Cement Plastering, Cement wash, Wall Painting two coats with weather coat. The size of the bricks shall be 250mm having 1st class Fly-ash brick having compressive strength with 75kg/cm2. The size of the beam and pillar has to be carried out as per the soil condition for proper stability of the boundary walls

Provision of the boundary wall Fencing with M.S Grill of 700 mm height fixing at the top

of the wall. It includes supply of all the materials & two coats of synthetic enamel paintings after primer application of the fencing as per the direction of Engineer incharge.

12.0 SWITCH YARD GATE

Gates shall be installed in locations shown on drawings. GI gate (Pully driven Sliding Gate) (5 mtsx2.5 mts) having one leaf of size (2.5mtx2.5mt,height) with all arrangaments like 3 hinges in each side to hold the gate with gate piller, locking arrangement, L drop etc along with RCC pillar with emboded channel for fixing of gates. Each gate should be 2

leaf. Bottom of gates shall be set approximately 40 mm above ground surface and necessary guiding mechanism (with roller on the bottom of the gate and fixed guider in the road).

Provision of gate lights (Post top lantern type of LED 70 watts) on each pillar of the gate. It includes supply & fixing of light fixtures including LED Gate lamp, LV XLPE cables, switchgear etc required to complete including all associated works as per specification and direction of Engineer incharge

Flexible cooper bond has to be provided to link earthing of the sub station.

13.0 CABLE TRENCHES

The cable trenches should be primarily with RCC (M20 Grade), U-Type having 175mm thick wall (2 nos.) at an interval of 1500mm and 175mm raft over 100 mm sand bedding and then PCC (1:3:6) base. In each pillar, 2 nos of GI angle of 75x75x6mm of 500mm exposed length (as per the drawing) shall be suitably fixed.

The cable trenches shall take the loads of 33kV 1C, 1000mm²/630mm², 33kV 3C, 95mm², 11kV 630mm²/ 400mm², LT 3½ 240 mm² cables and the different size of control cables.

Cable trench covers shall be designed for (i) self weight of top slab plus concentrated load of 200 kg at centre of span on each panel and a surcharge load of 2 tonnes per sq. metre.

The top of trenches shall be kept at least 300 mm above the finished ground level (FGL). The FGL means the finish level of the soil but not the top of metalling surface. The top of cable trench shall be such that the surface rain water does not enter the trench.
All metal parts inside the trench shall be connected to the earthing system.
Cables from trench to equipments shall run in hard conduit pipes (GI pipe and necessary
G.I bends and sockets).

A suitable clear gap shall be maintained between trench walls and

foundations. The vertical space between each tier and the floor shall be as per the drawing furnished. No sharp bending of cable trench is permissible; it should be done as per 20D principle.

The trench bed shall have a slope of 1/500 along the run and 1/250 perpendicular to the run.

Cable supports (all galvanised structures) shall be designed and constructed to be a single complete fabrication or assembly such that every layer of the horizontal ladder type cable supports are fixed, either bolted or welded, to a vertical steel support that is embedded in the concrete wall of the cable trough. It shall not be permitted to embed a horizontal support beam directly into the wall of the trough in order to use the concrete wall as a means of load bearing.
Concrete troughs shall be provided with concrete covers of suitable load bearing strength. Where the cable troughs are run across or within 3 m of substation roads, the trough covers shall be capable of bearing an accidental wheel load of 20 kN. The drawings showing the details of fixing of cable racks in concrete cable trench walls, number of layers to be provided has to be provided in the drawing.

A running earth strip has to run all through the cable trench for proper earthing of the cable trays and stand (frame).The size of the earth strip is of 50X6mm G.I flats. Welding the GI flats to the frame to be carried out. Earthing strips to be welded with the running earth mat at 10mtrs interval.

The covers of the slab are also of RCC (M20 Grade). The thickness of the slab shall be 100 mm (MS Rods to be used 8mm), The MS rods to be used shall be placed at 100 mm centre to centre both way and properly bided. The cover slab shall have provision of lifting hooks at two points for easy lifting of the slabs. Slabs having lifting hooks shall be placed at every 5^{th} slabs, it should remain inside the top of concrete surface of the slab.The length and breath of the cable trench cover slab shall be 1800mm X 300mm.

Once the trench covers have been made they are to be stored and not laid until all trench cabling, is finished. Any covers laid before this time which become damaged shall be replaced at the Contractor's expense.

Trench covers and bridging beams for covers, except where heavy duty, shall be light enough for two men to lift.

14.0 FOUNDATION MATERIALS

14.1 Cement

The cement to be used shall be the best quality of its type and must not be more than 3months old in stock.

All cement shall be sampled and tested in accordance with Indian Standards.The Portland cement used in concrete shall confirm to IS 269.

Requirement of sulphate resistant cement (SRC) for sub structural works shall be decided in accordance with the Indian Standards based on the findings of the detailed soil investigation to be carried out by the contractor.

High Alumina cement shall NOT be used.

14.2 Aggregate

Coarse and fine aggregate shall conform to the requirements of IS 383-1970. Sampling and testing of aggregates shall be in accordance with the relevant Indian Standard.

Fine and coarse aggregates shall be obtained from the same source and the Contractor shall ensure that material from the source is known to have a good service record over a long period of time.

Aggregate shall be hard and dense and free from earth, clay, loam and soft, clayey, shaley or decomposed stone, organic matter and other impurities.

14.3 Storage of aggregates

Coarse and fine aggregates shall be stored on site in bins or on clean, dry, hard surfaces, and be kept free from all sources of contamination. Aggregates of different gradings shall be stored separately, and no new aggregate shall be mixed with existing stocks until tested, and approved by

the Engg In-charge .

14.4 Water

Water used for mixing concrete and mortar shall be clean, fresh water obtained from an approved source and free from harmful chemicals, oils, organic matter and other impurities. Normally potable water may be considered satisfactorily for mixing and curingconcrete and masonry work.

14.5 Steel bar reinforcement

Reinforcement shall comply with the appropriate Indian Standards. All bar reinforcement shall be hot rolled steel except where the use of cold worked steel is specified on the drawings or otherwise approved. The bars shall be round and free from corrosion, cracks, surface flaws, laminations, rough, jagged and imperfect edges and other defects. The bar reinforcement shall be new, clean and of the lengths and diameters describedon the Drawings and Schedules. Bars shall be transported and stored so that they remain clean, straight, undamaged and free from corrosion, rust or scale. Bars of different diameters shall be separately bundled.

14.6 Welding of reinforcement

Spot or tack welding for positioning bars in heavily reinforced areas will only be allowed with the express permission of the Engg In-charge . Extension of lengths of reinforcement by welding will not be permitted. Welding will be approved only in low stress members, and lap welding will not be approved in any circumstances.

14.7 Fixing of reinforcement

Before fixing in the works bars shall be seen to be free from pitting, mud, oil, paint, loose rust or scale or other adherents harmful to the bond or strength of the reinforcement. Bars shall be fixed rigidly and accurately in position in accordance with the working drawings, unless otherwise approved by the Engg In-charge. Reinforcement at all intersections shall be securely tied together with 1.5 mm soft annealed tying wire the ends of which shall be cut and bent inwards. Cover to the reinforcement shall

be in accordance permissible standard and sufficient spacers and chairs of precast concrete of approved design shall be provided to maintain the specified cover and position. No insertion of bars in previously placed concrete shall be permitted. Projecting bars shall be adequately protected from displacement. The fixing of reinforcement in the works shall be approved by the Engg In-charge before concrete is placed. Measurement will be based on the calculated weights of steel actually used in tonnes corrected to second place of decimal.

Concrete cover to reinforcement

For durability the minimum concrete cover to any reinforcing bar shall be as follows:

Concrete above ground.

- Internal faces of slabs 25 mm
- Internal faces of beams and walls 30 mm
- Exposed faces of slabs, beams and walls 50 mm
- All faces of columns 50 mm

Concrete below ground (including piles).

- Faces in contact with soil including blinding concrete 75 mm
- All other faces (i.e. internal faces of basement wall) 50 mm

Only concrete or steel spacers shall be used to achieve the required minimum thickness of concrete cover to reinforcement. Concrete spacers shall have non metallic ties. Timber blocks for wedging the steel off the formwork will not be allowed.

14.8 Formwork

Formwork shall be constructed from timber, metal, lined as necessary for special finishes and designed with the quality and strength required to ensure rigidity throughout placing, ramming, vibration and setting of the concrete, without detrimental effect.

Formwork shall be erected true to line, level and shapes required using a minimum of approved internal ties. Faces in contact with the concrete shall be true and free from defect, jointed to prevent loss of water or fines, in panels or units which permit easy handling Ties or spaces remaining embedded shall have the minimum cover specified for reinforcement.

Forms for exposed concrete beams, girder casings and columns shall provide for a twenty five millimetre chamfer on external corners.

Wedges and clamps shall be kept tight during vibration operations. Before commencement or resumption of concreting, the interior of forms shall be cleaned and free of sawdust, shavings, dust, mud or other debris and openings shall be formed to facilitate this cleaning and inspection. The inside of the forms shall be treated with a coating of an approved substance to prevent adhesion. Care shall be taken to prevent this substance being in contact with the reinforcement.

14.9 Grades of concrete

Concrete shall be either ordinary or controlled and in grades designated M10, M15, M20 and M25 as specified in IS: 456 (latest edition Concrete shall be either ordinary or controlled and in grades designated M10, M15, M20 and M25 as specified in IS:456 (latest edition). In addition, nominal mixes of 1:3:6 of nominal size 12mm-20mm, or as indicated on drawings, or any other mix without any strength requirements as per mix design shall be used where specified.

Ordinary concrete

Ordinary concrete shall be used for all plain cement concrete work and where shown on drawings or allowed by the Engg In-charge. Ordinary concrete shall not require preparation of trial mixes.

In proportioning concrete, the minimum quantity of cement shall be as specified in of this clause and the amount to be used shall be determined by actual weight. The quantities of fine and coarse aggregate may be determined by volume, but preferably by weight.

The water cement ratio shall not be more than those specified in IS 456.

Grade of Concrete	Minimum cement content per c.m. of finished concrete
M 10	236 kg
M 15	323 kg

M 20	410 kg
M 25	530 kg

As a guide to perform the mix design properly, the relationship between water cement ratio, aggregate to cement ratio, workability and strength of concrete will be as per relevant IS.

The cement /total aggregate ratio is not to be increased beyond 1: 9.0 without specific permission of the Engg In-charge . It should be noted that such high aggregate/cement ratios will be required for concretes of very low slump and high water cement ratios which may be required to be used in mass concrete work only.

The actual cement aggregate ratios are to be worked out from the specific gravities of coarse aggregates and sand being used, and from trial mixes.

14.10 Strength requirements

The mix proportions for all grades of concrete shall be designed to produce the grade of concrete having the required workability and a characteristic strength not less than the value given below:

Grade of Concrete	Minimum cement content per c.m. of finished concrete
M 10	236 kg
M 15	323 kg
M 20	410 kg
M 25	530 kg

The strength of concrete given above is the 28 days characteristic compressive strength of 15 cm cube.

The placing of concrete shall be a continuous operation with no interruption in excess of 30 minutes between the placing of continuous portions of concrete. When fresh concrete is required to be placed on

previously placed and hardened concrete, special care should be taken to clean the surface of all foreign matter. For securing a good bond and water tight joint, the receiving surface should be made rough and a rich mortar placed on it unless it has been poured just before. The mortar layer should be about 15 mm thick with cement and sand proportion as that of the mix in use, and have the same water-cement ratio as the concrete to be placed.

After the concrete has been placed it shall be thoroughly compacted by approved mechanical vibration to a maximum subsidence without segregation and thoroughly worked around reinforcement or other embedded fixtures into the correct form and shape. Vibrators must be operated by experienced men and over vibration shall not be permitted. Care should be taken to ensure that the inserts, fixtures, reinforcement and formwork are not displaced or disturbed during placing of concrete. No concrete shall be placed in open while it rains. If there is any sign of washing of cement and sand, the concrete shall be entirely removed immediately. Slabs, beams and similar structure shall be poured in one operation normally. In special circumstances with the approval of Engg In-charge these can be poured in horizontal layers not exceeding 50 cm. in depth. When poured in layers, it must be ensured that the under layer is not hardened. Bleeding of under layer if any shall be effectively removed.

14.11 Compaction of Concrete

Compaction is necessary for production of good concrete. After the concrete has been placed it shall be thoroughly compacted by approved mechanical vibrator to a maximum subsidence without segregation and thoroughly worked around reinforcement or other embedded fixtures into the correct form and shape. Vibrators must be operated by experienced men. Care should be taken to ensure that the inserts, fixtures, reinforcement and formwork are not displaced or disturbed during the vibration of the concrete. The Contractors shall provide standby vibrators. Vibration is commonly used method of compaction of concrete, the use of mechanical vibrators complying with IS 2505, IS 2506, IS 2514 and IS 4656 for compacting concrete is recommended

For all practical purposes, the vibration can be considered to be sufficient when the air bubbles cease to appear and sufficient mortar appears to close the surface and facilitate easy finishing operations. The period of vibration required for a mix depends upon the workability of the mix.

14.12 Curing of Concrete

In order to achieve proper and complete strength of the concrete, the loss of water from evaporation should be prevented. Eighty to eighty five per cent of the strength is attained in the first 28 days and hence this 28-day strength is considered to be the criterion for the design and is called characteristic strength. The concrete after setting for 24 hours shall be cured by keeping the concrete wet continuously for a period of 10 days after laying.

The curing increases compressive strength, improves durability, impermeability and abrasion resistance. Failure to carry out satisfactory curing can lead to cracking in the concrete. This in turn can lead to salt attack of the reinforcement and consequential failure of the structure. If cracks occur in a structure which are severe enough to affect the structure, the Contractor shall cut out and replace the defective concrete at his own cost. The Contractor's attention is, therefore, drawn to this particular aspect of proper and adequate curing.

14.13 Removal of formwork

Formwork shall be kept in position fully supported, until the concrete has hardened and gained sufficient strength to carry itself and any loads likely to be imposed upon it. Stripping must be effected in such a manner and at such a time that no shock or other injury is caused to the concrete. The responsibility for safe removal rests with the Contractor but the Engg In-charge may delay the time of striking if he deems itnecessary.

Minimum periods, in the absence of agreement to the contrary, between completion of concreting and removal of forms are given below but due regard must be paid to the method of curing and prevailing conditions during this period.

Removal of forms are to be done as under

i) Sides of foundations, columns, beams and wall 2days

ii) Under side of slabs up to 4.5 m span 7days

iii) Under side of slabs above to 4.5 m span and underside of beams and arches up to 6m span 14days

iv) Under side of beams and arches above 6m and up to 9m span 21days

15.0 CONTROL ROOM CUM SWITCHGEAR BUILDING

17.1 General

The scope includes the construction of control room building along with office rooms & toilets. The size of the building will be (i) (18.25 Mtrs X 9.2 Mtrs (ii) (22.25 MtrsX 9.2 Mtrs :. The tentative layout showing the facilities to be provided is indicated at **E24.**

Building having the **Ground Floor:** Cable Cellar, Store room,Battery room, Security Room,Toilet & stair case etc,

First Floor : 33 & 11 KV GIS Equipment, Control room cum Relay panel, ACDB & DCDB , SCADA room, toilets, pantry, stair etc).Provision of a RCC platform with detachable Stainless steel railing for easy transportation of panels to the control room.

Second Floor: Open HALL, toilet, stair etc. A mumfty room over the stair case.

However, the size and layout of the building may be modified if the site condition does allow for it. The modification to be done with prior approval of the Engineer in Charge.

17.2 Specifications

Normally the building shall have the following design/construction parameters.

i) The structure will be of framed structure with M-20 grade concrete.

ii) The size and of specification of structural members like footings, columns, beams, lintel, slab, staircase etc. and will be as per approved structural drawings. However size of footings may be changed from site to site as per safe bearing capacity of soil at corresponding sites

iii) Flooring — Flooring with vitrified tiles (digital double charged with

ISO/IS mark) with dado in all the rooms and Bath and toilets shall be provided with digital anti skid vitrified tiles (wall of the same upto height of 8 feet also to be provided with same tiles) and the entire stair case shall be provided with Granite flooring.

iv) Painting –

(1) Internal wall and ceiling paintings

Make: Berger [3P 0778- Soft Light (Easy Clean)] / Asian Paints [7907-Candle Wick (AP Royale)] / Nerolac[2016P- Lemon balm(Lotus Touch)]

Procedure:

(i) The walls are to be applied with 2 coats of putty (JK/ Birla/ Bison make) of minimum 2 mm of thickness. After the first coat is applied, minimum of 2 days may be spared for drying up the wall. Then the second coat may be applied over the first coat so that 2mm thickness is achieved & uniformity is maintained.

(ii) After applying the second coat, another 2 days may be spared & then sand paper is to be applied to remove the undulation of the wall.

(iii) White primer (water thin-able / solvent thin-able) of one coat (Berger/Nerolac/ Asian Paints) is to be applied.

(iv) Then two coats of colour paints are to be applied on the wall.

(2) External wall paintings weather proof

Make: Exterior wall (body):Berger [2P 0229-Calming Touch (Weather Coat Smooth)] / Asian Paints [8564- Sweet Dreams (Apex)] / Nerolac[4051- Lightest Peach (Excel] Exterior wall (border): Berger[2A 0232- Cookie Crisp (Weather Coat Smooth)] / Asian Paints [8645-Rich Chocolate (Apex)] / Nerolac[2798C- Kitty Kat (Excel)]

Procedure:

(i) One coat of primer (Weather Coat) are to be applied.

(ii) Then two coats of weather coat need to be applied on the wall.

The two coatsshould be applied with an minimum interval of 12 hours in between.

The approved make & shade of paints on new work to give an even shade in all floors at all height including scafolding cost of brushes including cost of paint cost, conveyance royality of all materials

labour,T&P articles required for the work etc complete in all respect as per the latest specification and direction of the Engineer- in-charge.

v) Door and windows –

Doors and windows shall be of sliding type with locking facility and shall be of powder coated aluminium with taughned glaze of 6mm & windows shall have aluminium grills. The window shall be provided with vertical blinder to protect from sun ray.

Supply & Fixing of Fire proof door :- One no. fire proof door each at Battery Room & Cable cellar room to be considered.

(Supply & Fixing of 2 Hrs. Fire Rated hollow metal doors (make: Shakti Hormann or equivelent approval) as per IS 3614 (Pt. 1 & 2) & door frame including all type of hardware. The door shall have pressed galvanised steel confirming to IS 277 with single leaf duly tested at CBRI/ARAI. The test certificate shall be vision lites/panels. Prper lebel confirmimg the type of door and hourly rating is mandatory. The door leaf shall be 46 mm thick fully flush double skin door with vision/without vision lite. The door leaf shall be manufactured from 1.2 mm minimum thick galvanised steel sheet. The internal construction of the door shall be resin bonded honycomb core. All door shall be factory prepared for receiving of hardware,necessary reinforcement for hinges,locks & door closores. The edges shall be interlocked with lock seam. Vision lite wherever applicable shall be provided with a beeding and screw from inside. The glass shall be 6 mm clear borosilicated fire rated glass.

The door frame shall be double frame profile of size 143 mm X 58 mm made out of

1.6 mm minimum thick galvanised steel sheet. Frames shall be mitered & field assembled with self tabs. Frames shall be provided with back plate bracket & anchor fastners for installation.

The door & door frames shall be finished with polyurathene aliphetic grade paint of approved colour. The door leaf & frame shall have passed minimum 250 hrs. of salt spray test.) Toilet doors will be of fibre reinforced plastic (FRP) type

The doors and windows of the building shall be of aluminium extruded channels, angles etc.

I. A service verandah has been provided in front side of building with a staircase to provide access to terrace and a mumfty room over the stair case.
II. Provision of a RCC platform with detachable Stainless steel railing for easy transportation of panels to the control room has been provided in the first floor.
III. Provision PCC platform of width one meter with Concreate paver on top flooring surrounding the outer side of controlroom building preventing entry of rain water into building plinth.

17.3 Dimensions

An open space of 1.5 metre minimum shall be provided on the periphery of the rows of panels, and equipment generally, in order to allow easy operator movement and access as well as maintenance.

The building design shall also take into consideration the layout of the panels, switchboards, switchgear and other equipment in order to allow enough area for the future extension of switchyard depending upon the availability of substation area.

The building auxiliary services such as air conditioning and ventilation systems, fire protection and detection systems, CCTV and all other miscellaneous services shall be designed in accordance with the requirements specified in relevant sections of this Specifications to allow for easy access to equipment and maintenance of the equipment

17.4 Submission of data for approval

The following information shall be submitted for review and approval to the Engg In- charge :

- Design criteria for structural steel and reinforced concrete design. The criteria shall comprise the codes and standards used, applicable climatic data including wind loads, earthquake factors and maximum

and minimum temperatures applicable to the building locations, assumptions of dead and live loads, including equipment loads, impact factors, safety factors and other relevant information.

- Structural design calculations and drawings including those for construction and fabrication for all reinforced concrete and structural steel structures.
- Fully dimensioned floor plans, cross sections, longitudinal sections and elevations of each building. These drawings shall be drawn at a scale not less than 1:50 and shall identify the major building components.
- Fully dimensioned drawings showing details and sections, drawn to scales of sufficient size to clearly show sizes and configuration of the building components and the relationship between them.
- Product information of building components and materials, including walls, partitions, flooring, ceilings, roofing, doors and windows and building finishes.
- A detailed schedule of building finishes including colour schemes.
- A door and window schedule showing door types and locations, door lock sets and latch sets and other door hardware.
- Anti Termite treatment of Control Room to be done by the contractor.

Approval of the above information shall be obtained before ordering materials or starting fabrication or construction as applicable.

17.5 Flooring (52 mm Thick)

Flooring shall be done as per provision made in the price schedule (BOQ).

17.6 Walls

Walls shall be constructed with Fly ash Brick masonry by using cement sand mortar 1:6, with Fly Ash Bricks of size (230x110x75)mm of first class (Compressive strength not less than 10-12 n/mm²) with dimensional tolerance 3% after immersing the bricks for 6 hours in water before use, as per technical spec & direction of Engineer Incharge. as per provision made in the drawing and price schedule (BOQ).

17.7 Plastering

All internal surfaces shall have Plastering of 12 mm thk cement plaster 1:3 (1 cement:3 coarse sand) and All external surfaces shall have 12mm thick cement sand plaster intwo layers. Under layer 12mm thick cement plaster 1:6 (1 cement:6 coarse sand) and a top layer 6mm thick cement plaster 1:3 (1 cement:3 coarse sand) finished rough with sponge. And the ceiling shall have 6mm thick 1:4 cement sand plaster.

17.8 Roof

Roof of the building shall consist of cast in situ R.C.C. slabs (M-20) grade. Extra heavy water proofing treatment of approved standard shall be done.

17.9 Plumbing And Sanitation

All plumbing and sanitation work 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.

Providing and fixing 1000 litres capacity P.V.C Over Head (tripple layer) tank with all piping and valve arrangement with all fittings, complete as directed by the Engineer-in- charge.

Galvanised MS pipe of medium class conforming to IS : 1239 shall be used for internal piping works for portable water supply.

Sand CI pipes with lead joints conforming to IS:1729 shall be used for sanitary works above ground level.

A list of toilet fittings will be approved by the Engg In-charge , before procurement by the contractor and same will be inspected by the Engg In-charge before installation. Sufficient nos of toilets and bath rooms including separate urinal provision shall be provided at both ground and first and second floors. Required nos of wash basins (stand type) with good quality mirrors and other accessories as required are also to be provided at both ground and first floor of control room and second floor building.

Internal & External PHD work and other fittings(in Toilets,wash room,overhead water tank,septic tank and soak pit,pantry etc) of reputed

make having IS/ISO and provision of rain water discharge pipes at different locations as per requirement. It includes supply of all types of materials of reputed make.

16.0 EARTHING

Earth Grid should not be more than two meters square. This should be done by using 75x10 mm GI flats. Earth risers should be 50x6 mm GI flats. All equipments & metal parts of the Sub-Station should be connected with main earth grid by using 50x6 GI flats at two different places. The main earth grid should be laid not less than 600 mm below the finished ground level. The lap welding should not less than 100 mm. The welding of joints should be done after removal of Zinc by using Blow lamps. Welding should be done in all four sides and should be double layer continuous. Before taking up the second layer welding the deposited flux should be removed. During welding the two flats should be tightened properly by using ' C ' clamps. Immediately after welding two layers of anti-corrosive paints should be painted over the welded portion along with two coats of Black bituminous paints. Before back filling of earth trenches the welded portion should be covered by wrapping with bituminous tape properly and also jointing portion should be covered with PCC (1:3:6) mix. The backfilling of earth pits and trenches should be done with powered loam soil mixed with Bentonate powder (10:1) mix.

All equipments, steel structures etc should be connected with Main earth mat at two rows separately. All LAs, PTs, Columns having spikes should individually connected with individual Pipe electrodes and again should be connected with main earth grid at two separate places. The Neutral of Power Transformer should be connected with two separate pipe electrodes and again connected with main earth electrodes at two separate places. The separation distance between each pipe electrodes should not be less than 2 mts. The back filling of pipe electrodes should be done in layer of Charcoal, Salt & loam soil mixed with Bentonate power.

There should be a closely spaced earth grid (1.5 mts square having .5 mts spacing) below the mechanism boxes of equipment. In Sub-station the

diameter of pipe electrode should be 100 mm. The Flange(50x6) mm GI flat should be welded in all sides with Pipeelectrode. In each face of Flange there should be two nos 17.5 mm hole to accommodate 16 mm GI Bolt nut with 1 no spring washer.

There should be one 50x6 mm earth flat run over the cable rack and should be connected with main earth grid at an interval of 5 mts The jointing portion of earth flats over the ground should be painted with two coats of Anti-corrosive paints and two coats of good quality of Aluminium paints (Berger/Asian paints).

16.1 G.I. Flat (75x 10 mm) & G.I.Flat (50 x 6 mm)

The specification covers manufacture, testing and supply of Galvanized Steel flat for Earthing arrangements.

I. APPLICABLE STANDARDS:

Materials shall conform to the latest applicable Indian standards. In case bidders offer steel section and supports conforming to any other international specifications which shall be equivalent or better than IS, the same is also acceptable.

Sl. No	Standard No.	Title
1	IS:2062	Grade 'A' Quality Specification for M.S. Channel and M.S. Flat
2	IS:2062	Chemical and Physical Composition of material
3	IS:1852	Rolling and Cutting Tolerances for Hot Rolled Steel products

II. RAW MATERIAL :

The steel section shall be re-rolled from the BILLETS/INGOTS of tested quality from SAIL/TATA/RINL as per latest version of IS: 2830. The chemical composition and physical properties of the finished materials shall be as per the relevant standards.

III. TEST

Steel sections shall be tested in IS approved laboratory or standard laboratory of the Bidder country having all facilities available for conducting all the tests as prescribed in relevant IS or IEC or to any equivalent International laboratory or Institutions.

IV. PHYSICAL & CHEMICAL

PROPERTIESLength

The GS Flat to be supplied shall be in 5.5 meters to 13 meters lengths.

Weighment

The weighment of GS Flat shall be witnessed by the consignee at the time of taking delivery. The weight recorded in the material receipt certificate issued by the consignees shall be final.

Chemical composition and physical properties of M.S.Channels and M.S.Flat conforming to IS: 2062/84L composition.

Chemical	Composition	For Fe 410 WA Grade
1	C -	0.23% MAX.
2	Mn -	1.5% MAX.
3	S -	0.050% MAX.
4	P -	0.050% MAX.
5	SI -	0.40% MAX.
6	CE - (Carbon Equivalent)	0.42% MAX.

V. Mechanical Properties

1. Tensile strength Kgf/mm²⁻ - 410
2. Yield stress Min. for thickness/diameter <20 m - 26 Kgf/mm² 20-40 mm - 24Kgf/mm²40 mm - 23Kgf/mm
3. Elongation % - 23%
4. Bend Test (Internal Dia) Min-3t (this the thickness of thematerial)

VI. MARKING

It is desirable that the Bidders should put his identification marks on the finishedmaterials. The mark shall be in “legible English letters”

VII. METHOD OF GALVANISING:

Sl. No.	Tests	For GI Flat
1	Dip test	6 dips of 1 min each
2	Mass of Zinc coating	610 gram/sq.m minimum

Pre dispatch inspection shall be performed to witness following tests:

a) Freedom from defects,
b) Verification of dimensions
c) Galvanization tests
d) Mechanical tests
e) Chemical composition tests

These tests are to be performed and certified at Govt. recognized laboratory.
MS flat shall conform to IS 2062 & its latest amendments for steel & Galvanizationas per IS 4759 & its Latest amendments.
The flat shall be coated with Zn 98 Zinc grade.
The minimum Zinc coating shall be 610 gm/sqm for thickness more than 5 mm and 460 gm/sqm for item thickness less than 5 mm.
For use in construction at coastal areas as well as other areas it shall be required for galvanizing the Cross arms and Pole top brackets as following :

All galvanizing shall be carried out by the hot dip process, in accordance with Specification IS 2629. However, high tensile steel nuts, bolts and spring washer shallbe electro galvanized to Service Condition 4. The zinc coating shall be smooth, continuous and uniform. It shall be free from acid spot and shall not scale, blister or be removable by handling or packing. There shall be no impurities in the zinc or additives to the galvanic bath which could have a detrimental effect on the durability of

the zinc coating.

Before picking, all welding, drilling, cutting, grinding and other finishing operations must be completed and all grease, paints, varnish, oil, welding slag and other foreign matter completely removed. All protuberances which would affect the life of galvanizing shall also be removed.

The weight of zinc deposited shall be in accordance with that stated in Standard IS 2629 and shall not less than 0.61kg/m² with a minimum thickness of 86 microns for items of thickness more than 5mm, 0.46kg/m² (64 microns) for items of thickness between 2mm and 5mm and 0.33kg/m² (47 microns) for items less than 2mm thick.

Parts shall not be galvanized if their shapes are such that the pickling solutions cannot be removed with certainty or if galvanizing would be unsatisfactory or if their mechanical strength would be reduced. Surfaces in contact with oil shall not be galvanized unless they are subsequently coated with an oil resistant varnish or paint.

In the event of damage to the galvanizing the method used for repair shall be subjectto the approval of the Engineer in Charge or that of his representative.
Repair of galvanizing on site will generally not be permitted.

The threads of all galvanized bolts and screwed rods shall be cleared of spelter by spinning or brushing. A die shall not be used for cleaning the threads unless specifically approved by the Project Manager. All nuts shall be galvanized. The threads of nuts shall be cleaned with a tap and the threads oiled.

Partial immersion of the work shall not be permitted and the galvanizing tank must therefore be sufficiently large to permit galvanizing to be carried out by one immersion.

After galvanizing no drilling or welding shall be performed on the

galvanized parts of the equipment excepting that nuts may be threaded after galvanizing. To avoid the formation of white rust galvanized materials shall be stacked during transport and stored in such a manner as to permit adequate ventilation. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanization.

The galvanized steel shall be subjected to test as per IS-2633.

The galvanization tests are to be conducted as per IS: 2633/72 & IS: 6745/72 & its latest amendments.

16.2 Earth Electrode (100 NB 3.0 Mtr Length)

Metal parts of all equipment other than those forming part of an electrical circuit shall be connected directly to the main earth system via two separate conductors of adequate capacity at two different points.

All main members of structural steelworks shall be earthed by galvanised iron flatconnections bonded by welding or bolting to the steelworks.

Connections to apparatus and structures shall be made clear of ground level, preferably to a vertical face and protected as appropriate against electrolytic corrosion. They shall be made between clean surfaces and of sufficient size and pressure to carry the rated short circuit current without damage.

Earth bars installed directly into the ground should normally be laid bare and the trench back-filled with a fine top soil. Where the soil is of a hostile nature, special precautions must be taken to protect the earth bar. Wherever required to achieve the required resistance bentonite powder to be mixed in lom/ black cotton crushed soil in 1: 6proportion is permissible, the method used being subject to the agreement of the Engg. Incharge . In the event of bentonite powder being adopted, water supply through conduit to the area must be supplemented and regulated to keep the surface / mat moisture absorbent.

Joints in earth bars+ shall be welded and then coated with a suitable anti-corrosion protection treatment.

Facilities shall be provided on the earth bar run between equipment and the base of structures, comprising a looped strip, so as to permit the attachment of portable earth connections for maintenance purposes.

The cross sectional area of the earth bar and connections shall be such that the current density is not greater than 100 A/mm^2 for a 3 second fault duration.

17.0 WIRING, CABLING AND CABLE INSTALLATION

21.1 Cubicle wiring

Panels shall be complete with interconnecting wiring between all electrical devices in the panels. External connections shall be achieved through terminal blocks. Where panels are required to be located adjacent to each other all inter panel wiring and connections between the panels shall be carried out internally. The Contractor shall furnish a detailed drawing of such inter panel wiring. The Contractor shall ensure the completeness and correctness of the internal wiring and the proper functioning of the connected equipment.

All wiring shall be carried out with **1.1 kV** grade, **PVC** insulated, single core, stranded copper wires. The PVC shall have oxygen index not less than **'29'** and Temperature index not less than **250C**. The wires shall have annealed copper conductors of adequatesize comprise not less than three strands.

The minimum cross sectional area of the stranded copper conductor used for internalwiring shall be as follows :

a) All circuits excepting CT circuits and energy metering circuit of VT 2.5 sq.mm
b) All CT circuits and metering circuit of VT 2.5 sq. mm

All internal wiring shall be supported, neatly arranged, readily accessible and connected to equipment terminals and terminal blocks. Wiring gutters

and troughs shall be used for this purpose.

Cubicle connections shall be insulated with PVC to IEC 227. Wires shall not be jointedor teed between terminal points.

Bus wires shall be fully insulated and run separately from one another. 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 panel suite. Longitudinal troughs extending throughout the full length of panel shall be preferred for inter panel wiring.

All inter connecting wires between adjacent panels shall be brought to a separate set of terminal blocks located near the slots of holes meant for the passage of the interconnecting wires. Interconnection of adjacent panels on site shall be straightforward and simple. The bus wires for this purposes shall be bunched properly inside eachpanel.

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. Numbers 6 and 9 shall not be included for ferrules purposes unless the ferrules have numbers underscored to enable differentiation. (i.e. 6 and 9).

Fuses and links shall be provided to enable all circuits in a cubicle, except a lighting circuit, to be isolated from the bus wires.

The DC trip and AC voltage supplies and wiring to main protective gear shall be segregated from those for back-up protection and also from protective apparatus for special purposes. Each such group shall be fed through separate fuses from the bus wires. There shall not be more than one set

of supplies to the apparatus comprising each group. All wires associated with the tripping circuits shall be provided with red ferrules marked "**Trip**".

It shall be possible to work on small wiring for maintenance or test purposes without making a switchboard dead.

The insulation material shall be suitably coloured in order to distinguish between the relevant phases of the circuit.

When connections rated at 380 volt and above are taken through junction boxes they shall be adequately screened and "**DANGER**" notices shall be affixed to the outsides of junction boxes or marshalling kiosk.

Where connections to other equipment and supervisory equipment are required the connections shall be grouped together.

21.2 LV power cabling

LVAC cable terminals shall be provided with adequately sized, hot pressed, cast orcrimp type lugs. Where sweating sockets are provided they shall be without additional clamping or pinch bolts. Where crimp type lugs are provided they shall be applied with the correct tool and the crimping tool shall be checked regularly for correct calibration. Bi-metallic joints between the terminals and lugs shall be provided where necessary.

Terminals shall be marked with the phase colour in a clear and permanent manner.

A removable gland plate shall be provided by the Contractor. The Contractor shall be responsible for drilling the cable gland plate.

Armoured cables shall be provided with suitable glands for terminating the cable armour and shall be provided with an earthing ring and lug to facilitate connection of the gland tothe earth bar.

21.3 Multi-core cables and conduit wiring

External multi-core cabling between items of main and ancillary equipment

shall form part of the Contract Works and shall consist of un-armoured multi-core cable with stranded copper conductors PVC insulated and PVC over sheathed complying with the requirements of IEC 227 and 228 as applicable.

Multi-core cable for instrumentation and control purposes shall be supplied with 2.5 mm^2 stranded copper cores. Multi-core cables for CT and VT circuits shall be supplied with two by 2.5 mm^2 stranded copper cores and the cores shall be identified by the phase colour.

Where conduit is used the runs shall be laid with suitable falls and the lowest parts of therun shall be external to the equipment. All conduit runs shall be adequately drained and ventilated. Conduits shall not be run at or below ground level.

Multi-core cable tails shall be so bound that each wire may be traced to its cable without difficulty. All multi-core cables shall be provided with 20 % spare cores and the spare cores shall be numbered and terminated at a terminal block in the cubicle. Where cables are terminated in a junction box and the connections to a relay or control cubicle are continued in conduit, the spare cores shall be taken through the conduit and terminated in the cubicle. The dc trip and ac voltage circuits shall be segregated from each other as shall the circuits to main protective gear be segregated from those for back-up protection.
The screens of screened pairs of multi-core cables shall be earthed at one end of the cable only. The position of the earthing connections shall be shown clearly on the diagram.

All wires on panels and all multi-core cable cores shall be crimped with the correct sizeof crimp and crimping tool and will have ferrules which bear the same number at both ends. At those points of interconnection between the wiring carried out by separate contractors where a change of number cannot be avoided double ferrules shall be provided on each wire. The change of numbering shall be shown on the appropriate diagram of the

equipment. The same ferrule number shall not be used on wires in different circuits on the same panels.

The Contractor shall provide a two (2) metre loop of spare cable at both ends of all multi-core cable runs and shall leave sufficient lengths of tails at each end of the multi-core cables to connect up to the terminal boards. The Contractor shall also strip, insulate, ring through and tag the tails and shall also seal the cable boxes. The Contractor shall be responsible for re-checking the individual cores and for the final connecting up and fitting of numbered ferrules within all equipment provided on this contract.

The drilling of gland plates, supply and fitting of compression glands and connecting up of power cables included in the Contract scope of work shall be carried out under this contract.

18.0 LAYING AND INSTALLING OF CABLES

18.1 General

For cable laying the following shall apply:

a) Switchyard area — In concrete cable troughs (cable trench having cable racks with ladder type cable trays)
b) Control Room Cellar — On cable racks consisting of slotted type and ladder type hoisting and cable trays
c) Buildings — Conduits

Directly buried cables shall be used wherever necessary with the approval of Engg. Incharge .

18.2 Laying of cable

Cables shall be laid in concrete troughs provided under this contract or drawn into pipes or ducts or on cable racks or directly buried as may be required as per the direction of Engineer Incharge . All cable supports shall be earthed in accordance with IS 3043.

The cable support system shall be designed and constructed to carry the required cables without undue crowding of the supports and without

overloading the supports. The maximum number of layers of cable that shall be permitted on a single cable support shall be three. The width of the cable supports shall be selected to ensure that the supports are not crowded, the cable supports are not overloaded and that sufficient space is provided in the cable trough to allow for personnel access during and after cable installation.

Where cables pass under roadways they shall be laid in pipes at a depth not less than 800 mm below the surface.

The Contractor shall be responsible for the excavation of trenches which shall include all pumping and baling required and the provision of all necessary labour, plant, tools, water, additional soil, fuel or motor power for such purposes.

Cables in trenches will be inspected by the Engg. Incharge before the trenches are covered with protection slab.

The running of communications and power cables along the same route shall be avoided as far as possible. Where this is not possible they shall be segregated, the one group from the other. Power and communication cables shall be laid in separate tiers. For other than directly buried cables the order of laying of various cables shall be as follows:

a) Power cables on top tiers.
b) Control/ instrumentation and other service cables in bottom tiers.

18.3 Cable tags and markers

Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedule.

The tag shall be of aluminum with the number punched on it and securely attached tothe cable conduit by not less than two turns of 20 SWG GI wire conforming to IS 280. Cable tags shall be of rectangular shape for power cables and of circular shape for control cables.

Location of cables laid directly in the ground shall be clearly indicated with cable marker made of galvanised iron plate.

Location of buried cable joints shall be indicated with a cable marker having an additional inscription "**Cable joint**".

Cable markers shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change in direction. They shall be located on both sides of road and drain crossings.

Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct, conduit entry and at every twenty meters (20 m) in cable tray/trench runs. Cable tags shall be provided inside switchgear, motor control centres, control and relay panels etc. and wherever required for cable identification when a number of cables enter together through a gland plate.

The price of cable tags and markers shall be included in the installation rates forcables/conduits quoted by the Bidder.

18.4 Cable supports and cable tray mounting arrangements in control room

The control room will normally be provided with embedded steel inserts on concrete floors/walls for the purpose of cabling in the control room. The supports shall be secured by welding to these inserts or available building steel structures. However, in cases where no such embedded steel inserts are available, the same shall have to secure to the supports on walls or floors by suitable anchoring.

18.5 Cable support structure in switchyard cable trenches

The contractor shall fabricate and install cable support structures in cable trenches. These supports shall be provided at 750 mm spacing along the run of cable trenches.

Cable supports and cable racks shall be fabricated from standard structural steel members, channels, angles and flats of required size. The fabrication.

welding and erection of these structures shall conform to the relevant clauses of this Specification, in addition to the specification given herein.

18.6 Termination of cables and wires

Where cables leave the apparatus in an upward direction the cable boxes shall be provided with a barrier joint to prevent leakage of cable oil or compound into the apparatus. Where cable cores are liable to contact with oil or oil vapour the insulation shall be unaffected by oil.

PVC sheathed cables shall be terminated by compression glands complying with BS 6121 (or equivalent).

Auxiliary PVC insulated cables shall be terminated with compression type glands,clamps or armour clamps complete with all the necessary fittings.

Colours shall be marked on the cable box, cable tail ends and single core cables at all connecting points and/or any positions the Engg. Incharge may determine. Cable boxes shall be provided with suitable labels indicating the purpose of the supply where such supply is not obvious or where the Engg. Incharge may determine.

All cables shall be identified and shall have phase colours marked at their termination. All incoming and outgoing connections shall be terminated at a terminal block. Directtermination into auxiliary switches will not be accepted.

19.0 SUPPLY VOLTAGE

The auxiliary supply voltages on site shall be as follows:

Nominal Voltage V	Variation	Frequency Hzor DC	Phase	Wires	Neutral Connection
430	±10%	50 (-5% , +3%)	3	4	Solidly earthed
230	±10%	50(-5% ,	1	2	Solidly earthed

		+3%)			
48		DC	DC	2	

20.0 ERECTION CONDITIONS

The following shall supplement the conditions already contained in the other parts of these specifications and documents and shall govern that portion of the work on this Contract to be performed at Site.

21.0 CONTRACTOR'S FIELD OPERATION

21.1 General

The Contractor shall inform the Engg. Incharge in advance of field activity plans and schedules for carrying-out each part of the works. Any review of such plans or schedules or methods of work by the Engg. Incharge shall not relieve the Contractor of any of his responsibilities towards the field activities. Such reviews shall not be considered as an assumption of any risk or liability by the Employer or any of his representatives, and no claim of the Contractor will be entertained because of the failure or inefficiency of any such plan or schedule or method of work reviewed. The Contractor shall be solely

responsible for the safety, adequacy and efficiency of plant and equipment and his erection methods.

21.2 Unloading

Contractor shall make his own arrangement for unloading the equipment at site.

21.3 Tools, tackle and scaffoldings

The Contractor shall provide all the construction equipment tools, tackle and scaffoldings required for offloading, storage, pre-assembly, erection, testing and commissioning of the equipment covered under the Contract. He shall submit a list of all such materials to the Engg. Incharge before the commencement of pre-assembly at Site. These tools and tackles shall not be removed from the Site without the written permission of the Engg.

Incharge .

The Contractor shall maintain an accurate and exhaustive record detailing all equipment received by him for the purpose of erection and keep such record open for the inspection of the Engg. Incharge .

All equipment shall be handled carefully to prevent any damage or loss. All equipment stored shall be properly protected to prevent damage. Equipment from the store shall be moved to the actual location at an appropriate time so as to avoid damage of such equipment at Site.

All the materials stored in the open or dusty location shall be covered with suitable weather-proof and flameproof covering material.

The Contractor shall be responsible for making suitable indoor facilities for the storage ofall equipment which requires to be kept indoors.

22.0 SITE CLEARANCE

22.1 Clearing and uprooting of tree

The work shall also consist of numbering of trees, removing and disposing of all materials such as trees, bushes, woods, shrubs, grass, stumps, rubbish, rank vegetation, roots, foreign materials, etc., which in the opinion of the Engg In-charge are unsuitable for incorporation in the works, from within the limits and such other areas as may be specified on the drawings or directed by the Engg In-charge . Clearing and uprooting of tree shall be performed in advance of earthwork operations and in accordance with the requirements of these Specifications and taking prior permission from forest department. During clearing and grubbing, the contractor shall take all adequate precautions against soil erosion, water pollution etc., and where requiredundertake additional works to that effect.

22.2 Provision of plantation and developing a garden inside the sub-station

Provision of plantation and developing a garden inside the sub-station decorative plants,garden grass (Lawn), flowering plants, soil treatment and

its plantation as per the

advice of Engineer-in-charge to be planted along the road side and in and around the control room building after making surface treatment. Provision of water taps facilities at different locations for watering the plants and as well as to the peripheral earth pits.

Construction of platform & suitable GI pipe & other attachment for hoisting of National Flags. As per the direction of Engineer incharge.

22.3 Programme

The Contractor shall construct the works in compliance with the outline programme appended to the Bidding Document, and shall submit for the approval of the Engg In- charge a detailed programme in accordance with the requirements of this Specification.

22.4 Inclement weather

As per relevant Code, during hot weather, precautions shall be taken to avoid premature stiffening of the fresh concrete mix and to reduce water absorption and evaporation losses. During hot weather (atmospheric temperature above 40 degree C) or cold weather (atmospheric temperature at or below 5deg.C) concreting shall be done as per the procedure set out in IS 7861.

22.5 STANDARDS

All Civil works shall be carried out as per applicable Indian Laws, latest revision of International Standards and Codes. All materials shall be of best quality confirming to relevant Indian Standards and Codes.

Civil works shall be designed to the required service conditions and /or loads as specified elsewhere in this Specification or implied as per National and International Standards.

23.0 MATERIALS AND WORKMANSHIP

23.1 General

All materials used in the works shall be new and of the best quality of their respective kinds.They shall comply with the requirements of the latest edition of any relevant Indian Standard or Code of Practice where such exist, and current at the date of tendering.

All workmanship shall be of the highest standard, and shall be executed by competent men skilled in their respective trades.

23.2 Samples

In addition to the special provisions made in this specification for sampling and testing of materials by particular methods, samples of any materials and workmanship proposed to be used in the Works may be called for at any time during the Contract by the Engg In- charge and shall be furnished by the Contractor without delay and at the expense of the Contractor. Samples when approved, shall be regarded as the acceptable standard, and any material or workmanship subsequently not complying with that standard shall be rejected and replaced by those of acceptable standard at the expense of the Contractor. Sample storage boxes shall be provided by the Contractor free of cost if requested by the Engg In-charge.

23.3 Tests

Whenever considered desirable by the Engg In-charge , Inspectors may be sent to manufacturer's or subcontractors' premises to test materials or supervise their manufacture.

Where specified or requested the Contractor shall obtain from the manufacturer and send to the Engg In-charge certificates of test, proof sheets, mill sheets, etc., showing that materials have been tested in accordance with this Specification or the relevant Indian Standard.

Notwithstanding any tests which may be directed to be carried out at a manufacturer's and/or subcontractor's works, the Engg In-charge may carry out any tests or further tests he considers necessary or desirable after delivery of materials to the Site.

The Contractor shall provide all labour, equipment and facilities necessary for carrying out the tests both in works and on site.

The cost of routine tests required by IS and this Specification shall be borne by the Contractor. The cost of other tests shall be borne in accordance with the Conditions of Contract.

23.4 Names of suppliers and copies of orders

If so required, and before ordering material of any description, the Contractor shall submit for approval the names of makers or suppliers proposed. Copies of orders shall also be submitted if so required. The Engg In-charge may at any time withdraw his previously given approval to obtaining materials from any maker or supplier should such maker or supplier fail to supply materials of the specified quality or quantity in the requisite time.

23.5 Rejection of materials and workmanship

The Engg In-charge shall at any time have power to reject materials and workmanship not complying with this Specification or with the approved Drawings. Materials so rejected shall be immediately removed from site and replaced by materials of an approved standard at the expense of the Contractor. Rejected workmanship shall be broken out and replaced by work of an acceptable standard including the supply of new materials by the Contractor, at the expense of the Contractor, and without delay.

23.6 Cube Testing

150mmX 150mm x 150mm cube from each concrete batch shall be prepared and cureas per relevant IS and then shall be subject to laboratory test to determine it's strength inaccordance to the Indian Standard.

CHAPTER-E21

MANDATORY SPARE PARTS

MANDATORY SPARES

Sl.No	ITEMS	Unit	Quantity
1	**11kV, SF-6 RMU -Outdoor type-4 way (SCADA compatibility)** LBS+ Earth Switch-2 No (630A), CB + Disconnector+ Earth Switch (630A)-2 Nos (CT, Numerical O/C & E/F Protection relay, Numerical Differential Relay, Multi-function Meter, are to be installed on the panel)	No	2
2	High Voltage Testing equipment for conducting testing upto 33kV GIS/SIS/other equipment	No	1
3	High Voltage Tester upto 33kV	No	1
4	Tong Tester (Digital Clamp Meter , AC)	No	1
5	5kV Insulation Resistance Tester	No	1
6	Digital Multimeter	No	1
7	Relay Test Tool Kit (Test plug special type for voltage& Current)	No	1
8	Digital Earth Tester	No	1
9	100kV BDV Kit suitable for mineral & natural vegitable ester Oil (Transformer Oil breakdown voltage test set)	No	1
10	Good quality Discharge Rod	No	6
11	Portable Emergency Light LED	No	1
12	Rubber Gloves for operation of Isolator and EarthSwitch	Pair	2
13	Safety Helmet	No	4
14	Ultra High Sensitive SF6 Gas Leak Detector	No	1
15	SF6 Gas Cylinder (50kg)	No	1
16	SF6 Gas Service Cart (hand operating) portable withall Accessories of DILO make. Model : SF6 gas evacuating and refilling device / cylinder cart / mobile(3-001-4-R0xx series)	No	1
17	SF6 gas dew point measuring kit having provision of collection of SF6 gas from the equiupment/cylinder & also sending back the same to the equipment/cylinder after measurement.	No	1

Sl.No	ITEMS	Unit	Quantity
18	Vaccum Cleaner Industrial Type.	No	1
19	Closing Coil for 33kV	No	2
20	Tripping Coil for 33kV	No	2
21	Closing Coil for 11kV	No	2
22	Tripping Coil for 11kV	No	2
23	Auxiliary Contactor/Auxiliary Switch for 33kV	No	1
24	Auxiliary Contactor/Auxiliary Switch for 11kV	No	1
25	Motor for CB, Disconnector, Earth switch for 11kV	No	1
26	Motor for CB, Disconnector, Earth switch for 33kV	No	1
27	11kV CT (800/1-1-1A)	No	1
28	11kV CT (600/1-1A)	No	1
29	33kV CT (800-400/1-1A)	No	1
30	33kV CT (600-300/1-1-1A)	No	1
31	Tool Kit	No	1

CHAPTER E-23 GURANTEE TECHNICAL PERTICULARS	
GTP No	**Name of Items**
1	12.5 MVA 33/11kV Power Transformer
2	250 kVA 33/0.433kV Station Transformer
3	33kV CB
4	11kV CB
5	33kV CT
6	11kV CT
7	33kV IVT
8	11 kV IVT
9	Transformer Oil
10	Copper Bond
11	Earthing Pipe
12	33kV RMU
13	11kV RMU
14	33kV single core 630 mm^2 XLPE Copper Cable
15	33kV single core 1000 mm^2 XLPE Copper Cable
16	11kV single core 630 mm^2 XLPE Copper Cable
17	11kV Three core 400 mm^2 XLPE Aluminium Cable
18	LT Cable

GTP NO-1: GUARANTEED TECHNICAL PARTICULARS OF 12.5 MVA 33/11kV POWER TRANSFORMER		
Sl. No.	**Description**	**Bidder's offer**
1	Name and address of the Manufacturer	
a)	Transformer	
b)	HV & LV Bushings	
c)	Bimetallic connectors	
d)	Transformer Oil	
e)	On load tap changer	
f)	Instruments	
g)	Neutral Bushing CTs	
2	Service (Indoor / Outdoor)	
3	Normal continuous rating in kVA under site conditions at all taps :	
a)	HV winding (kVA)	
b)	LV winding (kVA)	
4	Rated Voltage	
a)	HV winding (kV)	
b)	LV winding (kV)	
5	Rated frequency (Hz)	
6	No. of phases	
7	Type of transformer	
8	Connections	
a)	HV winding	
b)	LV winding	
9	Connections symbols	
a)	HV – LV	
10	Tappings	
a)	Range	
b)	Number of steps	

c)	Position of tapping on HT winding for high voltage variation	
11	Reference ambient temperatures	
a)	Maximum ambient air temperature (°C)	
b)	Maximum daily average ambient temperature (°C)	
c)	Minimum ambient air temperature(°C)	
d)	Maximum yearly weighted average ambient temperature (°C)	
12	Maximum temperature rise over ambient temperature	
a)	In oil by thermometer (°C)	
b)	In winding by resistance measurement (°C)	
c)	Limit for hot spot temperature for which the transformer is designed (°C)	
d)	Type and details of winding hot spot temperature detector (°C).	
e)	Temperature gradient between windings and oil (°C).	
f)	Type of maximum winding temperature indicator (°C).	
13	Voltage to earth for which the star point will be insulated	
14	Cooling type	

GTP NO-1: GUARANTEED TECHNICAL PARTICULARS OF 12.5 MVA 33/11kV POWER TRANSFORMER		
Sl. No.	**Description**	**Bidder's offer**
15	Losses	
a)	Fixed (Iron) losses of 3 phase Transformer (kW) at rated voltage & rated frequency	
b)	Load losses at rated current at principal Tap at 75°C (kW)	
16	Max. Current density in winding at rated current for normal tap position	
a)	HV winding (Amps/ sq.mm.)	
b)	LV winding (Amps / sq.mm.)	
17	Impedance voltage at rated current , frequency and at 75°C expressed as percentage of rated voltage at :-	
a)	Principal (normal) tap (%)	
b)	Highest tap (%)	
c)	Lowest tap (%)	
18	Reactance at rated current & frequency as percentage of rated voltage at:	
a)	Principal (normal) tap	
b)	Highest Tap	
c)	Lowest Tap	
19	Resistance at 75º C	
a)	H.V. winding at normal tap position	
b)	L.V. winding	
c)	Resistance voltage drop at 75º C winding temperature expressed as percent of rated voltage (%)	
i)	Principal/ normal tap	
ii)	Highest tap	
iii)	Lowest tap	
20	Capacitance on open circuit conditions	

21	Insulation level	
a)	Separate source power frequency voltage withstand	
i)	HV winding (kV rms)	
ii)	LV winding (kV rms)	
b)	Induced over voltage withstand	
i)	HV winding (kV rms)	
ii)	LV winding (kV rms)	
c)	Full wave lightning impulse withstand voltage	
i)	HV winding (kV peak)	
ii)	LV winding (kV peak)	
d)	Power frequency high voltage tests	
i)	Test voltage for one minute withstand test on high voltage windings (induced)	
ii)	Test voltage for one minute withstand test on low voltage windings	
iii)	Test voltage for one minute withstand test on neutral end of low voltage windings	
e)	Lightning impulse withstand tests	
i)	Impulse test on high voltage winding 1.2/50 µ sec full wave withstand (kV peak)	

GTP NO-1: GUARANTEED TECHNICAL PARTICULARS OF 12.5 MVA 33/11kV POWER TRANSFORMER		
Sl. No.	**Description**	**Bidder's offer**
ii)	Impulse test on low voltage winding 1.2/50 µ sec full wave withstand (kV peak)	
iii)	Wave form for impulse test	
22	No load current, no load loss, no load power factor at normal ratio and frequency (Amp/ kW/ P.F.)	
a)	10 percent of rated voltage	
b)	25 percent of rated voltage	
c)	50 percent of rated voltage	
d)	85 percent of rated voltage	
e)	100 percent of rated voltage	
f)	105 percent of rated voltage	
g)	110 percent of rated voltage	
h)	112.5 percent of rated voltage	
i)	115 percent of rated voltage	
j)	120 percent of rated voltage	
k)	125 percent of rated voltage	
23	Efficiency at 75º C at unity power factor	
a)	Full load	
b)	75% load	
c)	50% load	
d)	25% load	
24(a)	The minimum percentage of load at which the transformer will run at maximum efficiency (%)	
b)	Maximum efficiency of the transformer	
25	Regulation at full load at 75º C	
a)	At unity power factor (%)	
b)	At 0.8 power factor (lagging) (%)	

26	Core data	
a)	Grade of core material used	
b)	Thickness of core plate lamination (mm)	
c)	Whether core laminations are of cold rolled grain oriented	
d)	Details of oil ducts in core	
i)	Whether in the plane & at right angle to the plane of winding	
ii)	Across the plane of lamination	
e) i)	Insulation of core lamination	
ii)	Insulation of core plates	
iii)	Type of core joints	
27	Flux density	
a)	Designed maximum flux density at normal tap at rated voltage and rated frequency (Tesla)	
b)	Operating continuous flux density (Tesla)	
i)	at normal tap	
ii)	at maximum tap	
iii)	at minimum tap	
c)	Designed maximum operating flux density which the transformer can withstand for one minute at normal tap (Tesla)	

GTP NO-1: GUARANTEED TECHNICAL PARTICULARS OF 12.5 MVA 33/11kV POWER TRANSFORMER		
Sl. No.	**Description**	**Bidder's offer**
d)	Designed maximum operating flux density which the transformer can withstand for five seconds at normal tap (Tesla)	
28	Inter-Tap insulation	
a)	Extent of extreme end turns reinforcement	
b)	Extent of end turns reinforcement	
c)	Extent of turn adjacent to tapping reinforced	
d)	Test voltage for 10 seconds 50Hz inter-turn insulation test on (a)	
e)	Test voltage for 10 seconds 50Hz inter-turn insulation test on (b)	
f)	Test voltage for 10 seconds 50Hz inter-turn insulation test on (c)	
29	Windings:	
a)	Material	
b)	Type of windings:	
i)	HV windings	
ii)	LV windings	
c)	Insulation of HV windings	
d)	Insulation of LV windings	
e)	Insulation between HV & LV windings	
30	Continuous rating under following conditions:	
a)	At 40ºC ambient air temp. at site	
b)	At 30ºC ambient air temp. at site	
c)	At 20ºC ambient air temp. at site	
31	Transformer Tank	
a)	Material	

b)	Thickness	
i)	Top	
ii)	Sides	
iii)	Bottom	
c)	Details of painting	
i)	Inner surface	
ii)	Outer surface	
32	Dimensions of 3 phase transformers:	
a)	Max. Height to top of bushings (mm)	
b)	Overall length (mm)	
c)	Overall breadth (mm)	
33	Weight data of transformer components : (Tolerance + 5%) (approximate values not allowed)	
a)	Core excluding clamping (Kg)	
b)	Core with clamping (Kg)	
c)	HV winding insulated conductor (Kg)	
d)	LV winding Insulated conductor (Kg)	
e)	Coils with insulation (Kg.)	
f)	Core and windings (Kg)	
g)	Weight of steel (Kg)	
h)	Fittings and accessories (Kg)	
	Oil required for first filling including 10% extra (ltrs / Kg)	
	i)Oil in main tank (Ltrs)	

GTP NO-1: GUARANTEED TECHNICAL PARTICULARS OF 12.5 MVA 33/11kV POWER TRANSFORMER		
Sl. No.	**Description**	**Bidder's offer**
i)	ii)Oil in the conservator (Ltrs)	
	iii)Oil in the radiators (Ltrs)	
	iv)Oil in the OLTC (Ltrs.)	
	v)Overall total quantity of oil with 10% extra oil for first filling (ltrs / Kg)	
j)	Transportation weight excluding accessories (Kg)	
k)	Shipping details	
i)	Weight of heaviest package (Kg.)	
ii)	Dimension of largest package (Kg)	
l)	Untanking weight (Kg)	
m)	Total weight of transformer with oil and fittings (Kg)	
34	Bushing data :	
a)	Type of bushing insulator	
i)	HV	
ii)	LV	
iii)	Neutral	
b)	Material of bushing (inner part / outer part)	
c)	Weight of bushing insulator (Kg.)	
d)	Quantity of oil in one bushing (lt.)	
e)	Minimum dry withstand & flash over power frequency voltage of bushing (kV)	
f)	Minimum wet withstand & flash over power frequency voltage of bushing (kV)	
g)	Minimum withstand & flashover impulse level (kV)	
h)	Voltage rating (kV)	

i)	Current rating (Amps.)	
j)	Thermal Short Time current & Duration	
k)	Rated Dynamic current & its duration	
l)	Cantilever with stand loading	
m)	Clearance in oil	
	i)phase to phase (mm)	
	ii)phase to earth (mm)	
n)	Creepage distance in oil & air (mm)	
o)	Minimum level of immersing / medium (oil) (mm)	
p)	Maximum pressure of immersing medium (oil) Kg/ cm^2	
q)	Free space required at top for removal of bushings (mm)	
r)	Angle of mounting	
35	Details of CT to be provided in the neutral for REF protection.	
a)	Outdoor bushing type	
b)	No. of cores and their function	
c)	Location (Line / Neutral)	
d)	Current rating for various cores (Primary / Secondary)	
e)	VA burden / Knee Point voltage (Core wise)	
f)	Magnetising current at half knee point voltage. (mA)	
g)	Classification (PS class) core wise	
h)	Test voltage	

GTP NO-1: GUARANTEED TECHNICAL PARTICULARS OF 12.5 MVA 33/11kV POWER TRANSFORMER		
Sl. No.	**Description**	**Bidder's offer**
i)	Construction details	
36	Conservator (Main Transformer and OLTC)	
a)	Total volume of the Conservator (Cub mtr / Ltr.)	
b)	Volume of the conservator between the highest and lowest level (Cubic mtr. / Ltrs)	
37	Calculated time constants for natural cooling	
38	Type of axial coil supports :	
a)	HV winding	
b)	LV winding	
39	Details of On Load tap changer	
a)	Make	
b)	Type	
c)	Rating	
i)	Rated Voltage	
ii)	Rated current	
iii)	Step voltage	
iv)	Number of steps	
d)	Whether Diverter switch provided with gas vent and buchholz relay (Yes / No)	
e)	Whether a separate oil surge relay with trip contacts provided (Yes / No)	
f)	Pressure relief valve	
g)	Details of motor device unit housed in kiosk / mounted on tap changer	
h)	Whether Remote control panel provided with Control scheme for simultaneous operation of Tap changer when transformers are running in parallel and	

	independent control when in independent operation.	
i)	Details of equipment in the OLTC kiosk	
j)	Details of OLTC panels	
	i)automatic tap changer relay	
	ii)literature of all the relays	
	iii)dimensions of OLTC, Panel L x B x H	
	iv)thickness of sheet	
	v)degree of protection	
	vi)details of equipment supplied	
40	Dispatch details :	
a)	Approx. mass of heaviest Package (Kg)	
b)	Approx. dimensions of largest Package	
	i)Length (mm)	
	ii)Breadth (mm)	
	iii)Height (mm)	
41	Un-tanking height (mm)	
42	Bimetallic connectors HV / LV	
a)	Normal current rating (A)	
b)	Short time current rating (A)	
c)	Tensile strength (Kg)	
d)	Maximum temperature limit	
e)	Dimensional sketch enclosed indicating tolerances (Yes/No)	
	Minimum clearance (mm)	

GTP NO-1: GUARANTEED TECHNICAL PARTICULARS OF 12.5 MVA 33/11kV POWER TRANSFORMER		
Sl. No.	**Description**	**Bidder's offer**
f)	i)Phase to phase	
	ii)Phase to Earth	
43	CORE ASSEMBLY :-	
a)	Core diameter (mm)	
b)	Core window height (mm)	
c)	Core leg centre (mm)	
d)	Gross core cross – sectional area (m^2)	
e)	Total height of core (mm)	
f)	Details of top end frame	
g)	Details of Bottom end frame	
h)	Details of clamp plate (material, thickness, insulation)	
i)	Total core weight (Kg)	
j)	Core loss, basing on core loss graph at operating flux density (rated voltage and rated frequency) (kW)	
k)	Core stacking factor	
l)	Net core area (Sq.m)	
m)	Margin towards corner joints, cross-fluxing, dielectric loss (kW)	
n)	Total core loss at rated voltage and rated frequency (kW)	
o)	Describe location / method of core grounding	
p)	Details of core- belting	
i)	Material , grade and type	
ii)	Width	
iii)	Thickness	
iv)	Fixing method	

44	**DETAILS OF WINDING**	
a)	Type of winding	
b)	Material of the winding conductor	
c)	Maximum current density of windings at rated current and conductor area	
d)	Whether windings are pre-shrunk ?	
e)	Whether adjustable coil clamps are provided for HV and LV windings ?	
f)	Whether steel rings are used for the windings ? If so, whether these are split ?	
g)	Whether electrostatic shields are provided to obtain uniform voltage distribution in the windings ?	
h)	Winding Insulation (Type & Class)	
i)	Insulating material , used for	
i)	H.V winding	
ii)	LV winding	
iii)	Tapping connection	
j)	Insulating material used between	
i)	L.V and H.V winding	
ii)	Core & L.V winding	
k)	H.V to H.V winding between phases	
l)	Type of axial supports	
i)	H.V winding	
ii)	L.V winding	

GTP NO-1: GUARANTEED TECHNICAL PARTICULARS OF 12.5 MVA 33/11kV POWER TRANSFORMER		
Sl. No.	**Description**	**Bidder's offer**
m)	Type of radial supports	
i)	H.V winding	
ii)	L.V winding	
n)	Maximum allowable torque on coil clamping bolts	
o)	Clamping ring details	
i)	Thickness of ring mm	
ii)	Diameter of ring mm	
iii)	No. & size of pressure screw	
p)	Bare conductor size (mm^2)	
i)	HV	
ii)	LV	
q)	Insulated conductor size (mm^2)	
i)	HV	
ii)	LV	
r)	No. of conductor in parallel (Nos.)	
i)	HV	
ii)	LV	
s)	No. of turns / phase	
i)	HV	
ii)	LV	
t)	No. of discs / phase	
i)	HV	
ii)	LV	
u)	No. of turns / Disc	
i)	HV	
ii)	LV	
v)	Gap between discs (mm)	

i)	HV	
ii)	LV	
w)	Inside diameter (mm)	
i)	HV	
ii)	LV	
x)	Outside diameter (mm)	
i)	HV	
ii)	LV	
y)	Axial height after shrinkage (mm)	
i)	HV	
ii)	LV	
z)	D.C Resistance	
i)	L.V winding at 75°C (Ohms)	
ii)	H.V winding at normal tap at 75°C (Ohms)	
iii)	H.V winding at highest tap at 75°C (Ohms)	
iv)	H.V winding at lowest tap at 75°C (Ohms)	
v)	Total I^2R losses at 75°C for normal tap (kW)	
vi)	Total I^2R losses at 75°C for highest tap (kW)	
vii)	Total I^2R losses at 75°C for lowest tap (kW)	
viii)	Stray losses including eddy current losses in winding at 75°C (kW)	
	i)Normal tap position	
	ii)Highest tap position	

GTP NO-1: GUARANTEED TECHNICAL PARTICULARS OF 12.5 MVA 33/11kV POWER TRANSFORMER		
Sl. No.	**Description**	**Bidder's offer**
	iii)Lowest tap position	
	iv)Any special measures, taken to reduce eddy current losses and stray losses. Mention in details	
ix)	Load losses at 75°C (I^2 R + Stray)	
	i)Normal tap position (kW)	
	ii)Highest tap position (kW)	
	iii)Lowest tap position (kW)	
x)	Details of special arrangement, provided to improve surge voltage distribution in the windings.	
45	DETAILS OF TANK :	
a)	Material of Transformer tank	
b)	Type of tank	
c)	Thickness of sheet (No approximate value to be mentioned)	
	i) Sides (mm)	
	ii) Bottom (mm)	
	iii) Cover (mm)	
	iv) Radiators (mm)	
d)	Inside dimensions of main tank (No approximation in dimensions to be used)	
	i) Length (mm)	
	ii) Breadth (mm)	
	iii) Height (mm)	
e)	Outside dimensions of main tank (No approximation in dimensions to be used)	
	i) Length (mm)	
	ii) Breadth (mm)	

	iii) Height (mm)	
f)	Vacuum recommended for hot oil circulation (torr / mm of Hg)	
g)	Vacuum to be maintained during oil filling in transformer tank (torr / mm of Hg)	
h)	Vacuum to which the tank can be subjected without distortion (torr / mm of Hg)	
i)	No. of bi-directional wheels provided	
j)	Track gauge required for the wheels	
	i) Transverse axis	
	ii) Longitudinal axis	
k)	Type and make of pressure relief device and minimum pressure at which it operates (Kpa)	
46	CONSERVATOR :-	
a)	Thickness of sheet (mm)	
b)	Size (Dia x length) (mm)	
c)	Total volume (Litres)	
d)	Volume between the highest and lowest visible oil levels (Litres)	

GTP NO-2: GUARANTEED TECHNICAL PARTICULARS OF 250kVA 33/0.433kV STATION TRANSFORMER		
Sl. No.	**DESCRIPTION**	**BIDDERS OFFER**
1	Make	
2	Name of Manufacturer	
3	Place of Manufacture	
4	Voltage Ratio	
5	Rating in kVA	
6	Core Material used and Grade:	
a)	Flux density	
b)	Over fluxing without saturation (Curve to be furnished by the Manufacturer in support of his claim)	
7	Maximum temperature rise of:	
a)	windings by resistance method	
b)	Oil by thermometer	
8	Magnetizing (no-load) current at:	
a)	90% Voltage	
b)	100% Voltage	
c)	110% Voltage	
9	Core loss in watts:	
a)	Normal voltage	
b)	Maximum voltage	
10	Resistance of windings at 20ºC,750C (with 5%	
a)	HV Winding (ohms)	
b)	LV Winding (ohms)	
11	Load losses (watts) at 75ºC at normal tap(100%	
12	TOTAL Losses (Load loss +No Load Loss)at 100%	
13	Total Losses at 50% load at 75ºC	

14	Current density used for: (Ampere/sq mm)	
a)	HV Winding.	
b)	LV Winding.	
15	Clearances: (mm)	
a)	Core and LV	
b)	LV and HV	
c)	HV Phase to phase	
d)	End insulation clearance to earth	
e)	Any point of winding to tank.	
16	Efficiency at 75ºC	
a)	Unity P.F and	
b)	0.8 P.F.	
i)	125°C load	
ii)	100°C load	
iii)	75°C load	
iv)	50°C load	
v)	25°C load	
17	Regulation at:	
a)	Unit P.F.	
b)	0.8 P.F. at 75ºC	
18	% Impedance at 75ºC	
19	Flash test:-	
i)	HV 70 kV/ 50HZ for 1 minute	
ii)	LV 3 kV /50 Hz for 1 minutes.	
20	Over potential test (Double voltage and Double	
21	Impulse test.	

GTP NO-2: GUARANTEED TECHNICAL PARTICULARS OF 250kVA 33/0.433kV STATION TRANSFORMER		
Sl. No.	**DESCRIPTION**	**BIDDERS OFFER**
22	Mass of : (kg)	
a)	Core lamination (minimum)	
b)	Windings (minimum)	
c)	Tank and fittings	
d)	Oil	
e)	Oil quantity (minimum) (litre)	
f)	Total weight	
23	Oil Data:	
a)	Quantity for first filling (minimum) (litre)	
b)	Grade of oil used.	
c)	Maker's name	
d)	BDV at the time of filling (kV)	
24	Transformer:	
a)	Overall length x breadth x height (mm x mm x mm)	
b)	Tank length x breadth x height	
c)	Thickness of plates for	
i)	Side plate (min)	
ii)	Top and bottom plate (min)	
d)	Conservator Dimensions.	
25	Radiation:	
a)	Heat dissipation by tank walls excluding top and	
b)	Heat dissipation by cooling tube	
c)	Diameter and thickness of cooling tube.	
d)	Whether calculation sheet for selecting cooling area	
26	Inter layer insulation provided in	

	design for:		
a)	Top and bottom layer		
b)	In between all layer		
c)	Details of end insulation.		
d)	Whether wedges are provided at 50ºC turns of the		
27	Insulation materials provided.		
a)	For Conductors		
i)	HV		
ii)	LV		
b)	For Core.		
28	Material and Size of the wire used.		
i)	HV Dia (mm)	(SWG)	
ii)	LV		
a)	Strip size		
b)	No. of Conductors in parallel		
c)	Total area of cross section (sq mm).		
29	Whether the name plate gives all particulars as		
30	Particulars of bushings HV/LV		
a)	Maker’s name		
b)	Type IS-3347/IS-2099/IS-7421		
c)	Rating as per IS		
d)	Dry power frequency voltage withstand test		
e)	Wet power frequency voltage withstand test.		

GTP NO-3: GUARANTEED TECHNICAL PARTICULARS OF 33kV CIRCUIT BREAKER (INDOOR)			
Sl. No	**Name of the Particulars**	**OPTCL Requirement**	**Bidder's Offer**
1	Make		
2	Service type	Indoor	
3	No. of Poles	3	
4	Nominal system voltage	33 kV	
5	Highest system voltage	36kV	
6	Rated normal current at 50°C		
i)	For Bus-bar of Circuit Breaker	1250A	
ii)	For Interrupter	1250A	
7	Maximum withstanding ambient temperature	25kA	
8	Rated short circuit making current (peak)	62.5kA	
9	Rated short time current withstand capability for 3sec.	25kA	
10	Rated insulation level:		
i)	One minute power frequency withstand voltage toearth (wet and dry) rms	70kV	
ii)	Impulse withstand voltage to earth with 1 .2/50 µsec, wave of +ve and — ve polarity(Peak)	170KV	
11	First — pole — to clear factor	1.5	
12	Rated operating sequence (for auto reclosing)	0-0.3 Sec- CO-3 min- CO	
13	Maximum break time	3 cycles	
14	Rated out of phase breaking current	25% of the symmetricalshort circuit breaking current	

15	Maximum pole scatter	10 mili seconds	
16	Rated Auxiliary supply for spring charge motor,lamp & heater circuit.	230V AC	
17	Rated supply voltage for trip/close coil	48 V DC	

GTP NO-4: GUARANTEED TECHNICAL PARTICULARS OF 11kV CIRCUIT BREAKER (INDOOR)			
SI. No	**Name of the Particulars**	**OPTCL Requirement**	**Bidder's Offer**
1	Make		
2	Service type	Indoor	
3	No. of Poles	3	
4	Nominal system voltage	11 kV	
5	Highest system voltage	12kV	
6	Rated normal current at 50°C		
i)	For Bus-bar of Circuit Breaker	2000A	
ii)	For Interrupter	1250A	
7	Maximum withstanding ambient temperature	25kA	
8	Rated short circuit making current (peak)	62.5kA	
9	Rated short time current withstand capability for3 sec.	25kA	
10	Rated insulation level:		
i)	One minute power frequency withstand voltage toearth (wet and dry) rms	28kV	
ii)	Impulse withstand voltage to earth with 1 .2/50 µsec, wave of +ve and —ve polarity (Peak)	75KV	
11	First — pole — to clear factor	1.5	
12	Rated operating sequence (for auto reclosing)	0-0.3 Sec- CO-3 min- CO	
13	Maximum break time	3 cycles	
14	Rated out of phase breaking current	25% of the symmetricalshort circuit breaking current	
15	Maximum pole scatter	10 mili seconds	

16	Rated Auxiliary supply for spring charge motor, lamp& heater circuit.	230V A.C	
17	Rated supply voltage for trip/close coil	48 V D.C	

GTP NO - 5: GUARANTEED TECHNICAL PARTICULARS FOR 33 kV CURRENT TRANSFORMER (GENERAL)			
Sl. No.	Name of the Particulars	OPTCL Requirement	Bidder's Offer
1	Make		
2	Type of CT/Installation.	Resin cast/Polycrate	
3	Type of mounting.		
4	Suitable for system frequency.	50 HZ (+ 5 % to -3%)	
5	Rated voltage (KV rms)	33	
6	Nominal system voltage (KV rms)	33	
7	Highest system voltage (KV rms)	36	
8	Current ratio (A/A)	a) 800-400/1-1A b) 600-300/1-1-1A	
9	Maximum withstanding ambient temperature	Solidly Effectively earthed.	
10	Rated continuous thermal current (A)	120 % of rated primary current	
11	Acceptable limit of temperature rise above 50°C ambient temperature for continous operation at rated continuous thermal current.		
(a)	Winding	45°C	
(b)	Oil	40°C	
(c)	External surface of the core, metallic parts in contact with or adjacent to, insulation.	45°C	
12	Acceptable partial discharge level	Less than 10 pico coulombs	
13	Maximum radio interference voltage at l. l times the maximum rated voltage.	Less than 500 micro volts	
14	l.2/50 micro second lightning impulse withstand voltage (kVP) (dry)	170	
15	1 minute dry power frequency withstand voltage primary (kV	70	

	rms)		
16	Switching Impulse with stand and voltage (kVP)		
17	l Minute dry power frequency withstand voltage secondary (kV rms)	3	
19	Rated short time withstand current for 3 second at all ratios (KA rms)	25kA	
20	Instrument security factor at all ratios for metering core.	Not more than 5.0	
21	Minimum rated short time thermal current density of the primary winding at all ratios (A/mm²)	r clause No9.6.3- Note of IS: 2705 (Part-I)/l992	
22	Application, current ratio, output burden, accuracy class, minimum knee point voltage, secondary winding resistance, maximum excitation current at minimum knee point voltage etc.		
23	Type of core	Torroidal type	
24	Seismic acceleration	0.15g (Vertical) 0.3g (Horizontal)	
25	Accuracy class of standard C.T. to be used during testing towards determination of ratio errors and phase angle errors for metering cores.	0.05 or better.	

GTP NO - 6: GUARANTEED TECHNICAL PARTICULARS OF 11KV CURRENT TRANSFORMERS (GENERAL)			
Sl. No.	**Name of the Particulars**	**OPTCL Requirement**	**Bidder's Offer**
1	Make		
2	Type of CT Installation	Resin cast/Polycrate	
3	Type of mounting		
4	Suitable for system frequency	50 HZ (- 5% t o + 3 %)	
5	Rated Voltage (KV rms)	11	
6	Nominal System Voltage (KV rms)	11	
7	Highest System Voltage (KV rms)	12	
8	Current Ratio (A/A)	a) 800-400/1-1A b) 600-300/1-1-1A	
9	Maximum withstanding ambient temperature	Effectively earthed	
10	Rated Continous Thermal Current (A)	120% of rated primary current	
11	Acceptable limit of temperature rise above 500C ambient temperature for continuous operation at rated continuous thermal current		
	(a) Winding	40ºC	
	(b) OIL	35ºC	
	(c)External surface of the core, metallic parts in contactwith or adjacent to, insulation.	40ºC	
12	1.2/50 micro second lighting impulse withstand voltage(kVP) (dry)	75	
13	1 Minute dry power frequency withstand voltage primary(kV rms)	28	
14	1 Minute dry power frequency withstand voltagesecondary(KV rms)	3	
16	Rated short time withstand current for 3 second durationat all ratios (KA rms)	25	

	Instrument security factor at all ratios for metering core	Not more than 5.0	
17	Maximum rated short time thermal current density of theprimary winding copper conductor (A/mm2) at all ratios	92	
18	Type of Core	Torroidal type	
19	Seismic acceleration	0. 15g (Vertical)	
		0.3g (Horizontal)	
20	Accuracy class of standard C.T to be used during testingtowards determination of ratio errors and phase angle errors for metering cores.	0.05 or better.	

GTP NO- 7: GUARANTEED TECHNICAL PARTICULARS OF 33/0.11 kV INDUCTIVE VOLTAGE TRANSFORMERS (GENERAL)			
Sl. No	**Name of the Particulars.**	**OPTCL Requirement**	**Bidder's Offer**
1	Type	Singlephase, 50Hz, self cooled, Hermetically sealed, indoor Resin Cast/Polycrate	
2	Nominal system voltage.	33kV.	
3	Highest system voltage.	36kV	
4	Frequency.		
5	System earthing.	Effectively solidly earthed	
6	Number of phases.	3 [single phase]	
7	(i) Number of secondary windings. Purpose of windings.	one protection and one Metering	
8	Rated primary voltage.	33/1.732kV	
9	Maximum withstanding ambient temperature	110/1.732V (Metering) 110/1.732V (Protection)	
10	Ratio	33KV/1 .732/ 110/1 .732	
11	Rated burden.	Winding-I(P)- 30VA Winding-II(M)- 30 VA	
12	Accuracy class .	3P & 0.2	
13	Rated voltage factor at rated frequency.	.2 continuous. 1.5 for 30 seconds	
14	Temperature rise at 1.2 times the rated primary voltage, rated frequency & rated	As per IEC-186.	
15	Temperature rise at 1.5 times the ratedprimary voltagefor 30seconds, rated frequency &rated	As per IEC-186	
16	One-minute power frequency dry withstands test voltage for primary	70kV (rms)	

	winding.		
17	1-minute power frequency wet withstands test voltage for primary winding.	70kV (rms)	
18	1.2/50 microsecond impulse withstandtest voltage for primary winding	170kV (peak)	
20	One-minute power frequency withstands test voltage for Secondary winding Between LV(HF) terminal & earth terminal Class of insulation.	3 kV (rms) ‘A’	
21	Material of the conductor of primary and secondary windings.	Copper	
22	Fault level of the bus to which PTs will be connected.	25kA for 3 second.	
25	Radio interference voltage at 1 .1 t imes maximum rated voltage at 1.0 MHZ.		
26	Partial discharge level.		
27	Accuracy class of standard V.T. to be used during testing towards determination of ratio errors and phase angle errors for metering windings.	0.05 or better.	
28	Capacitance (Pf)		

GTP NO-8 GUARANTEED TECHNICAL PARTICULARS OF 11/0.11 kV INDUCTIVE VOLTAGE TRANSFORMERS(GENERAL)			
Sl. No	**Name of the Particulars.**	**OPTCL Requirement**	**Bidder's Offer**
1	Type	Singlephase, 50Hz, self cooled, Hermetically sealed, indoor Resin Cast/Polycrate	
2	Nominal system voltage.	11kV.	
3	Highest system voltage.	12kV	
4	Frequency.		
5	System earthing.	Effectively solidly earthed	
6	Number of phases.	3 [single phase]	
7	(i)Number of secondary windings. (ii)Purpose of windings.	one protection and one Metering)	
8	Maximum withstanding ambient temperature	11/1.732kV	
9	Rated secondary voltage.	110/1.732V (Metering) 110/1 .732V Protection	
10	Ratio	11kV/1 .732/ 110/1 .732	
11	Rated burden.	Winding-I(P)-30VA Winding-II(M)- 30 VA	
12	Accuracy class .	3P and 0.2	
13	Rated voltage factor at rated frequency.	1.2 continuous. 1.5 for 30 seconds	
14	Temperaturerise at 1.2 times the rated primary voltage, rated frequency & rated burdens.	As per IEC-186.	
15	Temperature rise at 1.5 times the rated primary voltage for 30 seconds, rated frequency &rated	As per IEC-186	
16	One-minute power frequency dry withstands test voltage for primary	28kV (rms)	

	winding.		
17	1.2/50 microsecond impulse withstandtest voltage for primary winding	75kV (peak)	
18	One-minute power frequency withstands test vo lt a ge f or Secondary winding	3 kV (rms)	
(i)	Between LV(HF) terminal & earth terminal	3 kV (rms)	
20	Class of insulation.	'A'	
21	Material of the conductor	Copper	
22	Fault level of the bus to which PTs will be connected.	25kA for 3 second	
25	Radio interference voltage at 1 .1 t imes maximum rated voltage at 1.0 MHZ.		
26	Partial discharge level.		
27	Accuracy class of standard V.T. to be used during testing towards determination of ratio errors and phase angle errors for metering windings.	0.05 or better.	
28	Capacitance (Pf)		

GTP NO - 9 GUARANTEED TECHNICAL PARTICULARS OF TRANSFORMER OIL			
SL. NO.	**Name of the Particulars**	**OPTCL Requirement**	**Bidder's Offer**
1	Appearance	Clear and transparent free from suspended matter or sediments.	
2	Density at 29.5° C (Max) gm/cc	0.89	
3	Viscosity, Kinematic at 27° C (Max)	27	
4	Interfacial Tension at 27° C (Min) Newton / M	0.04	
5	Flash point, Pensky Marten (closed) in °C (min).	140	
6	Pour point in ° C (Max)	-6	
7	Neutralisation value		
	a) Total acidity, mg KOH/gm (Max)	0.03	
	Maximum withstanding ambient temperature	Nil	
8	Corrosive sulphur (Copper strip) 19 hours at 140°C	Non corrosive	
9	Electric strength (Breakdown Voltage) KV (rms).		
	a) New unfiltered oil (min).	60	
	b) After filteration (min).	60	
10	Dielectric dissipation factor (Tan Delta) at 90°C (Max).	0.002	
11	Specific resistance (resistivity)		
	a) at 90° C , ohm-cms (Min)	35×10^{12}	
	b) at 27° C , ohm-cms (Min)	1500×10^{12}	
12	Oxidation stability.		
	a) Neutralisation value, after oxidation for 164 hours at 100°C mg KOH/gm (Max).	0.4	
	b) Total sludge, after 164 hours at 100°C wt. % (max).	0.1	

13	Ageing characteristics after accelerated Ageing (open beaker method with copper Catalyst) for 96 hours at 115°C		
	a) Specific resistance(resistivity)		
	i) at 27°C, ohm-cms (Min)	2.5×10^{12}	
	i) at 90°C, ohm-cms (Min)	0.2×10^{12}	
	b) Dielectric dissipation factor (Tan Delta) at 90°C, ohm- cms (Min)	0.2	
	c)Total acidity, mg KOH/gm (max)	0.05	
	d) Total sludge value, Wt. % (max)	0.05	
14	Presence of oxidation inhibitor	The oil shall not contain anti oxidant additives.	
15	Water content, ppm (max)	20	
16	i) Proportion of classes of hydrocarbons in the crude oil including content of aromatic hydrocarbons.		
	ii) Details of barrel (Size, gauge inside/outside coating/weight of empty drum not less than 18 Kg.)		
	iii) List of equipments for testing of oil as per revised ISS		
	iv)Electric strength(breakdown voltage) KV (Min)		
	a) Value of the fresh sample in the supplied sealed drums KV(Min).		
	b) Value after filling in transformer upto & within 3 months (Min)		

GTP N0 - 10 GUARANTEED TECHNICAL PARTICULARS OF FLEXIBLE COPPER BOND			
Sl. No.	**Name of the Particulars.**	**OPTCL Requirement**	**Bidder's Offer**
1	Stranding	37/ 7/ 0.417	
2	Cross sectional area(Sq.mm)	75.6	
3	Minimum copper equivalent area(sq.mm)	34(each individual wire)	
4	Length of copper cable(mm)	500	
5	Material Lugs	Tinned copper	
6	Bolt Size		
	(i) Diameter(mm)	16	
	(ii) Length(mm)	40	
7	Maximum withstanding ambient temperature	0.0004(as per IS.2121)	
8	Total weight of Fexible copper bond(kg)	0.45(approx)	

GTP NO- 11 GUARENTEED TECHNICAL PARTICULARS OF EARTHING PIPE			
Sl. No	**Name of the Particulars.**	**OPTCL Requirement**	**Bidder's Offer**
		Multiplication Factor to Resistivity	
1	Length (mm)2000	0.21	
2	Length (mm)3000	0.15	
3	Short Time Current Rating	25kA	
4	Inner Diameter	100mm Pipe	
5	Outer Diameter	112mm Pipe	
6	Galvanization Range	Between 80 to 100 micro ohms	
7	Inner Space Contains	Heterogeneous Rich Crystalline Mixture	
8	Maximum withstanding ambient temp	G.I Type	

GTP 12: GUARANTEED TECHNICAL PARTICULARS FOR 33 kV RMU			
Sl. No.	**Name of the Particulars**	**OPTCL Requirement**	**Bidder's Offer**
1	Manufacturer's Name		
2	Manufacturer's Design / Type ref/Model.		
3	Material used for making the body of the RMU	CRCA/Aluzinc	
4	Standards of manufacturing		
5	Whether painting for RMU is done as per standards.	Yes	
6	Whether the enclosure is anti-corrosive	Yes	
7	Whether the RMU metal clad is provided with sufficient space for integration of Sufficient space for inspection, testing, etc Earthing arrangements Terminal output points for automation	Yes	
8	Whether RMU is compatible for SCADA operation	Yes	
9	Maximum withstanding ambient temperature	50 deg	
10	Spacing between live part to Earth		
11	Provision of dual connector in HT terminal busings for parallel feeder.	Yes	
12	Whether the RMU's are designed to withstand in all weather conditions (Saline weather in Seashore area, Chemical industries polluted area)	Yes	
13	Over all dimensions of the RMU (L x B x H)		
14	Thickness of the Material used for the fabrication of the RMU	3mm	
15	Whether the RMU is manufactured as per IEC/IS standards to hold SF6 gas without	Yes	

	leakage.		
16	Whether the provision has been made in the RMUs for sensors for temperature compensated pressure measurement in the relevant gas compartment to monitor the	Yes	
17	Whether the RMU is sealed pressure system.	Yes	
	Weight of RMU complete with operating mechanism.(for 2 VCB+2LBS)		
	Whether RMUs are provided with necessary take off terminals for SCADA / Automation		
18	Heater for dehumidifying inside the RMU chamber	Yes	
19	W hether the gas chamber is made of stainless steel / earth screened cast resin enclosures		
20	Bus PT Ratio	33000/110V	
21	PT Burden	30VA	
SF6/VCB Circuit Breakers used in the Compact RMU			
Sl. No.	Name of the Particulars	OPTCL Requirement	Bidder's Offer
1	Manufacturer's Name		
2	Manufacturer's / Type ref/Model.		
3	Materials used for making the body of the breaker	CRCA/Alu zinc	
4	Standards of manufacturing		
5	Whether the breakers are manufactured as per IEC/IS standards		
6	Maximum temperature with stand of the breakers		

7	Spacing between live part to Earth inside the breaker		

GTP 12: GUARANTEED TECHNICAL PARTICULARS FOR 33 kV RMU			
Sl. No.	**Name of the Particulars**	**OPTCL Requirement**	**Bidder's Offer**
8	Spacing between poles		
9	SF6 interrupter make		
10	Contact separation distance		
11	Type of main contacts		
12	Contact pressure		
13	Contact resistance		
14	Life of the interrupter (in number of operations)		
15	Tripping at rated current Tripping at maximum fault current. (Allowable maximum erosion 3 mm) (iii)Mechanical operations.		
16	Details of main contacts		
17	Control circuit voltage DC.	24 V	
18	Whether trip free or not		
19	Whether all the interlocks provided		
20	Rated Voltage	33 kV	
21	Rated Insulation Level	36 kV	
22	Rated Frequency	50 Hz	
23	Dry 1 minute power frequency withstand between line terminal and earth	70 kV	
24	1.2/50 full wave impulse withstand voltage between line terminal and earth	170 kVp	

25	Rated re striking voltage at 100% and 50% rated capacity. (a) Amplitude factor (b) Phase factor (c) Natural frequency (d)R.R.R.V.(Volts/micro sec.)		
26	Rated Normal Current	630 A	
27	Rated cable charging breaking current	25 A	
28	Rated short circuit withstand current	25 kA for 3 sec	
29	Rated short circuit breaking current (symmetrical)	25 kA	
30	Rated short circuit breaking current (Asymmetrical)		
31	Rated transient recovery voltage for terminal faults		
32	Rated short circuit making current	62.5 kA peak at rated voltage	
33	Total break time at 10% rated interrupting capacity	< 80ms	
34	Total break time at rated interrupting capacity	< 60ms	
35	Arcing time	< 15ms	
36	Make time	< 100 ms	
37	Minimum SF6 gas pressure required	0.1 MPa	
38	Clearance between live parts and contacts		
39	Special features if any		
40	Foundation loads and details.		
41	CT Rato	400-200/1-1-1A	

42	CT burden	2.5VA	
NUMERIC/COMMUNICABLE RELAY			
Sl. No.	Name of the Particulars	OPTCL Requirement	Bidder's Offer
1	Manufacturer's Name and Country of Origin		
2	Manufacturer's design / Ref. Type		
3	Applicable Standards		
4	Whether draw out type		

GTP 12: GUARANTEED TECHNICAL PARTICULARS FOR 33 kV RMU			
Sl. No.	**Name of the Particulars**	**OPTCL Requirement**	**Bidder's Offer**
5	Types of case		
6	Maximum and Minimum, operating ambient air temp.		
7	Certificate of Proof for Electro Magnetic Interference		
8	Whether Alpha numeric / LED display		
9	Relay characteristic for over current		
10	Relay characteristic for earth fault		
11	Current Range of over current relay		
12	Current Range of high set over current relay		
13	Current Range of earth fault relay		
14	Current Range of high set earth fault relay		
15	Time delay for over current relay		
16	Time delay for high set over current relay		
17	Time delay for earth fault relay		
18	Time delay for high set earth fault relay		
19	Communication port	RS 485	
20	Burden	2 VA	
SF6 Load Break Switch			
Sl. No.	Name of the Particulars	OPTCL Requirement	Bidder's Offer
1	Make		
2	Type		
3	Reference Standard		

4	Rated Insulation Level	36 kV	
5	Rated Frequency	50 Hz	
6	Dry 1 minute power frequency withstand between line terminal and earth	70 kV	
7	Dry 1 minute power frequency withstand voltage between terminals of breaker contacts open	80 kV	
8	1.2/50 full wave impulse withstand voltage between line terminal and	170 kVp	
10	Rated Normal Current	630 A	
11	Rated cable charging breaking current	25 kA	
12	Short time current of main circuit	25 kA for 3 sec	
13	Peak with stand current of main circuit	62.5 kA	
14	Rated Making current of main circuit	62.5 kA	
15	Short time current of earthing circuit	25 kA for 3 sec	
16	Peak with stand current of earthing circuit	62.5 kA	
17	Rated Making current of earthing circuit	62.5 kA	
18	Minimum SF6 gas pressure required	0.1 MPa	
19	Number of mechanical operations of main isolator	1000	
20	Number of mechanical operations of earth switch	1000	
21	Number of electrical operations at rated current	100	
22	Number of electrical operations of the at rated short circuit making of main isolator	5	
23	Number of electrical operations of the at rated short circuit making of earth switch	5	

24	Operating mechanism – closing & opening		
25	Earthing for operating mechanism and metal parts furnished		
26	Whether earth switch is prevented from closing when main isolator is on	YES	
27	Whether cable door is prevented from opening unless earth switch is on	YES	

GTP 13 - GUARANTEED TECHNICAL PARTICULARS FOR 11 kV RMU			
Sl. No.	**Name of the Particulars**	**OPTCL Requirement**	**Bidder's Offer**
1	Manufacturer's Design / Type ref/Model.		
2	Material used for making the body of the RMU	CRCA/Aluzinc	
3	Standards of manufacturing		
4	Whether painting for RMU is done as per standards.	Yes	
5	Whether the enclosure is anti-corrosive	Yes	
6	Whether the RMU metal clad is provided with sufficient space for integration of Sufficient space for inspection, testing, etc Earthing arrangements Terminal output points for automation	Yes	
7	Whether RMU is compatible for SCADA operation	Yes	
8	Maximum withstanding ambient temperature	50 deg	
9	Spacing between live part to Earth		
10	Provision of dual connector in HT terminal busings for parallel feeder.	Yes	
11	Whether the RMU's are designed to withstand in all weather conditions (Saline weather in Seashore area, Chemical industries polluted area)	Yes	
12	Over all dimensions of the RMU (L x B x H)		
13	Thickness of the Material used for the fabrication	Load bearing member:	

	of the RMU	2.5 mm and Non load bearing member : 2 mm	
14	Whether the RMU is manufactured as per IEC/IS standards to hold SF6 gas without leakage.	Yes	
15	Whether the provision has been made in the RMUs for sensors for temperature compensated pressure measurement in the relevant gas compartment to monitor	Yes (Manometer with Remote Contacts only)	
16	Whether the RMU is sealed pressure system.	Yes	
17	Weight of RMU complete with operating		
18	Whether RMUs are provided with necessary		
19	Heater for dehumidifying inside the RMU	Yes	
20	W hether the gas chamber is made of		
21	Bus PT Ratio	11000/110V	
22	PT Burden	30VA	
SF6/VCB Circuit Breakers used in the Compact RMU			
Sl No.	**Name of the Particulars**	**OPTCL Requirement**	**Bidder's Offer**
1	Manufacturer's Name		
2	Manufacturer's / Type ref/Model.		
3	Materials used for making the body of the breaker	CRCA/Aluzinc	
4	Standards of manufacturing		
5	Whether the breakers are manufactured as per IEC/IS standards		
6	Maximum temperature with stand of the breakers		
7	Spacing between live part to Earth inside the breaker		
8	Spacing between poles		

GTP 13 - GUARANTEED TECHNICAL PARTICULARS FOR 11 kV RMU			
Sl. No.	**Name of the Particulars**	**OPTCL Requirement**	**Bidder's Offer**
9	SF6 interrupter make		
10	Contact separation distance		
11	Type of main contacts		
12	Contact pressure		
13	Contact resistance		
14	Life of the interrupter (in number of operations)		
15	Tripping at rated current Tripping at maximum fault current. (Allowable maximum erosion 3 mm) (iii)Mechanical operations.		
16	Details of main contacts		
17	Control circuit voltage DC.	24 V	
18	Whether trip free or not		
19	Whether all the interlocks provided		
20	Rated Voltage	11 kV	
21	Rated Insulation Level	12 kV	
22	Rated Frequency	50 Hz	
23	Dry 1 minute power frequency withstand between line terminal and earth	28 kV	
24	1.2/50 full wave impulse withstand voltage between line terminal and earth	75 kVp	
25	Rated re striking voltage at 100% and 50% rated capacity. (a) Amplitude factor (b) Phase factor (c) Natural frequency (d)R.R.R.V.(Volts/micro sec.)		

26	Rated Normal Current	250 A	
27	Rated cable charging breaking current	25 A	
28	Rated short circuit withstand current	21 kA for 3 sec	
29	Rated short circuit breaking current (symmetrical)	21 kA	
30	Rated short circuit breaking current (Asymmetrical)		
31	Rated transient recovery voltage for terminal faults		
32	Rated short circuit making current	52.5 kA peak at rated voltage	
33	Total break time at 10% rated interrupting capacity	<80ms	
34	Total break time at rated interrupting capacity	< 60ms	
35	Arcing time	< 15ms	
36	Make time	<100 ms	
37	Minimum SF6 gas pressure required	0.1MPa	
38	Clearance between live parts and contacts		
39	Special features if any		
40	Foundation loads and details.		
41	CT Rato	400-200/1-1-1A	
42	CT burden	2.5VA	

NUMERIC/COMMUNICABLE RELAY

Sl. No.	**Name of the Particulars**	**OPTCL Requirement**	**Bidder's Offer**
1	Manufacturer's Name and Country of Origin		
2	Manufacturer's design / Ref. Type		
3	Applicable Standards		

4	Whether draw out type		
5	Types of case		
6	Maximum and Minimum, operating ambient air temp.		
7	Certificate of Proof for Electro Magnetic Interference		
8	Whether Alpha numeric / LED display		
9	Relay characteristic for over current		

GTP 13 - GUARANTEED TECHNICAL PARTICULARS FOR 11 kV RMU			
Sl. No.	**Name of the Particulars**	**OPTCL Requirement**	**Bidder's Offer**
10	Relay characteristic for earth fault		
11	Current Range of over current relay		
12	Current Range of high set over current relay		
13	Current Range of earth fault relay		
14	Current Range of high set earth fault relay		
15	Time delay for over current relay		
16	Time delay for high set over current relay		
17	Time delay for earth fault relay		
18	Time delay for high set earth fault relay		
19	Communication port	RS 485	
20	Burden	2 VA	
SF6 Load Break Switch			
Sl. No.	**Name of the Particulars**	**OPTCL Requirement**	**Bidder's Offer**
1	Make		
2	Type		
3	Reference Standard		
4	Rated Insulation Level	12 kV	
5	Rated Frequency	50 Hz	
6	Dry 1 minute power frequency withstand between line terminal and earth	28 kV	
7	Dry 1 minute power frequency withstand voltage between terminals of breaker contacts open	32 kV	
8	1.2/50 full wave impulse withstand voltage between line terminal and	75 kVp	

9	Rated Normal Current	630 A	
10	Rated cable charging breaking current	25 A	
11	Short time current of main circuit	21 kA for 3 sec	
12	Peak with stand current of main circuit	52.5 kA	
13	Rated Making current of main circuit	52.5 kA	
14	Short time current of earthing circuit	21 kA for 3 sec	
15	Peak with stand current of earthing circuit	52.5 kA	
16	Rated Making current of earthing circuit	52.5 kA	
17	Minimum SF6 gas pressure required	0.1 MPa	
18	Number of mechanical operations of main isolator	1000	
19	Number of mechanical operations of earth switch	1000	
20	Number of electrical operations at rated current	100	
21	Number of electrical operations of the at rated short circuit making of main isolator	5	
22	Number of electrical operations of the at rated short circuit making of earth switch	5	
23	Operating mechanism – closing & opening		
24	Earthing for operating mechanism and metal parts furnished		
25	Whether earth switch is prevented from closing when main isolator is on	YES	
26	Whether cable door is prevented from opening unless earth switch is on	YES	

GTP- 14: GUARENTEED TECHNICAL PARTICULARS OF 33kV SINGLE CORE 630 SQMM, XLPE INSULATED, ARMOURED COPPER CABLE			
Sl. No.	**Name of the Particulars**	**OPTCL Requirement**	**Bidder's Offer**
1	Type of cable	Cupper Conductor ,XLPE Insulated	
2	Standard according to which cable has been manufactured and tested	IS: 7098- Part 2, IEC-60840, IEC-62067	
3	Rated Voltage (Uo/U}	19/33(36) kV	
4	Highest System Voltage which the cable can withstand	36 kV	
5	Maximum Conductor temperature for continuous operation	0 AC 90	
6.a)	Maximum short time conductor temperature with duration	220 °C for 1 sec	
6.b)	Maximum allowable conductor temp.during overload	95°C for 2 hours	
7	Conductor Details		
a	No of Cores	1	
b	Normal Cross-Sectional Area	6 mm²	
c	Material and Grade	Annealed Plain Copper to IS 8130/84	
d	Shape of Conductor	Compacted stranded circular	
e	Diameter of Conductor	29.8 mm (Approx.)	
f	No. of Strands and Diameter of each Strand	55 (Min.) /4.10 mm (Approx.)	
8	Water swellable powder/yarn provided	Yes	

9	Conducting water swellable tape with 50% overlap over compacted conductor provided	Yes	
10	Extruded Conductor Screen		
a	Material	Extruded Semi-Conducting compound	
b	Nominal Thickness	0.5 mm (Approx.)	
c	Diameter over Conductor screen	32.2 mm (Approx.)	
d	Designed maximum stress at conductor screen	3.05 kV/mm	
11	Insulation		
a	Material	XLPE	
b	Nominal Thickness	8.8mm	
c	Minimum thickness at any point	7.1mm	
d	Diameter over insulation	50 mm (Approx.)	
e	Designed maximum stress	1.90 kV/mm	
f	Vulcanization Process		
i)	Extrusion Method	Triple Extrusion	
ii)	Curing Method	Dry Curing	
iii)	Cooling Method	Inert Gas	
iv)	CO/ or VOI Line	CCV/VCV line	
12	Extruded Insulation Screen		
a	Material	Extruded Semi-Conducting XLPE	
b	Semiconductor XLPE Thickness (Minimum)	1mm	
c	Diameter over insulation screen	52.2 mm (Approx.)	
d	Strippable/ Bonded	Bonded	
13	Inner Sheath		

a	Material	PVC, Type ST2	
b	Thickness of innersheath	As per IS 7098 Part 2	
c	Diameter of Cable after inner sheath application	Manufacture to Specify	
14	Armouring	Full coverage. Armour wires shall be applied as closely as practicable. Overall gap between armour wires should be less than diameter of single wire	

GTP- 14: GUARENTEED TECHNICAL PARTICULARS OF 33kV SINGLE CORE 630 SQMM, XLPE INSULATED, ARMOURED COPPER CABLE			
Sl. No.	**Name of the Particulars**	**OPTCL Requirement**	**Bidder's Offer**
15	Outer Sheath	Black extruded FR PVC	
a	Type	ST 2	
b	Colour	Black	
c	Thickness	As per Is 7098 (part 2)/2011	
d	Conductive Coating over outer sheath	Graphite coating	
e	Thickness (Nom/Min)	.6 mm (Nominal)/ 2.11 mm (Min. Spot)	
16	Nominal OVerall Diameter of Cable	72 mm (Approx.)	
17	Nominal Overall Weight of Cable per Metre	12.0 kg/m (Approx	
18	Standard Drum Length with Tolerance	500m + 5 %	
19	Minimum BendingRadius allowable during installation	1180 mm (during installation) 944 mm (after laying)	
20	Short Circuit Current Rating of for 1 Sec	90.09kA	
21	Soil Parameter		
a	Soil Temperature	30°C	
b	Ambient Temperature	50°C	
c	Soil Thermal Resistivity	150°C Cm/W	
22	Maximum Continuous Current Rating of a Circuit comprising of 3 nos. Single Core Cable		

	laid in trefoil formation		
a	Ground	580A	
b	Ducts	500A	
c	Air	920A	
23	Short Time Overload capacity with Duration of cable installed		
a	Ground	708A	
b	Ducts	610A	
c	Air	1168A	
24	Maximum AC Resistance at 90°C	0.040 ohm/km	
25	Equivalent Star Reactance of a Circuit comprising of 3 Nos. of Single Core cable laid in Trefoil Formation	0.115	
26	Maximum Charging Current per Conductor at Nominal Voltage 1.64 AI km	.91 A/Km (at 19kV)	
27	Loss in Metallic Screen of a Circuit comprising of 3 nos. of Single Core Cable installed in Trefoil Formation	22.38 W/m	
28	Maximum Current in Metallic Screen when the cable is installed	110A	
27	Details of Drum		
a	Material and Weight of Drum	Wooden Reel/ 500 kg (Approx.)	
b	Weight of Drum with Cable	6300 kg (Gross Weight) (Approx.)	
c	Flange Diameter of Drum	2750 mm (Approx.)	

d	Barrel Width of Drum	1100 mm(Approx.)	
e	Spindle hole Diameter	120 mm (Approx.)	
f	Safe Pulling force	5kg/mm2 of CU area	
29	Derating factor of Cable installed	As per IS	

GTP- 15: GUARENTEED TECHNICAL PARTICULARS OF 33kV SINGLE CORE 1000 SQMM, XLPE INSULATED, ARMOURED COPPER CABLE		
Sl. No.	**Name of the Particulars**	**Bidder's Offer**
1	Type of cable	
2	Standard according to which cable has been manufactured and tested	
3	Rated Voltage (Uo/U}	
4	Highest System Voltage which the cable can withstand	
5	Maximum Conductor temperature for continuous operation	
6.a)	Maximum short time conductor temperature with duration	
6.b)	Maximum allowable conductor temp.during overload	
7	Conductor Details	
a	No of Cores	
b	Normal Cross-Sectional Area	
c	Material and Grade	
d	Shape of Conductor	
e	Diameter of Conductor	
f	No. of Strands and Diameter of each Strand	
8	Water swellable powder/yarn provided	
9	Conducting water swellable tape with 50% overlap over compacted conductor provided	
10	Extruded Conductor Screen	
a	Material	
b	Nominal Thickness	

c	Diameter over Conductor screen	
d	Designed maximum stress at conductor screen	
11	Insulation	
a	Material	
b	Nominal Thickness	
c	Minimum thickness at any point	
d	Diameter over insulation	
e	Designed maximum stress	
f	Vulcanization Process	
i)	Extrusion Method	
ii)	Curing Method	
iii)	Cooling Method	
iv)	CO/ or VOI Line	
12	Extruded Insulation Screen	
a	Material	
b	Semiconductor XLPE Thickness (Minimum)	
c	Diameter over insulation screen	
d	Strippable/ Bonded	
13	Inner Sheath	
a	Material	
b	Thickness of innersheath	
c	Diameter of Cable after inner sheath application	
14	Armouring	
15	Outer Sheath	
a	Type	

GTP- 15: GUARENTEED TECHNICAL PARTICULARS OF 33kV SINGLE CORE 1000 SQMM, XLPE INSULATED, ARMOURED COPPER CABLE		
Sl. No.	**Name of the Particulars**	**Bidder's Offer**
b	Colour	
c	Thickness	
d	Conductive Coating over outer sheath	
e	Thickness (Nom/Min)	
16	Nominal OVerall Diameter of Cable	
17	Nominal Overall Weight of Cable per Metre	
18	Standard Drum Length with Tolerance	
19	Minimum BendingRadius allowable during installation	
20	Short Circuit Current Rating of for 1 Sec	
21	Soil Parameter	
a	Soil Temperature	
b	Ambient Temperature	
c	Soil Thermal Resistivity	
22	Maximum Continuous Current Rating of a Circuit comprising of 3 nos. Single Core Cable laid in trefoil formation	
a	Ground	
b	Ducts	
c	Air	
23	Short Time Overload capacity with Duration of cable installed	

a	Ground	
b	Ducts	
c	Air	
24	Maximum AC Resistance at 90°C	
25	Equivalent Star Reactance of a Circuit comprising of 3 Nos. of Single Core cable laid in Trefoil Formation	
26	Maximum Charging Current per Conductor at Nominal Voltage 1.64 AI km	
27	Loss in Metallic Screen of a Circuit comprising of 3 nos. of Single Core Cable installed in Trefoil Formation	
28	Maximum Current in Metallic Screen when the cable is installed	
27	Details of Drum	
a	Material and Weight of Drum	
b	Weight of Drum with Cable	
c	Flange Diameter of Drum	
d	Barrel Width of Drum	
e	Spindle hole Diameter	
f	Safe Pulling force	
29	Derating factor of Cable installed	

GTP - 16: GUARENTEED TECHNICAL PARTICULARS OF 11kV SINGLE CORE 630 SQMM, XLPE INSULATED, ARMOURED COPPER CABLE		
Sl. No.	**Name of the Particulars**	**Bidder's Offer**
1	Type of cable	
2	Standard according to which cable has been manufactured and tested	
3	Rated Voltage (Uo/U}	
4	Highest System Voltage which the cable can withstand	
5	Maximum Conductor temperature for continuous operation	
6.a)	Maximum short time conductor temperature with duration	
6.b)	Maximum allowable conductor temp.during overload	
7	Conductor Details	
a	No of Cores	
b	Normal Cross-Sectional Area	
c	Material and Grade	
d	Shape of Conductor	
e	Diameter of Conductor	
f	No. of Strands and Diameter of each Strand	
8	Water swellable powder/yarn provided	
9	Conducting water swellable tape with 50% overlap over compacted conductor provided	
10	Extruded Conductor Screen	
a	Material	

b	Nominal Thickness	
c	Diameter over Conductor screen	
d	Designed maximum stress at conductor screen	
11	Insulation	
a	Material	
b	Nominal Thickness	
c	Minimum thickness at any point	
d	Diameter over insulation	
e	Designed maximum stress	
f	Vulcanization Process	
i)	Extrusion Method	
ii)	Curing Method	
iii)	Cooling Method	
iv)	CO/ or VOI Line	
12	Extruded Insulation Screen	
a	Material	
b	Semiconductor XLPE Thickness (Minimum)	
c	Diameter over insulation screen	
d	Strippable/ Bonded	
13	Inner Sheath	
a	Material	
b	Thickness of innersheath	
c	Diameter of Cable after inner sheath application	
14	Armouring	
15	Outer Sheath	

GTP - 16: GUARENTEED TECHNICAL PARTICULARS OF 11kV SINGLE CORE 630 SQMM, XLPE INSULATED, ARMOURED COPPER CABLE		
Sl. No.	**Name of the Particulars**	**Bidder's Offer**
a	Type	
b	Colour	
c	Thickness	
d	Conductive Coating over outer sheath	
e	Thickness (Nom/Min)	
16	Nominal OVerall Diameter of Cable	
17	Nominal Overall Weight of Cable per Metre	
18	Standard Drum Length with Tolerance	
19	Minimum BendingRadius allowable during installation	
20	Short Circuit Current Rating of for 1 Sec	
21	Soil Parameter	
a	Soil Temperature	
b	Ambient Temperature	
c	Soil Thermal Resistivity	
22	Maximum Continuous Current Rating of a Circuit comprising of 3 nos. Single Core Cable laid in trefoil formation	
a	Ground	
b	Ducts	
c	Air	
23	Short Time Overload capacity with Duration of cable installed	
a	Ground	

b	Ducts	
c	Air	
24	Maximum AC Resistance at 90°C	
25	Equivalent Star Reactance of a Circuit comprising of 3 Nos. of Single Core cable laid in Trefoil Formation	
26	Maximum Charging Current per Conductor at Nominal Voltage 1.64 AI km	
27	Loss in Metallic Screen of a Circuit comprising of 3 nos. of Single Core Cable installed in Trefoil Formation	
28	Maximum Current in Metallic Screen when the cable is installed	
27	Details of Drum	
a	Material and Weight of Drum	
b	Weight of Drum with Cable	
c	Flange Diameter of Drum	
d	Barrel Width of Drum	
e	Spindle hole Diameter	
f	Safe Pulling force	
29	Derating factor of Cable installed	

GTP - 17 GUARENTEED TECHNICAL PARTICULARS OF 11kV THREE CORE, 400 SQMM ALUMINIUM, XLPE INSULATED, ARMOURED CABLE			
Sl. No.	**Name of the Particulars**	**OPTCL Requirement**	**Bidder's Offer**
1	Type of cable	Aluminium Conductor,XLPE Insulated	
2	Conductor Details		
a	No of Cores	3	
b	Normal Cross-Sectional Area	400mm²	
c	Material and Grade	Aluminium compacted, Stranded as per IS: 8130 with latest amendment	
d	Shape of Conductor	Circular	
e	Diameter of Conductor	22.6mm	
f	No. of Strands and Diameter of each Strand	as per IS 8130 with latest amendment	
3	Rated Voltage (Uo/U}	6.35/11kV	
4	Highest System Voltage which the cable can withstand	12kV(Um)	
5	Maximum Conductor temperature for continuous operation	90° C	
6	Maximum conductor temperature during short circuit	250°C	
7	Water swellable tape on conductor	Provided	
8	Extruded Conductor Screen		
a	Material	Extruded semiconducting Compound	

b	Nominal Thickness	0.30mm	
9	Insulation		
a	Material	XLPE	
b	Nominal Thickness	3.6 mm	
10	Detail of vulcanization process		
a	Extrusion Method	Triple Extrusion	
b	Curing Method	Dry Curing	
c	Cooling Method	Inert Gas	
11	Extruded Insulation Screen		
a	Material	Semi-Conducting Compound + Copper tape with thickness of 0.04 mm of 10% Overlap	
b	Semiconductor XLPE Thickness (Nominal/Minimum)	1.0 mm/ 0.85 mm	
c	Thickness of Copper tape with 10% overlap	0.04 mm	
12	Inner Sheath		
	(a) Material	PVC, Type ST2	
	(b) Thickness of innersheath	As per IS 7098 Part 2	
	(c) Diameter of Cable after inner sheath application	Manufacture to Specify	
13	Armouring	The type of armoring shall be designed to withstand fault current of 16 kA for 1 second	
14	Outer Sheath	FR PVC	
a	Type	ST2	

b	Colour	Black	
c	Thickness (Nom/min)	As per Is 7098 (part II)/2011	

GTP - 17 GUARENTEED TECHNICAL PARTICULARS OF 11kV THREE CORE, 400 SQMM ALUMINIUM, XLPE INSULATED, ARMOURED CABLE			
Sl. No.	**Name of the Particulars**	**OPTCL Requirement**	**Bidder's Offer**
15	Nominal OVerall Diameter of Cable	Manufacture to Specify	
16	Nominal OVerall Weight of Cable per Metre	Manufacture to Specify	
17	Standard Drum Length with Tolerance	500m + 5 %	
18	Minimum Bending Radius allowable during installation	As per Is 1255 / 1983 with latest amendment	
19	Short Circuit Current Rating of for 1 Sec	37.6 kA	
20	Soil Parameter		
a	Soil Temperature	30°C	
b	Ambient Temperature	50°C	
c	Soil Thermal Resistivity	150°C Cm/W	
21	System of Bonding	Manufacture To Specify	
21	Short Time Overload capacity with Duration of cable installed (4 hours)	Manufacturer to specify	
a	Ground	400A	
b	Ducts	350A	
c	Air	520A	
22	Maximum DC Resistance at 20°C in ohm/km	0.0778	
23	Maximum AC Resistance at 90°C in ohm/km	0.1023	
24	Reactance in ohm/km	0.089	
25	Capacitance in microfarad/km	0.53	
26	Derating factor of Cable installed	As per IS	

GTP-18 TECHNICAL SPECIFICATION OF LT THREE AND HALF CORE XLPE, UNARMOURED 120 SQMM CABLE			
Sl. No	**Name of the Particulars**	**OPTCL Requirement**	**Bidder's Offer**
1	Type of cable	Aluminium Conductor, XLPE Insulated	
2	Conductor Details		
a	No of Cores	3½	
b	Normal Cross-Sectional Area	3½ X 120 SQMM	
c	Material and Grade	(Class-2) Aluminium compacted,Stranded as per IS: 8130, Cl. No-5.3 with latest amendment	
d	Shape of Conductor	Conductor shall be stranded circular compacted or shaped conductor as per IS 1830 P-1	
e	Diameter of Conductor		
f	No. of Strands and Diameter of each Strand	as per IS 8130 with latest amendment	
3	Rated Voltage	1.1 kV	
4	Maximum conductor temperature under normal operating conditions	90º C	
5	Maximum conductor temperature at the termination of short circuit	250º C	
6	Insulation		
a	Material	Crosslinked Polyethylene(XLPE)	
b	Nominal Thickness	1.7/1.2 mm	

7	Inner Sheath		
a	Material	PVC as per IS:7098PT-1	
b	Thickness of inner sheath(mm)	As per IS 7098 P-1	
c	Diameter of Cable after inner sheath application	Manufacture to Specify	
8	Outer Sheath	PVC	
a	Type	FR ST 2 as per IS 5831	
b	Colour	Black	
c	Thickness	As per IS 7098 P-1	
9	Nominal OVerall Diameter of Cable	Manufacture to Specify	
10	Nominal Overall Weight of Cable per Metre	Manufacture to Specify	
11	Minimum Bending Radius all during installation	As per Is 1255 / 1983 with latest amendment	
12	Short circuit rating of conductor for the duration of 1 sec (kA)	22.56 kA	
13	Soil Parameter		
a	Soil Temperature		
b	Ambient Temperature		
c	Soil Thermal Resistivity		
14	Normal current rating in ampere		
a	Ground	325A	

GTP-18 TECHNICAL SPECIFICATION OF LT THREE AND HALF CORE XLPE, UNARMOURED 120 SQMM CABLE			
Sl. No	**Name of the Particulars**	**OPTCL Requirement**	**Bidder's Offer**
b	Ducts	270A	
c	Air	402A	
15	Maximum DC Resistance at 20°C ohm/km	0.125	
16	Maximum AC Resistance at 90°C ohm/km	0.162	
17	Reactance of Cable in in ohm/km	0.072	
18	capacitance of cable in micro farad/km	0.31	
19	Derating factor of Cable installed	As per IS	