Maharashtra Industrial Township Limited (MITL)

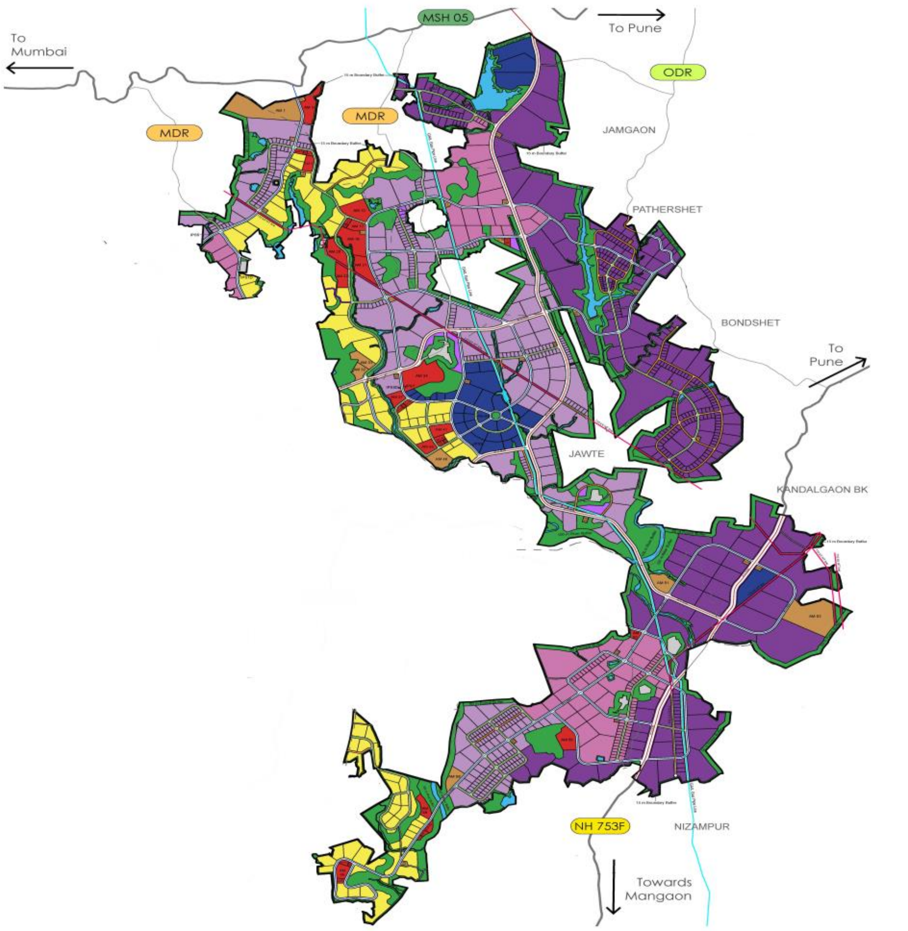
Design, Construction, Testing, Commissioning, Operation and Maintenance of Infrastructure Works at Dighi Port Industrial Area (DPIA) Phase 1 on EPC Basis - Package A

Request for Proposal cum Request for Qualification

Volume 2: Technical Specifications

Part D - Electrical Substations & Power Distribution Network

July 2025



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Nothing in this tender shall constitute the basis of a contract which may be concluded in relation to the Project nor shall such documentation/information be used in construing any such contract. Each Bidder must rely on the terms and conditions contained in any contract, when, and if, finally executed, subject to such limitations and restrictions which may be specified in such contract.

The Bidders are prohibited from any form of collusion or arrangement in an attempt to influence the selection and award process of the Bid. Giving or offering of any gift, bribe or inducement or any attempt to any such act on behalf of the Bidder towards any officer/employee of Employer or to any other person in apposition to influence the decision of the Employer for showing any favour in relation to this tender or any other contract, shall render the Bidder to such liability/penalty as the Employer may deem proper, including but not limited to rejection of the Bid of the Bidder and forfeiture of its Bid Security.

Laws of the Republic of India are applicable to this tender.

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1 Power & Electrical System

1.1 Scope

The Contractor shall provide a complete power and electrical system including civil works as detailed below, complete in all respects and covers design, engineering, procurement/manufacturing of electrical equipment, supply, inspection and testing at works (FAT), packing, transportation to site, storage, installation/erection, testing, commissioning, handing-over in complete working order all the equipment including all items as per contract, spares, manuals, etc. and to undertake subsequent DLP and O&M as detailed in the General Specifications section. Any works required to provide a complete and fully functional, and safe system shall be deemed to be included, whether mentioned here or not.

The scope of electrical works as a part of this contract shall broadly consist of the following major items unless explicitly specified otherwise. The scope has to be read in conjunction with the SLDs attached with the Bid document:

a) To achieve a reliable power supply to complete DPIA, it is proposed that, there will be one number of MRSS (under MSETCL scope) i.e., 400/220 kV substation to cater to the overall demand of Parcel A and Parcel B. In downstream of the 400/220 kV substation, there will be two numbers of ZSS (under MSETCL scope). i.e. 220/33 kV substations proposed with gas-insulated switchgear (GIS) sets (under MSETCL scope).

b) Each 220 kV/33kVZonal substation (under MSETCL scope) shall receive double-circuit 220 kV overhead transmission lines from 400/220 kV substation to keep 100% redundancy in LILO (under MSETCL scope). The two numbers of 220/33 kV Zonal substations (ZSS-1 and ZSS-2) of aggregate capacity 220/33 kV, 8 x 100 MVA, each one of 220/33 kV, 4 x 100 MVA capacity shall be considered to cater for the overall demand of Phase 1, 2 and 3 of DPIA Parcel B. The transformer ratings of 220/33kV, and 100 MVA are tentative and may also change, depending on MSETCL standard transformer ratings, but the scope remains with MSETCL, and it shall depend on their design factors. Voltage levels of 132 & 100kV may also be made available at ZSS by MSETCL depending on demand of consumers.

c) Zonal Substation (ZSS-1) with only one number of 220/33 kV, 4 x 100 MVA shall be provided (under MSETCL scope) to cater to the load of Phase-1, DPIA Parcel B.

d) Power supply to 400/220 kV substation shall be supplied through LILO (N+1 Configuration) on 400 kV Dabhol-Nagothane double circuit transmission line. Confirmation of the same has been received by Maharashtra State Electricity Transmission Co. Ltd (MSETCL) through letter number MSETCL/CMD/DIGHI/07610 dated 28/10/2022.

e) Supply and installation of 400/220 kV Substations, 220/33 kV substations along with EHV (400 kV and 220 kV) overhead transmission network shall be established by Maharashtra State Electricity Transmission Co. Ltd (MSETCL). So, details of the same will not be included in this document.

f) The detailed route survey for the proposed 400 kV and 220 kV double circuit transmission lines, along with the selection of the most optimum route to circumvent environmentally sensitive areas, will be conducted by the State Transmission Utility, i.e. MSETCL.

g) As a part of this contract, design, engineering, supply, installation, operation and maintenance of all the HT/LT power and control cables, OFC cables including cable containment up to the 220/33 kV substation equipment (e.g., laying and termination of 33 kV cables up to/from the 33 kV switchgear of 220/33 kV substation), within any (inter/intra) substations, instrumentation/ OFC cables up to the SCADA/any controllers/relays/instruments system of 220/33 kV substation including associated civil works shall be in the scope of the Contractor. 33kV Cables of minimum size of 300 sq. mm/400 sq. mm shall be used for distribution.

h) Power from the 400 kV substation shall be stepped down to 220 kV voltage level using 400/220 kV power transformers and further step down to 33 kV and 11 kV using 220/33 kV and 33/11 kV power transformers respectively to cater for the load demand of end consumers.

i) Power supply at 33 kV & 11 kV voltage levels shall be transmitted to HT consumers through 33 kV switching substation and 33/11 kV distribution substations respectively. Each 33 kV switching substation shall be capable of transmitting maximum power of 40 MVA and each 33/11 kV distribution substation shall be capable of transmitting maximum power of 30 MVA.

j) Power supply from 33 kV switching substation and 33/11 kV distribution substations to 33kV or 11kV RMU and 11kV/0.415kV CSS of Various plot & Utilities of Phase 1 area to establish a proper distribution network.

k) The number of 33 kV and 11 kV ring main units (RMU) supplied from 33 kV and 11 kV underground cables shall be provided by the contractor at different locations near the plot boundaries to feed the demand of industries, commercial centres, offices, and residential buildings etc. For LT consumers, 11/0.433 kV package substations supplied from the nearest RMU shall also be planned at different locations near the plot boundaries to feed the demand of small plot consumers, common utilities, street lighting etc. The minimum number of RMUs/CSS to be provided by the contractor shall be as per the distribution scheme regulated by local discom to be offered by the contractor and shall be subject to the Employer's Engineer approval. Every utility shall have its own battery limit of CSS/RMU fed power connection at the boundary and up to the metering room with specific power connection as per the load of that particular utility like STP, WTP, CETP or any ancillary units.

l) Large plot consumers may be directly supplied via 220 kV XLPE cables from 220/100 kV switchgear if required in future. Expenditure for the supplying and laying of 220/100 kV cables will be borne by plot owners. The cost of the 220/100kV feeder is to be borne by the consumer only if a separate dedicated feeder is provided from the substation and not from the Ring feeder (LILO).

m) Contractor shall provide 2 nos. of 33 kV Switching substations and 10 nos. of 33/11 kV Distribution substations at different locations/zones to feed power to various consumers in the phase-01 or the Construction scope/area of the project.

n) Both the 33 kV and 11 kV switchgear systems to be provided by the contractor at the Switching substations & Distribution substations shall have gas-insulated switchgear (GIS).

o) Three (3) sets of outdoor type 33/11 kV, 10 MVA, ONAN/ KNAN (Natural Mineral oil filled), 3 phase transformers shall be provided by the contractor at each of the 33/11 kV Distribution substations. Also, 2.4 MVAR, 11 kV, Automatically Switched HT shunt Capacitor Bank along with 11 kV Capacitor Panel and APFC Controller to be installed in each 11 kV bus section of 33/11 kV sub-stations shall be provided by the contractor. The actual location of the proposed switching stations shall be as per the Engineer-in-charge's direction/guidelines.

p) 33kV/11kV Distribution Substations to be provided by the contractor shall house 33kV, 11kV GIS-based switchgear. 415V LT Auxiliary Switchgear, 33kV/11kV Power transformers, 11kV/0.433kV Auxiliary transformers, Battery & Battery Chargers, RTCC Control panels, 11kV phase segregated Al Bus duct, 415V Diesel generator, AMF Panel, SCADA system with uninterruptible power supply system etc. shall be provided by the contractor in a G+1 building for reduced footprint.

q) For the Construction scope/area, all the Incoming & Outgoing feeders and bus couplers for 220kV GIS, 33kV GIS & 11kV GIS shall be as per the Overall scheme for Power Distribution indicated in drawings.

r) Space provision for other future 220kV, 33kV, 11kV and GIS feeders as per the Overall scheme for Power Distribution drawings which shall be supplied and installed by other package contractors.

s) Proposed 220kV, 33kV & 11kV GIS panels should be compatible for future upgradation and interfacing.

t) 11kV & 33kV Ring main Units - 11kV RMUs for plots up to demand estimation of 5 MVA & 33kV RMUs for plots up to demand estimation of 10 MVA shall be provided. The location of RMUs shall be as directed by the Employer's Engineer.

u) 11kV/0.433kV Compact Substations (CSS) shall be provided by the contractor for power and street lighting. The location of CSS shall be as per the direction of the Employer's Engineer.

v) Contractor shall provide 33kV, 11kV and 1.1kV XLPE armoured Cables and all other necessary equipment i.e. Cable trays, Trench work, Supports, terminations, jointing works, cable tags etc. as required for arranging the power for 220kV, 33kV, 11kV, 415V switchgear in substations and plot level distribution. Wherever buried cables cross the bridges at FGL level, the same shall be routed through either HDPE pipe or Cable brackets along the bridge structure. Dedicated structural support arrangements shall be provided for duct installation/Cable bracket at FGL along the bridges.

w) Contractor shall provide RCC Cable trench with FRP cable trays inside the Switching and Distribution Stations. The scope shall include such that the depth of the RCC Cable trench inside the Substation shall have space for the installation of 33kV, and 11kV Cables for proposed 33kV & 11kV GIS.

x) Contractor shall provide RCC Cable trench with FRP cable trays inside the Utility Premises such as STP, WTP, CETP, SWM etc. In addition to Electrical/MCC Rooms, RCC cable trench to be also considered for Roads inside the Utility Premises.

Commented [IP1]: Added.

y) Contractor shall provide Lighting and Power Feeder Pillars, wherever needed. The incoming and outgoing power cables shall be in the scope of contractor, while incoming cables upto all power feeder pillars to be in the scope of Contractor. A dedicated HM feeder pillar shall be provided for each High Mast. All lighting feeder pillars, power feeder pillars and HM feeder pillars shall be provided with Type 1+2 Surge Protection Devices along with surge counter and MFM with SCADA compatibility with NFC and RS485 communication port. The minimum number of Lighting poles, and feeder pillars, as per Lux levels and distribution scheme regulated by local discom/municipal authority to be offered, shall be subject to the Employer's Engineer approval. The minimum number of CSS and feeder pillars shall be as per the tender drawings power distribution, and to be approved by Engineer during detail engineering.

z) Street lighting feeder pillar and HM feeder pillar with Gateway controller compatible with Lighting SCADA at common control room building. All cable upto Power pillar feeder, all incoming and outgoing cable to and from CSS shall be in the scope of Contractor. Number of power and lighting feeder pillars shall be on need basis and as per plot distribution scheme. The maximum load for feeder pillar handling shall be as per state Discom norms and subject to Engineer's approval during detail engineering.

aa) Directly buried cabling system shall be used by the Contractor for 220kV cables, while RCC cable trenches or HDPE ducts shall be used for 33kV and 11kV cables and ducts shall be used for 415V and 240V. Both these cables can be laid together in ducts. Buried cables shall be sand-filled around the circuit, 33kV underground Cabling system through HDPE DWC pipes to be considered by the Contractor from ZSS-1 to the respective Switching and Distribution substation. The suitable permanent arrangement for dewatering electrical ducts at suitable locations is deemed to be in the contractor's scope and within the quoted price.

bb) Instrumentation and Fiber Optics cables shall be provided by the contractor for interfacing with SCADA, as required.

cc) External & Internal Lighting: Contractor shall provide 11kV/0.433kV, outdoor type transformers (as part of CSS) / feeder pillars for Galvanized Street lighting pole including fixtures. high mast, lighting poles, lighting panels, cabling etc. as required for street lighting, Luminaries, distribution boards etc. as required for each substation's internal lighting. Street lighting and street lighting cabling for the Phase-01 project area shall be as per the Engineer-In-Charge's instructions/Guidelines. However total lighting system with poles and luminaires and Lighting DBs should satisfy the Lux level for every area as mentioned in the technical specifications clause 1.6.8.

dd) RCC cable trench with FRP cable tray shall be provided for 33kV, 11kV, LV Power, control, and Fiber Optic cabling along both sides of the road corridor. HV & LV Power, Control and FO cabling as per Engineer-In-Charge's instructions/Guidelines. RCC cable trench shall be provided with required insert plates and cable tray supports including for future Cable tray installation/cabling as per typical trench and HDPE cross-section details of EHV, HV, MV and LV cables attached with tender specifications.

ee) DG Sets for Critical & Essential loads of Substation, CETP/STP/WTP and Pumphouse loads etc. A dedicated DG set shall be provided by the Contractor for each Substation and Utility plant, as required. DG power is not required for Outdoor lighting.

ff) Cost towards Diesel used in case of power breakdowns during O&M period for emergency/ essential services, as approved by Employer, will be reimbursed as per actuals.

gg) Earthing and Lightning protection system for complete power system

hh) Power Meters SMART TYPE (SCADA Compatible) for the Plots as directed by the Engineer-in-charge.

ii) 400/200 kV substation, 220/33 kV substation, 33 kV switching stations, 33/11 kV substations, 33 kV and 11 kV RMUs and 11/ 0.433 kV package substations shall be connected to supervisory Control and Data Acquisition (SCADA) system.

jj) The main control room shall be created at 400/220 kV and 220/33 kV substations by MSETCL to control and monitor the power flow of the entire cluster.

kk) SCADA system at 33kV switching stations interconnecting all 33/11 kV substations, 11/0.433 kV package substations, 11 kV and 33 kV RMUs etc. with optical fibre network (OFC) shall be considered. SCADA system of same shall be further integrated to main SCADA system of 220/33 kV substation.

ll) All required hardware, software, and associated equipment/ civil works including OFC cables, control cables etc. for the Integration of the 33 kV SCADA system to the main SCADA system at 220/33 kV substation shall be in the scope of the contractor.

mm) Gateway controller of all Lighting feeder pillars and HM feeder pillars shall be interfaced with Lighting SCADA at the common control room building by other package contractor.

nn) Further integration of the main SCADA system with the Integrated Command and Control Centre (ICCC) will be considered along with necessary hardware, software, and auxiliary equipment to enable seamless communication and coordination between these systems.

oo) Substation/Electrical room for STP/CETP/WTP/SWM etc. as required Each Substation/Electrical room shall be provided by the Contractor with adequate rating of 11kV RMU, 11kV/0.433kV ONAN Transformers, 415V DG set for critical loads if any, 415V LV Bus duct (If applicable), 415V LT aux switchboard, 415V Motor Control centre, Lighting DB, Cables, Cable tray, Substation lighting, earthing and Lightning protection etc.

Contractor shall design, supply, and install an adequate number of 11kV/33kV RMUs, CSS, Street lighting poles/High Mast, lighting feeder pillars and adequate quantity of 11kV & LV Cables & FRP Cable trays, etc. subjected to occupancy of consumers for project area in consultation with Engineer-in-charge. Ring main system of 33kV substations and switching stations should be proposed to improve the reliability, availability and flexibility of feeders' selection..

pp) Civil works complete in all respects.

qq) Cable installation shall be carried out as per IS: 1255 and other applicable standards. FRP-type ladder cable tray shall be considered for laying of all cables in the RCC duct. Power and control cables shall be laid on separate tiers. The laying of different voltage-grade cables shall be on different tiers according to the voltage grade of the cables. If any large consumer needs power at 220 kV voltage level, then power will be evacuated through 220 kV cables supplied from 220 kV GIS. 220 kV XLPE power cables may be laid in a flat/ trefoil arrangement with 1D spacing between them and will be directly buried in the ground. Expenditure for the supplying and laying of 220 kV cables will be borne by plot owners.

rr) HT cables shall be laid on the lowest tier and LT cables/ Control cables on subsequent upper tiers. All multicore cables shall be laid with a spacing of the diameter of the cable.

The electrical work required to be done under this contract is detailed below. The contractor shall design and construct the complete works necessary at the site required to operate the electrical system and meet the electrical needs of the development and all facilities properly, safely, and efficiently.

The contractor shall lay 220kV, 33kV & 11kV cables under the supervision of the engineer in charge of Maharashtra State Electricity Transmission Co. Ltd (**MSETCL**) & Maharashtra State Electricity Distribution Co. Ltd (**MSEDCL**).

Technical specifications for all Electrical equipment attached with these tender specifications are applicable to Electrics of Utility plants like STP, CETP, WTP, SWM, Pumping Stations etc. as when required.

1.2 Substation Installation

a) For Substation installation, the contractor shall install the same on the ground floor, on about 300mm plinth base, with proper space planning and routing for incoming and outgoing cables. Inside the substation building and along roads, the cables should be routed in covered concrete trenches with cable trays of FRP material so as to avoid any steel structural works.

b) Concealed conduit wiring shall be proposed inside MRSS, Switching Stations & Distribution Substations, and Electrical room for all process plants and administrative building. Lighting switch box, control switches and sockets etc shall be flush mounted suitable for concealed conduit wiring. Lighting inside the battery room shall be explosion-proof type and cable wiring is proposed.

c) The Compact Substation shall be installed outside the building, the contractor shall place the same on a 300mm plinth base, which shall be covered with a Canopy, the design of which shall be prepared by the Contractor and approved by the Engineer-in-charge.

d) The plinth size may be raised beyond 300mm if the area is likely to have flood water above 300mm. Under no case, water should enter the substation.

e) DG sets shall be installed by the contractor for each Substation and Utility area (Including Treatment Plants. The contractor shall submit a layout for placement of DG set with enclosure, fuel tanks, diesel filling arrangement, AMF, control panels, exhaust chimneys etc. on a plinth in an enclosed well-ventilated shed with a shutter, which shall be normally kept locked. The design and layout for such a shed shall be subject to the approval of the Engineer-in-charge.

f) All civil works associated with the installation of DG sets shall be in the scope of the contractor.

g) EHV cables shall be laid in a directly buried system. HV and LV XLPE cables shall be laid on the cable tray in the RCC cable trench. The contractor's design shall comply with the typical HDPE cable network and RCC cable trench section provided in this tender document. LT cables from the DG set to the metering panel, if any, shall be installed along with signalling cables so that the metering panel can control and record the electrical load/energy from the DG supply.

h) The LT cables from the CSS to the feeder pillar shall be laid on a cable tray inside the RCC cable trench for outdoor CSS feeding to houses/bungalows, schools, gymnasiums, street lighting and other amenity buildings.

i) Feeder pillar onward, the service cable shall extend from the nearest RCC cable trench to the meter board of the individual plots and the same shall be laid in a flexible adapter (duct).

j) Wherever the Cables from the RCC cable trench cross the road, the cables shall be laid through HDPE conduits and the Pulpit/Manhole shall be provided by the Contractor on either side of the HDPE conduit.

k) The cable shall be laid through suitable size pipes/Cable brackets on the bridges/culverts, as per instructions of the Engineer-in-charge.

l) Earthing system, complete in all respects including the provision of earth pits, laying of earthing conductors their termination jointing etc. shall be provided by the Contractor at all the required sites.

m) Street Light SMART poles, lighting fixtures, High Mast, lighting panels, cabling, etc. as required, for street lighting, parking area lighting and landscape area lighting so as to complete the works in all respects shall be in the scope of the contractor. Streetlight shall be SCADA compatible for remote (at the respective substation) and monitoring and control from the Central control room by other package contractors.

n) The entire system and all its components shall be SCADA-compatible for remote monitoring and control.

o) All Works concerning existing Power Supply and Infrastructure if any i.e., dismantling, shifting, re-installation etc. shall be in the contractor's scope.

p) All the required civil works such as foundations, trenches, fencing, duct laying, etc. shall be in the contractor's scope.

q) Any other works not included above but required to complete the works as per specification and project requirements.

r) All designs and drawings by the Contractor are to be vetted by respective Transco/Discom during the construction phase.

1.3 Design Criteria

The distribution system shall be planned considering the Climate and Isokeraunic Conditions, and basic electrical data.

1.3.1 Climate and Isokeraunic Conditions

The electrical equipment selected shall be such so as to give trouble free operation during the life of the equipment, under the most stringent atmospheric conditions prevailing at site. Typical atmospheric data at site is as below:

Table 1-1: Climatic conditions

S.No.	Description	Details
1	Maximum ambient Temperature	50°C
2	Minimum Ambient Temperature	3.5°C
3	Maximum Design Ambient Temperature	50°C
4	Relative Humidity	100.6% max 40% min
5	Average number of Thunderstorms (days /annum)	20
6	Altitude (meters)	Less than 1000 mm
7	Average annual Rainfall	>1450mm
8	Wind speed	10kMiles/hr

Equipment needs to be protected from the entry of ground water, tree roots, reptiles, lizards, wild animals etc. that can cause a short circuit.

1.3.2 Tropicalization

All electrical insulation, Panels or spacers and other materials, which could be damaged by fungus, termites, or other parasitic growths, shall be suitably protected. Enclosures containing electrical control and switching equipment and instruments shall be equipped with UL approved electric heaters for moisture control via Hygro-thermostat rated for 10A of heater load. The construction of the enclosures and the placement of heaters shall ensure effective circulation of air and prevent damage to equipment by overheating. Heaters shall be touching proof, encapsulated, DIN Rail mountable and of PTC type, without the use of thermostats.

1.4 Basic Electrical Data

1.4.1 System of Electrical Power Supply

The following System voltage & frequency as mentioned below shall prevail within the DIGHI project area and shall be adopted on case-to-case basis.

a) Classification of Supply (as per the Supply code of Maharashtra Electricity Regulatory Commission)

b) Two wires, single phase, 240 volts- General supply not exceeding 40 amperes.

c) Four / Three wires, three-phase, 240 volts between phase wire and neutral or 415 volts between the phases/lines and contract demand not exceeding 200 kVA. Provided that in case of multiple Consumers in the same building/premises with cumulative Contract Demand exceeding 160 kW / 200 kVA, such limit would be 480 kW / 600 kVA:

d) Three phase, 50 cycles, 11 kV HT installations with contract demand above the limit 200kVAKW up to 5000 kVA

e) Three phase, 50 cycles, 33 kV HT installations with contract demand above 5000KVA and up to 10,000 kVA

f) Three phase, 50 cycles, Extra High Voltage – all installations with contract demand is above 10,000 kVA i.e. For all loads of more than 10,000kVA Power shall be supplied at 220kV voltage level except express feeders.

In the case of utility/process plants like STP, CETP, ISPS, IEPS, PWPS, FFPS, REWPS etc., the power supply to the particular plant shall be arranged from

i. Two numbers of 11kV power tapings at different locations, if the maximum demand of each utility/process plant exceeds 200kVA. The utility/process plant shall be provided by the Contractor with a dedicated RMU, transformer, LT Panel and DG set. A dedicated electrical room shall be provided by the Contractor for each utility/process plant.

ii. Two numbers of 415V power supply cables shall be arranged from the nearest power feeder pillar (at two different locations) to the proposed LV Switchboard if the maximum demand of each utility/process plant is less than 200kVA.

1.4.2 System rated voltage; frequency maximum permitted variation & power factor design consideration.

Table 1-2: System Rated voltage, Frequency Maximum permitted variation and power factor.

S.No.	Description	Maximum Permitted Variation
1	Voltage Up to 650V	+ / - 6%
2	Voltage 650V to 33kV	+6 / -9%
3	Above 33kV	-12.5 / +10%
4	Frequency	50 Hz +/-3%
5	Combined Frequency & Voltage Variation	+ / -9%
6	Power Factor	0.9

1.4.3 Short Circuit Current of 220kV, 33kV, 11kV & 0.415kV system

It is recommended to adopt the following standard short-time current ratings while selecting the equipment for various voltage levels. However, the Contractor shall perform necessary calculations for actual findings during detail designing and equipment shall be selected accordingly.

Table 1-3: Short Circuit Current of 220kV, 132kV, 33kV & 11kV & 0.415kV

S.No.	Description	Proposed Short Circuit Current
1	220kV	31.5kA/40kA/1 Sec
2	33kV	25kA/3 Sec
3	11kV	25kA/1 Sec

S.No.	Description	Proposed Short Circuit Current
4	0.415kV. Up to 2000kVA	50kA/1 Sec
5	0.415kV Above 2000kVA	65kA/1 Sec

1.4.4 System Rated voltage for DIGHI Node

Table 1-4: System Rated voltage.

S.No.	Description	Voltage Level
1	Receiving (Primary) power supply voltage	400kV/220kV, 3 phase, 3 wire, 50 Hz,
2	Sending (Secondary) power supply voltage	33kV/11kV, 3 phase, 3 wire, 50 Hz,
3	A.C. drive motors	415V, 3 phase, 3 wire, solidly earthed.
4	Instrumentation & control including protection interlocking system	230V, 1 phase, A.C. (from UPS)
5	Control and protection of HT and LT switchgear including ACBs of MCCs.	110V, 2 wire, unearthed D.C.
6	Control and indication for MCC feeders (other than ACBs)	240V, 1 phase, line & neutral (through control transformers)
7	AC UPS	240V, 1 phase, 2 wire
8	Plant illumination	415V, 3 Phase, 4 Wire and 240 V, 1 phase, line & neutral
9	Emergency illumination (Only for Substation)	230V, 1 phase, 2 wire, 50 Hz, A.C (UPS supply)
10	Panel lighting and space heaters	240V, 1 phase, 2 wire, 50 Hz, A.C. with one point earthed
11	SCADA/PLC power supply	230V, 1 phase, 2 wire, 50 Hz, A.C (UPS supply)
12	Welding socket/power receptacles	415V, 3 Phase, 50 Hz, A.C. outlets. 240V, 1 phase, 2 wire, 50 Hz, A.C. with one point earthed.
13	Sockets for electrical tools, etc.	240V, 1 phase, 2 wire,50 Hz, with one point earthed

1.4.5 System Earthing

Table 1-5: System Earthing

S.No.	Voltage Level	System Earthing
1	220kV	Solidly Earthed System
2	33kV	Solidly Earthed System
3	11kV	Solidly earthed system
4	0.415kV	Neutral of Transformer solidly earthed system

Note: Two numbers independent earthing for transformer neutral will be considered.

1.4.6 Insulation Co-ordination

Standardized levels for the highest system voltages Um related to the rated voltages are defined in IEC 60071-1 and are the same in Indian Standard. According to these ki-levels the test voltages for the insulation of high voltage equipment are defined. The following levels have been selected out of IEC 60071-1, IEC 60364 and IS-SP39.

Table 1-6: Standardized Levels for the Highest System Voltages

Rated Voltage	Un (kVrms)	0.415	11	33	220	400
Highest system voltage	Um (kVrms)	1	12	36	245	420
Power frequency withstand voltages 50 Hz, 1 min, to earth	Upf (kVrms)	3	28	70	460	630
Lightning impulse with stand voltage 1.2/50 µs to earth	Uli (kVpeak)	8	75	175	1050	1425

IEC 60815 defines 4 different pollution levels from light to very heavy pollution. To each pollution level, the corresponding minimum nominal specific creepage distance is defined. The equipment to be installed in the project area will be exposed to rainy /fog conditions and to pollution due to exhausts. To consider this situation the pollution level “heavy” according to IEC will be selected.

1.4.7 Load Norm

Power demand estimates for the DIGHI project area may be derived based on figures and assumptions as mentioned in Table below. These figures are only for contractor’s reference. However, the contractor should arrive at necessary power demand basis and get it approved from client before the start of detailed engineering and design.

Table 1-7: Standardized Levels for the Highest System Voltages

S.No.	Description	W/ Sq. m	Diversity factor
1	Industrial	150	01.5
2	Residential, HIG, LIG	45	2.5
3	Commercial	125	1.5
4	Amenity / Public / Semipublic Area	2	2.5
5	Park & Open area	0.5	2.5
6	Roads	2	2.5
7	MSME & Other Industries	32	2.5

1.4.8 Existing Power Source and Proposed Power Distribution for Parcel B, DPIA

As per MSETCL//MERC/MSEDCL guidelines, acceptable supply voltages are 400kV, 220kV, 33kV, 11kV and 415V. Subjected to that 3 Stage 400kV, 220kV/33kV/11kV/0.415V Transmission and Distribution System is proposed for Power distribution of Parcel B, DPIA. Based on the final load demand calculations; the maximum power demand of Phase-1 Area , Parcel B, DPIA is 299.93MVA.

As per ‘The Maharashtra Electricity Regulatory Commission (MERC) and available power sources in the vicinity of DPIA, the voltage levels of 400 kV and 220 kV for the main receiving sub-station have been selected to cater to the overall demand.

As per MERC guidelines, the installed capacity of any single substation at different voltage levels shall not normally exceed the following values:

S. No.	Voltage Level	Maximum Capacity
1	400 kV	2000 MVA
2	220 kV	500 MVA

To achieve a reliable power supply to complete DIGHI, it is proposed that, there will be one number of MRSS i.e., 400/220 kV substation to cater to overall demand. In downstream of the 400/220 kV substation, there will be two number of 220 kV gas-insulated switchgear (GIS).

Each 220 kV substation shall receive double circuit 220 kV overhead transmission lines from 400/220 kV substation to keep 100% redundancy. Two number of 220/33 kV substations (viz. ZSS-1 and ZSS-2) of aggregate capacity 220/33 kV, 8 x 100 MVA, each one of 220/33 kV, 4 x 100 MVA capacity shall be considered to cater for the overall demand of phase 1, 2 and 3. In DPIA phase 1, only one number of 220/33 kV, 4 x 100 MVA (ZSS-1) substations shall be provided by the Contractor to cater for the load.

Power supply to 400/220 kV substation shall be supplied through LILO (N+1 Configuration) on 400 kV Dabhol- Nagothane double circuit transmission line. Confirmation of same has been received by Maharashtra State Electricity Transmission Co. Ltd (MSETCL) through letter number MSETCL/CMD/DIGHI/07610 dated 28/10/2022. Supply and installation of 400/220 kV Substations, 220/33 kV substations along with EHV (400 kV and 220 kV) overhead transmission network shall be established by Maharashtra State Electricity Transmission Co. Ltd (MSETCL). So, details of same will not be included in this document.

The detailed route survey for the proposed 400 kV and 220 kV double circuit transmission lines, along with the selection of the most optimum route to circumvent environmentally sensitive areas, will be conducted by the State Transmission Utility, i.e. MSETCL.

All HT/LT power and control cables, OFC cables including cable containments up to the 220/33 kV substation equipment e.g., laying and termination of 33 kV cables up to the 33 kV switchgear of 220/33 kV substation, instrumentation/ OFC cables up to the SCADA system of 220/33 kV substation including associated civil works shall be in the scope of EPC Contractor.

Construction power during the execution stage shall be arranged by the contractor by creating temporary substations of capacity 22/0.433 kV, 200 kVA at different locations.

11kV power supply shall be distributed to individual consumers as confirmed by Engineer-in-Charge through 11kV RMU's in proximity of each type of consumers connecting 6.35/11kV (E) XLPE FRLS cables laid through RCC cable trench with FRP cable tray to nearest proposed 33/11kV Zonal substations.

Wherever consumer load demand is less than 200kVA, 415V Power supply shall be provided from LV Feeder pillars which shall be fed from 11kV/0.415kV CSS. CSS shall consist of 11kV switchboard, dry type transformer (with off load tap changer) and LV board with switched capacitor bank. All these items shall be enclosed in a rust proof enclosure. CSS /Feeder pillars for LV clusters shall be located at plot boundary. RMU and CSS shall be proposed to be located at open spaces/inside the plot boundary. All HV, LV Power, control and Fiber optic cables shall be laid through RCC cable trench with FRP cable tray along both the sides of the road corridor.

All power and distribution transformer shall be designed such that each transformer is not loaded beyond approximately 80% of transformer rating.

415V Lighting feeder pillars shall be proposed for distributing power to Road lighting and lighting feeder pillars shall be fed from nearest 11kV/0.415kV Compact Substation. Lighting Feeder pillars shall be located at various location of Road corridor. 4 core cables shall be used for Street lighting supply distribution.

1.4.9 External connectivity

Power supply to the 400/220 kV substation shall be supplied through LILO (N+1 Configuration) on the 400 kV Dabhol- Nagothane double circuit transmission line. Confirmation of the same has been received by Maharashtra State Electricity Transmission Co. Ltd (MSETCL) through letter number MSETCL/CMD/DIGHI/07610 dated 28/10/2022. Supply and installation of 400/220 kV Substations, 220/33 kV substations along with EHV (400 kV and 220 kV) overhead transmission network shall be established by Maharashtra State Electricity Transmission Co. Ltd (MSETCL). So, details of same will not be included in this document.

1.4.10 Substation Design

The sub-station shall be located in a safe-area close to the load Centre. Consideration shall be given to vehicular traffic or any other factor that might affect the operation of the sub-station. A separate entry of 3.0 m with a rolling shutter shall be provided for drawing in all equipment for erection. The main entry for operating personnel shall be provided with single door system. The Substation shall also have an emergency door opening outwards.

400kV/220kV//33kV MRSS, 33kV Switching Station and 33kV/11kV Distribution substations will be indoor type and 400kV, 220kV, V, 33kV, 11kV GIS panels, Auxiliary LT panel, Battery & Battery chargers, control panel and AMF panel etc will be located inside the substation building. One number of Main Receiving Substation i.e. MRSS (under MSETCL Scope) & two numbers of 33kV Switching Stations and 10 numbers of 33kV/11kV Distribution substations shall be considered for DIGHI Phase-01 area of activation. The substation building will be sized based on switchgear dimensions which are accommodated inside the room and specified adequate clearances to be maintained as per below Table 1-8. MRSS (under MSETCL Scope) shall be designed considering space requirements for 400kV, 220kV,33kV, GIS Panels and 400kV, 220kV & 33kV control and relay panels. and Power Transformers as per drawing no. EIUD1MH003-NICDC-DIGHI-EL-001.

Table 1-8: Clearance requirement for Switchgear installation

S.No.	Description	Clearance
1	Front Clearance for all SB Panels	2000 mm for 11kV GIS 3000 mm for 33Kv, ,220kV & 400kV GIS or as per manufacturer’s recommendation.
2	Rear clearance for SB panel requiring maintenance from rear	1500 mm for 11kV GIS 2000 mm for 33kV,220kV, 400kV GIS or as per manufacturer’s recommendation.
3	Side Clearance between two SB panels or from nearest obstruction	1500 mm for 11kV GIS (But not less than twice the width of each panel) 3000 mm for 33kV, 1 220kV, & 400kV GIS or as per manufacturer’s recommendation.
4	Clearance from face off wall mounted equipment	1000 mm
5	Vertical Clearance measured from - Bottom of roof slab - Bottom of lowest roof beam	 1000 mm 500 mm
6	Battery Rack to Wall clearance	1000 mm
7	Between Battery Rack	1500 mm

S.No.	Description	Clearance
8	Maximum height of Battery Rack	1600 mm

Note: In case of 33kV, 220kV& 400kV GIS, front, rear and side clearance shall be as per GIS supplier's recommendation.

Equipment like oil filled transformers shall be located in Transformer area adjacent to the sub-station building. Oil immersed transformers with oil capacity exceeding 2000 litters, shall be provided with a soak pit of sufficient capacity to take the whole of the oil of the equipment. Where oil capacity of transformers exceeds 9000 litters, provision shall be made to drain away the oil to a separate waste oil tank/collection pit located away, through suitable drainpipes of 150 mm or 200 mm in diameter.

Power Transformer rating 10MVA and above shall be provided with Nitrogen injection fire protection system (NIFP).

RCC cable trenches will be provided for cable connectivity between the EHT, HT panels & transformers. RCC cable trenches will be provided with removable precast covers. Cables are to be laid in tier formation in the cable trenches for power, control, instrumentation cables. Transformer foundation drawings, substation GA will be submitted for approval prior commencement of installation.

Adequate ventilation to be maintained inside switchgear substation room with providing exhaust fans, louvers, and windows etc. Sub-station building shall be without any columns within the switchgear room to ensure optimum space utilization.

Each Sub-station shall have First aid boxes, EHV, HV & LV rubber gloves, Shock hazard charts, laminated AC and DC SLDs (final SLDs) at minimum two locations. EHV, HV & LV rubber mats shall be provided in front of all electrical switchgears & Equipment (charger/UPS/heater etc).

All switchgears panels are free floor standing type. The foundation frames for installation will be flush with finished floor level and cable open area in trenches will be covered with MS chequered plates.

1.4.11 Distribution Transformers

All distribution/auxiliary transformers shall be of dry type in case of Indoor Installation and Oil type in case of outdoor installation for ratings 11kV/433V with Dyn11 vector group. LV star winding shall be solidly grounded. Rating of Distribution/Auxiliary transformer as indicated on the single line diagrams.

1.4.12 Compact Substations

Wherever consumer load demand is less than 200kVA and for street lighting, 415V Power supply shall be provided from LV Feeder pillars which shall be fed from 11kV/0.415kV CSS. CSS shall consist of 11kV switchboard, dry type transformer (with off load tap changer) and LV board with switched capacitor bank. All these items shall be enclosed in a rust proof enclosure. CSS/Feeder pillars for LV clusters shall be located at plot boundary.

Quantity and location of CSS for activation area shall be based on occupancy of consumers and in consultation with Engineer's In charge.

1.4.13 Ring Main Units

It is proposed that all the consumer for load demand above 200kVA and up to 10MVA power demand shall receive power through V Ring main units. The RMUs shall be provided at the proximity of each type of consumers.

Voltage level and MVA capacity of RMUs has been decided based on following methodology.

a) Plot wise demand estimation.

b) 11kV up to 5 MVA

c) 33kV up to 10 MVA

In the ring configuration, 2 to 4 RMUs in one ring are interconnected to supply power to various consumers.

Quantity and location of RMUs for activation area shall be based on occupancy of consumers and in consultation with Engineer's In charge.

For the power supply arrangement of each RMU, the contractor shall ensure the provision of necessary power supply feeders in respective substation.

To maintain the redundancy and reliability in the power supply distribution network, 11kV/33kV Ring main units shall be connected in a 'Ring'. Each ring shall be connected to separate sources through the feeders on the different buses.

1.4.14 Color Coding

Bus bars, bare copper connections, earthing bars, cable cores and Mimic diagrams shall be provided with the following colors:

Table 1-9: Color coding

System	Color	
Three Phase AC System	R	Red
	Y	Yellow
	B	Blue
	N	Black
	Ground	Yellow/Green
DC System	Positive	Light Blue
	Negative	Grey
Mimic Diagram of Control Boards	400kV System	Light orange
	220kV System	Light blue
	33kV System	Olive green
	11kV System	Sea green
	415 V System	Dark violet

1.4.15 Preferred Make of Main Equipment

The List of Approved makes for Electrical equipment shall be as given in the last chapter of the specification. For the items which are not covered in List of approved makes for Electrical equipment, contractor should arrange Engineer-in-charge's approval against the make proposed by the contractor. Contractor's scope includes to arrange MSETCL/MSEDCL approval against Shop drawings for all Electrical equipment's.

1.4.16 Fire Fighting

For firefighting in CSS portable type fire extinguishers suitable for electrical fires shall be provided.

1.4.17 Diesel Generator Sets

Under normal conditions all the LV loads shall be fed from the grid supply. However, in case of grid failure or non-availability of grid supply due to system fault, all the essential loads, shall be fed from the standby diesel generator sets. DG sets shall be planned for essential loads i.e. streetlights, treatment plants etc.

1.5 Cabling System

1.5.1 Types of Cables

All EHV cables will be 230/400kV & 127kV/220kV of an earthed grade suitable for use in a solidly earthed system, stranded & compacted electrolytic Copper conductor, extruded semi conducting screen over the conductor, XLPE insulated, extruded semi-conducting insulation screen, armoured, semi-conducting followed by copper wire screened, Extruded aluminium or lead alloy metallic sheathed, PVC outer sheathed, conforming to IS 7098 (Part III) or IEC 60840 or IEC 62067 and IEC 60502 for constructional details and tests.

HV cables will be 19kV/33kV & 6.35/11 kV of earthed grade suitable for use in solidly earthed system, stranded & compacted electrolytic aluminium conductor, extruded semi conducting screen over conductor, XLPE insulated, armoured, semi-conducting followed by copper tape screened, extruded PVC, Type ST–2 inner sheathed, overall FRLS, PVC outer sheathed, conforming to IS 7098 (Part II), IEC 60502 for constructional details and tests.

LT Power Cable will be 1100 V grade, single / multi core, stranded electrolytic aluminium/ copper conductor, XLPE insulated, with PVC inner sheath, armoured and outer sheath made of FRLS PVC compound, generally conforming to IS-7098 (Part-II). The cables used for DC system will be of two core type. Minimum conductor cross section of power cables will be 10 mm2 for aluminium cables and below 10 mm2 it will be copper conductor. Minimum conductor cross section of power cables shall be 4 Sq.mm for Copper. Maximum size of the power cable shall be 240 Sq.mm.

Control cables will be 1100 V grade, multi core, minimum 2.5 mm2 cross section, stranded copper conductor having XLPE insulated, PVC inner sheathed / galvanized steel wire armoured, overall FRLS, PVC outer sheathed generally conforming to IS 1554 Part-I. In situations where accuracy of measurement or voltage drop in control circuit warrants, higher cross sections as required will be used. The number of cores will be standardized as 2,3,4,5,7,10,14,19,24.

1.5.2 Design methodology for calculation for EHT HT & LT cables:

The following factors will be considered for selection and sizing the EHT, HT & LT power cables & Lighting Wires.

a) Maximum design ambient temperature will be considered as 50°C.

b) Maximum permissible power supply variation

i. Voltage variation: +/-6%

ii. Frequency variation: +/-3%

iii. Combined Voltage & frequency variation: +/-9%

c) Maximum ground temperature

d) Depth of laying wherever applicable

e) Grouping of cables

f) Maximum fault level for HT/EHT cable

g) Maximum allowable Voltage drop power system network.

i. Allowable voltage drop at the terminal of the connected equipment will be maximum 5 % at full load.

h) Maximum allowable Voltage drop for Treatment Plant work.

i) Cable between PMCC and MCC or auxiliary switch board

Aux Switch board near PMCC/MCC: 0.5%

Aux Switch board situated remote from PMCC/MCC: 2.0 – 2.5%

i. Cables between PMCC/MCC and motors: 3%

ii. Cable between auxiliary switchboard and Lighting Panel: 1-1.5%

iii. Cable between lighting panels and lighting points: 4%

iv. During starting of heavy equipment, the voltage may drop by a maximum of 15%.

j) Actual load current

k) Lighting Wires: 1100 V grade, single core, stranded, copper conductor, PVC insulated wires conforming to IS 694 / IEC 60227 Part 1 to 5 / IEEE-719. Minimum cross section of copper wires will be 2.5 mm2 for lighting circuits and 4 mm2 for receptacle circuits.

1.6 Cable laying Methodology

1.6.1 Cable Tray & RCC cable Trench

RCC cable trenches with FRP cable tray is proposed for all Electrical Substation/Electrical room, Transformer yard and for Utilities viz:- STP, WTP, CETP or any ancillary units. Fiberglass products cable tray provides reliable cable support in corrosive application as well as melded & metered fittings, other accessories like coupler plates, struts, etc., standard Length of cable tray shall be 3000mm and major sizes of cable trays will be proposed 150mm/300mm/450mm/600mm/900mm with 3mm thick and providing supporting structure based on working load capacity of cable tray at span of 1.5-meter interval. Minimum 750mm maintenance walkway will be provided inside the RCC cable trench. RCC Trench on the Main Roads shall have minimum internal dimension of 1350mm (Width) & 2000mm (Height).

Commented [IP2]: Added

All the cables will be laid on FRP cable trays supported by MS angles inside the RCC cable trench. It is proposed that instrumentation cables will be laid at the upper level of RCC cable trench followed by LT, HT, EHT. Lowest levels will be occupied by 400kV or 220kV cables which will also require adequate clearance for cross bonding within the RCC cable trench. EHT, HT, LT XLPE cables and optical fibre cables will be laid in concrete cable trenches. The size of cable trench on respective ROW will be designed based on number of cables and cable tiers.

The relative position of the cables laid on the cable tray will be preserved, and the cables will not cross each other. At all changes in direction in horizontal and vertical planes, the cable will be bent smooth with a radius as recommended by the manufacturers. All cables will be laid with minimum one diameter gap and will be clamped at every meter to the cable tray. Cables will be tagged for identification with aluminium tag and clamped properly at every 20 Mtr. Tags will be provided at both ends and all changes in directions both sides of wall and floor crossings. All cable will be identified by embossing on the tag the size of the cable, place of origin and termination. All cables passing through holes in floor or walls will be sealed with fire retardant Sealant and will be painted with fire retardant paint up to one meter on all joints, terminations and both sides of the wall crossings.

1.6.2 Laying of Cables in Ground

Only street lighting cables from lighting feeder pillar to lighting poles are proposed to be laid through buried cable trenches. The minimum width of trench for laying single cable will be minimum 350 mm. Where more than one cable is to be laid in horizontal formation, the width of the trench will be workout by providing minimum one cable diameter gap between the cables, except where otherwise specified. There will be clearance of minimum half a cable dia or 25mm whichever is greater between the end cable and the side wall of the trench. Minimum depth of the LV cable trench will not be less than 600 mm for single layer of cables. When the cables are laid in more than one tier the depth of the trench will be increased by 300 mm for each additional tier.

1.6.3 Laying of Cables in HDPE Duct

All EHT cabling shall be laid through buried HDPE / DWC pipes along median. Refer typical cross section drawings attached with Tender document.

1.6.4 Route Marker

Route marker will be provided along straight runs of the cables not exceeding 30 meters also for change in the direction of the cable route and underground joints. Route marker will be of cast iron painted with aluminium paint. The size of marker will be 100 mm dia with “Cable” and voltage grade inscribed on it.

1.6.5 Earthing and Lightning protection System

Earthing of all electrical equipment shall be designed and provided as per the guidelines given in the latest IEEE-80 standard and IS-3043: Code of Practice for Earthing.

The earthing design shall be based on the soil resistivity measurement carried out at various locations of substation and CSS sites. Wherever required the earth grid shall be placed 600mm below ground. Where high resistivity values are encountered chemical earthing shall be employed. Resistivity measurement shall be in the scope of contractor. The grid system will cover the entire fenced substation area and will be extended to the outer of the substation fence. A perimeter conductor will run around the substation in a distance of 0.5m to the fence and will be connected to the inner earthing grid and to the fence in regular intervals. Where necessary to reduce the overall earth resistance, earth electrodes will be provided and connected to the perimeter of the main earth grid.

The earthing system includes the underground grid, ground rods and connections. The earthing system will be designed to minimize the dangers from step, touch and transferred potentials which can occur under maximum fault conditions.

The EHV, HV and LV systems are solidly earthed at the neutral point of the power transformer. The size of earthing conductors to be connected with the earthing system will be designed for an earth fault level of 50 kA (1 sec). All electrical equipment such as motors, transformers, substations, foundations, switchboards, control boards, relay and auxiliary relay boards, all other subsidiary electrical equipment as well as all metal parts of civil construction or the mechanical equipment such as transformer rails, pumps, pipes, steel structure, tanks, cable trays, etc. will be connected to the earthing system.

For Lightning protection IS/ IEC:62305 shall be followed.

1.6.6 Power supply to Field Instruments like Control valves, Pressure Transmitters, Level Transmitters, RTUs and online Analysers

Power supply requirement for all control valves, RTU'S, field devices and accessories for Potable, Recycled, Sewerage & Industrial effluent network will be sourced from nearest feeder pillars. Dedicated Power DB shall be equipped with Type 2 Surge Protection Device with in 30KA per phase to be provided for feeding power to field instruments. The power cables will be terminated to respective control valves, RTU'S, field devices and accessories of Potable, Recycled, and Sewerage & Industrial effluent network from RCC cable trenches through Double Wall Corrugated HDPE Ducts.

1.6.7 Streetlight

The street lighting system shall be designed considering the following. The basic design criteria for street Lighting as per the latest Indian standard.

a) Lux Level Calculation

b) Type of luminaries.

c) Control-scheme of luminaries with Type 3 SPDs

d) Power sources for street lighting.

e) Power distribution for street lighting with Type 2 SPDs.

f) Mounting arrangement of luminaries.

g) Selection of street lighting poles.

h) Cable laying and termination scheme.

1.6.8 Recommended values of Illumination

Considering the principles of vision, criteria of quality and characteristics of sources and luminaries the desirable minimum levels of illumination which are recommended as per IUT-Institute of Urban Transport and Indian Standard SP: 30 -2011) shall be adopted. Work plane height shall be 0 and Uo shall be minimum 0.4. Following are the minimum illumination level requirement for various buildings/Road corridors.

Table 1-10: Recommended values of illumination

S.No.	Location/Building/Plant	Average Illumination level (lux)	U0 (Emin/Eav)
1	Main roads lux level	30	0.4
2	Main road junction	30	0.4
3	Footpath and cycle track	20	0.4
4	Service road	20	0.4
5	Substation Building./Electrical room	300	0.4
6	Battery Room	150	0.4
7	SCADA/PLC Control/Operator room	400	0.4
8	Transformer Yard	150	0.4
9	Blower Building	200	0.4
10	CheDIGHIal House	150	0.4
11	Pumping Station/Pump House	200	0.4
12	Centrifuge Building	200	0.4
13	Conference Room	300	0.4
14	Reception Room	300	0.4
15	Plant Manager Room	300	0.4
16	Meeting Room	300	0.4
17	STP/CETP working area	300	0.4
18	Platform lighting	150	0.4
19	Outdoor street lighting of STP/CETP	20	0.4

1.6.9 Selection of Lighting Fixture

Light Emitting Diode (LED) type luminaried shall be used in the entire zone. Light fitting with in-built capacitor should be provided to improve the system power factor to 0.90 lagging or better.

1.6.10 Selection of Street Lighting Poles

a) Street Light poles structures should be designed to support single or multiple luminaire configurations.

b) The following factors shall be considered in pole selection/design:

c) Mounting Height (MH)

d) Luminaire Selection and Configuration

e) Auxiliary Equipment and Special Loading

f) Wind Speed

g) Terrain and Special Wind Regions

h) Finish

i) Special Requirements and Mounting Configurations

j) Conformance with the BEE (Bureau of Energy Efficiency)

k) Octagonal type street lighting Smart poles with necessary protection against rusting shall be selected due to the coastal area.

1.6.11 Power distribution for street lighting

There shall be a main distribution board, or Compact substations planned which will be dedicated to supply power for street lighting feeder pillar. Each feeder pillar shall be capable to feed supply 500 meter in either side. Not more than 1000 W load or 10 No. of light fixtures, either of which is achievable shall be kept on a single circuit. All the feeder pillars shall be IP-65 degree of protection and front operated. Feeder pillar construction shall be as per IEC-61439 with a provision to monitor relative humidity and temperature via Hygro-thermostat device. All Feeder pillars and HM feeder pillar shall be provided with 80A direct measurement type MFM with NFC capability as well as and gate way controller which shall be suitable for SCADA compatible. MFM of each Street lighting feeder pillar and HM feeder pillar shall be interfaced with respective substation SCADA. Gate way controller having licence free cloud access with Ethernet, Bluetooth and Wi-Fi connectivity of each lighting feeder pillar shall be interfaced with lighting SCADA to be located at Common control room/Common command centre by other package contractor.

1.6.12 Lighting Management System

To have efficient use of light automatic light control system is recommended. The lights shall be with Industrial Grade astronomical clock device with electrical life of 1 lakh cycles having NFC programming capability to automatically set the timings based on Indian Postal Codes for lights ON/OFF throughout the year in line with sunset timings.

A centralized solution shall be adopted for intelligent operation. In this system hardware modules are installed in control cabinet (Lighting feeder pillars) and enable communication from the central server location to control cabinet via fibre optics cable. Light dimming shall be provided through master slave type dimmers, say when traffic is rare as in case after mid night.

1.6.13 Earthing and Lighting Protection

The lightning protection should be provided for high masts. Both the earthing and lightning protection installation shall be done in accordance with earthing and lighting protection calculations as per relevant codes and standards including Surge Protection Devices and Surge counters.

1.6.14 SCADA (Supervisory Control and Data Acquisition) System

MRSS, ZSS, Switching Stations & Distribution substations will be provided with SCADA system where the substation panel i.e. 400kV, 220kV GIS EHT, 33kV GIS HT ,11kV GIS HT switchboard and 415V LV switchboard shall be monitored and automated. It also covers the monitoring of FRTU placed in the Ring main unit/CSS at site which are feed by respective substation.

The SCADA under the MRSS-shall share the data with central control room SCADA, where centralized monitoring of all MRSS shall be done through other package.

400/200 kV substation, 220/33 kV substation, 33 kV switching stations, 33/11 kV substations, 33 kV and 11 kV RMUs and 11/ 0.433 kV package substations shall be connected to supervisory Control and Data Acquisition (SCADA) system. Main control Room shall be created at 400/220 kV and 220/33 kV substations by MSETCL to control and monitoring the power flow of the entire cluster. Also, SCADA system at 33 kV switching stations interconnecting all 33/11 kV substations, 11/0.433 kV package substations, 11 kV and 33 kV RMUs etc. with optical fiber network (OFC) shall be considered. SCADA system of same shall be further integrated to main SCADA system of 220/33 kV substation.

All required hardware, software, associated equipment including OFC cables, control cables etc. for the Integration of 33 kV SCADA system to the main SCADA system at 220/33 kV substation shall be in the scope of EPC company.

Further integration of the main SCADA system with the Integrated Command and Control Centre (ICCC) will be considered along with necessary hardware, software, and auxiliary equipment to enable seamless communication and coordination between these systems. This integration is crucial for effective monitoring, control, and management of various utilities and services within the DIGHI.

The EHT & HT (400kV/220kV//33kV/11kV) panels under substation shall be monitored at substation SCADA via Modbus communication or the numerical relays shall have substation RTU/SCADA communication over IEC61850 protocol. Multi-function metering units shall transfer measured parameters to SCADA via RTU Modbus over RS-485/RS-232, TCP/IP communication links. For phase-01 activation area, MRSS-1 and 1 No. ZSS shall be provided with dedicated SCADA system, MRSS SCADA system shall include interface provision for GIS and Power Transformers also.

All RMUs, CSS and RTUs etc shall be interfaced with respective Substation SCADA through FO cable. All Energy meters of Auxiliary LV Panel in Substation building, CSS-LT switchboard, Lighting feeder pillar, HM Feeder pillar, Power feeder pillars, DG Set AMF panel etc also shall be interfaced with respective Substation SCADA.

Proposed SCADA system for MRSS shall be compatible to upgrade 20% IOs for future incoming and outgoing feeders.

Lighting Management system (LMS): Gateway controller having licence free cloud access with Ethernet, Bluetooth, and Wi-Fi connectivity, of all street lighting feeder pillar and HM feeder pillars shall be interfaced with Lighting SCADA at Common control room by other package contractor. However proposed Street lighting feeder pillar and HM feeder pillar for the project area should be SCADA compatible.

The power SCADA for each substation shall be equipped with following hardware’s,

a) Operator cum Engineering Workstation for Power SCADA with Minimum 32” Monitor.

b) Ethernet Switch with POE SPDs

c) Port Fiber Patch panel

d) PLC/RTU Panel

e) UPS System with 20KA In Type 2 SPDs

f) FRTU for RMU or CSS.

All electrical equipment's fed from respective Substation should be interfaced with respective Substation SCADA. All Substation SCADA shall be interconnected in FO cable in Ring formation and to be connected to Common Control Room Building by other package contractors. Redundancy Server is to be provided for each Substation SCADA and SCADA at Common Control room Building by Other package contractor.

Electrical equipment's of all STP/CETP/Pump house etc should be interfaced with PLC SCADA of Water which shall be located in separate control room building of STP/CETP/Pump house Building. This SCADA should be interfaced with Main SCADA which is in Common Control room Building by other package contractors.

The UPS power supply shall be provided in each substation SCADA control room to power the workstation and Ethernet switches. RTU's/FRTU's of RMU/CSS shall be powered from electrical power supply where, FRTU's are having inbuilt battery backup of 8 Hr. time which further used to for FRTU, Ethernet switch and control circuitry working in absence of main power supply.

in addition to the above, other critical components such as Closed-Circuit Television (CCTV), Mechanical, Electrical, and Plumbing (MEP) systems, Heating, Ventilation, and Air Conditioning (HVAC), communication infrastructure, and security facilities, as well as their associated interfaces, have been carefully considered and integrated into the overall project plan. These components collectively contribute to the comprehensive infrastructure and functionality of the project.

1.6.15 Material and Workmanship in the Climatic Conditions

All the equipment's shall be new and of best quality and capable of satisfactory operation under humid climate with rainy seasons, dusty conditions mentioned above. The workmanship shall be of the highest grade and the entire manufacture shall be in accordance with the best modern engineering practices. The contractor's Quality Management Plan shall address these factors and others to ensure the facilities and infrastructure provided and handed over meet all Employer's requirements.

1.6.16 Single Line Bid Drawing

Substation location and electrical distribution drawings indicate the arrangement of system planning of the project in Tender drawings.

1.6.17 Circuit Breakers

It should be noted, that unless technically required no HRC fuses are to be provided anywhere in the system.

For EHV, HV Distribution, gas insulated switchgears shall be used.

Only MCCB's (current limiting type) of rating as per IEC 60947-2 and IS13947-2 and MCB's (current limiting type) as per IEC-70898 (IS-8828) with the short circuit ratings of the system shown.

The MCCB's at the LT Board are to be coordinated with the MCB's at the receiving end. Therefore, the rating of MCCB's is tentative, and shall be finalised during the detailed engineering phase to achieve proper discrimination. Current limiting type MCCB/MCB shall be used at suitable locations for protections co-ordinations.

1.6.18 Codes & Standards

The following primary standards and codes (latest editions/ revisions/ replacements) shall be used for planning and design of the electrical distribution system within the scope of works:

Table 1-11: Codes & Standards

Code	Standard
General	Indian Electricity act 1956.
	Guidelines Laid down by MSEDCL. Guidelines Laid down by MSETCL. BIS: Bureau of Indian Standard BS: British Standard IEC: International Electro technical commission IEEE: Institute of Electrical & Electronics Engineers IS: Indian Standard Regulations lay down by Indian Electricity Rules National Electrical Code (SP 30, 2011) of India Bureau of Energy efficiency (BEE) CEA Guidelines Regulations laid by chief controller of explosives. Any other regulations laid down by the local or government authorities. Regulations laid down by tariff advisory committee / Fire insurance regulations
IEC-62271-203	Gas Insulated Metal-Enclosed Switchgear for rated voltage for 72.5kV & above
IEC-60517	Gas Insulated Metal enclosed switchgear for rated voltages of 72.5kV and above
IEC-60376	Sulphur Hexafluoride
IEC-62271-100	High Voltage Alternating Current Circuit Breakers
IEC-60694	Common Clauses for high voltage switchgear and control gear standards.
IEC-62271-100	Alternating Current disconnectors (Isolators) and Earthing switches.
IEC-61128	Alternating Current Disconnectors Bus-transfer current switching by disconnectors.
IEC-61129	Alternating Current earthing switches-induced current switching.
IEC-66044-1, IS-2705	Current Transformers
IEC-66044-2	Voltage Transformers.
IEC-60137, IS-2099	Bushing for alternating voltages above 1000V
IEC-60859	Cable connections for Gas insulated switchgear
IEC-60480	Guide to checking of Sulphur hexafluoride taken from electrical equipment.

Code	Standard
IEC-60099-1/4	Non-linear Resistor type arrestors for AC systems.
IEC 61439 PART I & II EDITION 3	Factory built assemblies of low voltage alternating current breaker
IEEE80-(2000) IEEE	Guide for safety in AC Substation Grounding
CIGRE-44	Earthing of GIS-an application guide
IEC-61639	Direct connection between power transformers and gas insulated metal enclosed switchgear for rated voltage 72.5kV and above.
IS-325	Three phase induction motors
IS-335, IEC-296, BS-148	Insulating oil for Transformers and switchgear.
IS-778	Gunmetal Gate, globe, and check valves for general purpose
IS-2026, IEC-76	Power Transformers
IS-13947	Degree of protection provided by enclosures for low voltage switchgear and control gear
IS-3203	Code of practice for climatic proofing for electrical equipment's.
IS-3347	Dimension of porcelain transformer bushings.
IS-3401	Silica Gel
IS-3637	Gas operated relays.
IS-3639	Fittings and accessories for power transformers.
IS-4253	Cork and rubber
IS-5561	Electric power connector
IS-5578	Marking and arrangement for switchgear
IS-11353	Bus bars, main connections, and auxiliary wiring
IS-6272	Industrial cooling fans
IS-6600	Guide of loading of oil immersed transformers.
IS-12676	Oil impregnated paper insulated condenser bushing dimension and requirements.
IS-2312-1967	Propeller type AC ventilating fans
IS-3024-1965	Electrical Steel Sheets (oriented)
IS-3151-1982	Earthing Transformers
IS-3131-1965	Electrical Relays for power system protection
IS-3588-1966	Electrical axial flow fans
IS-3624-1979	Burden tube vacuum and pressure gauges.
IS-6088	Oil to water heat exchangers for transformers
IS-3758	Thermocouples
IS-8468	On Load Tap Changers
IS-9700	Specification for activated alumina
IS-104	Ready mix paint, brushing, zinc chrome priming
IS-900	Code of practice for installation and maintenance of induction motors.
IS-1554 (Part-I) 1976	PVC insulated electric cables for working voltage up to and including 1100V
IS-10028	Code of practice for selection, installation and maintenance of Transformers.
IS-2266	Steel wire rope for general engineering purpose.
IS-2932-1974	Enamel, synthetic, exterior a) undercoating b) finishing
IS-3043-1966	Code of practice for earthing
IS-3638-1966	Application guide for gas operated relays
IS-3832-1986	Hand operated chain pulley blocks

Code	Standard
IS-5216-1982	Guide for safety procedures and practices in electrical work and electrical power connections.
IS-5528-1985	Guide for short circuit calculation
IS-6034-1971	Edge type vacuum filters
IS-6132	General requirement & dimensions of Deck shackles and Bow shackles
IS-8478-1977	Application guide for on load tap changer
IS-8923-1978	Warning symbol for dangerous voltages
IS-1966-1983	Code of practice for maintenance and supervision of insulating oil in service.
IS-6103-1971	Method of tests for specific resistance (Resistivity) of electrical insulating liquids.
IS-1876-1961	Method of voltage measurement by means of Sphere gap
IS-2071	Method of High voltage testing-Part I to Part III. (Part-I 1974 & Part II & III -1976)
IS-2165-1977	Insulation Co-ordination
IS-3716-1978	Application Guide for Insulation co-ordination
IS-6209-1982	Method of partial discharge measurement
IS-8690-1977	Application Guide for measuring device for high voltage testing.
IS-398 (Part-V)-1986 latest revision, IEC:1089-1991	Specification for Aluminium Conductor Galvanized Steel reinforced for extra high voltage (400kV) and above.
IS:209-1992, BS:3436-1986	Specification of Zinc
IS:1778-1980, BS:1559-1949	Reels and Drums for Bare Conductors
IS: 1521-1991, ISO 6892-1984	Method of tensile testing of steel wire
IS: 2629-1990	Recommended Practice for Hot Dip Galvanizing of Iron and Steel
IS: 2633-1992	Method of Testing Uniformity of Coating on Zinc Coated Articles
IS:4826-1992, IEC: 888-1987	Galvanized Coating on Round Steel Wires
IS:6745-1990, BS:433-1969	Methods of Determination of Weight of Zinc Coating of Zinc Coated Iron and Steel Articles
IS:8263-1990, IEC:437-1973	Method of Radio Interference Tests on High Voltage Insulators
IS: 9997-1988	Aluminium Alloy Redraw Rods
IEC: 888-1987	Zinc Coated steel wires for Stranded Conductors
IEC: 889-1987	Hard drawn Aluminium wire for overhead line conductors
IS:398 (Part-IV)	Aluminium Alloy Stranded Conductor
IS 278-1991	Galvanized Steel Barbed wire
IS 800-1991	Code of Practice for General Building Construction in Steel CSA 6.1
IS:808-1991	Dimensions for Hot Rolled Steel Beam, Column, Channel and Angle Sections.
IS:875-1992	Code of Practice for Design Loads (other than Earthquakes) for Buildings and Structures.

Code	Standard
IS:1363-1990, IS: 1363-1990	Hexagon Nuts (size range M5 to M36)
IS:1367-1992	Technical Supply Conditions for Threaded Steel/ Fasteners
IS:1477-1990	Code of practice for Painting of Ferrous Metals in Buildings: Part-I Pre-treatment: Part-II Painting
IS:1573-1991	Electro-Plated Coatings of zinc on iron and Steel
IS:1852-1993	Rolling and Cutting Tolerances of Hot Rolled Steel Products
IS:2551-1990	Danger Notice Plates
IS:2629-1990	Recommended Practice for Hot Dip Galvanizing of iron and steel.
IS:2633-1992	Method of Testing Uniformity of Coating of Zinc Coated CSA G164 Articles
IS:3063-1994	Single coil Rectangular Section Spring Washers for Bolts, Nuts Screws
IS:3757-1992	High Strength Structural Bolts
IS:5369-1991	General Requirements for Plain Washers
IS:5613-1993	Code of Practice for Design installation and Maintenance of Overhead Power Lines Section 1 Design Part 2, Section 2 Installation and Maintenance
IS:10238-1989	Step Bolts for Steel Structures
IS:12427-1988	Bolts for Transmission Line Towers
IS-206	Method of Chemicalal analysis of Slab zinc
IS-371, IEC:274, IEC:383	Porcelain insulators for overhead power lines with a nominal voltage greater than 1000V
IS-2486	Specification for Insulator fittings for overhead power lines with a nominal voltage greater than 1000V
IS: 2629	Recommended practice for Hot Dip Galvanization for iron and steel
IS-266	Testing for uniformity of coating of Zinc coated articles
IS: 3188	Dimensions for Disc Insulators
IS: 6745	Determination of Weight of Zinc coating on Zinc coated iron and steel articles
IS: 8263, IEC: 437	Methods of RIV Test of HV Insulators
IS-8269, IEC-506	Method for switching impulse test on HV insulators
IS-7098 (Part-II & Part-III)-2003	Standard for Cables, Part-II up to 3.3kV to 33kV and Part-III from 33kV to 220kV
IS:1885	HT Supply
IS:2713	GO (gang operated) Switch with Double Pole Structure
IS:1678-1978,	Prestressed Concrete Poles for Overhead Power Traction and Telecommunication Lines.
IS:2905-1966,	Concrete Pole for Overhead Power and Telecommunication Lines-Method of Test
IS:7321-1974	Selection, Handling and Erection of Concrete Poles for Overhead Power and Telecommunication Lines
IS:2026 (Part-I to Part-V)	Transformer
IS:10810 (Part-62)	Method of test for LT Cable
IS: 10810 (Part-61)	Flame Retardant Test for LT Cable
IS: 10810 (Part-58)	Oxygen Index Test for LT Cable

Code	Standard
IS: 10462 (Part-I)	Fictitious Calculation method for dimensions of Protective covering cables
IS: 10418	Drums Standard for Electric Cables
IS: 3961 (Part-II)	Recommended Current rating for cables
IS: 2633	Method for testing uniformity of coating
IS: 8130	Conductors for Insulated Electric cables and Flexible cord
IS: 5831	Cross linked polyethylene insulated PVC sheathed cables for working voltages up to & including 1100V
IS: 1554 (Part-I)	PVC Insulated (Heavy Duty) Electric Cables up to and including 1100V
IS: 1554 (Part-II)	PVC Insulated (Heavy Duty) Electric Cables for working voltages from 3.3kV up to and including 11kV
IS: 7098 (Part-II)	Crosslinked Polyethylene Insulated Thermoplastic sheathed cables for working voltage from 3.3kV to 33kV
IEC: 502	Power Cables with Extruded Insulation and their accessories for rated voltage 1kV
IS:4905	PVC insulation and sheath of electric cables
ASTMD 2863	Test Method for Measuring Minimum Oxygen Concentration to support candle like combustion of Plastics (Oxygen Index)
IS: 8623	Low Voltage Switchgear and Control Gear Assemblies
IS: 4237	General Requirement for Switchgear and Control Gear for voltage not exceeding 1 kV
IS: 2208-1962 or IS: 9224-1979	HRC Cartridge Fuse Link up to 650Volts
IS: 1248	Direct Acting Indicating Analogue
IS: 6875	Heat Treatment of Steel Raw Materials for Switchgear
IS: 3156	Voltage Transformer
IEC: 60947-2	Low Voltage Switchgear and Control gear – Circuit Breakers
IEC: 60947-3	Low Voltage Switchgear and Control gear – Switches, Disconnector, Switch disconnector and fuse combination Unit
IEC 60947-4	Low Voltage Switchgear and Control gear – Contactor, Motor Starters
IS: 1367 BS: 5649 Part VI 1982 BSEN 10025	Pole & Mast
IS 12834: 19889	Solar Photo voltaic energy systems
IS 12762 (PT 1):1989	Photovoltaic Devices- Measurement of current & Voltage Characteristic
IS10322 IEC 60529	Light Fitting and Lamp
IS 3043 / 1987	Earthing
IS 2309 IEC 62305	Lightning Protection
IS-14930 part – I & II	Pipe

1.6.19 Justification of Proposed Design

All Equipment/component shall be of well proven type and make that has performed successfully for identical or more severe conditions for not less than two years.

1.6.20 Equipment arrangement /Layout Requirement

When planning for equipment installation and layout, the contractor shall facilitate access for operation, maintenance, and inspection of any one or more equipment/components at a time without disturbing the balance of equipment. Further, the Contractor shall comply with the criteria given under this specification.

1.6.21 Maintenance and Availability Consideration

Equipment and components to be installed by the contractor shall be designed/selected for high repair parts availability, low maintenance and ease of maintenance wherever required. The contractor shall specifically state the design features incorporated to achieve a high degree of reliability/availability and ease of maintenance. As far as possible equipment shall be of the "fit and forget" type.

Lifting devices i.e. jacks, etc. for transformers shall be provided for handling and carrying out maintenance of any equipment.

Normal and special maintenance tools shall be furnished by the contractor for attending to different equipment. The Contractor shall indicate in his offer all the special tools, tackles and lifting devices included in his offer. A detailed description of each tool/tackle and its function along with the equipment or part for which it is meant for, will also be listed in his offer.

1.6.22 Material of Construction

All materials used for the construction of the equipment shall be new and shall be in accordance with the requirements of this specification. Materials utilized for various components shall be those which have established themselves for use in such application. Galvanizing & thickness of zinc shall be so selected that rusting of equipment over its life cycle does not happen.

1.6.23 Operating Instructions

If after the commissioning and initial operations of the equipment at the substations, the instruction manuals require any modifications, additions/changes, the same shall be incorporated and the updated final instruction manuals in the form to be mutually agreed between the Engineer and the Contractor shall be submitted by the Contractor to the Owner/Engineer. At least six copies of O & M Manual shall be provided.

1.6.24 Rating Plates, Name Plates and Labels

Each main and auxiliary item of equipment shall have permanently attached to it in a conspicuous position, a rating plate of non-corrosive material upon which shall be engraved the manufacturer's name, equipment, type or serial number together with details of the loading conditions under which the item or plant in question has been designed to operate, along with diagram plates.

Each item of the plant shall be provided with a nameplate or label designating the service of the particular equipment. The inscriptions shall be approved by the Site Engineer / Consultant or as detailed in the appropriate sections of the technical specifications.

Such name plates or labels shall be of black non-hygroscope material with engraved white lettering or alternatively, in the case of indoor circuit breakers, starters, etc. of transparent plastic material with suitably coloured lettering engraved on the back.

Items of the Plant such as valves, which are subject to handling, shall be provided with an engraved chromium-plated nameplate or level with engraving filled with enamel.

All such name plates, instruction plates, lubrication charts danger plates etc. shall followed by English inscription. Alternatively, two separate plates one with Hindi and the other with English inscription may be provided.

1.6.25 Design Coordination

As per the sections above, the contractor is responsible for a complete, thorough, and quality design for the entire electrical distribution system at DPIA Parcel B, Phase-1 area. The Contractor shall be responsible for the selection and design of appropriate equipment and components to provide the best-coordinated performance of the entire system. The 220kV GIS, 220/33kV/22kV Transformers, 33/22kV GIS technical specifications are only for reference as they shall be finally be over ruled, regulated and implemented by respective Transco/Discom. Also approval of all Transmission and distribution Power/Electrical drawings shall be wetted by respective Transco/Discom, wherever the scope pertains to Bidder/Contractor.

1.7 Technical Specification for 220 kV, Gas Insulated Switchgear (GIS)

The specification covers the scope of design, engineering, fabrication, manufacturing, shop assembly, inspection and testing before supply, transportation, delivery at destination, unloading & storage at site, site erection, site testing, commissioning and putting in to successful operation complete with all materials, support structures, anchoring bolts, accessories, commissioning spares & maintenance spares, special spanners, tools & tackles, any specific required ancillary services, SF6 Gas for first filling & spare, etc., for efficient and trouble free operation along with for 220kV metal (aluminium alloy) encapsulated SF6 gas insulated switch-gear suitable for INDOOR installations, as per details given herein at the requirement of Substation in the specification.

The scope also covers the provision of additional bays (without equipment) over and above bays, with foundations & earthing arrangements so as to install the bay module as and when required without any works pending except the procurement of the required bay module and other related equipment.

1.7.1 Circuit Configuration

220kV/GIS double bus, 220kV/ GIS shall be double bus design respectively as shown in the single line diagram and each module shall be complete with SF6 breaker, disconnectors, current and voltage transformers, earthing switches, surge arrestors and all necessary components as detailed in this specification. The 220kV/ GIS equipment shall be Phase segregated type, 220kV/ GIS equipment shall be a 3-phase/1-phase encapsulated type with proven performance.

1.8 Design Concept, construction & performance of SF6 GIS

a) Each manufacturer has its own particular SF6 GIS design concept and the purpose of this specification is general guidelines of the requirement only. However, in the interest of safety, reliability and serviceableness, the switch gear offered shall meet the following minimum requirements.

b) The station layout and equipment rating shall be based on the single line diagram and general layout enclosed. The supplier has to work out an optimum layout and building size based on the specific features of his product within the constraints of the overall dimensions of the plot.

c) All equipment, accessories and wiring shall have tropical protection, involving special treatment of metal and insulation against fungus, insects, and corrosion.

d) Furthermore, no part of the enclosure, or any loose parts may fly off the switchgear in such an event, and no holes may burn through the enclosure until the nearest protective relay has tripped. All grounding connections must remain operational during and after an arc fault.

e) Proper grounding for mitigating over voltages during disconnector operation shall be included.

f) Viewing windows shall be provided at the Disconnectors and earthing switches to ensure that each contact position can be inspected easily from the floor level. Each section shall have plug-in modules or easily removable connection pieces to allow for easy replacement of any component with the minimum of disturbance to the remainder of the equipment.

g) The number of transport/shipping splits shall be minimized to keep the installation time of GIS to a minimum.

h) The arrangement shall afford maximum flexibility for routine maintenance. Equipment removal and SF6 handling should be accomplished with ease. The ease of operation shall be ensured.

i) In general, the contours of energized metal parts of the GIS and any other accessory shall be such as to eliminate areas or points of high electrostatic flux concentrations. Surfaces shall be smooth with no projection or irregularities, which may cause corona.

1.8.1 Modular Design & Future extensions

The GIS switch gear shall be of modular design offering a high degree of flexibility. Each module shall be complete with SF6 gas circuit breaker, Disconnectors, Maintenance Grounding switches, Fast Earthing switches, voltage transformers, Current transformers, Surge Arrestor (Only for Line Bay – Part of GIS) bus & elbow sections, cable end enclosures, local control cubicle and all necessary components required for safe & reliable operation and maintenance. All three phases of the busbars and associated equipment like breakers, disconnectors, instrument transformers, earthing switches and surge arrestors etc., as detailed in the enclosed single line diagram and Bill of Quantities (MSETCL Scope).

The bus bars shall be sub-divided into compartments including the associated bus bar disconnector. Bus bars are partitioned at each bay with the objective to isolate the Busbar compartment for the purpose of extension and at the same time avoiding damage to adjacent bays in the event of fault.

a) Materials used in the manufacture of the switchgear equipment shall be of the type, composition, and physical properties best suited to their particular purposes and in accordance with the latest engineering practices.

b) The switchgear shall be of the freestanding, self-supporting dead-front design, with all high-voltage equipment installed inside gas-insulated, metallic grounded enclosures, and suitably sub-divided into individual arc and gas-proof compartments.

c) Arc faults caused by external reasons shall be positively confined to the originating compartment and shall not spread to other parts of the switchgear. In case of any internal arc fault in a busbar, busbar disconnector or circuit breaker, of the double bus system, repair works must be possible without shutting down the complete substation and at least one busbar and the undisturbed bays must remain in operation.

d) Where Bus Coupler / Sectionaliser is specified and in case of any internal arc fault in a busbar, busbar disconnector or sectionaliser, repair work must be possible without shutting down the complete substation and at least one half of the substation must remain in operation. Documents indicating the sequence of repair work steps and description of necessary restrictions during work shall be submitted with the technical bid.

e) Each bay module should be equipped with a suitable arrangement for easy dismantling and refitting during maintenance without disturbing other units.

f) The maximum temperature in any part of the equipment at a specified rating shall not exceed the permissible limits as stipulated in the relevant standards.

g) There shall not be any kind of interference to the connected & nearby equipment and system, when the equipment is operated at maximum service voltage.

1.8.2 Maintenance and repair of a circuit breaker

The positioning of the circuit breaker in the GIS shall be such that it shall be possible to access the circuit breaker of any feeder from the front side for routine inspection, maintenance, and repair without interfering with the operation of the adjacent feeders.

The GIS shall be so designed that any component of the GIS can be removed easily. With minimum flexibility in the layout arrangement, it shall be possible to remove the circuit breaker with both busbars remaining in service and it shall be possible to remove the disconnector of the busbars, with one busbar remaining in service.

1.8.3 Interchangeability

As much as possible, all the parts shall be of standard manufacturer with similar parts and assemblies being interchangeable.

1.8.4 Future Extension

The modular design of GIS switch gear shall be capable of extension in the future on either end by the addition of extra feeders, bus couplers, busbars, circuit breakers, Disconnectors, and other switch gear components without drilling cutting, welding or dismantling any major part of the equipment. The Vendor is required to demonstrate clearly in his submitted documents the suitability of the switchgear design in this respect. The arrangement shall be such that expansion of the original installation can be accomplished with minimum GIS downtime. In case of extension, the interface shall incorporate facilities for installation and testing of extension to limit the part of the existing GIS to be re-tested and to allow for connection to the existing GIS without further dielectric testing.

1.8.5 SF6 GIS

SF6 GIS shall be of INDOOR type having degree of protection as IP-42 and suitable for the atmosphere of the location, which is heavily polluted, windy, sandy desert & service condition.

1.8.6 Switchgear

The required switchgear shall be capable of being supplied in a completely gas-insulated version in which case all switchgear components including the busbars shall be of gas-insulated type.

1.8.7 Specification requirements

The 220 kV GIS switchgear (MSETCL Scope) shall be of Double bus bar design having phase wise separate or three-phase common (single) enclosure concept. It shall consist of Line & transformer bays as indicated in attached Single line Diagram.

a) Three isolated phases, 2500A, 40kA for 1 second, SF6 gas-insulated metal enclosed bus bar of 245kV along with bus PT, for each bus comprising of the following.

b) Three (3) individual single phases encapsulated or 3 phase encapsulated bus bars enclosures running the length of the switchgear to interconnect each of the circuit breaker bay modules in Double Bus bar system.

   i. One (1) number 3-phase, 1600A, gang operated (both Mechanical and Electrical) Disconnector cum Earth switch complete with manual, and motor driven operating mechanisms for each Bus for Bus PT.

   ii. 1-phase Potential Transformers for each phase or 3 phase Potential transformer for each Bus.

   iii. phase 190KV Surge Arrestors for each phase per Bay

   iv. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors etc. as required.

   v. Local control cubicle, along with Redundant MFMs with 4 to 20mA outputs as well as RS 485 Modbus if required separately.

   vi. Unless otherwise specified, all equipment(s)/piping component(s)/material(s) shall have a design life of not less than 20 years based on continuous and intermittent operation under all loadings and ranges of operating conditions specified.

vii. Where wear is likely to occur during normal operation, the equipment shall be designed to enable a potentially affected area of a component part to be replaced without replacing the whole component. No part subject to wear shall have a life from new to replacement or repair of less than one year of continual operation. Where major dismantling to replace a part cannot be avoided, the life of such parts shall not be less than 5 years.

c) 245kV, 40kA for 1 second, SF6 gas-insulated metal enclosed Transformer Bay module each set comprising of the following:

i. One (1) number 3-phase, 1600A, SF6 insulated circuit breaker without PIR complete with operating mechanism with CB redundant Trip coils and capacitor Tripping Device at Transformer HV & LV side.

ii. 1-phase, 800-500-300A, 5-core, multi ratio, current transformers duly distributed on both side of circuit breaker for each phase.

iii. Two (2) number 3-phase, 1600A gang operated (both Mechanical and Electrical) Disconnector switch cum Earth switch complete with manual and motor driven operating mechanisms.

iv. One (1) number 3 phase, 1600 A gang operated (both Mechanical and Electrical) Disconnector Switch complete with manual and motor driven operating mechanism.

v. One (1) number 3-phase, 1600 A gang operated safety grounding / earth switches, complete with manual and motor driven operating mechanisms.

vi. phase 190KV Surge Arrestors for each phase not a part of GIS at transformer HV Bushing Area (Outside of GIS)

vii. SF6 Gas duct with RIP/OIP Bushing from GIS to Transformer HV Bushing Area

viii. Gas monitoring devices, barriers, pressure switches, UHF PD Sensor etc. as required.

ix. Local Control Cubicle, along with Redundant MFMs with 4 to 20mA outputs as well as RS 485 Modbus.

d) 245kV, 40kA for 1 second, SF6 gas-insulated metal enclosed Line Bay module each set comprising of the following:

i. One (1) number 3-phase, 1600A, SF6 insulated circuit breaker without PIR complete with operating mechanism with CB redundant trip coils.

ii. 1-phase, 800-500-300A, 5-core, multi ratio, current transformers duly distributed on both side of circuit breaker for each phase.

iii. Two (2) number 3-phase, 1600A, gang operated (both Mechanical and Electrical) Disconnector switch cum Earth switch complete with manual and motor driven operating mechanisms.

iv. One (1) number 3 phase, 1600 A, gang operated (both Mechanical and Electrical) Disconnector Switch complete with manual and motor driven operating mechanism.

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

vi. 1-phase Potential Transformers for each phase or 3 phase Potential Transformer for each line.

vii. Gas monitoring devices, barriers, pressure switches UHF PD Sensors etc. as required.

viii. Local Control Cubicle along with Redundant MFMs with 4 to 20mA outputs as well as RS 485 Modbus.

ix. Two (2) numbers cable connecting provision for 220KV 1200 sqmm XLPE UG cable.

e) 245kV, 40kA for 1 second, SF6 gas-insulated metal enclosed Bus Coupler Bay module each set comprising of the following:

i. One (1) number 3-phase, 2500A, SF6 insulated circuit breaker without PIR complete with Spring – Spring operating mechanism with CB redundant trip coils.

ii. 1-phase, 2000-1600-800A, 4-core, multi ratio, current transformers duly distributed on both side of circuit breaker for each phase.

iii. Two (2) number 3-phase, 1600A, gang operated (both Mechanical and Electrical) Disconnector switch cum Earth switch complete with manual and motor driven operating mechanisms.

iv. Gas monitoring devices with 4 to 20mA sensors, barriers, pressure switches UHF PD Sensors etc. as required.

v. Local Control Cubicle along with Redundant MFMs with 4 to 20mA outputs as well as RS 485 Modbus.

vi. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, IDIS (Integrated Density Information System), IVIS (Intelligent Electronic voltage detection system with integrated indication) etc. as required.

vii. Local control cubicle along with Redundant MFMs with 4 to 20mA output as well as RS 485 Modbus.

1.8.8 Current Rating

The current rating of the switchgear should be assessed on the following requirements.

a) The switchgear described in this specification is intended for continuous duty at the specified ratings and under all system operating conditions including sudden change of load and voltage within its ratings and at specified ambient conditions 24 hours a day, 365 days a year unless indicated otherwise.

b) The rating of the power transformer/s is given in the SLD attached in the respective tender. However, the rating of bus bars and bays are as per the maximum augment power transformer rating.

1.8.9 Electrical, Mechanical and Thermal Capability

The assembled equipment shall be capable of withstanding the electrical, mechanical and thermal ratings of the specified system. All joints and connections shall be required to withstand the forces of expansion, vibration, contraction, and specified seismic requirements without deformation or malfunction and leakage. The apparatus shall be capable of withstanding the specified environment.

1.8.10 Insulation level

The switchgear and other equipment shall be designed for a maximum operating voltage and rated impulse withstand voltage as specified in cl. 2.3. The switchgear may require to be installed in an unmanned distribution network with predominantly overhead interconnection or EHV cable as the case may be. Circuit breakers shall be capable of interrupting lines, transformers, capacitor bank & cable charging currents of the magnitude indicated in the data schedules.

1.8.11 Physical arrangement

The layout shall be properly designed by the bidder to completely accommodate the present & future requirements of the substation as per the furnished single line diagram and the enclosed site plan. They may be adjusted as necessary to suit the manufacturer's standard design and MSETCL/MSEDCL requirement.

a) The arrangement of the switchgear offered must provide adequate access for checking and maintenance.

b) Optimized arrangements are required so as to reduce installation time, minimize maintenance & repair cost, provide ease of operation, and facilitate future expansions.

1.8.12 Gas Sectionalisation

a) The switch-gear gas enclosures must be sectionalized, with gas tight barriers between sections or compartments.

b) The sections shall be so designed as to minimize the extent of plant rendered inoperative when gas pressure is reduced, either by excessive leakage or for maintenance purposes, and to minimize the quantity of gas that has to be evacuated and then recharged before and after maintaining any item of equipment.

c) The arrangement of gas sections or compartments shall be such that it is possible to extend existing busbars without having to take out of service another section of the busbar at a time.

d) For limitation of any internal arc to the concerned bay and to reduce the extent of necessary gas works of each section of the busbar must be sectionalized bay by bay.

e) Sectionalisation shall ensure that circuit breaker enclosure will not include any other equipment in its gas compartment.

1.8.13 Expansion Joints and Flexible Connections

a) The layout shall sufficiently take care to the thermal expansion / contraction of the assembly by the provision of expansion joints. Expansion joints shall be placed in between any bay section of the busbar. All joint surfaces shall be machined, and all castings shall be spot faced for all bolt heads or nuts and washers.

b) If necessary, the number and position of expansion joints or flexible connections are to be determined by the manufacturer to ensure that the complete installation will not be subject to any expansion stresses which could lead to distortion or premature failure of any piece of the SF6 equipment, support structures or foundations.

c) Bracing shall be provided for all mechanical components against the effects of short circuit currents specified under system parameter. The design of the equipment shall be such that the agreed permitted movement of foundations or thermal effects does not impair the assigned performance of the equipment. The design calculations for all the supports shall be submitted to ensure care taken.

d) The continuity of service during thermal expansion / contraction and vibrations shall be ensured. Expansion joints, flexible connections and adjustable mountings shall be provided to compensate for reasonable manufacturing and construction tolerances in the associated equipment to which the GIS may be connected. Required sliding plug-in contacts for conductors shall be provided. This is to ensure that unreasonably excessive accuracy is not required when installing such equipment and constructing the associated foundations or support structures, e.g. transformers or the interconnection of isolated sections of switchgear by means of long GIS bus-bar or duct installations. Flexible joints may also be provided to allow more efficient maintenance and future extensions of the GIS.

1.8.14 Sectionalisation (Barrier and Non-Barrier Insulators)

a) Support insulators shall be used to maintain the conductors and enclosure in proper relation. These support insulators may be of two types. Barrier insulators which are employed to isolate gas compartments and non-barrier insulators which allow the gas pressure to equalize.

b) The gas barrier insulators sealing to the conductors and the enclosure wall shall be designed to withstand the maximum pressure difference that could occur across the barrier, i.e. maximum operating pressure at one side while a vacuum is drawn at the other side & in case of internal arc fault with a safety factor of 2.

c) The support insulators and section barriers / insulators shall be manufactured from the 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 also be of sufficient strength to ensure that the conductor spacing, and clearances are maintained when short circuit faults occur.

d) Tests shall be carried out during the manufacture of the Switchgear to ensure that all parts of the equipment are free of partial discharge with a partial discharge extinction voltage which is at least 10% higher than the rated voltage.

e) Gas seals, Gas Density & pressure Monitors with 4 to 20mA output along with DC Converters and other requirements. IGIS (Intelligent Gas Information System) and IVIS (Intelligent Electronic Voltage Detection System with integrated indicator) according to IEC 61243-5, VDE 0682 Part 415 to be provided wherever required. This shall be finalized during detailed Engineering.

f) Single sealing of O-ring type shall be used for sealing the connections between the switch-gear modules. The leakage rates shall be kept to an absolute minimum under all normal pressure, temperature, electrical load and fault conditions. The guaranteed leakage rate of each individual gas compartment and between compartments must be less than 0.1% p.a. for the service life of equipment.

g) Piping and fittings for gas monitoring and gas supply shall be made of copper or brass. The gas monitor device should be installed at each individual compartment of the module. Each gas compartment must be independent, external gas pipe connections should be avoided to minimize leakage.

h) All gas compartments shall be fitted with filter material which absorbs the residual moisture and moisture entering inside the High-voltage enclosure. Filters in gas compartments with switching devices must also be capable to absorb the gas decomposition products resulting from the switching arc.

i) The rated pressure of the SF6 insulating gas in the metal-clad equipment shall be as low as is compatible with the requirements for electrical insulation and space limitations to reduce the effects of leaks.

j) 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.

k) Connections including bolts and nuts shall be adequately protected from corrosion and easily accessible with the proper tools.

l) All components shall be fire retardant and shall be tested in accordance with relevant standards. Gas emissivity when the Material is heated shall be minimal.

1.8.15 Gas Treatment Requirements

Under normal operating conditions it shall not be necessary to treat the insulating SF6 gas between major overhauls. In all gas compartments permanent efficient filters and desiccants shall be effective for the duration of time between major overhauls. Notwithstanding this, the insulators in the circuit breaker shall be made of epoxy resin composition that will resist decomposition products in contract with moisture.

1.8.16 Gas Monitoring Devices

Gas density or pressure monitoring devices shall be provided for each gas compartment. The devices shall provide continuous and automatic monitoring of the state of the gas. The SF6 gas monitoring device shall have two supervision and alarm settings in addition to 4 to 20mA Pressure Transducers for Connecting to SAS. These shall be set so that, an advanced warning can be given that the gas density/pressure is reducing to an unacceptable level. After an urgent alarm, operative measures can be taken to immediately isolate the particular compartment electrically by tripping circuit breakers and opening disconnectors. It shall be ensured that there is no chance of the gas liquefying at the lowest ambient temperature.

The gas monitoring device shall monitor at least the following, locally and on remote.

a) Gas Refill" Level- This will be used to annunciate the need for gas refilling.

b) "Breaker Block" Level- This is the minimum gas density at which the manufacturer will guarantee the rated fault interrupting capability of the breaker. At this level the device contact shall trip the breaker and block the closing circuits.

c) Over pressure alarm level- This alarm level shall be provided to indicate abnormal pressure rise in the gas compartment.

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 of the plug.

Two potential free electrical contacts shall be provided with each and every alarm condition.

4 to 20mA Pressure Transducers for Connecting to SAS.

1.8.17 Conductors

The conductors shall be made of aluminium alloy or copper suitable for specified voltage and current ratings. The electrical connections between the various gas sections shall be made by means of multiple contact connectors (plug-in type) so that electrical connection is automatically achieved when bolting one section to another. Field welding of conductor is not acceptable. The surface of the connector fingers and conductor on such connections shall be silver plated. Both, the conductors as well as the contacts for the conductor connections must be designed for the continuous rated current of the switch gear under the ambient conditions furnished and shall not exceed the permissible temperature rise.

1.8.18 Enclosures

a) The metal enclosures for the SF6 gas insulated equipment modules shall be made from Aluminium alloy/Stainless steel. Suitable anti corrosive paints shade 631 of IS: 5 must be applied on the exterior of the enclosures. The enclosure for 220 kV class enclosure shall be single OR phase wise separate metallic type. The external fixtures should be made of corrosion-resistant material and should be capped where required.

b) Bellow compensators shall be made of Stainless steel to preserve the mechanical strength of the equipment at the connection portions to deal with the following problems:

   i. Expansion and Contraction of outer enclosure and conductor due to temperature variations.

   ii. Mismatch in various components of GIS.

   iii. Vibration of the transformer and switching equipment.

   iv. Dimensional variations due to uneven settling of foundation.

   v. Seismic forces as mentioned in climatic condition.

c) Standard paint shade 631 of IS: 5 shall be used with satin mat finish having high scratch resistance.

d) The gas-filled enclosures shall conform to the pressure vessel code applied in the country of manufacturer. Gas section barriers including seals to the conductor and enclosure wall shall be gas-tight and shall be capable of withstanding the maximum pressure differential that could occur across the barrier, i.e., with a vacuum drawn on the one side of the barrier and on the other side, at least the maximum gas pressure that can exist under normal operating or maintenance conditions and in case of internal arc fault.

e) The finish of interior surfaces of the metal-clad enclosures shall facilitate cleaning and inspection. High quality primer followed by two coats of anti-corrosive paint of glossy white shade shall be used such that they will not deteriorate when exposed to the SF6 gas and other vapors, Arc products, etc., which may present in the enclosures. They shall also not contain any substances which could contaminate the enclosed gas or affect its insulating properties over a period of time.

1.8.19 General Finish and Cleaning

a) The equipment shall be manufactured and assembled at the manufacturer's works under conditions of the utmost cleanliness.

b) Very dusty / sandy conditions may exist at the site hence, whenever possible, the complete feeders or major assembly of components should be shipped as transport units. Before the metal clad enclosed sections are joined together and charged with the SF6 gas they must be thoroughly cleaned.

c) Paints shall be carefully selected to withstand heat and weather conditions. The paint shall not scale-off or crinkles or gets removed by abrasion due to normal handling.

d) Sufficient quantities of all paints and preservatives required for touching up at sites shall be furnished with GIS.

1.8.20 Gas filling and Evacuating Plant for 220kV GIS units

a) All apparatus necessary for filling, evacuating, and recycling the SF6 gas into and from the switch-gear equipment shall be supplied by the bidder to enable any maintenance work to be carried out.

b) Where any item of the filling and evacuating apparatus is of such a weight that it cannot easily be carried by maintenance personnel, it shall be provided with facilities for lifting and moving with the overhead cranes.

c) The apparatus for filling, evacuating, and recycling all gases to be used shall be provided with all necessary pipes, couplings flexible hoses, tubes, and valves for coupling to the switch-gear equipment.

d) The gas compartments shall preferably be fitted with permanent vacuum couplings through which the gas is pumped into or evacuated from the compartments.

e) Details of the filling and evacuating apparatus that will be supplied, and also a description of the filling, evacuating, and recycling procedures, shall be provided with the bid.

f) The initial gas filling of the entire switchgear including the usual losses during commissioning shall be supplied over and above the required quantity of spare gas.

g) An additional quantity of SF6 gas for compensation of possible losses during installation and service of 20 years shall be supplied. The quantity of the same shall be indicated in GTP, considering leakage rate of 1% per year for complete GIS system, even if, the designed leakage rate is lower than 0.5% per annum. Such spare gas shall be supplied in sealed cylinders of uniform size, which shall be decided during detailed engineering.

h) Gas filling and Evacuating Plant shall have gas storage facility of sufficient capacity.

i) SF6 Gas Processing Unit:

i. An SF6 gas-processing unit suitable for evacuating, liquefying, evaporating, filling, drying and purifying SF6 gas during the initial installation, subsequent maintenance and future extension of GIS shall be provided. The cart shall be equipped with rubber wheels and shall be easily manoeuvrable within the GIS building.

ii. A wheeled maintenance unit shall be supplied which shall be self-contained (except for additional gas storage bottles and external power supply at 415 V AC, 3-phase, 50 Hz) and fully equipped with an electric vacuum pump, gas compressor, gas drier, gas filter, refrigeration unit, evaporator, gas storage tank, full instrumentation for measuring vacuum, compressor inlet temperature, tank pressure and temperature, valving and piping to perform the following operations as a minimum requirement:

iii. Evacuation from a gas filled compartment using the vacuum pump,

iv. Transfer of SF6 gas from a system at some positive or negative pressure to the storage tank via the gas drier and filter.

v. Recirculation of SF6 gas in the storage tank through the drier,

vi. Recirculation of SF6 gas in any switchgear or bus duct compartment through the drier and filter.

vii. Evaporating and filling SF6 gas,

viii. Drawing off and liquefying SF6 gas,

ix. A combination operation of filling SF6 gas into a gas system and evacuating a second gas system using the vacuum pump.

x. Adequate length of hoses with necessary adaptors shall be provided for filling of SF6 gas in any of the gas compartment with the help of gas cart.

xi. GA drawing and Schematic drawing for gas processing unit shall be submitted for approval.

1.8.21 Support Structures

a) All supporting structures necessary for the support of the GIS equipment including associated parts such as anchor bolts, beams etc. shall be supplied. Sufficient attachment points to the apparatus and concrete foundations shall be furnished to ensure successful installation, with required clearances, while considering thermal expansion and contraction. Earthquake requirements are also to be considered.

b) Any scaffolding or a movable platform, required for maintenance, shall also be supplied.

c) All steel structure members shall be hot dip galvanized after fabrication.

d) Unless otherwise specified, minimum mass of zinc coating for Galvanizing shall be 610 gm/square meter. Under marine environment, the fabricated structures shall have a minimum overall Zinc coating of 900 gm/square meter. All field assembly joints shall be bolted. Field welding shall not be acceptable.

e) Non-corrosive metal or plated steel shall be used for bolts and nuts throughout the work. Manufacturer shall provide suitable foundation channels and anchor bolts to support the switchgear assemblies. All mounting bolts, nuts and washers shall be provided to fasten the switchgear base frames to the foundation channels.

f) Foundation channels and anchor bolts shall be installed in the civil works in accordance with instructions provided by the manufacturer.

1.8.22 Auxiliary Equipment

The following items shall be included for a complete installation:

a) Control system including local control cabinets.

b) Cable and wiring between individual items of supplier supplied equipment.

c) Name plates.

d) All ladders, platforms, stairs, walkways, and supports necessary to operate and maintain all equipment safely and efficiently.

e) Special tools and tackles for installation.

f) Special tools and tackles for maintenance.

g) Safety Precautions

h) The switchgear must provide a maximum degree of safety for the operators and others in the vicinity of the switch gear under all normal and fault conditions. The safety clearances of all live parts of the equipment shall be as per relevant standards.

i) It must be made impossible to touch any live part of the switchgear unwillingly, i.e. without use of tools or brute force.

j) An operator standing in the normal operating position should not be endangered by any moving external part of the switchgear.

k) Power cables termination shall be of touch proof, heat shrinkable, humid environment proof design.

l) Interlocks: Mechanical & electrical interlocks must be provided to ensure absolute and reliable protection against potentially harmful Mal-operation of the switchgear. All interlocks that prevent potentially dangerous mal operations shall be so constructed such that they cannot be defeated easily, i.e. the operator must use tools and/or technique to over-ride them only in case of emergency.

m) The following functions shall be provided:

i. The operator must be forced in to the only safe and logical sequence to actuate the circuit breakers, disconnectors & earthing switches.

ii. The actual, completely closed or completely opened position of all switching devices must be checked before and after each move.

iii. Implementation of logic checks and issuing the resultant signals Enabled or Blocked for the switching device.

iv. LCC Level Interlocks shall be provided and associated wiring is to be done.

n) If in spite of all possible safety measures if any arc occurs, the following is required.

i. The effects of an internal arcing fault must be limited to the related gas compartment.

ii. Each gas compartment must have its own automated external pressure relief device to provide instant and safe discharge of accidental overpressure during internal arc. Rupture diaphragms shall be preferably used as pressure relief mechanisms. The bursting pressure of relief device should be effectively coordinated with the rated gas pressure and the pressure rise due to arcing. PRD shall be positioned such that it will not be below any circuit breaker or disconnector drive or LCC.

iii. All earthing connections must remain operational.

iv. The enclosure of the switch gear must withstand the thermal effects of an arc at the full rated short circuit current until the nearest protective relay has acted and tripped the breaker.

v. To limit the effects of an internal arc the switch gear shall be suitably subdivided into individual arc and gas-proof compartments, at least for

vi. Busbar together with bus-bar isolator and earthing switch

vii. Circuit breaker

viii. Line isolators and earthing switch, (Line, transformer)

ix. Instrument transformers.

o) The following requirements are to be followed.

i. The bracing/welding of all components subject to mechanical forces caused by short circuit currents shall be capable so as to withstand the effects of at least 2.5 times the rated symmetrical short time withstand current.

ii. The thermal rating for all current carrying parts and insulating materials shall be a minimum of three seconds for the rated short time withstand current.

iii. All components of the switch gear which are on ground potential shall be electrically interconnected and effectively earthed.

1.8.23 Special tools, tackles, and equipment

Special tools, tackles and equipment that are required to perform installation, commissioning, operation & maintenance of the gas insulated switch gear shall be included in scope of supply. Minimum following tools shall be supplied.

a) Dew point measurement meter

b) SF6 gas leakage detector

c) Precision pressure gauge

d) Gas-service carts (with Gas filling and Evacuating Plant / Gas reclaimer)

e) Online PD monitoring system for 220kV GIS modules.

f) Any other special tool/tackle required.

The tools shall be shipped in separate containers, clearly marked with the name of the equipment for which they are intended.

The requirement of HV testing during commissioning or repairing or replacement shall be fulfilled by successful bidder by arranging the required HV testing equipment at no extra cost to MSETCL/MSEDCL. No delay shall be permitted on account of the non-availability of the HV test equipment.

1.8.24 Grounding of GIS

a) GIS will be housed on GIS floor. The bidder will provide under-ground mat below the substation. The bidder shall also provide adequate number of Galvanized steel risers to be connected to grounding mat, as per relevant standards and in consultation with MSETCL/MSEDCL during detailed engineering, in the event of an order.

b) The bidder shall supply entire material for ground bus of GIS such as conductor, clamps, joints, operating and safety platforms etc. to be laid / embedded in GIS floors. The bidder is also required to supply all grounding connectors and associated hardware material for:

   i. Connecting all GIS equipment, Bus duct, enclosures, control cabinets, supporting structures etc. to the ground bus of GIS

   ii. Connecting ground bus of GIS to the ground mat risers.

c) The grounding arrangement of GIS shall ensure that touch and step voltages are limited to safe values as per IEEE std. 80-2000. The enclosures of the GIS shall be grounded at several points such that there shall be a grounded cage around all live parts. The ground continuity between each enclosure shall be affected over flanges, with or without links or straps to bridge the flanges. Copper/aluminium straps shall however bridge the metallic expansion bellows. The grounding switches shall be connected to ground through the enclosure. Individual ground leads for the ground switches are not allowed. The inductive voltage against ground in each part of the enclosure shall not be more than 65 Volts.

d) Where operating mechanism cabinets are mounted on the switchgear, the grounding shall be made by separate conductor. Bay control cabinets shall be grounded through a separate conductor.

e) All conduits and control cable sheaths shall be connected to the control cabinet grounding bus. All steel structures shall be grounded.

f) Each removable section of catwalk shall be bolted to the support structure for ground continuity.

g) The enclosure grounding system shall be designed to minimize circulating currents and to ensure that the potential rise during an external or internal fault is kept to an acceptable level. The guidelines of IEEE Std. 80-2000 on GIS grounding, especially the transient ground potential rise caused by high frequency phenomena, shall be taken into consideration while designing the grounding system for GIS.

h) The manufacturer shall furnish readily accessible connectors of sufficient mechanical strength to withstand electromagnetic forces as well as capable of carrying the anticipated maximum fault current without overheating by at least from two paths to ground from the main ground bus.

i) Provisions of IEC 517 & 694 regarding safeguards in grounding of connected cables, testing during maintenance and other safety measures shall be ensured.

j) Earthing conductors shall be designed to allow flow of short circuit current. Conductors with copper bars are preferred over copper wires.

1.8.25 GIS Hall

a) The Bidder shall provide a GIS hall having reinforced concrete roof and brick walls.

b) The width of the building and the overall height shall be determined primarily by the design and layout of the GIS being offered but shall preferably be limited to the dimensions as minimum as possible.

c) The Bidder shall also provide a complete floor plan detailing the fixing positions, level, and size of fixing bolt pockets, if any, required for equipment to be installed against this specification. Drawings giving similar details for fixing positions, bolt hole pockets in the walls of the GIS hall shall also be provided.

d) All possible static, dynamic and impact loads generated under various operating conditions of the GIS and dimensional tolerances shall be furnished by the Bidder in the offer in order to facilitate civil design.

e) The Bidder shall also indicate in the offer, the required capacity and height of overhead crane (if required) to be provided in the GIS hall.

1.9 Service Conditions

1.9.1 Climatic Conditions

The equipment and the accessories to be supplied against this technical specification shall be suitable for satisfactory continuous operation under the following tropical conditions.

Table 1-12: Service condition particulars

S.No.	Description	Details
1	Maximum ambient Temperature	50°C
2	Minimum Ambient Temperature	3.5°C
3	Maximum Design Ambient Temperature	50°C
4	Relative Humidity	100%
5	Average number of Thunderstorms (days /annum)	0
6	Altitude of operation	Less than 1000 m
7	Average annual Rainfall	>1450mm
8	Wind speed	10 Miles/hr

1.10 System Particulars

1.10.1 Pole designation

Bus bar	Single OR separate phase wise for 220 kV
Bay	As above.
Enclosure material	Aluminium Alloy/Stainless steel.

1.10.2 Standards

Common clauses for high voltage switchgear & control gear	IEC 60694
High voltage metal enclosed switchgear for 72.5 KV & above	IEC 62271-203
Specification for acceptance of new Sulphur Hexa fluoride	IEC 60376
Guide to checking of Sulphur Hexa fluoride taken from Electrical equipment	IEC 60480
Surge Arresters	IEC 60099
Overhead line, Cable, and Transformer	IEC 60137
Terminals Bushings for alternating voltages above 1000 V	
Cable connections for gas insulated metal	IEC 60859
enclosed Switchgear for rated voltages of 72.5	
KV and above	
High voltage test techniques	IEC 60060
Insulation coordination	IEC 60071
Electrical Relays	IEC 60255
High voltage switches	IEC 60265
Partial discharge measurement	IEC 60270
Degree of protection	IEC 60529
Pollution levels	IEC 60815
EMC	IEC 61000
Use and handling of SF6 gas	IEC 61634

Standards for station grounding.	IEC 60364/60479/ IEEE 80
Pressure vessel code	CENELEC/SVDB
Recommendation for heat treated Aluminium alloy busbar material of the Aluminium- magnesium-silicon type	IEC 60114
IEEE Guide for Gas-Insulated Substations	IEEE std C37.122.1-1993
Seismic design	IEC 693

1.10.3 Instrument Transformers

Instrument transformers	IEC 60044
Current transformers	IEC 60185: IEC 61869
Voltage transformers	IEC 60186: IEC 61869

1.10.4 Circuit Breaker

High Voltage Alternating Current Circuit Breakers	IEC 62271-100
Report on Synthetic testing of high voltage alternating Current Circuit breakers	IEC 60427

1.11 Disconnectors and earthing switch

1.11.1 Electrical Data

Table 1-13: Electrical data for 220KV and 132kV GIS

Description	Unit	220KV GIS
Rated System Voltage /	kV	220/245
Highest System/Equipment Voltage		
One min. Power frequency withstand voltage	kV rms	460
Across open isolator	kV rms	530
Across the open gaps of CB	kV rms	460
Rated Lightning Impulse withstand voltage (1.2/50 μs peak value)		
Phase to phase	kVp	1050
Phase to earth	kVp	1050
Across open isolator	kVp	1200
Across the open gaps of CB	kVp	1050
Rated Frequency	Hz	50
Rated Continuous current at 40°C	Amps	2500
ambient temperature Bus bar		
Feeder and Transformer Bay	Amps	1600
Rated Short circuit Withstand current	kA	50kA for 1 second
Rated dynamic withstand current	kAp	100
Partial Discharge (at 1.1 Un)	pico-coulombs	5(max.)
System Neutral earthing		Solidly earth
Maximum SF6 Gas leakage rate per year less than	% per year	0.1

1.11.2 Auxiliary Supply

For Operation, control, and signalling.

Note: The control voltage shall be considered as per BOQ of respective tender only.

For other loads: 415/240 Volts, AC 50Hz. (+10% & -15%)

1.11.3 Seismic requirements

The GIS shall comply with IEEE STD 693 – 1984 guideline to ensure functional adequacy under seiismi disturbances. The maximum ground acceleration shall be 0.5 g.

1.12 Detailed technical requirements for GIS Components

1.12.1 Circuit Breaker

1 General

a) The GIS circuit breakers shall comply with the following general requirements for circuit breakers and the latest revisions of the relevant IEC-62271-100 specifications.

b) For 220KV GIS shall comply with Classifications to IEC 62271-200 Partition class PM IAC AFLR 40 kA, for 1 sec.

c) Circuit – breakers shall be of single pressure, single break, self-compression self-blast / auto puffer type with SF6 as arc quenching & insulation medium and with a minimum-maintenance contact system.

d) For 220 kV class enclosure shall be single OR phase wise separate metallic type.

e) Ratings of the circuit breaker shall be as per enclosed technical parameters.

f) Each circuit-breaker shall have spring mechanism ensuring proper closing and opening and shall permit checking of adjustments and opening/closing characteristic. The ON/OFF latches shall be mechanically interlocked with each other. The circuit breaker shall be completely factory assembled, adjusted, and tested.

g) The total break time from energizing the trip coil at rated control voltage to final arc extinction shall be as short as possible, but in any event not greater than 3 cycles i.e. 60 ms.

h) The circuit breaker shall be capable of breaking all currents from zero up to the specified maximum fault current in accordance with the relevant IEC recommendations.

i) The breakers are to be restrike-free.

j) The circuit-breakers shall be capable of tripping and re-closing (Auto reclose) according to the specified duty cycle without derating: O – 0.3 s – CO – 3 min. – CO.

k) Breaker shall be suitable for following switching duties:

i. Terminal faults

ii. Short line faults

iii. Out of phase switching

iv. Interruption of small inductive current including transformer magnetizing inrush currents.

v. Interruption of line and cable charging currents.

l) The circuit breaker shall meet all the double Circuit overhead transmission line and cable characteristics for any type of fault or fault location, and for line charging and dropping when used on an effectively grounded system. Effect of second circuit in parallel shall also be considered.

m) The circuit breakers shall be capable of being operated locally or from remote. Local operation shall be by means of an open/close control switch located in the bay control cabinet.

n) The minimum guaranteed nos. of maintenance free operations of complete GIS shall be 10000 nos. at rated capacity.

o) The Drive shall have sufficient stored energy for completing 2 CO with auxiliary power switched off.

p) Circuit breakers, being an arcing device, shall not house any passive device like current transformer in its housing.

q) The breaker layout arrangement shall be vertical or horizontal but shall provide higher mechanical stability and ease in maintenance. The operating principle of the breaker shall ensure minimized dynamic floor loading. Low reaction forces on foundations especially dynamically, are favourable and considered in the elevation.

2 Closing Devices

The closing coils shall be suitable for operation at any voltage between 110% and 80% of the nominal control voltage measured at the device terminals.

The breaker shall close correctly when an electrical closing pulse of 50 msec. duration is applied to the closing coil.

3 Tripping Devices

All electrical tripping coils shall be suitable for operation at any voltage between 110% and 70% of the nominal control voltage measurelicd at the device terminals.

Each circuit-breaker shall be equipped with two shunt trip system. Each shunt trip system shall be electrically separated from the other system.

An emergency hand tripping (mechanical) device shall be provided in the operating mechanism.

4 Anti-Pumping

The circuit-breaker mechanism shall be provided with means to prevent pumping while the closing circuit remains energized, should the circuit breaker either fail to latch, or be tripped during closing due to the operation of the protective relays.

5 Operating Mechanism

The breaker shall include suitable spring operating mechanism to assure proper opening & closing operations. The provision shall be made for checking adjustments and opening characteristics. The mechanism shall be capable of re-closing within the range specified in the applicable standards. The mechanism shall include dual trip coils. Charging of opening mechanism shall be possible in the event of failure of the motor drive.

6 Spring Operated Mechanism

a) Spring operated mechanism shall be complete with motor, opening spring, closing spring with limit switch for automatic charging and all necessary accessories to make the mechanism a complete operating unit.

b) As long as power is available to the motor, a continuous sequence of closing and opening operations shall be possible.

c) After failure of power supply to the motor, at least two close-open (C-O) operations of the circuit breaker shall be possible.

d) Breaker operation shall be independent of the motor which shall be used solely for compressing the closing spring.

e) Motor rating shall be such that it requires only about 30 seconds for fully charging the closing spring.

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

g) When closing springs are discharged after closing a breaker, closing springs shall automatically be charged for the next operation.

The mechanism shall be in a dust proof (IP55) box for this outdoor installation of Gas Insulated Switchgear.

One vermin-proof, sheet steel cabinet of adequate size shall be provided for housing the operating mechanism, aux relays, control, and auxiliary equipment and for terminating all control, alarm and auxiliary circuits in suitable terminal boxes. The control cabinet shall be provided with hinged doors with provision for locking and removable cable gland plates for bottom cable entry. Viewing windows shall be provided for observation of the instruments without opening the cabinet. Suitably engraved nameplates shall be provided to identify all equipment in the control cabinet.

7 Auxiliary Switches

Each breaker shall have auxiliary switches with adequate number of NO and NC contacts all wired to terminals located in the local control cabinet of the circuit breaker bay. 20 % spare contacts should be provided.

8 Indicating Devices

Position indicators shall be provided to clearly indicate whether a circuit-breaker is open or closed.

	Status	**Colour**
Open position	Open	Green
Closed position	Closed	Red

Each circuit-breaker shall be provided with an operation counter to record the number of tripping operations performed. The counter may be located at the local control cabinet.

All position indicators and counters shall be readable at a convenient elevation i.e. from the place of operation.

9 Gas Connections

Necessary valves and connections shall be provided to assure ease in handling the SF6 gas.

10 Timing Test

Timing tests are to be carried out after the switch gear has been completely charged with SF6 gas.

11 Testing instruments

a) Air / gas humidity tester,

b) Gas purity detector for SO2, H2O, CF4, AIR etc.,

c) Gas leakage tester,

d) Breaker timing measurement kit,

e) Set of equipment for pressure measurement and gas density meter along with 4 to 20mA Pressure transducer.

12 Testing facilities

Timing test facility shall be provided with switchgear such that it is not necessary to open up any gas section to make test connections to the circuit breaker terminals.

All details of test facilities to be provided shall be submitted with technical bid.

13 Principle Parameters

The Circuit Breakers of GIS equipment shall confirm to the specific technical requirements given as under.

Table 1-14: Circuit Breaker

S.No.	Particulars	220KV
1)	Enclosure	Single or separate phase wise
2)	Enclosure material	Aluminum Alloy/Stainless steel
3)	Rated voltage	245 kV
	Rated Bus Bar Current	2500 A
4)	Rated current	16000 A feeder/1600 A PTR bay
5)	Rated frequency	50Hz
6)	Rated short-circuit breaking current Duration	40kA/ 1sec
7)	Rated break-time	1 cycle
8)	Rated short-circuit making current	100 kAp
9)	Difference for simultaneity of 3 poles.	4 ms (Max)
10)	Rated insulation level under minimum SF6 gas pressure	
	Power frequency withstand voltage	460 kVrms
	Lighting impulse withstand voltage	1050 kVp
	Switching impulse voltage	As per IEC 62271-1)
9)	Rated operating sequence	O-0.3s-CO-3min-CO
10)	Type of operating mechanism for circuit Breaker	Spring
11)	Rated control voltage	
	- Closing coil	220 VDC
	- Tripping coil	220 VDC
12)	Mechanical Endurance class	M2
13)	Electrical Endurance class	E2

S.No.	Particulars	220KV
14)	Restriking probability class	C2
15)	Rated line charging breaking current	125A (Max over breaking capacity voltage factor 1.5 PU)
16)	Rated cable charging breaking current	250A
17)	Rated capacitor bank switching current	400A
18)	Rated out of phase making and breaking current in % of rated short circuit breaking current	50 KA rms
19)	Characteristic for short line fault related to rated short circuit breaking current	As per IEC 62271 - 100
20)	TRV characteristics	As per IEC 62271 - 100
21)	Inductive current breaking capability	Switching No load current of transformer
22)	First pole to clear factor	As per IEC 62271 - 100
23)	Opening time in ms	Not more than 40
24)	Closing time in ms	Not more than 100
25)	Noise level at the base of CB	As per NEMA standard
26)	No of tripping coils per breaker	2
27)	No of closing coils per breaker	1

1.13 Disconnector Switches and Maintenance Grounding switches

1.13.1 General

a) The GIS disconnector switches, and grounding switches shall comply with the following general requirements of disconnect switches and the latest version of the relevant specifications IEC 60129, 61128, 61129, 61259.

b) Disconnect switches shall be gang operated and separate phase wise for 220 kV, group operated, no break, with one common motor operated mechanism for all the three poles. They shall also have facilities for emergency manual operation and necessary handles shall be provided.

c) Maintenance earthing switches shall be gang operated and separate phase wise for 220 kV, group operated, no break, with one common motor operated mechanism for all the three poles. They shall also have facilities for emergency manual operation and necessary handles shall be provided.

d) Disconnect switches and grounding switches shall have electrical and Mechanical interlocks to prevent grounding switch from closing on an energized section.

e) Interlocks with other bays for bus transfer switching shall be done through bay control cabinets. Actuation of the emergency manual operating device shall also disable the electrical control. Disconnectors in open condition shall be secured against reclosure.

f) Disconnecting switches and adjacent safety grounding switches shall have electrical interlocks to prevent closure of the grounding switches when the disconnecting switches are in the closed position and to prevent closure of the disconnecting switch when the grounding switch is in the closed position. The disconnector shall be pad lockable in the close & open position.

1 Interlocks

Interlocking devices must provide absolute and positive protection against potentially harmful mal operations of the switchgear. The following functions shall be assured:

a) Forcing the operator into the only safe and logic sequence to actuate breakers, switches, isolators, and grounding switches.

b) Checking the actual fully closed or fully open position of all switching elements before and after each move.

c) Providing the logical checks and issuing the resulting PERMISSIVE or BLOCKED signals for the switchgear.

d) Indicating positively the absolute condition/position of the supervised equipment.

e) Local manual and remote electrical operation of all essential functions.

f) Local emergency unlocking facilities via safety-key switches under the full responsibility of the operator. Intrabay and interbay interlocking shall be provided. Electrical interlocking arrangement shall be fail-safe type. Mechanical interlocks for isolator & Earthing Switch shall be fail-safe type.

All main contacts, male and female, shall be silver plated.

Each disconnect switch and grounding switch shall open or close only due to motor driven or manual operation independently. The switch contact shall not move due to gravity or other means, even if a part fails. Once initiated, the motor mechanism shall complete an open or close operation without requiring the initiating contact be held closed. Operation of respective end position limit switches shall only disconnect the motor mechanism. There should also be a pre-set timer in motor circuit for protection against time over run in case of inadvertent failure of drive mechanism in any intermediate position of the disconnector travel path.

The disconnect switches and grounding switches shall be located as shown in the Single Line Diagram.

The disconnect switches shall be capable of interrupting the charging current of the connected GIS bus & associated components.

2 Duty requirements

a) The disconnecting switches shall have breaking capabilities as per IEC requirements. Contact shielding shall be designed to prevent restrikes and high local stresses caused by the transient recovery voltages when currents are interrupted.

b) The bus disconnecting switches shall reliably handle capacitive currents due to the making and breaking of switchgear components as well as commutation currents due to bus bar reconfiguration.

c) The fast-acting ground switches, used for overhead double circuit lines and underground cable feeders shall be capable of switching induced current as per IEC requirement.

3 Short Circuit Requirements

The rated peak short-circuits current or the rated short time current carried by an isolator or earthing switch for the rated maximum duration of short circuit shall not cause:

a) Mechanical damage to any part of the isolator or earthing switch.

b) Separation of the contacts or contact welding.

c) A temperature rise likely to damage insulation.

4 Access for maintenance and repair:

Suitable means of access should be provided in each disconnect-switch and grounding-switch housing and mechanism for repair and/or maintenance of contacts.

5 Operation Mechanism

a) Mechanism shall be arranged mechanically, electrically, so that all three phases of any disconnect switch or grounding switch operate simultaneously.

b) All mechanisms shall be suitable for electrical motor operation to achieve a fully automatic operation. For emergency situations manual operation shall be possible. Handles or hand cranks shall be provided, together with all necessary operation rods and rod guides. Manual operation shall be prevented if the interlocking system does not allow the operation of the switch.

c) The auxiliary supply shall be electrically decoupled from the motor when the switch is operated manually.

d) The mechanisms shall be arranged for locking in the open and in the closed position. Facility shall be available to allow the switch to be padlocked in any position.

e) Disconnecting operating mechanism of all disconnector/ isolator & earth switches shall be at easy operable height.

f) The isolator shall be provided with positive continuous control throughout the entire cycle of operation.

g) The operating pipes and rods shall be sufficiently rigid to maintain positive control under most adverse conditions and when operated in tension or compression for isolator closing. They shall also be capable of withstanding all torsional and bending stresses due to operation of the isolator.

h) It shall not be possible, after final adjustment has been made, for any part of the mechanism to be displaced at any point in the travel sufficiently to allow improper functioning of the isolator when the isolator is opened or closed at any speed.

i) The operating mechanism design shall be such that during the operation of the isolator (especially manual operation), once the moving blades reach the sparking distance, springs shall take over to give a quick, snap action closing so that the isolator closing is independent of manual efforts. Similarly, the springs must assist during the opening operation to give quick breaking feature.

j) Disconnector and high-speed motor operated earthing switch mechanisms shall be provided with a mechanism with stored energy to always assure completed operations.

6 Auxiliary Switches

All disconnecting switches shall be provided with electrically independent auxiliary switch, directly driven by the common operating shaft. Each disconnect switch and grounding switch shall furnished with sufficient Nos. of NO – NC as per entire scheme requirement plus two (2) NO-NC electrically independent contacts terminated up to terminal board, at user's disposal. The auxiliary switches shall indicate the position of the switch contacts and shall be independent of the motor operation.

7 Position Indicators

Mechanically connected position indicators shall be provided externally to permit observation of close/open position of the disconnect switch and grounding switch. The place of Position Indicators should be easily visible from the place of operation of respective equipment.

	Status	Colour
Open position	Open	Green
Closed position	Closed	Red

Visual verification shall be provided for each pole of each disconnect switch and grounding switch to permit visual inspection of each switchblade position.

8 Technical Data Requirement

Table 1-15: Disconnectors

S.No.	Description	220KV
1	Rated voltage (kV rms)	245
2	Rated frequency (Hz)	50
3	Rated short circuit with stand capacity (kA rms) 1sec	50
4	Rated short time making current capacity (kA peak)	125
5	No. of Poles	3
6	Rated continuous current (A) Feeder bay Transformer bay Bus coupler bay	1600 1600 1600 2500
7	Operating Mechanism	Spring – Spring Motor
8	Operating time	Less than 12 sec
9	Rated lightning impulse withstand voltage (kV peak) Phase to earth Across the open contacts	 1050 1200
10	One minute power frequency withstands voltage (kV rms) Phase to earth Across the open contacts	 450 530
11	Rating of auxiliary contacts	10A to 220V DC
12	Breaking capacity of auxiliary contacts	2A

9 Low-voltage test provision:

A low-voltage test provision may be supplied with a grounding switch to permit test voltages of up to 10kV (optional 2.5kV) and up to 200 A to be applied to the conductor without removing SF6 gas or other components, except for ground shunt leads.

1.14 Fast Acting Grounding Switches

1.14.1 General

a) Fast acting grounding switches can be located at the terminal of HV/EHV overhead line/ cable. They shall be able to switch safely load currents of overhead lines. They must have fault making capability and be able to switch on a live line. Applicable standards are IEC 60129, 60517, 61129. The fast-acting grounding switches shall comply with the following general requirements of fast acting grounding switches and the latest revision of the relevant IEC specifications.

b) Fast acting grounding switches shall be of three phases, encapsulated, three phase linkage group operated by a maintenance-free self-contained electrical motor. They shall also have facilities for emergency manual operation and the necessary operating handles or hand cranks shall be supplied.

c) Fast acting grounding switches shall be electrically or mechanically interlocked with related disconnector, to prevent the fast-acting grounding switch from closing on an energized bus section.

d) All main contacts, male and female, shall either be silver plated or shall have silver inserts.

e) Each fast-acting grounding switch shall open or close only due to motor-drive or manual operation but shall be operable from local only. The switch contact shall not move due to gravity or other means, even if a part fails. Once initiated, the motor mechanism shall complete an open or close operation without requiring the initiating contact to be held closed.

f) Each fast-acting grounding switch shall be fully insulated and connected to ground by a removable bolted link in order that the grounding switch may be used for various test purposes. The insulation shall be capable of withstanding an applied power frequency voltage of 5 kV.

1.14.2 Operation Mechanism.

a) Mechanisms shall be coupled either mechanically or electrically or by both, so that all three phases of any particular fast acting grounding switch operate simultaneously without any discrimination.

b) All mechanisms shall be equipped with a motor suitable for operation from the auxiliary supply, and a set of springs so arranged that energizing of the motor will cause the springs to be charged and then released. The springs in turn shall cloequipment,st acting grounding switch.

c) Motors shall be suitable for operation at any voltage between 80% and 110% of the rated auxiliary voltage, measure at the motor terminals.

d) For emergency situations manual operation shall be possible. Handles or hand cranks shall be provided, together with all necessary operation rods and rod guides.

e) The auxiliary energy shall be electrically uncoupled from the motor when the switch is operated manually.

f) The mechanisms shall be arranged for locking in the open and in the closed position.

1.14.3 Auxiliary Switches

Each fast-acting grounding switch shall be furnished with sufficient Nos. of NO – NC as per entire scheme requirement plus two (2) NO-NC electrically independent contacts, suitably terminated at terminal blocks, at user's disposal. The auxiliary switches shall indicate the position of the switch contacts and shall be independent of the motor operation.

1.14.4 Position Indicators

Mechanically connected position indicators shall be provided externally to ascertain the open/close position of the grounding switch. It should be easily visible from the place of operation of equipment.

	Status	Colour
Open position	Open	Green
Closed position	Closed	Red

Visual verification shall be provided for each pole of each disconnect switch and grounding switch to permit visual inspection of each switchblade position.

1.14.5 Test Facility

Each fast-acting grounding switch shall be fully insulated and connected to ground by a removable bolted link in order that the grounding switch may be used for various test purposes. The insulation shall be capable of withstanding an applied power frequency voltage of 5 kV.

High speed earthing switches shall be capable of interrupting line coupling currents upon opening and in worst conditions closing.

1.14.6 Technical Data Requirement

Table 1-16: Earthing Switch

S.No.	Description	220 KV
1	Rated voltage (kV rms)	245
2	Rated frequency (Hz)	50
3	Rated short circuit with stand capacity (kA rms) 1sec	50
4	Rated short time making current capacity (kA peak) For high-speed earthing switch	120
5	Rated lighting impulse withstand voltage (kV peak)	1050
6	One minute power frequency withstands voltage (kV rms)	460
7	Operating mechanism For maintenance earthing switch For high-speed earthing switch	 Motor Motor
8.	Operating time For maintenance earthing switch For high-speed earthing switch	Less than 12sec Less than 300msec

1.14.7 Current Transformers

1 General

a) The current transformers provided for each phase shall be supplied in accordance with the following general requirements and the latest revisions of the relevant IEC 60044 specifications.

b) The current transformers must be suitable for continuous operation when installed on the conditions.

c) The current transformer shall be ring / toroid type, multi ratio with fully distributed secondary windings with relay accuracy as per IEC 60185 (1987), incl. IEC 60044-4 (1992), 61869 (2007) multi core as per requirement and shall be mounted inside the high voltage enclosure.

d) The secondary terminals of current transformers shall be placed outside the high voltage enclosures, mounted in suitable, accessible terminal boxes and the secondary leads of all the current transformers shall be wired to shorting type terminals.

e) It shall be possible to test each current transformer without the removal of gas through the insulated grounding switches.

f) The number and position of the current transformers shall be relative to the circuit-breakers, disconnecting switches and ground switches as detailed in the attached single line diagram.

g) The rating, No of cores, ratios, accuracy class, characteristics etc. for the individual current transformer secondary cores shall be as specified below. The various ratios of current transformers shall be obtained by changing the effective number of turns on the secondary winding.

h) Each current transformer shall be provided such that the enclosure current does not affect the accuracy or the ratio of the device or the conductor current being measured. Provision shall be made to prevent arcing across the enclosure insulation.

2 Rating and Diagram Plates

Rating and diagram plates shall be provided. The information to be supplied on each plate shall be as specified in the relevant IEC specification, which shall be given for the tap for which the rated performance is specified and for each transformer core.

3 Technical Data Requirement

Table 1-17: Technical particulars for current transformer

S.No.	Description	220KV system
1	Rated voltage	245kV
2	Rated frequency	50
3	Current Ratio (A) For Feeders	800-500-300/1-1-1-1-1
	For Transformer	800-500-300/1-1-1-1-1
	For bus coupler/ Bus sections	2000-1600-800/1-1-1-1
4	Ratio taps	On Secondary side

S.No.	Description	220KV system
5	Accuracy Class For Protection For metering	 PS 0.2S
6	Burden For protection For metering	 10VA 10VA
7	Rated short circuit withstand current (kA rms)	50
8	Rated dynamic withstand current (kA peak)	125
9	Safety factor for metering (The bidder should co-ordinate with metering equipment)	<5

1.15 Voltage Transformers

1.15.1 SF6 insulated:

Each voltage transformer shall be metal enclosed, SF6 insulated in accordance with relevant IEC 60044. The location, polarity, ratios, and accuracy shall be as specified.

1.15.2 Construction

a) VTs should be in segregated compartment and not forming a part of bus bar.

b) Transformers should be of either plug-in construction or the disconnect-link type and be attached to the gas-insulated system in such a manner that they can be easily disconnected while the system is being dielectrically tested.

c) Alternately, a voltage transformer designed so that it does not have to be disconnected during dielectric testing may be specified. The metal housing of the transformer should be connected to the metal enclosure of the GIS with a flanged, bolted, and gasketed joint so that the transformer housing is grounded to the GIS enclosure. Adequate measures shall be provided to prevent any unacceptable impact on the secondary control and protection circuits, which might result from fast transients (VFT) or Ferro-resonance.

1.15.3 Covers and shields.

Special covers and any necessary corona shields should be supplied so that the system can be pressurized and dielectrically tested after removal of the transformer.

1.15.4 Primary and secondary terminals

Primary and secondary terminals should have permanent markings for identification of polarity, in accordance with IEC.

Provision shall be made for grounding of the secondary windings inside the local control cabinet.

Test condition for tests at site: Power frequency tests for the completed GIS at site shall be possible without removing the VT. The primary and secondary neutral terminal points, intended to be earthed, should be insulated and shall withstand power frequency voltage of 3 kV rms for 1 minute. The VT shall be capable to withstand discharge current arising from capacitance of underground cable circuits.

1.15.5 Technical Data Requirement

Table 1-18: Technical Particulars for Voltage transformer

S.No.	Description	220 KV
1	Rated voltage (kV rms)	245
2	Rated frequency (Hz)	50
3	Rated lightning impulse withstand voltage (kV peak)	1050
4	One minute power frequency withstands voltage (kV rms)	460
5	Voltage Ratio	220kV/sqr(3):110V/sqr(3)
6	Number of secondary windings For feeder For busbar For Transformer	3 (for synchronization) 3(1-metering/ 2-protection) NA
7	No of Phase For feeders For busbars For transformers	 3 3 NA
8	Accuracy class For protection For metering / synchronizing	 3P 0.2
9	Burden (VA) For protection For metering / synchronizing	 50 50
10	Rate voltage factor	1.5 for 30 seconds 1.2 continuous

1.15.6 Bushings

Outdoor bushings shall be provided for connection of conventional external conductors to SF6 GIS if asked in general layout plan.

Suitable clamp & connectors shall be supplied with bushing. The dimensional and clearance requirements for the metal clad enclosure shall be maintained as per requirement of relevant standards.

All the bushings shall have an impulse & power frequency withstand level that is higher or equal to the level specified in cl. 2.3.

Only SF6 insulated bushings will be accepted. The terminals on the outdoor bushings shall be a solid stem with dimensions specified.

1.15.7 Insulating Gas and Gas Leakage Rate

The GIS shall be furnished with sufficient sulfur hexa fluoride (SF6) gas to pressurize the complete system in a sequential approach, one zone or compartment at a time to the rated nominal density. The guaranteed leakage rate of each individual gas compartment and between compartments must be less than 0.1% p.a. for the service life of equipment.

The quality of new filled-in SF6 gas shall meet the following requirements in line with IEC 60376.

SF_6 > 99.90 % by weight

Air < 500 ppm by weight (0.25 vol.-%) CF_4 < 500 ppm by weight (0.1 vol.-%) H_2O < 15 ppm by weight (0.012 Vol-%) Mineral oil < 10 ppm by weight

Acidity, in terms of HF < 0.3 ppm by weight Hydrolysable fluorides,

In terms of HF < 1 ppm by weight

Reuse or recycling of removed gas.

The supplier should provide guidelines or recommended practices for the reuse or recycling of SF6 gas removed from the equipment. These guidelines should be consistent with current industry practices, as they pertain to the effect of SF6 on global warming, i.e. SF6 gas should be reused and recycled whenever possible and never be unnecessarily released into the atmosphere.

Clear instructions shall be provided by bidder about handling, recycling & treatment of new and used SF6 gas.

During commissioning dew point of SF6 gas shall be measured and documented.

Components may be filled with N2 for transportation and refilled with SF6 at site.

1.15.8 Gas sections

The GIS enclosures shall be divided into several gas sections separated by gas-tight barriers. Each section shall be provided with necessary valves to allow evacuation and refill of gas without evacuation of any other section. Location of gas barrier insulators is to be clearly discriminated outside the enclosure by a band of distinct colour normally used for safety purposes.

The gas system proposed shall be shown on a “gas single line diagram” and submitted with the technical bid and in the event of an order for approval. It should include the necessary valves, connections, density monitors, gas monitor system and controls, indication, orifices, and isolation to prevent current circulation. Means of calibrating density monitors without de-energizing the equipment should be specified by the supplier.

For the purpose of gas monitoring and maintenance, the GIS shall be divided into various individual zones in each bay. The CB gas zone shall be independent from all other gas compartments and shall meet the requirement of relevant IEC.

Each gas zone shall be furnished with a gas monitoring system consisting of a gas density continuous monitoring device provided with two electrically independent contacts which operate in two stages as follows:

a) First alarm	At a gas density normally 5 to 10% below the nominal fill density.
b) Second alarm	Minimum gas density to achieve equipment

In special cases determined by the supplier, a third stage with a set of contacts may be necessary in certain areas.

Provisions shall be made for connecting pressure gauges, service cart, and moisture test instrumentation to any one of the gas sections.

Permanent Gas Treatment Devices

Means shall be provided inside each enclosure for treating the SF6 gas by the use of Desiccants, driers, filter, etc. to remove impurities in the gas.

All gas compartments shall be fitted with static filter material containers that will absorb residual and entering moisture inside the high voltage enclosures. Filters inside the breaker compartment shall also be capable of absorbing gas decomposition products resulting from the switching arc.

1.16 Technical Specification for Portable PD Monitoring System for Gas Insulated Switchgear

1.16.1 General

a) The equipment shall be used for detecting different types of defects in Gas Insulated Stations (GIS) such as Particles, Loose shields and Partial Discharges as well as for detection of Partial discharges in other types of equipment such as Cable Joints, CTs and PTs.

b) It shall be capable for measuring PD in charged GIS environment as EHV which shall have bandwidth in order of 10 KHz – 500 KHz with possibility to select a wide range of intermediate bandwidths for best measurement results. The principal of operation shall be on acoustic technique and the method of measurement shall be non-intrusive. The instrument is able to detect partial discharges in cable joints, terminations, CTs and PTs etc., with the hot sticks.

c) Detection and measurement of PD and bouncing particles shall be displayed on built in large LCD display and the measurement shall be stored in the instrument and further downloadable to a PC for further analysis to locate actual source of PD such as free conducting particles, floating components, voids in spacers, particle on spacer surfaces etc.

1.16.2 Technical specification

Measurement shall be possible in noisy environment.

Stable reading shall be possible in presence of vibrations within complex GIS assemblies, which can produce signals similar to PD.

Equipment should have necessary synchronizing circuits to obtain PD correlation with power cycle and power frequency.

The equipment shall be battery operated with built-in-battery charger. It shall also be suitable for 230V AC/50 Hz input.

Measurement shall be possible in the charged switchyard in the presence of EMI/EMC.

Supplier should have supplied similar detector for GIS application to other utilities. Performance certificate and the list of users shall be supplied along with the offer.

Instrument shall be supplied with standard accessories i.e., re- locatable sensors with mounting arrangements, connecting cables (duly screened) to sensors, Lap-top PC, diagnostic software, carrying case, rechargeable battery pack with charger suitable for 230V AC, 50Hz supply connecting cables (duly screened) to view in storage.

The function of software shall be covering the following:

a) Data recording, storage, and retrieval in computer

b) Data base analysis

c) Template analysis for easy location of fault inside the GIS

d) Evaluation of PD measurement i.e, Amplitude, Phase Synchronization etc.

e) Evaluation of bouncing/loose particles with flight time and estimation on size of particle.

f) Report generation.

To prove the suitability in charged switchyard condition, practical demonstration shall be conducted before acceptance.

Supplier shall have “Adequate after sales service” facility in India.

Necessary training may be accorded to personnel to make use of the kit for locating PD sources inside the GIS.

Instrument shall be robust and conform to relevant standard.

1.17 GIS Connection

1.17.1 GIS to Transformer

For 220 kV side: By XLPE cable to GIS (As specified in SLD / SECT DRG / BOQ.)

The bidder may suggest alternative arrangements to meet these requirements. The corona rings/stress shields for the control of electrical field in the vicinity of the isolation gap shall be provided by the GIS manufacturer. All supporting structures for the SF6 bus-duct connections between the XLPE cable sealing ends and the GIS shall be supplied by the supplier. The supplier may specify alternative connecting & supporting arrangements for approval of the purchaser.

The connection between GIS and high voltage cable at GIS end shall be done through cable termination / cable sealing end. The plug-in cable sealing ends for XLPE cables shall consist of gas tight plug in sockets and prefabricated plugs with grading elements of silicone rubber.

For transformer end connection the cable termination on structure shall be provided outdoor, if specified in schedule of requirements.

Cable termination kit shall be supplied by cable supplier. It should be heat shrinkable, humid environment proof, touch proof. The ducts and the casing shall be suitable for the requirements for which it is designed. This interface section shall be designed in a manner which will allow ease of operation and maintenance.

The SF6 GIS to XLPE cable termination shall conform to IEC-859 (latest edition). The provision shall be made for a removable link. The gap created when the link is removed should have sufficient electric strength to withstand the switchgear high voltage site tests.

When the SF6 to the bushing of an oil-insulated transformer is connected, the transformer bushing must be oil-tight, gas-tight and pressure resistant. Any temperature related movement and irregular setting of the switchgears or transformer's foundations are absorbed by the expansion fittings.

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

A separate cable basement is provided for cable entry, its distribution and installation.

The design of the cable end box shall fully comply with the IEC standard. The type and size of cable is specified. All end cable modules shall be suitable for connecting single core, XLPE specified cable.

1.17.2 GIS to Line

220, kV class: by GIS to XLPE cable (220 kV – single or twin, 1C 1200 mm2,) to line termination gantry by conductor. (As specified in SLD / SECT DRG / BOQ.)

1.17.3 SF6 GIS to XLPE Cable Termination

Necessary provision for termination of specified nos. of such power cables shall be made in GIS. GIS supplier shall either carry out the work of termination or coordinate with cable terminator for such connection as specified in schedule of requirement.

1.18 Local & Remote Control and Operation

1.19 General

One local control cabinet (LCC) of OEM of GIS shall be supplied for the local control and operation of each bay. Each LCC shall contain the local control, interlocking, operation, and indication devices for the associated GIS bay.

The LCC shall be mounted on each GIS bay. The LCC's shall be located with sufficient space for access and the possibility to work at the equipment even when the LCC doors are open, or directly at the switchgear in front of the related circuit breaker.

The LCC's shall be installed indoor/ OUTDOOR, and care must be taken with the design to ensure that all LCC's are drip and splash proof. The LCC's shall also be dust and vermin proof. LCC shall comply degree of protection class IP-42

Cable termination kit shall be supplied by cable supplier. It should be heat shrinkable, humid environment proof, touch proof The ducts and the casing shall be suitable for the requirements for which it is designed. This interface section shall be designed in a manner which will allow ease of operation and maintenance.

The SF6 GIS to XLPE cable termination shall conform to IEC-859 (latest edition). The provision shall be made for a removable link. The gap created when the link is removed should have sufficient electric strength to withstand the switchgear high voltage site tests.

The bidder may suggest alternative arrangements to meet these requirements. The corona rings/stress shields for the control of electrical field in the vicinity of the isolation gap shall be provided by the GIS manufacturer. All supporting structures for the SF6 bus-duct connections between the XLPE cable sealing ends and the GIS shall be supplied by the supplier. The supplier may specify alternative connecting & supporting arrangements for approval of the purchaser.

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

A separate cable basement is provided for cable entry, its distribution and installation.

The design of the cable end box shall fully comply with the IEC standard. The type and size of cable is specified. All end cable modules shall be suitable for connecting single core, XLPE specified cable.

Necessary provision for termination of specified nos. of such power cables shall be made in GIS. GIS supplier shall either carry out the work of termination or coordinate with cable terminator for such connection as specified in schedule of requirement. Provision shall be suitable for terminating MSETCL/MSEDCL Approved cable.

According to IEC60529. The control and operation circuits shall be well shielded and with safety measures to protect operator from touching energized parts. Power frequency withstand of control circuits shall be 2 kV for 1 minute.

The LCC should have required arrangement for control and operations of GIS from Remote i.e. from the control room through SCADA as well as SCADA compatible control and protection panel.

The LCC shall include all required functions for control and supervision of a complete GIS as well as the marshalling of all connections to and from the GIS bays.

Safe station operation is ensured through following base functions.

a) Feeder & station interlocking, depending on the position of all high voltage components with their blocking functionality.

b) Blocking of commands when crank handle of disconnector or earthing switches is introduced.

c) Extensive circuit breaker supervision through “Anti-Pumping”, pole discrepancy, Gas density and position supervision of circuit breaker,

1.19.1 Required features for conventional local control cabinets.

The LCC’s shall be provided with the following features:

a) A mimic diagram showing the single line diagram. Position indictors, on/off switches for the HV devices and local / off / remote switches shall be installed on or adjacent to the various symbols of the mimic diagram.

b) The following devices shall be supplied as a minimum:

i. Circuit breaker control switch with ON – OFF indicating lamps. – Circuit breaker “local-remote” selector switch.

ii. Disconnect switch, control switch with ON – OFF indicating lamps.

iii. Grounding switch, control switch with ON – OFF indicating lamps.

iv. Mimic bus including symbols according to the single line diagram.

v. Monitoring control of all high voltage switching devices in a bay.

vi. Digital display of current, voltage, active and reactive power, power factor etc.

c) Any interposing relays with built-in fuse and control switches associated with the circuit breakers disconnect switches, grounding switches etc.

d) The alarm and indication for devices specified e.g. gas, DC & AC supervision.

e) Fuses and links. These shall be installed in the interior of the LCC’s.

f) Terminal blocks for the terminating and marshalling of auxiliary supply circuits, control, interlocking, and indication & alarm circuits from the GIS and for cable connections to the remote-control room or the owner’s control system.

g) Each LCC shall be furnished with a guarded / touchproof DIN Rail Mountable PTC resistance heater to prevent the internal equipment from humidity deposit. The heater shall be rated 230 V AC controlled with DIN Rail Mountable UL approved Hygro-thermostats and fed through a two-pole fused disconnect switch.

h) A fluorescent LED lamp of 1200 lumens with build-it PIR Sensor and a duplex convenience outlet rated 230 V AC, 15 amps with ground fault interrupter shall be installed in each LCC.

The Local control cubicle shall be fitted with prewired interface terminal blocks for connection to user’s control & protection panels. The interface includes CT & PT inputs for protection & Measuring system, Protection trip 1 & 2 signals, Aux switch contacts etc.

1.19.2 Wiring Requirements

a) Each circuit breaker shall have control suitable for operation on 110 V/220 V DC with two electrically independent trip circuits. The miniature circuit-breakers (MCB) shall be provided for the closing circuit and an independent separate switch fuse unit of suitable rating shall be provided for the primary and back up trip circuits.

b) Wiring shall be complete in all respects to ensure proper functioning of the control, protection, and monitoring and interlocking schemes.

c) DC circuit for trip coil 1 & 2 shall be wired separately.

d) Wiring shall be done with flexible 1100V grade, FRLS, PVC insulated, switchboard wires with 2.5 mm2 stranded copper conductor. The control wire in a grouped environment shall not convey flame, continue to burn. Wiring between equipment and control cubicle shall be routed through G.I. rigid conduits and shall be done by PVC & screened cable only, with safety measures to protect operator from touching energized parts.

e) Each wire shall identify at both ends with permanent markers bearing wire numbers as per Contractor's wiring diagram.

f) Wire termination shall be done with crimping type connectors with insulating sleeves. Wires shall not be spliced between terminals.

g) All spare contacts of relays, push buttons, auxiliary switches etc. shall be wired up to terminal blocks in the control cubicle.

h) Interposing relays SSR/EMR type shall be with slim design, built-in fuse, UL approved with electrical life of minimum 60000 cycles at 6A load and temperature capacity of 85 Deg C

i) Terminal blocks shall be 1100V grade, stud type with engraved numbers suitable for termination of at least two numbers of 2.5 mm2 stranded copper conductor. Terminal blocks for CT, PT, auxiliary AC & DC supply shall be disconnecting link type.

j) Not more than two wires shall be connected to any terminal. Spare terminals equal in number to 20% active terminals shall be furnished.

k) Terminal blocks shall be located to allow easy access. Wiring shall be so arranged that individual wires of an external cable can be connected to consecutive terminals.

l) Terminal connectors that carry power supply should be shrouded from adjoining connectors.

m) Manufacturer shall provide all control wiring and terminations internal to the switchgear and connecting the switchgear to the bay control cabinets.

n) All control cables shall be shielded. Cable shields shall be grounded. Grounding connections shall be as short and direct as possible and shall terminate at the point of entry to cabinets or terminal boxes.

o) Co-axial type cable glands suitable for use with shielded cables shall be used at each termination.

p) All control cables shall be installed and terminated in such a manner as to limit the effects of transient electromagnetic voltages on the control conductors to an acceptable level.

q) Any cabling within GIS shall be supported on cable tray. No cable shall be in hanging position.

r) Insulator cones shall be embedded in full return current carrying metal fixing rings in order to avoid mechanical stresses to the cast resin part and to impart full conductivity across the flange connection. Earthing of different gas compartments/enclosures is not allowed with cross bonding with any metal strips.

1.19.3 Connections within the GIS and their LCC’s

a) All cable connections between the various GIS modules and the LCC’s shall be made by prefabricated multi-core cables with multipoint plug-in connections on both the ends. PTs & CTs circuit shall be wired with crimped type copper lugs.

b) All cables shall be shielded and adequate for their application (indoor / outdoor). The cables shall be firing retardant low smoke.

c) The length and the number of terminal points of control wiring & SF6 gas connections shall be minimized.

d) The electrical connections between the various gas sections shall preferably be made by means of multiple contact connectors so that electrical connection is automatically achieved when bolting on section to another. The surface of the connector fingers and conductor tubes on such connections shall be silver plated.

1.19.4 Name Plates

a) Name plates of the following types shall be furnished in a convenient central location to provide information for operation and maintenance.

   i. Gas Single Line Diagram showing all HV devices in a single line diagram with the gas sectionalizing of the GIS indicated. Also shown shall be the GIS nomenclature, a legend, Manufacturer's type and serial number and year of manufacture.

   ii. GIS Rating / Name plate:

   iii. Manufacturer's name & address, type & designation, Sr. No, Maximum ambient temperature, System freq.uency, Maximum continuous voltage, Maximum continuous current at 40oC ambient temperature, Basic Impulse Level, Power Frequency one minute voltage, short circuit current, rms., symmetrical Short time (rms) current & duration, symmetrical Momentary current, peak, Total weight of gas at rated density, Rated gas pressure at 20oC. Opening pressure of the bursting disc, recommended moisture limits of insulation gas (PPMV), Auxiliary voltages, Contract/Purchase Order numbers, Total weight of the equipment

   iv. Equipment nameplate containing nameplate rating information for all HV modules (like circuit breaker, disconnect switches, current transformer, voltage transformer, surge arrester, etc.) as required in relevant IEC.

   v. Nameplates showing serial numbers and similar data specific to individual components shall be mounted on the components. Each instrument transformer must have its own rating plate mounted adjacent to each terminal box cover, will all terminal and ratio markings. Each bay auxiliary control cubicle must be identified with its designation to which it is assigned.

b) Bidder shall specify the number of skilled / semi-skilled / unskilled persons, supervisors and Engineers required to be deputed for complete erection, testing, commissioning of GIS board.

1.19.5 Type Tests

Following type test reports from the laboratory as per specification, as specified in IEC standard 62271– 203 & 62271-100 (amended up to date) shall be submitted for the offered type, rating of GIS invariably with the technical bid. Bid without type test reports will not be considered for evaluation. The type test reports should have been conducted within TEN years prior to the date of opening of Techno Commercial Bid. The GIS shall be from the type tested country works.

a) Tests to verify the insulation level (Lightning impulse, switching impulse and ac withstand test with PD) test on each GIS device (CB, Disconnector, bus, etc).

b) Dielectric tests on auxiliary circuits.

c) Tests to prove the radio interference voltage (RIV) level.

d) Tests to prove the temperature rise of any part of the equipment and measurement of the resistance of the main circuit.

e) Tests to prove the ability of the main and earthing circuits to carry the rated peak and the rated short time withstand current.

f) Tests to verify the making and breaking capacity of the included switching devices.

g) Tests to prove the satisfactory operation of the included switching devices.

h) Tests to prove the strength of enclosures.

i) Verification of the degree of protection of the enclosure.

j) Gas tightness tests

k) Electromagnetic compatibility tests (EMC).

l) Additional tests on auxiliary and control circuits.

m) Tests on partitions.

n) Tests to prove the satisfactory operation at limit temperatures.

o) Tests to prove performance under thermal cycling and gas tightness tests on insulators.

p) Corrosion test on earthing connections (if applicable).

q) Tests to assess the effects of arcing due to an internal fault.

r) Tests on solid dielectric components (operating rods, spacers, etc)

s) Seismictest

t) Test on Auxiliary switches (Electrical & Mechanical Endurance, Heat run, IR & HV test)

Important note for type tests: The type test report shall be submitted for the offered class and rating of GIS. However, the type test report for higher class/rating can be accepted for scrutiny of technical bid but the same test/s shall have to be carried out on the offered class/rating GIS. Bidder shall invariably confirm to carry out the required type test/s, special tests, before commencement of supply, without affecting delivery schedule, free of cost, from the laboratory as per specification, or at suppliers works in presence of MSETCL/MSEDCL representative, in the event of order.

1.19.6 Routine / Acceptance Testing:

During manufacture and on completion, all equipment shall be subjected to the Routine tests as laid down in IEC Standard IEC 62271-203. All the acceptance tests shall be carried out in presence of MSETCL/MSEDCL representative on offering the material for inspection and testing by successful bidder. Tests shall include the following:

a) Dielectric test on the main circuit.

b) PD test

c) Tests on auxiliary and control circuits.

d) Measurement of the resistance of the main circuit.

e) Tightness test.

f) Design and visual checks.

g) Pressure tests of enclosures.

h) Functional tests

i) Tests on auxiliary circuits, equipment, and interlocks in the control mechanism.

j) Pressure test on partitions.

k) LCC – Complete functional & interlock test as per approved drawings with LCC duly connected to respective Bay GIS module in all respect.

l) IR test

m) HV test

1.19.7 Test Certificates

a) Certified reports of all the tests carried out at the works shall be furnished in required number copies for approval of the Owner.

b) The equipment shall be dispatched from works only after receipt of Owner/ Purchaser's written dispatch clearance & approval of the test reports.

c) Routine test certificates of bought out components shall be furnished.

d) Type test certificate on any equipment or component if so desired by the Owner shall be furnished. Otherwise, the equipment shall have to be type tested, free of charge, to prove the design.

1.19.8 Test after installation of complete GIS at Site

After installation and before being put into service, the GIS shall be tested in order to check the correct operation and dielectric integrity of the equipment as laid down in IEC 62271-203. The successful bidder shall furnish a commissioning test plan and a statement method for the tests on site.

Tests shall include the following:

a) Dielectric tests on the main circuits.

b) Dielectric tests on auxiliary circuits.

c) Measurement of the resistance of the main circuit.

d) Gas tightness tests.

e) Checks and verifications.

f) Gas quality verifications.

g) On site power frequency voltage withstand test with PD test.

h) Tests as per IEEE C37.122.1 clause 4.10.5

i) Functional & interlock tests for all items

j) Demonstration of operational compatibility with SCADA

k) Visual inspection, checks & verifications.

l) Mechanical operation tests of circuit breakers, Disconnectors and earthing switches and high-speed earthing switches

m) Insulation resistance measurement

n) Tests on CTs and PTs

o) Tests on Surge Arresters

1.19.9 Required test equipment.

During the onsite tests, the supplier shall provide all necessary test facilities and equipment for the switch-gear power frequency tests, i.e. test bushing or test cable, test adapter, test transformer or resonant test set etc.

1.19.10 Spares

Bidder shall submit all spares indicated in list which are considered in the scope of supply.

Each list shall be complete with specification, ratings, type, make, identification number, unit rate, quantity etc.

1.19.11 Drawings, Data & Manuals

Drawings, Data and Manuals shall be submitted in triplicate with the bid and in quantities and procedures as specified in General Conditions on Contract and/or elsewhere in this specification for approval and subsequent distribution after the issue of Letter of Intent.

To be submitted with the Bid:

a) Typical general arrangement drawings of the equipment's indicating space requirement, room dimensions, crane capacity etc.

b) Technical Specifications of equipment and special tools explaining construction features, principle of operation, special features etc.

c) Comprehensive QAP, FQP, SLD, Gas Schematic diagram, technical brochures, building requirements, Earth mat design, List of recommended spares, special tools or fixtures, O&M manuals, environmental guide for handling SF6 gas & decommissioning, estimated time schedule for installation & commissioning, bill of materials, and any other documents required for successful commissioning & operation of complete GIS.

d) Control and protection: Block & principal diagram showing proposed scheme, layout & equipment arrangement drawings, catalogues & brochures of offered devices.

Successful bidder shall submit 3 sets of spiral bound volume of following drawings & data for approval before commencement of supply:

e) A sselieve him of his contractual obligation.

The bidder may note that the drawings, data and manuals listed herein are minimum required only. The bidder shall ensure that all other necessary write-up, curves, etc require to fully describe the equipment are to be submitted with the bid.

All drawings shall be prepared by using AutoCAD and documents shall be generated using electronic version. The paper copy of the drawings & document shall be submitted for approval & reference. All final drawings and documents shall be submitted in CD in AutoCAD 2010 and MS office format as applicable for Owner's future reference. Also, AutoCAD version of Main GA drawings is to be submitted for Owner's layout finalization.

1.19.12 Maintenance

The operational integrity of the GIS switchgear shall not subject to external influences, such as pollution, moisture, dust etc. As a consequence of this GIS switchgear should be practically maintenance free, however, the details of inspection required at regular interval shall be indicated in the offer. Visual inspection shall be required not below 2 (two) years interval. Inspection shall not be required often than every 10 years. During inspection it must not be necessary to open the switchgear enclosures for interrupt operation of substation. Provision of functional testing of the close and trip coils, auxiliary switches, pressure, and control switches etc. shall be provided. Following minimum maintenance period shall be accepted.

a) Circuit breaker: 5000 closing and opening or 20 interruptions at max rated current.

b) Disconnector: 5000 closing and opening operations.

c) Fast acting earth switch: 2000 closing and opening operations or 2 making operations on to max rated fault current.

The bidder shall provide the services of experienced persons, supervisors, engineers, experts, etc., for complete specified work for satisfactory operation.

The bidder shall have dedicated localized after sales & service team which should be capable any activity to operate complete GIS satisfactorily.

1.19.13 GIS Building

The GIS building, if it is a part of schedule of requirements, shall comply with the requirements of Civil specifications.

The proposed arrangement of building and positions in which the switchgears shall be installed relative to lines, transformers, cable circuit and any other switchgear of any other voltages will be indicated in general arrangement layout. The overall height of building shall allow for overhead traveling crane.

1.19.14 Design information to be submitted by bidder.

The bidder shall provide complete floor plan detailing the fixing positions, levels and size of fixing bolt pockets and foundation required for all equipment's. Drawings giving similar details shall be provided.

All static and dynamic loads plus dimensional tolerances shall be given on these drawings.

Guaranteed and technical particulars as called for in attached SCHEDULE 'A' shall be furnished along with the technical bid.

1.19.15 Training

Training to Ten (10) persons of MSETCL/MSEDCL/MITL/Client on construction, installation, commissioning, and O&M shall be imparted by bidder free of cost. Duration of the complete training shall be 7 working days, covering minimum below specified curriculum. Any other specific area may be brought to notice and included.

a) General Explanation for GIS

b) Layout and Architecture of GIS

c) Gas Sectionalisation of GIS

d) Construction of CB

e) Operating Mechanism of CB

f) Maintenance of CB

g) Overhaul of CB (Interrupting chamber)

h) Overhaul of CB (Operating Unit)

i) Construction of DS/ES

j) Maintenance of DS/ES

k) Overhaul of DS/ ES

l) Construction of Bus/ Cable head/ SF6 – air bushing

m) Maintenance of Bus/ Cable head/ SF6 – air bushing

n) Overhaul of Bus/ Cable head

o) Overhaul of various transformer connections

p) Operation of GIS with SCADA

q) Construction & Maintenance of Lightning Arrester

r) Construction & Maintenance of VT/CT

s) Construction & Maintenance of Local control panel

t) Erection of GIS at site.

u) Installation & Testing of GIS at site

v) Type tests of GIS

w) Routine tests of GIS.

x) Faults simulation of GIS

y) Localization of GIS fault.

Bidder shall at his cost arrange for the above training facilities and in addition shall bear all living expenses plus inland travel expenses of all the trainees. The Purchaser shall only pay to and fro passage of the trainees.

1.19.16 Shipment storage and installation:

a) All equipment's shall be suitably packed and protected during shipment/transportation. Each shipping unit shall be sealed in a clean dry condition with leak-tight shipping covers securely mounted for shipment. All covers to be removed during installation shall be clearly marked. Each shipping section shall be carefully sealed and filled with dry gas to a slightly positive pressure to prevent the entrance of moisture and contamination.

b) The packing method for the GIS equipment shall be standard and it shall be guaranteed that each component of the equipment will not be damaged, deformed or lost. The storage instructions shall be submitted by bidder for long term storage. Component requiring indoor storage shall be so identified.

c) Gas insulated switchgear (GIS) shall be properly packed to protect during ocean shipment, inland transport, carriage at site and outdoor storage during transit and at the site. Completely assembled bays (subject to transport limitations) of the GIS shall be transported as one shipment unit.

d) Packing materials shall be dust and waterproof. All packages shall be clearly, legibly, and durably marked with uniform block letters on at least three sides. Fragile items like bushings, CTs, VTs, LAs and fully assembled bays shall be securely packaged and shipped in containers. Silica gel or approved equivalent moisture absorbing material in small cotton bags shall be placed and tied at various points on the equipment wherever necessary.

e) As far as possible, transshipment should be avoided.

f) Impact recorders (Accelerometers) shall be provided on the packages to confirm that GIS has not suffered any shocks during shipment, transport, handling, etc. The impact recorders readings are to be noted on receipt of equipment at site and reported to user & manufacturer in case the readings are exceeding the permissible values. It shall be at discretion of user to accept or reject the same.

1.19.17 Quality Assurance

Superior quality control system shall be adopted to assure high product quality. Raw materials of the best commercial grade quality and high reliability shall be used in the manufacture of GIS. High reliability of materials shall be ensured so as to keep maintenance work to a minimum.

A quality assurance plan for major components such as breakers, disconnecting switches, lightning arrestors, earth switches, etc. with in-process inspection methods, tests, records, etc. shall be submitted with the technical bid. Customer hold points will also be included in the plan, which shall be mutually agreed by the Purchaser and Manufacturer and approved.

1.19.18 Schedule of Guaranteed Technical For Gas Insulated Substation

S.No.	Particulars	To be filled by the Bidder
1	General	
2	Name of manufacturer (OEM)	
3	Country of Origin	
4	Delivery from (location)	
5	Type & Designation	
	Type tested at	
	Name of Laboratory	
6	Address of laboratory	
7	Installation (indoor or outdoor)	
8	Standards applicable	
9	No. of Phases	
10	Single or Three Phase design	
11	Configuration	
i	Number of Feeder bays	
ii	Number of transformer bays	
iii	Number of Bus coupler bay	
iv	GIS to transformer connection	
v	GIS to Feeder connection	
vi	Number of VT	
vii	Number of SA	
	Future extension possibility	
12	Service conditions	
i	Ambient Air Temp. in Deg. C	
ii	Max Temp. in Deg. C	
iii	Min Temp. in Deg. C	
iv	Daily Average Temp. in Deg. C	
v	Solar Radiation W/sq mtr	
vi	Altitude above MSL, in mtr	
vii	Pollution class	
viii	Creepage distance, in mm/kV	
ix	Relative humidity	
x	Condensation	
xi	Vibration level	
xii	Noise level	
xiii	Induced Electromagnetic Disturbance, in kV	
xiv	Seismic conditions	
a	Vertical	
b	Horizontal	
13		
i	Code of pressure vessel	
ii	Type of manufacturing	

S.No.	Particulars	To be filled by the Bidder
iii	Design temperature in Deg.C	
iv	Material	
v	Material grade & applicable standard	
vi	Outside diameter in mm	
vii	Minimum Wall Thickness, in mm	
viii	Painting Shade & Thickness	
a	- External	
b	- Internal	
ix	Degree of Protection	
x	Inductance in H/mt	
xi	Capacitance in pF/mt	
xii	Resistance in Ohm/mt	
xiii	Expansion Bellow	
a	Material	
	Min allowable adjustable displacement	
b	Longitudinal	
	Transverse	
xiv	Sealing system	
a	Type	
xv	Estimated life in years	
xvi	Barrier	
a	Material	
b	Dielectric strength	
14	Support Structure	
i	Material	
ii	Minimum thickness of galvanizing	
iii	Foundation channels /Anchor bolts	
15	Grounding	
i	Grounding Material	
ii	Grounding of complete GIS	
iii	Grounding of individual compartment	
iv	Grounding at flange joints	
16	System Parameters	
i	Highest System voltage in kV	
ii	Rated voltage of System in kV	
iii	Rated voltage of Equipment in kV	
iv	Rated Insulation level Phase to Earth and between Phases	
a	One Min Power Frequency withstand voltage kVrms	
b	Switching impulse withstand voltage, kVp	
	- Phase to Earth	
	- Between Phases	
c	Lightning Impulse withstand voltage, kVp	
iv	Rated Frequency	
v	Rated current in Amp	
vi	Rated current at 50 °C (equipment) in Amp	
vii	Rated current at 50 °C (bus bar) in Amp	

S.No.	Particulars	To be filled by the Bidder
viii	Rated short circuit withstand current kArms	
a	Duration in sec	
b	Peak, kAp	
ix	Enclosure withstand time for an internal fault in sec	
x	Estimated total energy loss at 100% of rated capacity	
	75 % of rated capacity	
	50 % of rated capacity	
	25 % of rated capacity	
xi	Measures taken to minimize Over Voltage	
xii	Phase labeling	
xiii	Auxiliary supply (AC Voltage, Frequency; DC voltage)	
	Operation	
	Control	
	Illumination & heater	
17	Delivery conditions	
i	Bays fully assembled at works	
ii	Dimensions of longest section for transportation	
iii	Weight of heaviest package	
iv	Pressure of SF6 gas during transportation	
v	SF6 gas monitoring system provided during transportation.	
18	Bus Bar	
i	Configuration (Single / Double)	
ii	Nos of Phases	
iii	Material	
iv	Size	
v	Rating	
vi	Current density adopted	
vii	Current density as per type test report	
viii	Short time current withstand rating in kA	
ix	Duration	
x	Resistance per phase	
xi	Surge impedance	
xii	SF6 immersed insulator	
a	Material	
b	Dielectric strength	
xiv	Maximum Partial Discharges measured at	
	HSV	
19	SF6 Gas	
i	Applicable standard	
ii	Quantity of SF6 Gas of complete GIS at filling pressure, in kg	
iii	Quantity of SF6 Gas of largest compartment GIS at filling pressure, in kg	
iv	Nos of Gas compartments	

S.No.	Particulars	To be filled by the Bidder
v	Quantity of SF6 Gas of individual compartment GIS at filling pressure, in kg	
vi	Maximum permissible dew point, in Deg.C	
vii	Composition of Gas	
a	SF6 > 99.90 % by weight	
b	Air < 500 ppm by weight (0.25 vol.-%)	
c	CF4 < 500 ppm by weight (0.1 vol.-%)	
d	H2O < 15 ppm by weight (0.012 Vol-%)	
e	Mineral oil < 10 ppm by weight	
f	Acidity, in terms of HF < 0.3 ppm by weight	
g	Hydrolysable fluorides,	
	In terms of HF < 1 ppm by weight	
	PRESSURE	
vii	Design pressure	
a	Circuit breaker	
b	Other compartments	
ix	Rated filling pressure	
a	Circuit breaker	
b	Other compartments	
x	Type tested pressure.	
a	Circuit breaker	
b	Other compartments	
xi	Routine test pressure	
a	Circuit breaker	
b	Other compartments	
xii	Operating pressure of PRD	
a	Circuit breaker	
b	Other compartments	
xiii	Alarm Pressure	
a	Circuit breaker	
b	Other compartments	
c	CB lock out Pressure	
d	Over pressure signaling	
xiv	Maximum SF6 Gas leakage rate, in % per year	
xv	Density Monitor to be provided for each	
	Individual gas compartment.	
20	Circuit Breaker	
i	Applicable standard	
ii	Type	
iii	Designation	
iv	Operating Mechanism type	
v	Nos. of phases	
vi	Rated current in Amp	
vii	Mechanical Endurance class	
viii	Electrical Endurance class	
ix	Restrike probability class	
x	Rated SC breaking current	

S.No.	Particulars	To be filled by the Bidder
xi	Rated SC breaking current - single phase test	
xii	Rated Line charging breaking current	
xiii	Rated Cable charging breaking current	
xiv	Capacitor bank switching capability,	
	BC1	
	BC2	
xv	Inductive current	
xvi	Reactive current	
xvii	Out of phase making & breaking current	
xviii	Rated short line fault current	
xix	TRV characteristic	
xx	First Pole to Clear factor	
xxi	Nos. of interrupters per phase	
xxii	Type of arc control device provided if any	
xxiii	Type of arcing contacts	
xxiv	Material of main contact	
xxv	Material of Arcing contacts	
xxvi	Filter material	
xxvii	Timings of operations	
a	- Opening at nominal control voltage	
	- Opening at minimum control voltage	
b	Closing time at nominal control voltage	
	Maximum pole discrepancy time	
xxviii	Tripping	
	Closing	
xxix	Rated operating duty cycle	
xxx	Tripping Coils	
	- No of coils	
	- Rated Voltage	
	- Rated Current	
	- Rated Watts	
	- Resistance	
xxxi	Closing Coil	
	- Rated Voltage	
	- Rated Current	
	- Rated Watts	
	- Resistance	
xxxii	Spring Charging Motor	
	- Rated Voltage	
	- Rated Current	
	- Rated Watts	
xxxiii	Spring charging time at rated Aux supply	
xxxiv	Spring charging time at min Aux supply	
xxxv	Maintenance required after nos. of operation at	
i	No load	
ii	Rated current	
iii	25% of rated SC current	

S.No.	Particulars	To be filled by the Bidder
iv	50% rated SC current	
v	Rated SC current	
e	Provision of anti-pumping	
f	No of operations after switching off motor Aux. supply	
xxxvi	Provision of Manual trip	
xxxvii	Electrical interlocking	
xxxviii	Padlocking	
xxxix	Type of Operation counter provided	
21	DISCONNECTORS	
i	Applicable standards	
ii	Type	
iii	Rated current in Amp for	
	- Bus disconnector	
	- Line disconnector	
	- Transformer disconnector	
	- PT disconnector	
	Maximum Current that can be safely	
iv	interrupted by the Isolator (Amp).	
	- Inductive	
	- Capacitive	
v	Rate Short time withstand Current in kA, for 3 sec	
vi	Rated peak short time Current, kAp	
vii	Rated bus charging current, in Amp	
viii	Type of contacts	
ix	Material of contacts	
x	Current Density at minimum cross section (A/mm2)	
xi	Rated lightning impulse withstand voltage across the open gap, kVp	
xii	Rated Power Freq withstand voltage across the open gap, kVrms	
xiii	Mechanical Endurance class	
xiv	Type of Operating Mechanism	
xv	Operating Motor details	
	- Type	
	- Rated Voltage	
	- Rated Current	
	- Rated Watts	
xvi	Operating Time	
	- Closing	
	- Opening	
xvii	Mechanical indication on drive shaft	
22	Maintenance Grounding Switch	
i	Applicable standards	
ii	Type	
iii	Rate Short time withstand Current in kA, for 3 sec	
iv	Rated peak short time Current, kAp	

S.No.	Particulars	To be filled by the Bidder
v	Rated lightning impulse withstand voltage across the open gap, kVp	
vi	Rated Power Freq withstand voltage across the open gap, kVrms	
vii	Type of Operating Mechanism	
viii	Operating Motor details	
	- Type	
	- Rated Voltage	
	- Rated Current	
	- Rated Watts	
ix	Operating Time	
	Closing	
	Opening	
x	Mechanical indication on drive shaft	
23	Fast Acting Grounding Switch	
i	Applicable standards	
ii	Type	
	Rate Short time withstand Current in kA, for	
iii	3 sec	
iv	Rated peak short time Current, kAp	
	Rated induced current switching capability	
v	Rated capacitive current switching capability	
	Rated lightning impulse withstand voltage	
vi	across the open gap, kVp	
vii	Rated Power Freq withstand voltage across the open gap, kVrms	
viii	Electrical Endurance class	
ix	Type of Operating Mechanism	
x	Operating Motor details	
	- Type	
	- Rated Voltage	
	- Rated Current	
	- Rated Watts	
xi	Operating Time	
	- Closing	
	- Opening	
xii	Mechanical indication on drive shaft	
24	Current transformers	
i	Type	
ii	Material	
iii	Position of Current Transformer	
iv	Reference Standard	
v	Rated Continuous thermal current	
vi	Rated Short Time current	
vii	Duration	
a	Feeder Bay CT	
i	Metering Core	

S.No.	Particulars	To be filled by the Bidder
	- Ratio	
	- Output Burden	
	- Accuracy Class	
	- ISF	
ii	Protection Core -1	
	- Ratio	
	- Output Burden	
	- Accuracy Class	
	- ALF	
iii	Protection Core -2	
	- Ratio	
	- Output Burden	
	- Accuracy Class	
	- ALF	
b	Transformer Bay CT	
i	Metering Core	
	- Ratio	
	- Output Burden	
	- Accuracy Class	
	- ISF	
ii	Protection Core -1	
	- Ratio	
	- Output Burden	
	- Accuracy Class	
	- ALF	
iii	Protection Core -2	
	- Ratio	
	- Accuracy Class	
	- Minimum Knee Point Voltage at highest ratio	
	- Maximum Excitation Current at Vk	
	- Maximum Resistance at highest ratio	
iv	Protection Core -3	
	- Ratio	
	- Accuracy Class	
	- Minimum Knee Point Voltage at highest ratio	
	- Maximum Excitation Current at Vk	
	- Maximum Resistance at highest ratio	
c	Bus Coupler Bay CT	
i	Metering Core	
	- Ratio	
	- Output Burden	
	- Accuracy Class	
	- ISF	
ii	Protection Core -1	
	- Ratio	
	- Burden	
	- Accuracy Class	

S.No.	Particulars	To be filled by the Bidder
	- ALF	
iii	Protection Core -2	
	- Ratio	
	- Burden	
	- Accuracy Class	
	- ALF	
	- Accuracy Class	
iii	Protection Core -2	
	- Ratio	
	- Output Burden	
	- Accuracy Class	
27	Local Control Cubical	
i	Name of Manufacturer (OEM of GIS)	
ii	Location in GIS	
iii	Material	
iv	Sheet Thickness	
v	Degree of Protection	
vi	Padlocking arrangement	
vii	Major components of LCC	
	Bay control mimic diagram	
	Control Switches	
	LED Indicating lamps	
	Position indicators	
	Annunciation scheme	
	Modular DIN Rail Mountable Auxiliary relays	
	Modular DIN Rail Mountable Contact multiplication relays	
	System parameters display	
	Heater with Hygro-thermostat	
	Interface terminal blocks for relaying & protection	
28	GIS to Line connection	
i	Nos of XLPE cable can be terminated	
ii	Type of cable termination required	
29	GIS to Transformer connection	
i	Nos of XLPE cable can be terminated	
ii	Type of cable termination required	
30	Maintenance	
i	Maximum down time for replacement or removal of any part	
ii	Maximum down time for degassing and re- filling the biggest compartment	
iii	Time between two refilling of SF6 gas.	
iv	Recommended period for overhauling	
v	Operation and Maintenance manual attached	
vi	Nearest local service centre	
vii	Minimum time of availability of local service	
viii	Availability of spares at local service centre	

S.No.	Particulars	To be filled by the Bidder
ix	List of recommended spares attached?	
x	List of recommended special tools, etc attached?	
xi	List of recommended spares attached?	
xii	List of recommended special tools, etc attached?	

1.20 Technical Specifications for 220kV//33kV ONAN Type Transformer.

This specification covers design, engineering, manufacture & assembly of 3-Phase, 100MVA, 220kV//33kV Power Transformer complete with all fittings and accessories required for efficient and trouble free operations of the transformer, testing at manufacturer's works and customer's premises, supply, loading at factory, delivery at site, unloading, handling, dragging for proper storage at site on the plinth of transformer if the same is ready at respective site or at suitable location as per direction of site-in-charge of customer.

1.20.1 General Requirement

The Transformer shall be multi-winding, oil immersed complying as per Specific Technical parameters and suitable for outdoor installation.

1.20.2 Specific Requirement

a) Type Test: The transformers should be Type Tested as per IS 2026 or IEC 60076 in conjunction with their relevant Part. Necessary test documents of previously tested similar or higher rated (both in MVA and voltage class) transformer shall have to be submitted with the bid.

b) Dynamic Effect of Short Circuit

c) Dynamic Short Circuit Test shall be carried out on similar or higher MVA rated 220 kV or above class of Power transformer as on the date and shall enclose the relevant Test Report and Certificate along with bid. This shall be applicable for 220 kV class transformer of MVA rating similar to or higher than the tendered transformer.

d) **Tests at Manufacturer's works**: The Transformers shall be subjected to type & routine test, special tests and no load & load loss measurement as per relevant IS as mentioned in the Clause "TEST AT FACTORY AND TESTCERTIFICATES".

e) **Guaranteed Technical Particulars:** Guaranteed technical particulars shall be submitted as called for in this specification.

f) **Core Materials:** Core materials should be directly procured from either the manufacturer or their accredited reputed marketing organization and not through any age.

1.20.3 Standard

The Power Transformer covered under this specification shall comply with the requirements of the latest edition of following Standards:

a) IS:2026 (Part I to IV) Specification for Power Transformer

b) IS:2099 & IS:3347 Bushing for alternating voltage above 1000 volt

c) IS: 6600 Guide for loading of oil immersed transformer

d) IS: 335 Specification for transformer oil

e) CBIP Manual on transformer.

f) IEC-60076 Power Transformer

g) IEC-60214 On Load Tapchanger.

h) IEC-354 Loading Guide for Oil immersed Transformer.

i) IEC-551 Tr. Sound Level.

1.20.4 General Design

a) The Transformer and accessories shall be designed to facilitate easy inspection, cleaning, and repairs. All fittings and accessories shall be designed to ensure satisfactory operation under worst conditions of load and voltage as may be met under working conditions in the system.

b) All materials used shall be of best quality and of the class most suitable for working under the conditions specified. It shall withstand the variations of temperature and atmospheric conditions without undue stressing etc. i.e. not affecting the workability/durability of the various parts of the transformer.

c) All outdoor fittings and accessories, including bushings insulators with their mounting, shall be so designed as to avoid pockets in which water can collect. All electrical connections shall be of ample cross sections for carrying the specified currents continuously without undue heating. All fixing bolts and screws shall be reliable under worst conditions of operations.

d) Transformers shall be suitable for continuous operation with a frequency of 50 Hz and variation of± 3% without exceeding specified temperature rise.

e) Transformer with all its accessories including Bushing CTs etc. shall be designed to withstand without injury, the mechanical and thermal effects, and any external short circuit to earth and of short circuits at the terminals of any winding for a period of 3 Sec. The short circuit level of HV & LV system to which the subject transformer will be connected is 50KA (Sym, rms, 3Ph. Fault on 220KV) and 40KA& 31.5KA (Sym., rms, 3 Ph. fault on 33kV). Transformer shall be capable of withstanding thermal and mechanical stresses caused by symmetrical or asymmetrical faults on any winding.

f) For parallel operation with other transformers, necessary provision is to be kept in transformer RTCC panel for tap changing operation in any of Master/Follower/Independent mode.

g) Clearances of line terminals in Air:

h) The clearance of HV & LV terminal shall be maintained as specified below:

Highest System voltage of equipment (KV rms)	Phase to Phase clearance (mm)	Phase to earth clearance (mm)
245	2000	1800
36	300	280

i) Transformer shall be designed for full lightning impulse voltage as well as chopped and reduced chopped impulse voltage as per relevant clauses of IS:2026 (Pt.-III)/ IEC:60076-3.

1.20.5 Vibration and Noise

Transformer when energizes at normal voltage and frequency with fans and pumps are running shall have minimum hum and abnormal noise shall not exceed when measured under standard condition the value specified as per the NEMA standard publication TR-1.

1.20.6 The Loading Guideline

Over loading of transformer shall be guided by latest IS-6600.

1.20.7 Temperature Rise

Each Transformer shall be capable of operating continuously at its normal rating without exceeding temperature rise and hot spot limits.

Type of Cooling	Maximum Ambient Temp.	Maximum Top Oil Temp. Rise	Maximum Winding/ Core Temp Rise	Maximum Winding Temp.	Maximum permissible value of Avg. Temp. of Winding after 3 sec of short ckt.
ONAN	50oC	50oC	55oC	105oC	250oC
ONAF	50oC	50oC	55oC	105oC	250oC

1.20.8 Thermal ability to withstand short circuit

a) Thermal ability to withstand short circuit shall be demonstrated by calculation and shall be furnished along with the drawing.

b) Designed time period for short circuit withstand shall be taken as 3 (three) seconds and fault current will be taken as per General Technical Specification. The maximum permissible value of the highest average temp of winding after withstanding the above stipulated Short Circuit shall not exceed 250°C and the submitted calculations shall be as per Cl.No. 9.1 of IS: 2026 (Part-I)

1.20.9 Detailed Transformer Particulars. Tank and Tank Cover

a) The tank and cover shall be fabricated from low- carbon mild steel plate of adequate size and suitable for welded construction. The tank so welded shall be reinforced by stiffener of structural steel for general rigidity. Each tank cover shall be of adequate strength and shall not distort when lifted.

b) The tank shall be designed to have sufficient strength to withstand without distortion:

   i. Transformer tank of each size, its radiator, conservator vessel and other fittings together or separately shall be subjected to a pressure corresponding to twice the normal head of oil or to the normal pressure plus 35 KN/m^2 whichever is lower measured at the base of the tank and maintained for one hour. The permanent deflection of flat plates after the excess pressure has been released shall not exceed the figures specified under vacuum test above and

ii. The tank shall be designed to have sufficient strength to withstand mechanical shock during transport.

c) The internal and external surface including structural steel work and oil filled chambers are to be painted after removing all rust and scale of foreign adhering matter or grease by sand blasting or other approved method. All steel surfaces in contact with insulating oil shall be painted with two coats of heat resistant oil insoluble insulating paint.

d) All steel surface exposed to weather shall be given a primary coat of zinc chromate and shall be applied immediately after cleaning. The second coat shall be of an oil and weather resisting nature and of shade or colour easily distinguishable from the primary. The final coat shall be of epoxy paint of minimum thickness of 80 DIGHIrons and weather resisting non-fading paint of shade No. 631 of IS:5.

e) All paints shall be carefully selected to withstand heat and weather. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling.

f) The tank construction shall be of Bell Tank construction. Adequate number of inspection cover shall be provided to give easy access to the bushing or other parts as may be necessary. To make joints oil tight, nitrile rubber gaskets shall be cut to size and shape to avoid joints on gaskets as far as practicable. It shall be fitted with pockets for thermometer and for the bulbs of oil and winding temperature indicators. The thermometer pockets shall be fitted sufficiently above on the surface of the top cover of main tank with a captive screwed top to prevent ingress of water. The pockets shall be located in position of maximum temperature, and it shall be possible to remove bulb without lowering the oil in the tank.

g) Bi-directional flanged rollers for moving the transformer on rail gauge shall be provided. The direction of the roller through 90º (degrees) can be changed by jacking up the assembly. Bi-directional rollers can be locked in required direction by bolting the roller mounting pad welded on the base of the tank and bi-directional flanged rollers bracket with bolts. The tank shall be provided with all fittings and accessories.

h) Lifting lugs shall be provided on all parts of transformer requiring independent handling during assembly or dismantling. In addition, the transformer shall be provided with lifting lugs and bosses properly secured to the side of the tank for lifting complete transformer assembly filled with oil either by crane or by pulley. Pulling lugs shall also be provided to facilitate movement of transformer horizontally.

i) The transformer tank shall be equipped with the following valves and plugs with standard screw connection for piping:

i. Drain valve at the bottom.

ii. Filter valve at top

iii. Filter valve at bottom

iv. Sampling valve at top

v. Sampling valve at bottom

vi. Radiator shut off valve at top and bottom.

vii. Buchholz relay shut off valve at both ends of the relay.

viii. Air release plugs on tank.

ix. One no. oil inlet valve

Any other valves & plugs other than those mentioned above, are also to be provided as per requirement.

j) 4 no. thermometer pocket should be provided for WTI & 2 no. for OTI. Amongst 4 no. pocket for WTI, two (2) will be used for direct connection with the WTI in MK of Transformer. Balance Two (2) shall be provided with PT 100 sensor and Current Converter Unit (CCU) at MK for WTI repeater at the RTCC panel to be installed in Substation. Similarly, amongst Two (2) no. pocket for OTI, one (1) will be used for direct connection with OTI in MK of Transformer. Balance one no. (1) shall be provided with PT 100 sensor and Current Converter Unit (CCU) at MK for OTI repeater at the RTCC panel to be installed in substation Building.

k) Design shall be such that Tank cover can be lifted independently without lifting active part of core, winding etc.

l) A step ladder shall be provided with each transformer to step in to the top of the tank.

1.20.10 Core

a) The magnetic circuit shall be core type. Each limb shall be joined with top and bottom yokes. The laminations shall be made from high grade non-ageing cold rolled grain-oriented silicon alloy of HI -B or its equivalent grade steel. The insulation of lamination shall be coated with oxide/silicate/phosphate coating or any coating inert to the action of hot transformer oil. The core should be bottom mounted.

b) The core shall be of stepped cross-section. The yokes shall be clamped by means of end frames and yoke bolts and limbs shall be clamped by means of clamp plates. Sufficient number of lifting lugs is to be provided on end frames so that core with windings can be lifted when required.

c) The design of magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or to the earthed clamping structure and production of flux component at right angles to the plane of lamination which may cause local heating.

d) The insulation for the core to bolts and core to clamps shall be such as to withstand a test voltage of 2 (two) KV rms at 50 Hz for one minute.

e) The maximum flux density in any part of the core and yoke at the rated MVA, voltage & frequency shall be such that less than 10% continuous over voltage condition does not exceed 1.9 Tesla.

f) For consideration of over fluxing, the transformer shall be suitable for continuous operation for values of over fluxing at (i) 110% (ii) one minute for 125% and (iii) 5 seconds for 140% of rated voltage.

g) The prime core materials are only to be used. Bidders should furnish following document as applicable as a proof towards use of prime Core material to be submitted before the stage inspection:

i. Invoice of supplier

ii. Mill's test certificate

iii. Packing List

iv. Bill of lading

v. Bill of entry certificate by Custom.

vi. Description of material, electrical analysis, physical inspection, certificate for surface defects, thickness and width of the materials.

vii. Place of cutting of core materials

1.20.11 Windings

The Material of winding conductor should be of electrolytic grade copper of minimum 99.90% purity and free from scales, spills, splits and other defects. The windings shall be so designed that all coil assemblies of identical voltage ratings shall be interchangeable and field repair is possible. The coils shall be supported between adjacent sections by insulating spacers, and the barriers. Bracing and other insulation used in the assembly of the windings shall be arranged to ensure a free circulation of the oil and to reduce hot spots in the windings. The stacks of windings shall receive adequate shrinkage treatment before final assembly and the same shall be assembled in dust-controlled chamber.

The insulation of the coils shall be such as to withstand the full electrical strength of the windings. All 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 adversely affected under the operating conditions. The dielectric strength of winding insulation shall confirm to values given in IS: 2026, as amended up to date, or as per specific Technical Parameters.

All threaded connections shall be provided with locking facilities.

All leads from the windings to the terminal board and bushings shall be rigidity supported to prevent injury from vibration. Guide tubes shall be used where practicable.

The windings shall be clamped securely in place so that they will not be displaced or deformed during short circuits. The assembled core and windings shall be vacuum dried and suitably impregnated with insulating oil. The copper conductors used in the coil assembly shall be best suited to the requirements and all permanent current carrying joints in the windings and the leads shall be welded or brazed. Oil ducts shall be such as will not impede the free circulation of oil through windings assembly.

The conductor shall be transposed at sufficient intervals in order to minimize eddy currents and to equalize the distribution of currents and temperature along the winding.

1.20.12 Tap Changing Mechanism

The transformer shall give full load output on all taps. The transformer shall operate without danger on any particular tapping at the rated MVA within a voltage variation of ±10% of the rated nominal voltage.

Transformer shall be provided with ON LOAD TAP CHANGER with the tapping range shall be +15% and –15% in 1.25% equal steps. Remote Tap Changer Panel shall also be provided to be installed at Substation.

In Tap Position Indicator sufficient terminals are to be provided for sending inputs for SCADA/SAS.

1.20.13 On load tap changer

This shall be designed suitable for remote control operation from RTCC Panel in the Substation to be supplied by the manufacturer in addition to being capable of local manual as well as local electrical operation.

The on-load tap changer shall include the following:

a) An oil immersed tap selector and arcing switch or arc suppressing tap selector, provided with reactor or resistor for reduction of make and break arcing voltages and short circuits.

b) Motor driven mechanism

c) Control and protection devices.

d) Local /Remote tap changer position indicator

e) Manual/Electrical operating device.

The on-load tap changer shall be designed so that the contacts do not interrupt arc within the main tank of the transformer. The tap selector and arcing switch or arc suppressing tap selector switch shall be located in one or more oil filled compartments. The compartment shall be provided with Oil Surge relay. Those compartments shall be designed so as to prevent the oil in tap selector compartment from mixing with the oil in the transformer main tank.

An oil surge relay with trip float arrangement shall be provided for the OLTC unit.

The tap changer shall be capable of permitting parallel operation with either existing or future transformers of the same type as Master or Follower.

The manual operating device shall be so located on the transformer that it can be operated by a man standing at the level of the transformer track. It shall be strong and robust in construction.

The control scheme for the tap changer shall be provided for independent control of the tap changers when the transformers are in independent service. In addition, provision shall be made so that under parallel operation the tap changer will give alarm and visual indication for becoming out of step. Visual indication during the operation of motor shall also be incorporated. The tap change control must ensure step by step operation under all operating conditions.

Necessary interlock blocking independent control when the units are in parallel shall be provided.

Under parallel operation, as may occur if the contactor controlling one tap changer sticks, the arrangement must be such as to switch off supply to the motor so that an out of step condition is limited to one tap difference between the units. Details of out of step protection provided for the taps should be furnished in the bid.

The contactors and associated gear for the tap change driving motors shall be housed in a local kiosk mounted on the transformer. The motors shall be suitable for operation with 3-phase 415 volts, 50 cycle external power supply.

1.20.14 Conventional RTCC Panel

The supplier shall furnish, in addition to the equipment above, the following accessories mounted in a separate Remote Tap Changer Control (RTCC) panel to be installed in substation.

a) Raise and Lower Push Button Switch

b) Remote tap position indicator and other required devices. One chart showing the voltage corresponding to tap position indicator shall be engraved on a metal sheet and the same shall be fixed near the tap position indicator on the RTCC (Panel). In Tap Position Indicator sufficient terminals are to be provided for sending inputs for SCADA/SAS.

c) An indication lamp showing tap changing in a progress.

d) Master, Follower and Independent selecting switch and other accessories required for complete operation of tap changer.

e) Name plate of each component & relays

f) Winding & Oil temperature (0° –150°C) repeaters to be connected to winding and oil Temperature meter housed in the main Transformer Marshalling Box at outdoor. In addition to above necessary arrangements are to be made in RTCC panel for Hot spot temperature indication and alarm by optical sensor method as mentioned.

Complete particulars of the tap changing gear including the capacity of the motor shall be stated in GTP. An under-voltage relay shall be incorporated to monitor the 110 Volt AC control circuit voltage of tap changer. Audible Alarm and annunciation shall be provided for failure of control circuit supply, failure of 415 V AC supply to the motor. All the relays requisite for remote tap change operation shall be provided in RTCC panel. The OLTC should have been Type Tested.

1.20.15 Insulating Oil

Oil for first filling together with 5% extra oil shall be supplied with each transformer. The oil shall comply in all respect with the provisions of the latest edition IS:335 (as amended up to date) of specification for New Insulation oils for transformers and switchgears. Particular attention shall be taken to deliver the oil free from moisture having uniform quality throughout in non-returnable steel drums. The quantity of oil for first filling of each transformer shall be stated in the offer. One transformer of each type atleast shall be filled with Easter Synthetic oil.

After site processing through filtration and before commissioning, the moisture content shall be as follows:

a) Less than 72.5 KV : 25 ppm

b) 72.5 KV to 145 KV : 20 ppm

c) Above 145 KV : 15 ppm

1.20.16 Conservator Vessel

a) The conservator is a vessel for oil preservation. The oil level in the conservator shall not be below the level of the H.V. bushing caps unless the bushings are of oil sealed type construction. The size of the conservator tank shall have adequate capacity with highest and lowest visible level to meet the requirement of expansion of total cold oil volume in the transformer and cooling equipment from minimum ambient temperature to 100ºC.

b) The conservator shall have one filter valves at suitable location, in addition to the valve specified in the accessories for the main tank. The conservator with sump shall also have a small drain valve and sampling cock, the latter so arranged as not to interfere with oil lines. The oil level gauge shall be mounted on the conservator. The oil level at gauge shall have three indications viz., oil level at 30ºC shall be marked on the gauge and indicating range shall be minimum to maximum level.

c) There shall be one “Atmoseal type” sealing to prevent direct contact of transformer oil with the atmospheric air to retard oxidation and contamination of oil.

d) The oil connection from the transformer tank to the conservator vessel shall be arranged at a rising angle of 3 to 9 degree to the horizontal up to the Buchholz relay. The inside diameter shall be 50mm/80mm as per capacity of the transformer and IS: 3639.

e) Valves shall be provided at the conservator to cut off the oil supply to the transformer after providing a straight run of pipe for at least five times internal diameter of the pipe on the tank side of the Buchholz relay and at least three times the internal diameter of the pipe on the conservator side of the Buchholz relay. The pipe connecting the transformer tank with conservator will project above the lowest point in the conservator such that the portion below the pipe acts as a sump where the impurities in conservator will be collected.

f) Magnetic oil level gauge with low oil level alarm shall be provided.

g) Atmoseal type conservator shall be filled with oil to a level appropriate to the filling temperature. The oil shall be separated from atmosphere by a flexible air cell of nitrile rubber reinforced with nylon cloth air cell. Flexible air cell of nitrile rubber shall be able to withstand max temp of oil considering continuous operation as well as considering overloading of transformer as per relevant IS/IEC. The connection of air cell to the top of the conservator is to be made by air proof seal to prevent entry of air to the conservator.

h) OLTC Conservator shall have oil indicator made of glass.

i) Dehydrating Filter Breather: Conservator shall be fitted with a dehydrating filter breather. It shall be designed to facilitate the followings:

  i. Passage of air through silica gel.
  ii. Silica gel is isolated from atmosphere by an oil seal.
  iii. Two breathers (of identical size) shall be connected in parallel for main conservator tank. A stop valve shall be provided for each breather and also for the common pipeline. The same arrangement shall be made for OLTC tank conservator by providing adequate size of two identical breathers.
  iv. Breathers are to be maintained approx. at a height of 1200 mm. above rail top level.
  v. Moisture absorption indicated by a change in colour of the silica gel can be easily observed from ground level.

1.20.17 Bushing

a) Bushing shall have high factor of safety against leakage to ground and shall be so located as to provide adequate electrical clearances between bushing and grounded parts. Bushings of identical voltage rating shall be interchangeable. All bushings shall be equipped with suitable terminals of approved type and size and shall be suitable for bimetallic connection, if necessary. The insulation class of the high voltage neutral bushing shall be properly coordinated with the insulation class of the neutral of the high voltage winding.

b) All main windings and neural leads shall be brought out to outdoor through bushings which shall be so located that the full flashover strength will be utilised and phase to phase and phase to earth clearance shall be more than minimum value specified below. Location and arrangement of bushing shall follow Indian Standards.

c) Each bushing shall be so coordinated with the transformer insulation that flashovers will occur outside the tank.

d) All porcelain used in the bushings shall be made of the wet process, be homogeneous and free from cavities or other flaws. The glazing shall be uniform in colour and free from blisters, burns, and other defects. Upper portion of Bushing made of Porcelain & lower portion made of Epoxy/porcelain is also acceptable.

e) Bushings shall be Oil Filled Condenser type and shall be hermetically sealed. All OIP bushing shall have provision of measurement of capacitance and tan-delta without dismantling of the bushing. Rating plate of bushing shall be provided near each type of bushing with terminal marking and physical position as per IS:2026.

f) The electrical and mechanical characteristic of bushings shall conform to IS:2099 and IS:3347. The characteristic of the oil used in the bushing shall be the same as that of the oil in the transformer.

g) Main terminals shall be solder less and "Terminal Connectors" shall be as specified below of this technical specification. The spacing between the bushings must be adequate to prevent flashover between phases under all conditions of operation.

h) All bushings shall be suitable for heavily polluted atmosphere and minimum creepage distance shall be taken as 25 mm per KV.

i) Where Bushing mounted Current Transformers are specified, the bushing shall be removable without disturbing the current transformers.

j) Bushing Current Transformer:

i. Current transformer shall comply with IS:2705/IEC-185.

ii. It shall be possible to remove the turret mounted current transformers from the Tr. Tank without removing the tank cover. Necessary precautions shall be taken to minimize eddy currents and local heat generated in the turret.

iii. Current transformer secondary leads shall be brought out to a weatherproof terminal box near each bushing. These terminals shall be wired out to cooler control cabinet/marshalling box using separate cables for each core.

iv. The technical parameters of Bushing current transformer indicated under Specific Technical Parameters are to be followed One no. Bushing CT (One core, Class: PS) for each phase as well as LV winding and Neutral side shall be provided.

v. No of Bushing CTs required for

vi. HV winding - 3 no

vii. LV winding - 3 no

viii. Neutral winding - 3no

k) Adequate rated bushing CT shall be provided.

1.20.18 Terminal Connector

a) The bushing shall be equipped with suitable terminals for connector as specified herein.

b) Each terminal (including the neutral) shall be distinctly marked on both the primary and secondary side in accordance with the diagram of connection supplied with the transformers.

c) Vertical/horizontal/universal type bi-metallic, rigid connector for bushing stud shall be provided.

d) Clamp and connector shall be made from Cold forged Aluminium Alloy.

e) The Nuts & Bolts associated with equipment of connector pieces shall be MS Hot dip galvanized. Quality of Nuts & bolts shall conform to relevant IS of latest edition.

f) Minimum thickness at any point of current carrying part of any clamp & connector shall not be less than 12mm.

g) From outermost hole edge to nearest edge of any clamp & connector the distance shall not be less than 10mm.

h) Minimum thickness of Bimetal in bimetallic connection shall be 2mm.

1.20.19 Cooling System

Three winding transformer (220//33kV) transformer shall employ ONAN/ONAF type cooling.

1.20.20 Radiators

a) Transformers shall have separate plinth & structure mounted radiator and all transformers shall be fitted with detachable radiator consisting of a series of separate circular/elliptical/rectangular, etc. tubes or fins, welded at their top and bottom into headers which in turn are connected to the tank by means of bolted, oil tight, flanged joints. There shall be indicating butterfly or similar valves fitted in between the tank and the headers, which can be kept in open or closed position. There shall also be filter valves for circulation of oil, at each of top and bottom header. One air release plug at the top header shall be provided.

b) The radiator tubes/fins shall be seamless and made of mild steel/CRCA and in order to prevent rusting epoxy paint of 80 micron shall be applied and minimum wall thickness not less than 1.2 mm, with a clean bright internal surface free from rust and scale. They shall be suitably braced to protect them from mechanical shocks normally met in transportation.

c) A separate blanking plate shall be supplied to permit the blanking of the main oil connection to each cooler unit when the same is detached. Each cooler unit shall have a lifting eye, oil drain valve at the bottom and a vent at the top.

1.20.21 Cooling Fans

a) The radiator stacks shall be provided with A.C.3 Phase Motor driven Fans for Forced Air cooling. The fan motors shall be suitable for continuous operation. Blades shall be suitably painted for outside use.

b) The fans shall operate without any abnormal noise. They shall be fitted with guards of close mesh-wire-netting for safety. The terminal connections and the greasing caps of the fan motors shall be accessible without the need of removing any fan guard.

c) Fan shall be so located so that they are readily accessible for inspection and repair.

d) Cooling fans shall not be directly mounted on radiator bank to avoid undue vibration on the same. These shall be located in such a manner as to prevent ingress of rainwater. The exhaust air flow from cooling fan shall not be directed towards the main tank in any case.

1.20.22 Cooler Groups

The whole cooler plant shall be grouped as indicated below:

For ONAN/ONAF cooling: 2×50% cooling banks consisting of radiators & fans. 1(one) standby fan for each bank shall be provided.

1.20.23 Oil Pumps

a) Each cooler unit shall consist of a totally enclosed, oil immersed motor- pump, and a forced air cool heat exchanger. Motor & pump shall be enclosed in an oil tight container with motor leads brought through hermetically sealed bushings. Moving parts of motor & pump shall be readily removable without dismantling of cooler and with minimum spillage of oil. Pump shall have open type impeller to permit oil circulation when pump is idle. Heat exchangers, fans and oil pumps shall be completely interchangeable.

b) Radiators shall be connected to the tank by machined steel flanges welded to Radiator Bank and to the tank through proper gaskets. At each such connection there shall be provided on the tank an indicating shut off valve which can be fastened in either open or closed position.

c) An oil flow indicator with alarm contacts shall be furnished with each pump assembly to indicate normal pump operation and direction of oil flow. An indication shall be provided in the flow indicator to indicate reverse flow of oil/loss of oil flow.

d) Suitable precautionary arrangement should be provided to arrest mal operation of the main tank Buchholz relay due to starting of the forced oil pumps.

1.20.24 Cooler Control

a) Cooler units shall be suitable for operation with 415 volts, 3 phase, 50 Hz. A.C. power supply Main and standby power supply shall be given for cooler control and source selected through contactor.

b) Cooler control equipment for oil pump and fan motors shall be mounted in a marshalling cabinet adjacent to the transformer and shall include necessary MCB with automatic control and annunciation equipment and switches for remote and local control.

c) Main 415 Volt, 3- phase supply for control of cooler banks shall be taken to cooler control cabinet through a MCB of suitable rating. The supply to cooler fans and oil pumps motors shall be made through individual MCB with overload trip arrangements. The control scheme for the cooler shall be so designed to ensure satisfactory operation of cooler groups as specified in the specification.

d) The switching in or out of the cooling equipment shall be controlled by winding temperature and there shall be provision for automatic switching in or out at predetermined temperature differences which should be capable of adjustment and setting at will. Hunting of the transformer cooling equipment should be avoided.

e) Remote control of cooling equipment and its alarm and indicating devices shall be provided in the RTCC panel. Indication for operation of individual fan group and oil pump shall also be provided in the RTCC panel.

1.20.25 Accessories

Each transformer shall be provided with the following accessories and only type tested accessories shall be supplied. All accessories mounted outdoor shall have contact enclosure tested with IP-55 as per IS: 13947 in order to avoid mal operation during rain or condensation.

1.20.26 Temperature Meters

a) One dial type gas thermometer (having 150 º scale, with accuracy of 1.5% of FSD) of robust design and in weatherproof casing shall be provided for temperature indication of oil of all type power transformers shall be housed in the ground mounted marshalling box to indicate the hot oil temperature. Both alarm and trip contacts shall be provided. Maximum oil temperature indicating pointer shall also be provided. Remote indication of oil temperature shall be provided in RTCC and as such the oil temperature indicator shall be suitable for the same.

b) Indicating type winding temperature indicator: All transformers shall be provided with a device for indicating the combination of top oil temperature and heating by winding current calibrated to follow the hottest spot temperature of the transformer winding. The device shall have a dial type indicator, and in addition an indicating pointer to register the hottest temperature reached. The temperature indicator shall be connected to CT secondary current in one phase of each winding of the transformer.

c) Two separate winding temperature indicators with potential free mercury contacts for control, indication, alarm & trip shall be provided in two winding transformers with independent facility for setting the contacts at any temperature.

d) In addition to WTI & OTI, optical sensors are to be used for hotspot temperature measurement.

1.20.27 Valves

a) Two Nos. oil inlet valves located in suitable locations.

b) One oil drain valve each suitably located at top and bottom.

c) One filter valve suitably located near the top of the tank.

d) One filter valve suitably located near the bottom of the tank.

e) One valve each for oil sampling suitably located at bottom and top.

f) Radiator shut off valve at top and bottom.

g) Buchholz relay and oil surge relay shut-off valves at both ends of the relays.

h) Main Conservator – filter, drain, sample valve, air release valve, air release plug.

i) OLTC Conservator – Oil filling valve, Drain valve, Suction valve.

j) One drain valve for OLTC

k) One oil inlet valve

l) One no. Bleed valve with pet cock for Buchholz relay.

m) Any other valves other than those mentioned above for improvement of operation and maintenance facility if required & pointed during drawing approval stage shall also be within the scope of supply of manufacturer.

1.20.28 Pressure Relief Devices

a) Adequate nos. of pressure relief device with two sets of electrically insulated NO contacts shall be provided for Alarm/Tripping. It shall be of sufficient size to release pressure rapidly that may be generated within the tank to prevent damage to any part of the transformer. It shall operate at a static pressure less than the hydraulic test pressure of the tank. Design shall be such as to prevent ingress of rainwater. It shall be mounted on the cover of main tank and shall be designed to prevent gas accumulation.

b) Gas actuated relay: One double float gas detector relay (Buchholz relay) of reputed make with alarm and tripping contacts to detect accumulation of gas and sudden changes of oil pressures, complete with two shut-off valves and flange coupling to permit easy removal without lowering oil level in the conservator tank. A bleed valve for gas venting and a test valve are to be provided. Pressure relief device & Buchholz relay shall be tested for IP: 55 protections in accordance with IS: 13947 to avoid mal operation due to ingress of moisture.

c) If specifically mentioned in BOQ, Transformer shall be equipped with FIRE FIGHTING SYSTEM as mentioned below:

d) Necessary provision for incorporating fire prevention and extinguishing system by ‘CTR’ make Nitrogen injection drain & stir system -NIDS (also referred as Nitrogen injection fire prevention system -NIFPS) shall be provided. The flanges / gate valves shall be provided with blanking plates.

e) Sufficient quantity of valves, flanges, pipelines shall have to be provided to protect the whole portion of transformer & surroundings from fire hazard. Details of location & size of the flanges, valves, dummy pipe and other pipelines for incorporating the NIDS / NIFPS later at site shall be finalized during detailed engineering. The exact details including size of additional outlet / inlet pipes, valve with flange and other features like provision of non-return valve in conservator, spare ‘NO’ contact in PRV etc., for the fire protection system shall be having to be considered.

1.20.29 Grounding Terminals

Two grounding terminals capable of carrying for 3 (three) seconds the full short circuit current of the transformer shall be provided at positions close to the bottom at two corners of the tank for bolting the earthing terminals to the tank structure to suit local condition.

Neutral Earthing Arrangement: The neutral terminal of autotransformer & two winding transformer shall be brought to the ground level by adequate sized brass/tinned copper grounding bar (considering the system fault level as stated in STP) supported from the tank by using porcelain insulators. The end of the tinned copper bar shall be brought to the bottom of the tank at the convenient point for making bolted connection to two nos. galvanized steel grounding flat connected to sub-station grounding mat.

1.20.30 Rating, Diagram and Property Plates

The following plates shall be fixed to the transformer tank at an average height readable from the transformer base level.

a) A rating plate bearing the data specified in the appropriate clauses of IS: 2026

b) A diagram plate showing the internal connections and also the voltage vector relationship of the several windings in accordance with the IS and in addition, a plan view of the transformer giving the correct physical location of the terminals. No load voltage shall be indicated in each tap. The winding temperature C.T. and the thermometer pocket shall also be indicated in the said plate.

c) A plate showing the location and function of all valves and air release plugs and plate material preferably in stainless steel.

d) An indoor cubicle for remote control of coolers, position of tap, alarm and indicating devices with the help of control equipment’s, annunciation, relays, indicating instrument, etc.

e) A separate rating plate embossing different losses obtained after relevant test for each transformer is to be provided.

f) A rating plate for each type of bushing shall be provided and to be fixed at the base of the bushing.

1.20.31 Ground Mounted Marshalling Box

a) A suitable weatherproof cubicle for housing the control, equipment, terminal block etc., made of 3 mm sheet steel, shall be provided for each transformer. The box shall accommodate all (i) winding and oil temperature indicators and (ii) control and protection equipment for cooling plant.

b) All terminal blocks for cable connection shall be located in this box. Terminal blocks shall be of 1100 Volt grade “Elmex/Connect well” make and have continuous rating to carry the maximum expected current on the terminals. The terminal block shall be fully enclosed with removable covers of transparent, non-deteriorating type plastic material. Insulating barrier shall be provided between the terminals. The terminal blocks shall have locked arrangement to prevent its escape from the rails. 20% spare terminals are to be provided. These spare terminal blocks shall be uniformly distributed on all the terminal block column. All terminal blocks shall be numbered for easy identification. Terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal blocks.

c) The marshalling box shall be provided with LED based UL approved cubicle lamp with 1200 lumens having electrical life of minimum 60000 hrs with built-in PIR Sensor (without door switch), DIN Rail Mountable PTC based, and UL approved encapsulated space heater with differential hygro-thermostat and removable cable gland plate etc. Cable shall enter from the bottom of the box.

d) Marshalling box of each type shall be tested for IP-55 in accordance with IS:13947. The provision of Louvre if any should also be with EN779 grade filter and UL Approved IP55 Housing

e) All internal wiring shall be carried out with 1100 Volt grade PVC insulated stranded copper conductor of 2.5 sq. mm or larger size as per scheme requirement.

1.20.32 Wiring

a) All control, alarm and indicating devices provided with the transformer shall be wired up to the terminal blocks in the marshalling box.

b) Wiring from transformer to the cubicle shall be done with PVC wires in conduit or by PVC armoured cable of 1100 V grade. Minimum wire size shall be 2.5mm^2 copper. Not more than two wires shall be connected to a terminal. 20% spare terminals shall be provided.

c) All devices and terminal blocks within the marshalling box shall be identified by marking corresponding to the circuit in schematic or wiring diagram. All fuses shall be of cartridge type and IS marked.

d) Phase marking on each terminal bushing (including neutral) shall be distinctly made on both the primary, secondary, and tertiary winding side in accordance with the connection diagram of the transformer.

e) Interconnection of wires in between transformer and marshalling box will be in the scope of the contractor.

1.20.33 Centre of Gravity

The centre of gravity of the assembled transformer shall be low and as near the vertical centre line as possible. The transformer shall be stable with or without oil. Location of Centre of Gravity shall be shown on the outline general arrangement drawing.

1.20.34 Cleaning and Painting

a) Before painting or filling with oil, all non-galvanised parts shall be completely clean and free from rust, scale and grease and all external rough surfaces on castings, shall be made smooth. The interior of all transformer tanks and other oil filled chambers and internal structural steel work shall be cleaned of all scale and rust by sand blasting or other approved method. These surfaces shall be painted with an oil resisting varnish or paint.

b) Except for nuts, bolts, and washers, which may have to be removed for maintenance purposes, all external surfaces shall receive a minimum of three coats of paint. The primary coat shall be applied immediately after cleaning. The second coat shall be of oil paint of weather resisting nature and of a shade or colour easily distinguishable from the primary, and the final coats shall be applied after the primary coat has been touched up where necessary. The final coat shall be of a glossy, oil and weather resisting non-fading paint of battleship grey colour.

c) All interior surfaces of mechanism chamber and kiosks except those which have received anti- corrosion treatment shall receive three coats of paints applied to the thoroughly cleaned metal surface. The final coat shall be of light-coloured anti-condensation paint.

1.20.35 Packing & Transportation Limitations

a) Power Transformer is to be transported in an atmosphere of nitrogen or dry air at positive pressure.

b) Necessary arrangement shall be ensured by the manufacturer to take care of pressure drop of nitrogen or dry air during transit and storage till completion of oil filling during erection. The nitrogen or dry air cylinder provided to maintain positive pressure can be taken back by the contractor after oil filling. A gas pressure testing valve with necessary pressure gauge and adaptor valve shall be provided.

c) The Transformer during transportation shall also be fitted with at least one electronic impact recorders (on returnable basis) to measure the movement due to impact in all three directions. The acceptance criteria and limits of impact in all three directions which can be withstood by the equipment during transportation and handling shall be submitted by the manufacturer before delivery. The recording shall commence in the factory before dispatch and must continue till the unit is installed on its foundation. The data of electronic impact recorder(s) shall be downloaded at site and a soft copy of it shall be handed over to Engineer-in-charge. Further, within three weeks from the placement of the Transformer on the foundation, manufacturer shall communicate the interpretation of the data.

d) The transformer Main Tank with Core-coil assembly shall be shipped/ transported filled with inert gas due to transport weight regulation. If the transformer is equipped with inert gas pressure system, then a low-pressure alarm device is to be provided. The alarm device shall be required for extended storage at site.

e) Special attention shall be paid in packing the accessories & spares to avoid moisture ingress. All parts shall be adequately marked to facilitate field erection. Boxes and crates shall be marked with the contract number and shall have a packing list enclosed showing the parts contained therein.

f) The Bushings shall be crated & packed and transported as per standard guideline of the Bushing Manufacturer. All care should be taken to avoid any damage of the porcelain due to vibration during transport.

g) The weights & dimensions of the packages to be transported to site shall be governed by facilities available for the routes by road/rail/ship.

1.20.36 Labels

a) Labels shall be provided for all apparatus such as relays, switches, fuses contained in any cubicle or marshalling kiosk.

b) Descriptive labels for mounting indoor or inside cubicles and kiosks shall be of material that will ensure permanence of the lettering. A mat or stain finish shall be provided to avoid dazzle from reflected light. Labels mounted on dark surfaces shall have white lettering on a black background Danger notice shall have red lettering on a white background. All plates shall be of material which will not be corroded. Labelling shall be clear, concise, and adequate.

c) Labels for mounting outdoors shall be weather and corrosion proof formed by etching to ensure permanence.

d) Labels shall be attached to panels with brass screws or with steel screws which have received rust preventive treatment.

e) Labels should have lettering sizes of at least 1 to 1.5mm stroke width and 3 to 6mm height.

1.20.37 Contract Drawings and Manuals

After placement of P.O. following drawings, manuals and literatures shall be submitted for approval:

a) Drawing for Controls:

i. Schematic diagram of transformer cooler control

ii. Schematic diagram and location of WTI and OTI.

iii. General arrangement of ground mounted Marshalling Box for all type of transformer.

iv. Schematic diagram of manual and push button control of on load tap changer.

v. Abbreviation table for OLTC and RTCC.

vi. Explanatory note for RTCC

vii. General Arrangement & scheme drawing for RTCC.

viii. Explanatory note for transformer cooler

ix. Wiring diagram of ground mounted Marshalling Box for each type of Transformer.

x. Wiring diagram of RTCC panel.

xi. Drawings other than there mentioned above if required as per provision of Technical Specification for Erection & Maintenance are also to be submitted.

b) Drawings of Transformer:

i. General outline drawing showing front, side elevation, plan of the transformer and accessories with detailed dimensions and detailed legend.

ii. Detailed foundation plan.

iii. Drawing of each type of bushings, lifting dimensions, clearance between Terminals of different voltage level and ground, quantity of insulation oil, name plate, details etc.

iv. Operation and maintenance guide for transformer and ON LOAD TAP CHANGER.

v. Transport Outline Drawing

vi. Valve Schedule Plate

vii. Measured Loss Plate

viii. Clamp & connectors.

ix. Rating Plate diagram

x. Oil filling instruction plate.

xi. Roller locking arrangement.

xii. Foundation Plan drawing.

xiii. Drawings other than those- mentioned above if required as per provision of Technical Specification for Erection & Maintenance is also to be submitted.

xiv. Operation, maintenance, and erection manuals contain the drawings and information required for erection, operation and maintenance of the power transformer.

1.20.38 Tender Drawing, Literature, and type Test Certificates

a) One copy of each drawings incorporating the following particulars along with one set of complete type test report on similar transformer carried out as per IS & IEC in Govt.

b) Recognized Test House or Laboratory/NABL accredited Laboratory shall be submitted by each bidder with each copy the bid to the Purchaser for the purpose of evaluation of bid as follows:

c) General outline drawing showing dimensions, net weights of transformers, tap changing gear, marshalling box and their shipping weights.

d) Sectional views showing the general construction features and disposition of various fittings and accessories.

e) Bushing drawing showing full details of construction of HV/LV condenser bushing and other technical data, weight of bushing assembly etc.

f) Dimension of the largest part to be shipped and the position in which these are to be transported.

g) Technical literature on tap changing control, cooling system, relays meters and general construction feature for winding temperature indicators, Buchholz relays, oil temperature indicator, Oil pumps, pressure release device (where required) etc.

h) Transformer similar to offered one should have type tested as per relevant IS.

1.20.39 Transformer Losses, Evaluation of Bid & Acceptance

a) The bidder must clearly specify that the offered losses are "Maximum"(including IS/IEC tolerance) and no further positive tolerance as per IS/IEC shall be applicable on the offered values during evaluation as well as during testing of transformer.

b) Loss Capitalization shall be done with the accepted bids with loss values within specified limit. For the purpose of evaluation of bids, the capitalized cost of iron loss, load loss and auxiliary loss (KW) shall be added to the quoted price of the transformer at the following rates:

i. Capitalized value of No-Load loss per KW : Rs. 4,53,000/-

ii. Capitalized value of load loss per KW : Rs. 1,85,500/-

iii. Capitalized value of Auxiliary loss per KW : Rs. 1,81,000/-

c) However, once a bidder becomes successful on the basis of loss capitalization with certain declared loss value, they have to strictly achieve the same loss value during the course of testing of transformers, offered for supply. No tolerance as per IS/IEC will be applicable.

1.20.40 Stage Inspection

Stage inspection will be carried out by the customer on Core, Coil & Tank during the manufacturing stages of the transformer. The manufacturer will have to call for the stage inspection and shall arrange the inspection at manufacturer's premises or manufacturer's bidder's premises free of cost. Stage inspection of core and coil will be carried out on 1 (one) number Transformer against each Purchase order or a particular design. On the basis of satisfactory Stage Inspection, manufacturer will proceed further. The following stage inspection shall be carried in one inspection.

Prior to stage inspection following documents shall have to be submitted by manufacturer for verification:

a) Document related to prime core, procurement establishing traceability vide relevant Cl. of Technical Specification of Power Transformer.

b) Documents for coil establishing traceability.

Following tests have to be carried out in stage inspection.

c) On Core

i. Flux density checking of assembled core (without having any insulating tape etc. rapped around the core) vis-à-vis measurement of step thickness, lamination width etc.

ii. Window height, leg centre dimension, core diameter of assembled core.

iii. Physical verification of core in respect of lamination thickness, bend, camber, and waviness etc.

iv. Carlite test, Watt loss and ageing test on the sample of prime core. (Core sample shall be selected during stage inspection and sent to any NABL accredited laboratory for tests under Sl.No. 4)

v. Loss measurement of Prime core (Loss/Kg).

vi. 2KV test between core and Yoke clamps.

d) On Coil

i. Physical verification of HV, LV wound coil.

ii. Measurement of resistance of each finished coil (HV & LV).

iii. Measurement and current density calculation of each winding.

iv. Copper purity test (after cutting from finished coil offered for inspection).

Calibration Certificates of all measuring instrument to be used during stage and final inspection shall be produced on tank.

e) Physical inspection & Dimension Checking of Main Tank

f) Vacuum Withstand Test on the Main Tank.

g) Pressure Withstand Test on the Main Tank.

h) Leakage Test of the main Tank.

1.20.41 Test at Factory and Test Certificates

All Routine and Acceptance tests at manufacturer's works shall be carried out in presence of MSETCL/MSEDCL/MITL representative in compliance with IS: 2026/ IEC 60076 (as amended up to date) on the transformers. The entire cost of acceptance test, routine test and special test as follows that are to be carried out as per relevant SHALL be treated as included in quoted price of transformer. The Contractor shall offer the transformer for final testing with at least 15 (fifteen) days prior to the actual date when the tests will be carried out.

The following tests are to be carried out as a part of routine tests as per IS:2026 / IEC 60076 and as per our standard requirement:

a) Resistance of each winding at all taps (wherever applicable).

b) Turns ratios for all sets of windings on each tap.

c) Polarity and phase vector relationship

d) Measurement of No-Load Loss and No-Load Current at 90, 100 and 110 percent rated voltage.

e) Impedance voltage at normal, maximum, and minimum tap for each pair of winding.

f) Measurement of insulation resistance between windings and between windings and earth. IR value is to be measured before and after impulse test.

g) Measurement of aux. losses.

h) Regulation at rated load and at unity, 0.8 lagging power factors

i) Efficiencies at u.p.f. and 0.8 p.f. at 50%, 75% and 100% loading.

j) Measurement of Load Losses.

k) Separate source voltage withstand test.

l) Induced over voltage withstand test with Partial Discharge measurement.

m) Tests on on-load Tap changer.

n) Magnetic Balance test.

o) Oil leakage test on tanks and all oil filled compartment of transformer shall be tested as per CBIP for 12 hours (minimum) filled with oil for which no oil leak shall occur.

p) Test on pressure relief device.

q) Operation of Tap changer from RTCC as well as from OLTC

r) Test on RTCC, Cooler Control Cabinet and Marshalling Box.

s) Measurement of Tan Delta Capacitance of Windings and Bushings.

t) Zero Sequence Impedance measurement.

u) Frequency Response Analysis (FRA) in factory and field (sub-station) for all voltage classes & rating for all transformers.

v) Switching Impulse test

w) Full wave Lightning Impulse test as per IS/IEC

x) BDV measurement of transformer oil.

y) DGA of Transformer oil after type test

z) Functional test of Fiber Optic sensor types hot spot measurement system

aa) Visual, dimensional checking of transformer.

The following Type tests are to be carried out for at least on one of each type of transformer against each purchase order without any price implication:

bb) Temperature rise test (cl.no.16.8 of IS 2026)

cc) Full wave Lightning Impulse withstand Tests in all phases.

dd) Checking of acoustics noise level.

ee) Pressure & vacuum test on finished empty tank during stage inspection.

1.20.42 Test at Factory and Test Certificate

All Routine and Acceptance test at manufacturer's works shall be carried out in presence of MITL//MSETCL/MSEDCL and manufacturer's representative in compliance with IS:2026/ IEC 60076 (as amended up to date) on the transformer.

1.20.43 Test on Associated Equipment

Porcelain Bushings, Windings Temperature Indicating Devices. Dial Thermometers, Buchholz Relays, Auxiliary Meters, Motor Starting Contactors, Control devices, insulating oil and other associated equipment covered by the contract shall be certified by the contractor to have been tested in accordance with the relevant IS specification by the manufacturer. The contractor shall furnish a certificate of compliance of the relevant tests, for all auxiliary apparatus. Six certified copies of the aforesaid test reports shall have to be furnished.

1.20.44 Supervision of Erection, Testing & Commissioning

The MANUFACTURER shall arrange for the services of their Supervisor/Engineer from the manufacturer during erection, testing and commissioning of the equipment at sites at free of cost.

1.20.45 Specific Technical Parameters for 100MVA, 220KV/33kV Transformers

S.No.	Description	Items	Technical Parameters
	Rated Capacity	100MVA	3-ph Three winding transformer
	Voltage Rating:	For all rating	220kV//33kV
	Maximum system voltage (KV)	220 kV/ /33kV	245kV//36kV
	Cooling	For all rating	ONAN/ONAF
	Type of Transformer	For all rating	Outdoor Type Interconnection Power Transformer
	System frequency (Hz)	For all rating	50 ± 3%
	No. of phases in system	For all rating	3
	System Earthing	For all rating	Effectively earthed, Neutral is Solidly earthed.
	Insulation level of the winding (withstand)		
	i) 1.2x50 Micro-second lightning impulse (KVP)	220///33	950/650/170
	iii) Power frequency withstand (KVrms)	220//33	395/235/75
	System fault level (KA).	220 KV	50 KA FOR 1 SEC
		33KV	33 KA FOR 1 SEC
	Partial Discharge level		500 Pc.
	Maximum hot spot temperature (o Centigrade) over weighted average temp of 32 Degree C		98° Centigrade
	Type of tap changer	i) For all rating	On Load Type
		ii) Tapping range	+ /- 15% in steps @ 1.25%
	Partial Discharge level	For 220kV	500 Pc.
	Vector group	100MVA	YNd1
	Short circuit level (KA)	220kV	40
		/ 33kV	31.5
	Minimum creepage Distance (mm) of bushing	220 KV	6125
		/33kV	/1215
	Type of insulating media	For All Rating	Mineral insulating oil immersed.
	Indoor or outdoor type	For All Rating	Outdoor
	Auxiliary AC supply to Fans, tap changer etc. (volt)	For All Rating	3-ph, 415 ±10%
	Auxiliary DC supply for alarm and tripping (volt)	For All Rating	110V ±10%
	Altitude above mean sea level	For All Rating	Less than 1000 mtr.
	Terminal Connectors	220kV & 33kV	For ACSR Moose / ACSR Moose. For ACSR Moose/Moose or suitable Cable

S.No.	Description	Items	Technical Parameters
	Acoustic noise level (DB) of all transformers	For All Rating	As per NEMA Publication TR- 1.
	Insulating level of bushing: 1.2/50 micro second lightning impulse withstand voltage (KVP)	220 KV	1050
		33KV	170
	Insulating level of bushing: One minute Power frequency withstand voltage (KVrms)(dry & wet).	220 KV	460
		33KV	78
	Minimum Total Creepage distance (mm) for Bushing	220 KV	6125
		33kV	1215

1.21 Technical Specification For 33kV/11kV, ONAN Type Transformer

These specifications are intended to cover design, manufacture, testing / inspection before dispatch, packing, and transportation to site, erection supervision, testing and commissioning of 33/11kV Step-down outdoor type ONAN transformers complete with all accessories / fittings and spare parts as specified herein.

1.21.1 Specific Technical Requirements (Standard Conditions)

Rated MVA	:	As per calculation
Number Required	:	As per calculation
Number of phases	:	Three
Type of Installation	:	Outdoor
Frequency	:	50Hz
Cooling medium	:	Insulating oil
Rated Voltage		
Primary Winding	:	33kV (Delta)
Secondary winding	:	11kV (Star)
Highest continuous system Voltage		
Primary	:	36 kV
Secondary	:	12 kV
Method of System earthing		
Primary	:	Unearthed
Secondary	:	Solidly grounded
Tap Changer Type	:	ON LOAD TAP CHANGER
Range of tapping	:	+10% to -10% in sixteen equal steps of 1.25%
Neutral terminal to be brought out	:	On LV side only
Impedance on rated MVA at 75°C	:	As per Indian Standard
Type of Insulation & Insulation level	:	33kV 11kV
Type of insulation	:	Uniform Uniform
One minute power frequency		
Withstand test voltage (kV-RMS)	:	70 28
Impulse withstands test voltage		
(kvp)	:	170 75
Winding connection	:	Delta(HV) Star(LV)

Material	:	Copper
Vector Group	:	Dyn-11
Type of cooling	:	ONAN
Neutral Earthing easily	:	LV neutral shall be solidly earthed through an accessible neutral Current Transformer
Terminal details	:	
33 kV & 11 kV Termination	:	Cable box with disconnecting chamber for Indoor switchgear with cable glands. Suitable to receive Al. Armoured XLPE cable.
Temperature rise of the windings	:	55°C
Neutral current Transformer	:	One No.
CT shall be provided in the neutral circuit of LV side of the transformer. The CT secondary shall be wired out to the Transformer marshalling box. This is for REF & SBEF protection.		

1.21.2 Maximum Temperature Rise for various types of cooling

Maximum design ambient temp.	:	50°C
Maximum ambient temp.	:	40°C
Temperature rise of top oil. (measured by Thermometer)	:	50°C
Temperature rise of winding. (measured by resistance)	:	55°C
Overload capacity	:	As per IS: 6600
Noise level at rated voltage & frequency	:	As per NEMA Pub TR-1

1.21.3 Marshalling Box

One sheet steel, (2mm size) weatherproof marshalling box of suitable construction shall be provided Degree of Protection IP-55. Other requirements as per details provided in General Technical Particulars of this section.

1.21.4 Capitalization of Looses and Damages

The capitalization of guaranteed losses of the transformer shall be calculated and considered while evaluating the bids. The guaranteed values of no-load losses and load losses shall be started in the bid. Liquidated damages will be applied to successful bidder for not achieving the quoted guaranteed figures.

1.21.5 Performance

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

b) The maximum flux density in any part of the core and yoke at normal voltage and Frequency shall be such that the flux density under 10% over voltage condition shall not exceed 1.76 Tesla. With limiting value as (vi) below:

c) 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.

d) The transformer may be operated continuously without danger of any particular tapping at the rated MVA plus minus 10% of the voltage corresponding to the tapping.

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

f) With combined voltage and frequency variation of +10%, the flux density shall not exceed 1.9 Tetsla.

1.21.6 Auxiliary Power Supplies

The following power supplies shall be available at site:

a) AC, 3 phase 415 volts 50 Hz. Earthed

b) AC, 1 phase 240 volts 50 Hz. Earthed

c) 110 volts DC ungrounded

1.21.7 Drawing incorporating the following particulars shall be submitted with the bid.

a) 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.

b) Height of centre line of HV and LV connectors of transformers from the rail top or foundation level.

c) Dimensions of the largest part to be transported.

d) GA drawings / details of various types of bushing.

e) Type test certificates of similar transformers.

f) Illustrative & descriptive literature of the Transformer.

g) Maintenance and Operating Instructions.

1.21.8 Miscellaneous

Padlocks along with duplicate keys as asked for various valves, marshalling box etc., shall be provided by the supplier / contractor, wherever applicable.

Foundation bolts for wheel locking devices of Transformer shall be supplied by the supplier / contractor.

1.21.9 Delivery

The equipment shall be delivered, erected, and commissioned at site by supplier / contractor in presence of Client’s electrical site engineer.

1.21.10 Conflict in Clause

In case of any conflict between the Specific Technical Requirements and General Technical Requirements, the requirements indicated as Specific Technical Requirement shall prevail over the General Technical Requirements.

1.21.11 Services and Equipment

a) The following is also in the contractor’s scope of work for executions.

b) Design of soak pit, cable trenches and foundations for transformers and other ground mounted equipment.

c) Construction of soak pit, cable trenches and foundations for transformers and other ground mounted equipment.

1.21.12 Name Plate

Transformer rating plate shall contain the information as given in clause 15 of IS-2026 (Part-I). It is proposed to have some information besides English in local language (Hindi language) also, shall be provided to the manufacturer by the purchaser. The details on rating plate shall be finalised during the detailed engineering.

1.22 General Technical Requirements

1.22.1 Codes and Standards

The design, material, fabrication, manufacture, inspection, testing before dispatch, erection testing, commissioning, 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 constructed to relieve the supplier / contractor of this responsibility.

Transformers shall conform to the current applicable standards and codes of practice as specified.

1.22.2 Standards / Codes

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

Table 1-19: Codes & Standards

Standard	Description
IS:2026 (Part I to IV)	Power Transformer
IS:6600/BS:CP”1010	Guide for loading of oil immersed transformers
IS:335	New insulating oil for transformers, Switchgears
IS:3639	Fittings and accessories for power Transformers
IS:2099	High voltage porcelain bushings
IS:2705	Current Transformers
IS:3347	Dimensions for porcelain Transformer Bushings
IS:3202	Code of practice for climate proofing of electrical equipment.
IS:2147	Degree of protection
IS:2071	Method of high voltage testing
IS:3637	Gas operated relays
IS:1271	Classification of insulating materials for electrical machinery and apparatus in relation to their stability in services.
IS:5	Colour for ready mixed paints

IS:10028	Code or practice for selection, installation and maintenance of transformers, Part I, II and III
IS:5561	Electric Power Connectors
C.B.I.P. Publication	Manual on Transformers

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

1.22.3 Drawings

The supplier / contractor shall furnish, within fifteen days after issuing of Letter of Award, six hard copies along with soft copies for each of the following drawings/documents incorporating name of project and 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 unthanking, size of lugs and eyes, bushing lifting dimensions, clearances between HV and LV terminals and ground, quantity of insulating oil etc.

b) Foundation plan showing loading on each when and jacking points with respect to centre line of transformer.

c) Illustrative & descriptive literature of the Transformer

d) Maintenance and Operating Instructions

e) Height of centre line of HV and LV connectors of transformers from the rail top level

f) Painting procedure.

g) Complete CT details including VA, class, ALF, resistance, magnetization characteristic curves, dimensions fixing arrangement etc. of neutral and phase side current transformers (as applicable).

h) Specification of the insulating oil.

i) GA drawings / details of bushing and terminal connectors.

j) Name plate drawing with terminal marking and connection diagrams.

k) Wheel locking arrangement drawing.

l) Transportation dimensions drawings.

m) Magnetization characteristics curves of PS class neutral and phase side current transformers, if applicable.

n) Interconnection diagrams.

o) Over fluxing withstand time characteristics of transformer.

p) GA drawing of marshalling box.

q) Control scheme / wiring diagram of marshalling box.

r) Technical leaflets of major components and fittings.

s) As built drawings of schematics, wiring diagram etc.

t) Setting of oil temperature indicator, winding temperature indicator.

u) Completed technical data sheets.

v) Details including write-up of tap changing gear.

w) H.V. cond. bushing.

x) Bushing Assembly.

y) GA of HV & LV cable Box.

z) Radiator type Assembly.

aa) Detailed wiring/schematic drawings for ONAF operation of the transformer.

bb) Motor Drive (circuit diagram plus parts list etc.)

cc) Earthing and Insulation of Core

dd) Locking Facilities and Accessories for Valves

ee) Construction of Globe Valves and Gate Valves

ff) Factory Test Procedure and Test Schedules for Factory Tests

gg) Commissioning Test Procedure and Report

hh) Operation and Maintenance Manual including Test Reports

ii) Outline of Radiator

jj) Outline of Fan Unit

kk) Mechanical Protection of Auxiliary Wiring and Capillaries

All drawings/documents, technical data sheets and test certificates / results / calculations shall be furnished.

1.22.4 Drawing Approval

Any approval given to the drawings or documents by the purchaser shall be of general nature and this would not relieve the supplier / contractor of its responsibility for completeness of equipment, correctness of the drawings, dimensions, sizes, fittings, designs, supply of proven standard quality of bought out items and in the manufacture of the equipment. If any defect is noticed subsequent to the inspection, clearance of despatch, receipt, or operation of transformer, it shall be at the risk and responsibility of manufacturer/ supplier to remove the deficiency/ replace the faulty equipment without any financial liability to purchaser under any circumstances and in any form.

1.22.5 General Constructional Features

a) All material used shall be of best quality and of the class most suitable for working under the conditions specified and shall withstand 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.

b) Similar parts, particularly removable ones, shall be interchangeable.

c) 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 galvanised.

d) Nuts, bolts and pins used inside the transformers and tap changer compartments shall be provided with lock washers or locknuts.

e) Exposed parts shall not have pockets where water can collect.

f) Internal design of transformer shall ensure that air is not trapped in any location.

g) 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 galvanised or cadmium plated.

h) 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.

i) All internal connections and fastenings shall be capable of operating under overloads and over-excitation, allowed as per specified standards without injury.

j) Transformer and accessories shall be designed to facilitate proper operation, inspection, maintenance, and repairs.

k) No patching, plugging, shimming or other such means of overcoming defects, discrepancies or errors will be accepted.

l) Schematic Drawings of the wiring, including external cables shall be put under the prospane sheet on the inside door of the transformer marshalling box.

1.22.6 Painting

a) The interior of all transformer tanks and other oil filled chambers and internal structural steel work shall be cleaned (seven tank process) of all scale and rust by shot blasting. These surfaces shall be painted with not less than two coats of heat resistant, oil insoluble and insulating varnish. Steel surfaces exposed to the weather shall be thoroughly cleaned and have a priming xcbvncoat of zinc chromate applied. The second coat shall be of a glossy oil and weather resisting nonfading, paint of shade No. 631 as per IS:5.

b) Metal parts not accessible for painting shall be made of corrosion resistant material.

c) Interior surfaces of mechanism chambers and marshalling kiosks shall receive three coats of paint after proper cleaning. The final coat shall be of a light-coloured anti-corrosion paint.

d) All paints shall be carefully selected to withstand heat, rain, and extremes of weather. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling.

e) In case finish paint chips off or crinkle during transit or installation, the supplier / contractor shall arrange for repainting transformer at site at his cost. The paint for repainting shall be supplied by the supplier / contractor.

f) The following treatments shall be applied on External surfaces.

i. All steel surfaces shall be sand blasted in accordance with DIN 55928 Part 4 (equivalent to SIS 055900), and shall then be painted in the following sequence:

ii. One (1) primer coat 60 µm

iii. Two-component epoxy zinc-phosphate

iv. One (1) intermediate coat 60 µm

v. Two-component epoxy micaceous iron oxide

vi. One (1) topcoat 40 µm

vii. Two-component polyurethane

viii. Total coating thickness (dry-film incl. tolerances) min. 160 µm

g) The final coat of painting shall be of pore-free and homogeneous quality and shall be of uniform shade of colour.

h) Power Transformer rating 10MVA and above shall be provided with Nitrogen Injection Fire Protection System (NIFP).

1.23 Detailed Description

1.23.1 Tank:

a) The Transformer tank and cover shall be fabricated from high grade low carbon plate steel of tested quality. The tank and the cover shall be of welded construction.

b) Tank shall be designed to permit lifting by crane or jacks of the complete transformer assembly filled with oil. Suitable lugs and bosses shall be provided for this purpose.

c) All beams, flanges, lifting lugs, braces and permanent parts attached to the tank, shall be welded and where practicable, they shall be double welded.

d) The main tank body of the transformer, excluding tap changing compartments and radiators, shall be capable of withstanding pressure of 760 mm of Hg.

e) 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. The weight of cover shall be easily lifted by a single person, whenever required.

f) All bolted connections to the tank shall be fitted with suitable oil-tight gaskets which shall give satisfactory service under the operating conditions. Special attention shall be given to the methods of making the hot oil-tight joints between the tank and the cover as also between the tank cover and the bushings and all outlets to ensure that the joint can be remade satisfactorily and with ease, with the help of semi-skilled labour. Where compressible gaskets are used, steps shall be provided to prevent over-compression.

g) Suitable guides shall be provided for positioning the various parts during assembly or dismantling. Adequate space shall be provided between the cores and windings and the bottom of the tank for collection of any sediment.

h) The completely assembled tank shall be fully vacuum proof.

1.23.2 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 so that it does not retain rainwater. Neoprene/cork/hemp type gaskets are not acceptable.

1.23.3 Under Carriage

a) The transformer tank shall be supported on steel structure with detachable forged steel flanged wheels suitable for moving the transformer completely filled with oil. Rail gauge shall be 1676 mm in both directions. Flanged wheels shall be spaced accordingly. Wheels shall be provided with suitable bearings which will resist rust and corrosion and shall be equipped with 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 transformer.

b) Jacking pads shall be provided on the transformer. It shall be possible to change the direction of the wheels through 90 degrees when the transformer is lifted on jacks to permit movement of the transformer both in longitudinal and transverse directions.

c) Suitable hydraulic jacks (4 nos.) for lifting the transformer shall be supplied by the supplier / contractor, for each rating.

1.23.4 Core

a) The magnetic circuit shall be constructed from high grade cold rolled non-ageing grain-oriented silicon steel lamination with low loss, such as of W17/50; max 1.05W/Kg.

b) The laminations shall be free of all burns and sharp projections. Each sheet shall have an insulating coating resistant to the action of hot oil.

c) The insulation structure for the core to bolts and core to clamp plates shall be such as to withstand a voltage of 2000 V for one minute.

d) The completed core and coil shall be so assembled that the axis and the plane of the outer surface of the core stack shall not deviate from the vertical plane by more than 25 mm.

e) All steel sections used for supporting the core shall be thoroughly shot or sand blasted, after cutting, drilling, and welding.

f) The finally assembled core with all the clamping structures shall be free from deformation and shall not vibrate during operation.

g) The core clamping structure shall be designed to minimise eddy current loss.

h) The framework and clamping arrangements shall be securely earthed.

i) The core shall be carefully assembled and rigidly clamped to ensure adequate mechanical strength.

j) Oil ducts shall be provided where necessary to ensure adequate cooling. The welding structure and major insulation shall not obstruct the free flow of oil through such ducts.

k) The design of magnetic circuit shall be such as to avoid static discharge, development of short circuit paths within itself or to the earthed clamping structure and production of flux component at right angle to the plane of the lamination which may cause local heating. The supporting framework 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.

l) The construction is to be of '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 transport or short circuits.

m) The earthing of core shall be done at the top of the cover, with removable link so as to test the same.

1.23.5 Internal Earthing

a) All internal metal parts of the transformer, with the exception of individual laminations, core bolts and their individual clamping plates shall be earthed.

b) 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:

c) By connection through vertical tie-rods to the top structure.

d) By direct metal to metal contact with the tank base.

e) By a connection to the top structure on the same side of the core as the main earth connection to the tank.

f) 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 dis-connecting link shall be provided on transformer tank to facilitate disconnections from ground for IR measurement purpose.

g) 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.

1.23.6 Winding

a) 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.

b) All low voltage windings for use in the circular coil concentric winding shall be would on a performed insulating cylinder for mechanical protection of the winding in handling and placing around the core.

c) 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.

d) 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 the otherwise affected under the operating conditions.

e) Varnish application on coil windings may be given only for mechanical protection and hot for improvement in dielectric properties. In no case varnish or other adhesive, be used which will seal coil and prevent evacuation of air and moisture and impregnation by oil.

f) Winding and connections shall be braced to withstand shocks during transport or short circuit.

g) Permanent current carrying joints in the windings and leads shall be welded or brazed. Clamping bolts for current carrying parts inside oil shall be made of oil-resistant material which shall not be affected by acidity in the oil. Steel bolts, if used, shall be suitably treated.

h) Terminals of all windings shall be brought out of the tank through bushings for external connections.

i) The completed core and coil assembly shall be dried in vacuum at not more than 0.5mm 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.

j) The winding shall be so designed that all coil assemblies 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.

k) 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.

l) Adequate barriers shall be provided between coils and core and between high and low voltage coil. End turns shall have additional protection against abnormal line disturbances.

m) 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.

n) Tapping’s 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 the transformer at all voltage ratios.

o) Magnitude of impulse surges transferred from HV to LV windings by induction and capacitance coupling shall be limited to B.I.L. of LV winding.

1.23.7 Insulating Oil

a) The insulating oil for the transformers shall be of LHV / MHV grade, generally conforming to IS:335.

b) 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 first filling of oil plus 10% extra. However, the rate of transformer oil in Rupee per litre shall be quoted separately also. The transformer oil shall be supplied in non-returnable containers / drums.

c) The design and materials used in the construction of the transformer shall be such as to reduce the risk of the development of acidity in the oil.

d) The gaskets of PU Foam or similar type such as cork, which can be damaged by over-pressing or not acceptable.

1.23.8 Valves

a) Valves shall be of forged carbon steel up to 50 mm size and of gun metal or of cast iron bodies with gun metal fittings for sizes above 50 mm. 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.

b) Each valve shall be provided with an indicator to show the open and closed positions and shall be provided with facility for padlocking in either open or closed position. All screwed valves shall be furnished with pipe plugs for protection. Padlocks with duplicate keys shall be supplied along with the valves.

c) 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 supplier / contractor shall supply the same.

d) Each transformer shall be provided with following valves on the tank:

i. Drain valves so located as to completely drain the tank.

ii. Two filter valves on diagonally opposite corners, of 50 mm size.

iii. Oil sampling valves not less than 8 mm at top and bottom of main tank.

iv. One 15 mm air release plug.

v. Valves between radiators and tank.

vi. Drain and filter valves shall be suitable for applying vacuum as specified in the specifications.

1.23.9 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 means for sampling and draining the liquid. The angle of inclination to vertical shall not exceed 30 degrees.

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 galvanised.

h) Bushing shall be so located on the transformers that full flashover strength will be utilised. Minimum clearances as required for the BIL shall be realised 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 bimetallic / terminal connector / clamp suitable for fixing to bushing terminal and the PURCHASER'S specified conductors. The connector /clamp shall be rated to carry the bushing rated current without exceeding a temperature rise of 45° degree centigrade over an ambient of 50°C. 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 voltage winding.

m) Each bushing shall be so co-ordinated with the transformer insulation that all flashovers will occur outside the tank.

1.23.10 Current Transformer

a) The current transformer shall comply with the requirements of latest issue of IS:2705. The reports of all type and routine tests as stipulated in the Indian Standards shall be furnished for approval to the purchaser. Each current transformer shall be subjected to routine tests as specified in the Indian Standards.

b) All technical particulars of current transformers as called for in bidding schedule shall be furnished with the bid. The parameters given for the current transformers in the specification may be modified before final approval of drawings, but these changes shall not affect the cost of the transformers.

c) All secondary leads, including tapping's shall be brought out to a weatherproof outlet box near on the current transformer. The supplier / contractor shall carry out conduit wiring from this outlet box up to the transformer marshalling box or control cabinet. CT shorting terminals shall also be provided in the marshalling box.

d) Current transformer name plate shall be mounted on the equipment adjacent to the terminal box.

1.23.11 Cable Box and Cable Box Bushings

a) Cable boxes are to be suitable for operating outdoor and suitable for vertical arrangements of cables ascending to the box from below. Cable boxes for the transformers shall be with the disconnecting chambers so that the transformers with accessories can be removed for servicing for repair without disconnecting the cable connections.

b) Boxes shall be suitable for aluminium conductor, XLPE insulated armoured, and PVC sheathed cables of sizes approved by Purchaser.

c) Compression glands and lugs shall be provided suitable for PVC cables.

d) The design and construction of the cable box shall be such as not to permit the entry of moisture into the box.

e) Supports for cable boxes shall be provided by the tenderer.

f) Suitable draining plug shall be provided with each cable box.

g) Suitable earthing arrangement for cable armouring shall be provided.

1.23.12 Marshalling Box

a) Single sheet construction vermin proof of sheet steel .Sheet thickness not less then 1.5 mm with nanoceramic coating , followed by electrophoertic dip coat and powder coating to RAL 7035/steel vermin proof, well-ventilated and weatherproof marshalling box with water-tight hinged and padlocked door of a suitable construction shall be provided for the transformer ancillary apparatus. The box shall have slopped 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-55. The sheet thickness shall not be less than 1.5 mm Louvers if required shall be with EN 779 G3 Filters and IP55 Rated.

b) The schematic diagram of the circuitry inside the marshalling box be prepared and fixed inside the door under a prospone sheet.

c) Transformer Oil temp low & high, winding temp low & high, Bucholz relay, MOG OLTC voltage settings, tap positions and PRV status etc should be interfaced with SCADA.

1.23.13 Auxiliary Power Supplies

The following power supplies shall be available at site.

a) AC, 3 phase 415 volts 50 Hz earthed.

b) AC, 1 phase 240 volts 50 Hz earthed.

c) 110 volts DC ungrounded.

1.23.14 On Load Tap Changer

a) The transformers shall be provided with an On-Load Tap Changer (OLTC) of well reputed proven make as per technical requirement for varying the effective transformation ratio while the transformer is ON Load and without providing phase displacement. The salient features of the OLTC shall be as under:

b) The tap changing mechanism should be suitable for automatic, remote-control operation from remote control panel in the Substation building in addition to being capable of local manual as well as local electrical operation.

c) The On Load Tap Changer (OLTC) shall include the following:

i. An oil immersed tap selector and arcing switch on arc suppressing tap selector provided with ohmicor resistor type high speed diverter switch, for reduction of make and break arcing voltages, overloads, and short circuits.

ii. Diverter switch should be with snap action mechanism with energy accumulator mounted directly on the diverter switch.

iii. Separate oil compartment

iv. Easily removable diverter switch unit.

v. Motor driven mechanism

vi. Control and Protection devices.

vii. Local tap changer position indicator

viii. Manual operation device

ix. Make of OLTC – Esun MR Indigenous make (type test certificates from (CPRI).

x. voltage rating -69 KV (as appropriate)

xi. Current rating – 300 A

xii. Control voltage – 230 Volt (AC)

d) The on-load tap changer shall be designed so that the contacts do not interrupt arc within the main tank of transformer. The tap changer selector and arcing switch on arc suppressing tap selector switch shall be located in one or more oil filled compartments. The diverter switch should be provided with gas vent and buchholz relay. It shall be designed so as to prevent the oil in tap selector and diverter switch compartments from mixing with the oil in transformer. The barrier board between OLTC and the transformer tank shall be made of silicon bonded rasin paper (SBRP).

e) The tap changer shall be capable of permitting parallel operation with other transformers of the same type. The transformer shall give full load output on all taps without exceeding the limit of permissible temperature rise in oil and winding. The manual operating device shall be so located on the transformer that it can be operated by a man standing at the level of transformer track. It shall be of robust construction and shall be capable of frequent operations. It shall not be possible to operate the electric drive when the manual operating gear is in use.

f) Necessary interlocks blocking independent control when the units are in parallel shall be provided.

g) The controls shall be so arranged as to ensure that when a tap change operation has commenced, it shall be completed independently of the operation of control relays or switches. Local or remote-control switch shall cause one tap movement only, until the control switch has returned to the off position between successive operations. Under abnormal conditions such as may occur when the contractor controlling one tap change sticks, the arrangement must be such as to switch off supply to the motor so that an out of step condition is limited to one tap difference between the units. Limit switches shall be provided to prevent over running of mechanism.

h) The transformer and the tap changing equipment shall be designed to permit full rated operation with tap changing equipment temporarily installed in any intermediate position. Details of out of step protection provided for the taps should be furnished in the tender.

i) The control scheme for the tap changer shall be provided for independent auto/non-auto control of the tap changer when the transformers are in independent service. Voltage regulating relay should be designed for maximum operational simplicity for regulating the secondary voltage of power transformer with OLTC. The required dead band settings are set by setting the nominal value and lower and upper levels independently.

j) In addition, provisions shall be made to enable non-auto/automatic parallel control also so that the tap changers of two or more transformers will be operated simultaneously when one unit is in parallel with another so that under normal conditions the tap changer will not become out of step, and this will eliminate circulating current. Additional features like “Master / Follower” and visual indication, during the operation of motor shall also be incorporated.

k) A mechanical tap position indicator shall be provided on the tap changer in addition to remote indication equipment in the substation on remote control cubicle of OLTC. Necessary interlocks, for independent control when the units are in parallel shall be provided.

l) The whole of motor drive unit comprising the motor and its control gear including contractors, indicators, local electrical push buttons, five-digit operation counter, handle for manual control etc. as well as terminals for the control and indication wiring shall be housed in a dust proof kiosk mounted on a tap changer. A heating element with thermostat and MCB shall also be provided in kiosk. Arrangement shall be made for padlocking the kiosk. Tap position indication shall be visible by a number appearing in a small glass window on the front of the kiosk. For remote indication, digital type instrument shall be provided on the panel.

m) Any enclosed compartment not oil filled shall be adequately ventilated. All contractors, relay coils or other parts shall be suitably protected against corrosion or deterioration due to condensation, fungi etc.

n) The oil in the compartments of the main tap changing apparatus which do not contain contacts used for making or breaking current shall be maintained under conservator head by means of a pipe connection from the highest point of the chamber to the conservator. This connection shall be controlled by a suitable valve and shall be arranged so that any gas leaving the chamber will pass into the gas and oil actuated relay. A separate oil buchholz relay with trip contacts shall be provided for the On-Load Tap Changer chamber. Each tap changer shall also be provided with a Pressure Relief Valve outside OLTC to protect against sudden pressure development in OLTC.

o) Each compartment in which the oil is not maintained under conservator head shall be provided with a suitable direct reading oil level gauge.

p) A permanently legible lubrication chart shall be fitted with the driving mechanism chamber.

q) Local electrical control switches and the local operating gear shall be clearly labelled in suitable manner to indicate the direction of operation of tap changer.

r) The remote-control panel of OLTC gear to be installed in the Substation building should match in colour and dimensions sheet steel size etc. with the purchaser's transformer control panel for which details would be furnished to the successful tenderer.

s) In addition to the fittings, auxiliaries and accessories considered necessary by the tenderer the following shall be provided.

1 For Local Electrical Control

a) Raise lower selector switch with an intermediate 'OFF' position.

b) Auxiliary transformer (if necessary) along with MCB's and links.

c) Step by step contactor

d) Thermal over-load relay for the motor

e) Reversing contactor

f) ON/OFF automatic trip air circuit breaker for motor supply

g) Local / Remote change-over selector switch.

2 For Remote Electrical Independent Control

a) All equipment listed in (I) above.

b) Tap position indicator for mounting on control panel in the Substation building.

c) Signal lamp and buzzer, for indicating "Tap Change in Progress".

d) Raise lower switch push button type with intermediate off/position for remote control.

e) Emergency stop button (push button type) with visual indication.

f) Visual and alarm indication for non-completion of operation within pre-set time.

g) Provision of interlocking system for blocking independent control when the units are to run in parallel by providing interlocking phase sequence selector switch.

h) All audio-visual indications should be brought to the Remote Tap Changer Cubicle (RTCC) panel.

i) DC supply isolators, DC supply 'ON' indicator & DC failure, booth along with cancellation.

j) All equipment and their connections in RTCC panel should be properly marked. The buzzer / bell (industrial type) should be provided.

k) Voltage regulating relay for automatic operation.

l) HV side and LV side digital voltmeters.

3 For Simultaneous Parallel Operation of Transformer

a) All equipment listed in (II) above.

b) Out of step relay along with auxiliary relays, contactors and other equipment including a buzzer and signal lamp to indicate the out of step indication when transformers in one of pair of groups of rating in parallel are one tap out of step and also to trip the circuit breaker.

c) Control selector switch to enable to run a transformer as Master / Follower or independent in a group.

d) Selection switches for individual / parallel operation.

e) D.C. supply, Isolators, D.C. supply, 'ON" indication & DC failure, hooter along with cancellation

1.23.15 Voltage Regulator Relay for OLTC

a) Voltage Regulator Relay for OLTC should have the following characteristics:

b)	Input Voltage (nominal value)	95 to 130 V
c)	Rated Frequency	50 Hz
d)	Band width	+0.6 to +6% of nominal value
e)	Time delay circuit	10 to 180 seconds
f)	Integral response	to be switched on.
g)	Under Voltage blocking	70 to 90%
h)	Line drop compensator	0 to 25 V
i)	Current path of LDC	1 A

Note: If OLTC built-in feature is available in the main relay, separate voltage regulating feature may not be provided.

1 Off Circuit Tap Changer

The off circuit Tap changer (wherever specified and required) shall be operable by means of an operating handle brought outside the tank and operable from ground level. It shall be equipped with an indicating device to show the tap in use and shall be provided with a locking arrangement to lock the switch in position. The tap changer contacts and connections shall be accessible through an access hole having bolted gasketed cover.

1.23.16 Fittings

The following fittings shall be provided on the transformers:

a) Conservator with isolating valves, oil filling hole with cap and drain valve. The conservator vessel shall be fitted with constant oil pressure diaphragm oil sealing system.

b) Magnetic type oil level gauge (150 mm dia.) with low oil level alarm contacts.

c) Prismatic/toughened glass oil level gauge.

d) Silica gel breather with oil seal and connecting pipe complete with first fill of activated silica gel or Alumina mounted at a level of 1300 mm above ground level.

e) 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). A 5 mm dia. cooper pipe shall be connected from the relay test cock to a valve located about 1.25 meters 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.

f) Pressure relief device the necessary air equalizer connection between this and the conservator with necessary alarm contacts.

g) Air release plugs in the top cover.

h) Inspection cover, access holes with bolted covers for access to inner ends of bushing, etc.

i) Winding temperature (hot spot) indicating device for local mounting complete in all respects. Winding temperature indicator shall have two sets. of contacts to operate at different settings:

j) To provide winding temperature ‘high alarm’.

k) To provide temperature too high ‘trip’.

l) Dial thermometer with pocket for oil temperature indicator with one set of alarm and one set of trip contacts and maximum reading pointer.

m) Lifting eyes or lugs for the top cover, core and coils and for the complete transformer.

n) Jacking pads

o) Haulage lugs

p) Protected type mercury / alcohol in glass thermometer and a pocket to house the same.

q) Top and bottom filter valves on diagonally opposite ends with pad locking arrangement on both valves.

r) Top and bottom sampling valves.

s) Drain valve with pad locking arrangement.

t) Rating and connection diagram plate.

u) Two numbers of tank earthing terminals with associated nuts and bolts for connections to purchaser’s grounding strip.

v) Bi-directional flagged rollers with locking and bolting device.

w) Marshalling Box (MB) Shut off valve on both sides of flexible pipe connections between radiator bank and transformer tank.

x) Cooling Accessories: Requisite number of radiators provided with:

y) One shut off valve on top.

z) One shut off valve at bottom.

aa) Air release device on top

bb) Drain and sampling device at bottom.

cc) Lifting lugs. Air release device and oil drain plug on oil pipe connectors:

dd) Terminal marking plates for Current Transformers and Main Transformer.

ee) Neutral earthing to be brought down through tinned copper strip to purchaser’s earthing grid via support insulators on tank.

ff) On load tap changer (OLTC), motor operated, complete in all respects, with separate oil chamber from main tank and provided with:

gg) Operating handle (for manual operation).

hh) Surge relay.

ii) PRV.

jj) Silica gel breather.

kk) Conservator.

ll) Magnetic level gauge for low level alarm.

mm) Motor, terminals, heater with thermostat, lighting etc complete in all respects.

1.23.17 Control Connections and Instrument and Wiring Terminal, Board and Fuses

a) Normally no fuses shall be used anywhere instead of fuse 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.

b) 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 with wire.

c) 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 of the compression type. All wiring to a panel shall be taken from suitable terminal boards.

d) 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 below ground level.

e) When 415-volt connections are taken through junction boxes or marshalling boxes, they shall be adequately screened, and 415 volts Danger Notice must be affixed to the outside of the junction boxes or marshalling box. Proper colour code for red, yellow, blue wirers shall be followed.

f) All box wiring shall be in accordance with relevant IS. All wiring shall be of stranded copper (48 strands) of 1100-volt grade and size not less than 2.5 sq.mm.

g) All wires on panels and all multicore cables shall have ferrules which bear the same number at both ends, as indicated in the relevant drawing.

h) 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.

i) The same ferrule number shall not be used on wires in different circuits on the same panels.

j) 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.

k) 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.

l) 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.

m) Where apparatus is mounted on panels, all metal cases shall be separately earthed by means of stranded (48 No.) copper wire of strip having a cross section of not less than 2 sq.mm where strip is used, the joints shall be sweated. The copper wire shall have green coloured insulation for earth connections.

n) 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. The control relays with built-in fuse shall be of slim type 1CO SSR/EMR Type with UL approved electrical life of minimum 60000 cycles and temperature withstand capability of 85 Deg C

o) Terminal board rows should be spaced adequately not less than 100 mm apart to permit convenient access to external cables and terminations.

p) Terminal boards shall be placed with respect to the cable gland (at a minimum distance of 200 mm) as to permit satisfactory arrangement of multicore cable tails.

q) Terminal boards shall have pairs to terminals for incoming and outgoing wires. Insulating barriers 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 adequately protect 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.

r) All fuses shall be of the HRC cartridge type, and these shall be properly labelled, wherever these cannot be replaced by MCB as normally only MCB's shall be used.

s) 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.

t) The schematic diagram shall be drawn and fixed under a transparent prispane sheet on the inner side of the marshalling box cover.

u) As a rule, the fuses shall be replaced by Miniature Circuit Breakers (MCBs) in the control and other supplies.

v) To avoid condensation in the MB, a space heater shall be provided with an MCB and thermostat.

w) Suitable 11 W, CFL light shall be provided in the Marshalling Box for lightning purpose.

1.23.18 Radio Interference and Noise Level

Transformers shall be designed with particulars care to suppress at least the third and fifth harmonic voltages so as to minimise interference with communication circuits. Transformer noise level, when energised at normal voltage and frequency shall be as per NEMA stipulations.

1.24 Tests

The Transformers shall be completely factory tested before despatch in accordance with the standards and with such other tests as may be necessary to ensure that the equipment is satisfactory and is in accordance with this specification.

1.24.1 Routine Tests

a) Transformer routine tests shall include tests stated in latest issue of IS:2026 (Part-I). These tests shall also include but shall not be limited to the following:

b) Measurement of winding resistance.

c) Voltage ratio on each tapping and check of voltage vector relationship.

d) Impedance voltage at all tappings

e) Magnetic circuit test.

After routine tests, each core shall be tested for 1 minute at 2 KV between all bolts, side plates and structural steel work. Immediately prior to the despatch of the transformer, the magnetic circuit shall be pressure tested for 1 minute at 2 kV A.C. between the core and the earth.

f) Load losses.

g) No load losses and no-load current

h) Absorption index i.e. insulation resistance for 15 seconds and 60 seconds (R60/R15) and polarization index i.e. Insulation Resistance for 10 minutes and one minute (R10 mt / R1 mt)

i) Induced over voltage withstand test.

j) Separate source voltage withstands test (applied potential).

k) Tan delta measurement and capacitance of each winding to earth (with all other windings earthed) & between all windings connected together to earth.

l) Dissolved gas analysis test

m) Measurement of acoustic noise level

n) Measurement of Zero sequence impedance.

All routine & type tests should be done free of cost. If it is to be done on the cost basis, the same may be indicated in the schedule of prices and delivery and this will be considered for evaluation of prices.

1.24.2 Type Tests

Moreover, in addition to the routine tests, the transformer shall be subjected to the following type tests:

a) Lightning Impulse Test

This test shall be carried out in accordance with clause 12 of the latest issue of IS: 2026 (Part-III). The bidder shall quote separate price for lightning impulse test on HV and LV windings. (One limb only).

b) Temperature Rise Test

The temperature rise test shall be carried out in accordance with IS:2026 Part-II. The Temperature rise shall not exceed the values stated elsewhere in the specification.

1.24.3 Test Waival, Procedures and Costs

a) The purchaser, at his option, may waive impulse tests provided type test reports of impulse tests carried out on essentially identical units in their factory in India are furnished by the manufacture.

b) No load losses and exciting current shall be measured at rated voltage, rated frequency and at 90% and 110% of rated voltage, both before and after the lightning impulse tests.

c) The method of test loading shall be described in the test report for determination of both average and hottest spot temperature. Where the winding temperature equipment is specified, data shall also be included for calibration of hottest spot temperature indicator.

d) Resistance of each winding of each phase shall be measured at principal and at all the taps and corrected to 75°C.

e) Impedance voltage shall be measured at principal and at all taps.

f) No load Loss Measurement at 415 Volt.

g) The bidder shall indicate separately the cost of each of the following types tests:

   i. Lightning impulse test separately for HV and LV winding

   ii. Temperature rise test

1.24.4 Tests on Transformer Tank

a) Vacuum Test: One transformer tank of each size shall be subjected to the vacuum pressure of 760 mm of mercury. The tanks designed for full vacuum shall be tested at an internal pressure of 3.33 KN/m2 (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.

b) Pressure Test: One transformer tank of each size together with its radiators, conservator vessel and other fittings shall be subjected to pressure corresponding to twice the normal head of oil or to the normal pressure plus 35 Kn/m2 (5 1b/sq.in) whichever is lower measured at the base of the tank and will be maintained for one hour. The permanent deflection of flat plates after the excess pressure has been released shall not exceed the value specified in C.B.I.P. Manual on Transformers (Revised 1999).

c) The pressure relief device shall be subjected to increasing oil pressure. It shall operate before reaching the test pressure specified above. The operating pressure shall be recorded. The device shall seal off after the pressure in excess has been relieved (routine test).

d) Oil leakage test: All tanks and oil filled compartments shall be tested for oil tightness by oil of a viscosity not greater than that of insulating oil to IS: 335, at the specified ambient temperature and subjected to a pressure equal to the normal pressure plus 35 KN/m2 square (5 1b/sq.in) measured at the base of the tank. This pressure shall be maintained for a period of not less than 12 hours, during which time to leakage shall occur.

1.24.5 Test on Associated Equipment

Porcelain bushings, bushing current transformers, wherever provided, winding temperature indicating devices, dial thermometers, buchholz relays, ON LOAD tap changer, coolers, control devices, insulating oil and other associated equipment shall be tested by the supplier /contractor in accordance with relevant IS. If such equipment is purchased by the supplier/ contractor on a sub-contract, he shall have them tested to comply with these requirements.

1.24.6 Sequence of Testing on Assembled Transformer

Unless otherwise agreed, the sequence of testing shall be as follows:

a) Ratio and vector group

b) Winding resistance measurement

c) Insulation resistance measurement

d) Separate source voltage withstands test.

e) Measurement of Iron losses

f) Load losses and impedance voltage measurement.

g) Lightning impulse test

h) Temperature rise test.

i) Induced voltage withstands test

j) Measurement of iron loss

k) Measurement of insulation resistance

l) Tests on OLTC

1.24.6.1 Test Measurements

a) The zero-sequence impedance, insulation power factor and capacitance for each winding and between windings shall be measured and recorded.

b) Certified test report and oscillograms shall be furnished to the Purchaser / Consultants for evaluation as per the schedule of distribution of documents. The Contactor shall also evaluate the test results and rectify the defects in the equipment based on his and the Purchaser’s evaluations of the tests without any extra charges to the Purchaser. Manufacturer’s Test Certificates in respect of all associated auxiliary and ancillary equipment shall be furnished.

c) The bidder shall state in his proposal the testing facilities available at his works. In case 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 testing’s.

1.24.7 Witnessing of Tests and Excessive Losses

The Purchaser and / or his representative reserves the right to witness any or all tests, or to accord waival at its sole discretion.

The Purchaser reserves the right to reject the Transformer it losses exceed the declared losses beyond tolerance limits as per IS or if temperature rise of oil and winding exceed the values specified elsewhere. (See clause 3.5.0).

1.24.8 Site Tests

After the transformer is installed, the following pre-commissioning tests and checks shall be done before putting the transformer in service.

a) Dry out test.

b) Megger test

c) Resistance measurement of windings

d) Ratio test

e) Phase relationship test

f) Tap changer test.

g) Buchholz relay alarm & surge operation test

h) Low oil level alarm

i) Temperature Indicators

j) Marshalling kiosk

k) Protective relays

l) Magnetising current

m) Tests on OLTC

n) The following additional checks shall be made:

o) All oil valves are in correct position closed or opened as required.

p) All air pockets are cleared.

q) Thermometer pockets are filled with oil.

r) Oil is at correct level in the bushing, conservator, divertor switch, tank etc.

s) Earthing connections are made.

t) Colour silica gel is blue.

u) Bushing arcing horn is set correctly, and gap distance is recorded.

v) CT polarity and ratio is correct.

1.24.9 Transformer Losses, Evaluation of Bid & Acceptance

a) The bidder must clearly specify that the offered losses are "Maximum"(including IS/IEC tolerance) and no further positive tolerance as per IS/IEC shall be applicable on the offered values during evaluation as well as during testing of transformer.

b) Loss Capitalization shall be done with the accepted bids with loss values within specified limit. For the purpose of evaluation of bids, the capitalized cost of iron loss, load loss and auxiliary loss (KW) shall be added to the quoted price of the transformer at the following rates:

i. Capitalized value of No-Load loss per KW: Rs. 4,53,000/-

ii. Capitalized value of load loss per KW: Rs. 1,85,500/-

However, once a bidder becomes successful on the basis of loss capitalization with certain declared loss value, they have to strictly achieve the same loss value during the course of testing of transformers, offered for supply. No tolerance as per IS/IEC will be applicable.

1.24.10 Rejection

The Purchaser may reject any transformer if during tests or service any of the following conditions arise:

a) No load loss exceeds the guaranteed value by 15% or more.

b) Load loss exceeds the guaranteed value by 10% or more.

c) Impedance value exceeds the guaranteed value by + 10% or more.

d) The difference in impedance values or any two phases during single phase short circuit impedance test exceeds 2% of the average value guaranteed by the vendor.

e) Oil or winding temperature rise exceeds the specified value.

f) Transformer fails on impulse test.

g) Transformer fails on power frequency voltage withstand test.

h) Transformer is proved to have been manufactured not in accordance with the agreed specification.

1.24.11 Instructions 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 others, the followings particulars:

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 tappings, 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 approve drawings.

f) Detailed O&M instructions with periodical check lists and proforma etc.

1.24.12 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 plant, shall be deemed to be included in the specification and shall be furnished by the supplier /contractor 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 the Purchaser under any circumstances.

All deviations from this specification shall be separately listed under the requisite schedules, in the absence of which it will be presumed that all the provisions of the specification are complied with by the bidder.

1.24.13 Tools & Tackles

All the necessary tools and tackles required for normal operation shall be supplied by the supplier/Contractor.

1.24.14 NIFPS (Nitrogen Injection Fire Protection System)

Power transformer rating 10MVA and above shall be provided with NIFPS system. As per CEI's letter for other government projects, fire protection system is statutory requirement for oil transformer of rating 10MVA and above & oil capacity is more than 2000 liters.

1.24.15 Commissioning

The equipment shall be commissioned as per CBIP manual, IS 10028 and manufacturer's recommendations. All the as built drawings / manuals shall be pre-requisite for release of payment for final payment.

1.25 Technical Specification for 11kV/0.433kV ONAN Transformers

1.25.1 Scope

These specifications are intended to cover design, manufacture, testing / inspection before dispatch, packing, and transportation to site, erection supervision, testing and commissioning of 11/0.433kV Step-down outdoor type ONAN transformers complete with all accessories / fittings and spare parts as specified herein.

1.25.2 Specific Technical Requirements (Standard Conditions)

Rated KVA	**As per design requirement**
Number of phases	Three
Type of Installation	Outdoor
Frequency	50Hz
Cooling medium	Insulating oil

Rated Voltage		
HV Winding	11kV (Delta)	
LV winding	0.415kV (Star)	
Highest continuous system Voltage		
HV	12 kV	
LV	0.433 kV	
Method of System earthing		
HV	Unearthed	
LV	Solidly gronded	
Tap Changer Type	Off Circuit Tap Changer	
Range of tapping	+ 5% to -10% with 7 steps of 2.5% on 11 kV side	
Neutral terminal to be brought out	On LV side only	
Impedance on rated MVA at 75°C	As per Indian Standard	
Type of Insulation & Insulation level	11kV	0.433kV
Type of insulation	Uniform	Uniform
One minute power frequency Withstand test voltage (kV-RMS	28	3
Impulse withstands test voltage (kvp)	75	8
Winding connection	Delta(HV)	Star(LV)
Material	Copper	
Vector Group	Dyn-11	
Type of cooling	ONAN	
Neutral Earthing	LV neutral shall be solidly earthed	
Terminal details		
HV & LV	Cable box with disconnecting champ	
Temperature rise of the windings	55°C	
Maximum Temperature Rise for various types of cooling		
Maximum design ambient temp.	50°C	
Maximum ambient temp.	40°C	
Temperature rise of top oil. (measured by Thermometer)	50°C	
Temperature rise of winding. (measured by resistance)	55°C	
Overload capacity	As per IS: 6600	
Noise level at rated voltage & frequency	As per NEMA Pub TR-1	

1.25.3 Marshalling Box

One sheet steel, (2mm size) weatherproof marshalling box of suitable construction shall be provided Degree of Protection IP-55. Other requirements as per details provided in General Technical Particulars of this section.

1.25.4 Capitalization of Looses and Damages

The capitalization of guaranteed losses of the transformer shall be calculated and considered while evaluating the bids. The guaranteed values of no-load losses and load losses shall be started in the bid. Liquidated damages will be applied to successful bidder for not achieving the quoted guaranteed figures.

1.25.5 Performance

Transformer shall be capable of withstanding for two seconds without damage to any external short circuit, with the short circuit kVA available at the terminals.

The maximum flux density in any part of the core and yoke at normal voltage and Frequency shall be such that the flux density under 10% over voltage condition shall not exceed 1.76 Tesla. With limiting value as (vi) below:

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.

The transformer may be operated continuously without danger of any particular tapping at the rated MVA plus minus 10% of the voltage corresponding to the tapping.

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

With combined voltage and frequency variation of +10%, the flux density shall not exceed 1.9 Tetsla.

1.25.6 Auxiliary Power Supplies

The following power supplies shall be available at site:

a) AC, 3 phase 415 volts 50 Hz. Earthed

b) AC, 1 phase 240 volts 50 Hz. Earthed

c) 110 volts DC ungrounded

1.25.7 Drawing incorporating the following particulars shall be submitted with the bid.

a) 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.

b) Height of centre line of HV and LV connectors of transformers from the rail top or foundation level.

c) Dimensions of the largest part to be transported.

d) GA drawings / details of various types of bushing.

e) Type test certificates of similar transformers.

f) Illustrative & descriptive literature of the Transformer.

g) Maintenance and Operating Instructions.

1.25.8 Miscellaneous

Padlocks along with duplicate keys as asked for various valves, marshalling box etc., shall be provided by the supplier / contractor, wherever applicable.

Foundation bolts for wheel locking devices of Transformer shall be supplied by the supplier /contractor.

1.25.9 Delivery

The equipment shall be delivered, erected, and commissioned at site by supplier / contractor in presence of Client's electrical site engineer.

1.25.10 Conflict in Clause

In case of any conflict between the Specific Technical Requirements and General Technical Requirements, the requirements indicated as Specific Technical Requirement shall prevail over the General Technical Requirements.

1.25.11 Services and Equipment

The following is also in the contractor's scope of work for executions.

Design of soak pit, cable trenches and foundations for transformers and other ground mounted equipment.

Construction of soak pit, cable trenches and foundations for transformers and other ground mounted equipment.

1.25.12 Name Plate

Transformer rating plate shall contain the information as given in clause 15 of IS-2026 (Part-I). It is proposed to have some information besides English in local language (Hindi language) also, shall be provided to the manufacturer by the purchaser. The details on rating plate shall be finalised during the detailed engineering.

1.26 General Technical Requirements

1.26.1 Codes and Standards

The design, material, fabrication, manufacture, inspection, testing before despatch, erection testing, commissioning, 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 constructed to relieve the supplier / contractor of this responsibility.

Transformers shall conform to the current applicable standards and codes of practice as specified.

1.26.2 Standards / Codes

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

Standard	Description
IS:2026 (Part I to IV)	Power Transformer
IS:6600/BS:CP"1010	Guide for loading of oil immersed transformers
IS:335	New insulating oil for transformers, Switchgears
IS:3639	Fittings and accessories for power Transformers

IS:2099	High voltage porcelain bushings
IS:2705	Current Transformers
IS:3347	Dimensions for porcelain Transformer Bushings
IS:3202	Code of practice for climate proofing of electrical equipment.
IS:2147	Degree of protection
IS:2071	Method of high voltage testing
IS:3637	Gas operated relays
IS:1271	Classification of insulating materials for electrical machinery and apparatus in relation to their stability in services.
IS:5	Colour for ready mixed paints
IS:10028	Code or practice for selection, installation, and maintenance of transformers, Part I, II and III
IS:5561	Electric Power Connectors
C.B.I.P. Publication	Manual on Transformers

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

1.26.2.1 Drawings

The supplier / contractor shall furnish, within fifteen days after issuing of Letter of Award, six hard copies along with soft copies for each of the following drawings/documents incorporating name of project and 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 untanking, size of lugs and eyes, bushing lifting dimensions, clearances between HV and LV terminals and ground, quantity of insulating oil etc.

b) Foundation plan showing loading on each when and jacking points with respect to centre line of transformer.

c) Illustrative & descriptive literature of the Transformer

d) Maintenance and Operating Instructions

e) Height of centre line of HV and LV connectors of transformers from the rail top level

f) Painting procedure.

g) Complete CT details including VA, class, ALF, resistance, magnetization characteristic curves, dimensions fixing arrangement etc. of neutral and phase side current transformers (as applicable).

h) Specification of the insulating oil.

i) GA drawings / details of bushing and terminal connectors.

j) Name plate drawing with terminal marking and connection diagrams.

k) Wheel locking arrangement drawing.

l) Transportation dimensions drawings.

m) Magnetization characteristics curves of PS class neutral and phase side current transformers, if applicable.

n) Interconnection diagrams.

o) Over fluxing withstand time characteristics of transformer.

p) GA drawing of marshalling box.

q) Control scheme / wiring diagram of marshalling box.

r) Technical leaflets of major components and fittings.

s) As built drawings of schematics, wiring diagram etc.

t) Setting of oil temperature indicator, winding temperature indicator.

u) Completed technical data sheets.

v) Details including write-up of tap changing gear.

w) H.V. cond. bushing.

x) Bushing Assembly.

y) GA of HV & LV cable Box.

z) Radiator type Assembly.

aa) Detailed wiring/schematic drawings for ONAF operation of the transformer.

bb) Motor Drive (circuit diagram plus parts list etc.)

cc) Earthing and Insulation of Core

dd) Locking Facilities and Accessories for Valves

ee) Construction of Globe Valves and Gate Valves

ff) Factory Test Procedure and Test Schedules for Factory Tests

gg) Commissioning Test Procedure and Report

hh) Operation and Maintenance Manual including Test Reports

ii) Outline of Radiator

jj) Outline of Fan Unit

kk) Mechanical Protection of Auxiliary Wiring and Capillaries

All drawings/documents, technical data sheets and test certificates / results / calculations shall be furnished.

1.26.2.2 Drawing Approval

Any approval given to the drawings or documents by the purchaser shall be of general nature and this would not relieve the supplier / contractor of its responsibility for completeness of equipment, correctness of the drawings, dimensions, sizes, fittings, designs, supply of proven standard quality of bought out items and in the manufacture of the equipment. If any defect is noticed subsequent to the inspection, clearance of despatch, receipt, or operation of transformer, it shall be at the risk and responsibility of manufacturer/ supplier to remove the deficiency/ replace the faulty equipment without any financial liability to purchaser under any circumstances and in any form.

1.26.3 General Constructional Features

All material used shall be of best quality and of the class most suitable for working under the conditions specified and shall withstand 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.

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 galvanised.

Nuts, bolts and pins used inside the transformers and tap changer compartments shall be provided with lock washers or locknuts.

Exposed parts shall not have pockets where water can collect.

Internal design of transformer shall ensure that air is not trapped in any location.

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 galvanised or cadmium plated.

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.

All internal connections and fastenings shall be capable of operating under overloads and over-excitation, allowed as per specified standards without injury.

Transformer and accessories shall be designed to facilitate proper operation, inspection, maintenance, and repairs.

No patching, plugging, shimming or other such means of overcoming defects, discrepancies or errors will be accepted.

Schematic Drawings of the wiring, including external cables shall be put under the prospane sheet on the inside door of the transformer marshalling box.

1.26.4 Painting

The interior of all transformer tanks and other oil filled chambers and internal structural steel work shall be cleaned (seven tank process) of all scale and rust by shot blasting. These surfaces shall be painted with not less than two coats of heat resistant, oil insoluble and insulating varnish. Steel surfaces exposed to the weather shall be thoroughly cleaned and have a priming coat of zinc chromate applied. The second coat shall be of a glossy oil and weather resisting nonfading, paint of shade No. 631 as per IS:5.

Metal parts not accessible for painting shall be made of corrosion resistant material.

Interior surfaces of mechanism chambers and marshalling kiosks shall receive three coats of paint after proper cleaning. The final coat shall be of a light-coloured anti-corrosion paint.

All paints shall be carefully selected to withstand heat, rain, and extremes of weather. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling.

In case finish paint chips off or crinkle during transit or installation, the supplier / contractor shall arrange for repainting transformer at site at his cost. The paint for repainting shall be supplied by the supplier / contractor.

The following treatments shall be applied:

1.26.5 External surfaces

All steel surfaces shall be sand blasted in accordance with DIN 55928 Part 4 (equivalent to SIS 055900), and shall then be painted in the following sequence:

a) One (1) primer coat 60 µm

b) Two-component epoxy zinc-phosphate

c) One (1) intermediate coat 60 µm

d) Two-component epoxy micaceous iron oxide

e) One (1) topcoat 40 µm

f) Two-component polyurethane

g) Total coating thickness (dry-film incl. tolerances) min. 160 µm

The final coat of painting shall be of pore-free and homogeneous quality and shall be of uniform shade of colour.

1.27 Detailed Description

1.27.1 Tank:

The Transformer tank and cover shall be fabricated from high grade low carbon plate steel of tested quality. The tank and the cover shall be of welded construction.

Tank shall be designed to permit lifting by crane or jacks of the complete transformer assembly filled with oil. Suitable lugs and bosses shall be provided for this purpose.

All beams, flanges, lifting lugs, braces and permanent parts attached to the tank, shall be welded and where practicable, they shall be double welded.

The main tank body of the transformer, excluding tap changing compartments and radiators, shall be capable of withstanding pressure of 760 mm of Hg.

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. The weight of cover shall be easily lifted by a single person, whenever required.

All bolted connections to the tank shall be fitted with suitable oil-tight gaskets which shall give satisfactory service under the operating conditions. Special attention shall be given to the methods of making the hot oil-tight joints between the tank and the cover as also between the tank cover and the bushings and all outlets to ensure that the joint can be remade satisfactorily and with ease, with the help of semi-skilled labour. Where compressible gaskets are used, steps shall be provided to prevent over-compression.

Suitable guides shall be provided for positioning the various parts during assembly or dismantling. Adequate space shall be provided between the cores and windings and the bottom of the tank for collection of any sediment.

The completely assembled tank shall be fully vacuum proof.

1.27.2 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 so that it does not retain rainwater. PU Foam/cork/hemp type gaskets are not acceptable.

1.27.3 Under Carriage

The transformer tank shall be supported on steel structure with detachable forged steel flanged wheels suitable for moving the transformer completely filled with oil. Rail gauge shall be 1676 mm in both directions. Flanged wheels shall be spaced accordingly. Wheels shall be provided with suitable bearings which will resist rust and corrosion and shall be equipped with 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 transformer.

Jacking pads shall be provided on the transformer. It shall be possible to change the direction of the wheels through 90 degrees when the transformer is lifted on jacks to permit movement of the transformer both in longitudinal and transverse directions.

Suitable hydraulic jacks (4 nos.) for lifting the transformer shall be supplied by the supplier / contractor, for each rating.

1.27.4 Core

The magnetic circuit shall be constructed from high grade cold rolled non-ageing grain-oriented silicon steel lamination with low loss, such as of W17/50; max 1.05W/Kg.

The laminations shall be free of all burns and sharp projections. Each sheet shall have an insulating coating resistant to the action of hot oil.

The insulation structure for the core to bolts and core to clamp plates shall be such as to withstand a voltage of 2000 V for one minute.

The completed core and coil shall be so assembled that the axis and the plane of the outer surface of the core stack shall not deviate from the vertical plane by more than 25 mm.

All steel sections used for supporting the core shall be thoroughly shot or sand blasted, after cutting, drilling, and welding.

The finally assembled core with all the clamping structures shall be free from deformation and shall not vibrate during operation.

The core clamping structure shall be designed to minimise eddy current loss.

The framework and clamping arrangements shall be securely earthed.

The core shall be carefully assembled and rigidly clamped to ensure adequate mechanical strength.

Oil ducts shall be provided where necessary to ensure adequate cooling. The welding structure and major insulation shall not obstruct the free flow of oil through such ducts.

The design of magnetic circuit shall be such as to avoid static discharge, development of short circuit paths within itself or to the earthed clamping structure and production of flux component at right angle to the plane of the lamination which may cause local heating. The supporting framework 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.

The construction is to be of ‘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 transport or short circuits.

The earthing of core shall be done at the top of the cover, with removable link so as to test the same.

1.28 Internal Earthing

All internal metal parts of the transformer, with the exception of individual laminations, core bolts and their individual clamping plates shall be earthed.

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:

By connection through vertical tie-rods to the top structure.

By direct metal to metal contact with the tank base.

By a connection to the top structure on the same side of the core as the main earth connection to the tank.

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 dis-connecting link shall be provided on transformer tank to facilitate disconnections from ground for IR measurement purpose.

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.

1.28.1 Winding

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.

All low voltage windings for use in the circular coil concentric winding shall be would on a performed insulating cylinder for mechanical protection of the winding in handling and placing around the core.

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.

Materials used in the insulation and assembly of the windings shall be insoluble, non-catalytic and che DIGHI ally inactive in the hot transformer oil and shall not soften or the otherwise affected under the operating conditions.

Varnish application on coil windings may be given only for mechanical protection and hot for improvement in dielectric properties. In no case varnish or other adhesive, be used which will seal coil and prevent evacuation of air and moisture and impregnation by oil.

Winding and connections shall be braced to withstand shocks during transport or short circuit.

Permanent current carrying joints in the windings and leads shall be welded or brazed. Clamping bolts for current carrying parts inside oil shall be made of oil resistant material which shall not be affected by acidity in the oil. Steel bolts, if used, shall be suitably treated.

Terminals of all windings shall be brought out of the tank through bushings for external connections.

The completed core and coil assembly shall be dried in vacuum at not more than 0.5mm 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.

The winding shall be so designed that all coil assemblies 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.

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.

Adequate barriers shall be provided between coils and core and between high and low voltage coil. End turns shall have additional protection against abnormal line disturbances.

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.

Tappings 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 the transformer at all voltage ratios.

Magnitude of impulse surges transferred from HV to LV windings by induction and capacitance coupling shall be limited to B.I.L. of LV winding.

1.28.2 Insulating Oil

The insulating oil for the transformers shall be of LHV / MHV grade, generally conforming to IS:335.

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 first filling of oil plus 10% extra. However, the rate of transformer oil in Rupee per litre shall be quoted separately also. The transformer oil shall be supplied in non-returnable containers / drums.

The design and materials used in the construction of the transformer shall be such as to reduce the risk of the development of acidity in the oil.

The gaskets of PU Foam or similar type such as cork, which can be damaged by over-pressing or not acceptable.

1.28.3 Valves

Valves shall be of forged carbon steel up to 50 mm size and of gun metal or of cast iron bodies with gun metal fittings for sizes above 50 mm. 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.

Each valve shall be provided with an indicator to show the open and closed positions and shall be provided with facility for padlocking in either open or closed position. All screwed valves shall be furnished with pipe plugs for protection. Padlocks with duplicate keys shall be supplied along with the valves.

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 supplier / contractor shall supply the same.

Each transformer shall be provided with following valves on the tank:

a) Drain valves so located as to completely drain the tank.

b) Two filter valves on diagonally opposite corners, of 50 mm size.

c) Oil sampling valves not less than 8 mm at top and bottom of main tank.

d) One 15 mm air release plug.

e) Valves between radiators and tank.

f) Drain and filter valves shall be suitable for applying vacuum as specified in the specifications.

1.28.4 Bushing

All porcelain used in bushings shall be homogeneous, non-porous, uniformly glazed to brown colour and free from blisters, burns and other defects.

Stress due to expansion and contraction in any part of the bushing shall not lead to deterioration.

Bushing shall be designed and tested to comply with the applicable standards.

Liquid / oil-filled bushings shall be equipped with liquid level indicators and means for sampling and draining the liquid. The angle of inclination to vertical shall not exceed 30 degrees.

Oil in oil-filled bushings shall meet the requirements of the transformer oil standards.

Bushing rated for 400A and above shall have non-ferrous flanges and hardware.

Fittings made of steel or malleable iron shall be galvanised.

Bushing shall be so located on the transformers that full flashover strength will be utilised. Minimum clearances as required for the BIL shall be realised between live parts and live parts to earthed structures.

All applicable routine and type tests certificates of the bushings shall be furnished for approval.

Bushing shall be supplied with bimetallic / terminal connector / clamp suitable for fixing to bushing terminal and the PURCHASER'S specified conductors. The connector /clamp shall be rated to carry the bushing rated current without exceeding a temperature rise of 45° degree centigrade over an ambient of 50°C. The connector / clamp shall be designed to be corona free at the maximum rated line to ground voltage.

Bushing of identical voltage rating shall be interchangeable.

The insulation class of high voltage neutral bushing shall be properly coordinated with the insulation class of the neutral of the low voltage winding.

Each bushing shall be so coordinated with the transformer insulation that all flashovers will occur outside the tank.

1.28.5 Current Transformer

The current transformer shall comply with the requirements of latest issue of IS:2705. The reports of all type and routine tests as stipulated in the Indian Standards shall be furnished for approval to the purchaser. Each current transformer shall be subjected to routine tests as specified in the Indian Standards.

All technical particulars of current transformers as called for in bidding schedule shall be furnished with the bid. The parameters given for the current transformers in the specification may be modified before final approval of drawings, but these changes shall not affect the cost of the transformers.

All secondary leads, including tappings shall be brought out to a weatherproof outlet box near on the current transformer. The supplier / contractor shall carry out conduit wiring from this outlet box up to the transformer marshalling box or control cabinet. CT shorting terminals shall also be provided in the marshalling box.

Current transformer name plate shall be mounted on the equipment adjacent to the terminal box.

1.28.6 Cable Box and Cable Box Bushings

Cable boxes are to be suitable for operating outdoor and suitable for vertical arrangements of cables ascending to the box from below. Cable boxes for the transformers shall be with the disconnecting chambers so that the transformers with accessories can be removed for servicing for repair without disconnecting the cable connections.

Boxes shall be suitable for aluminium conductor, XLPE insulated armoured, and PVC sheathed cables of sizes approved by Purchaser.

Compression glands and lugs shall be provided suitable for PVC cables.

The design and construction of the cable box shall be such as not to permit the entry of moisture into the box.

Supports for cable boxes shall be provided by the tenderer.

Suitable draining plug shall be provided with each cable box.

Suitable earthing arrangement for cable armouring shall be provided.

1.28.7 Marshalling Box

Single sheet construction vermin proof of sheet steel .Sheet thickness not less then 1.5 mm with nanoceramic coating , followed by electrophoretic dip coat and powder coating to RAL 7035/ steel vermin proof, well-ventilated and weatherproof marshalling box with water-tight hinged and padlocked door of a suitable construction shall be provided for the transformer ancillary apparatus. The box shall have slopped 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-55. Louvre if required shall be UL approved and IP 55 type with G3 Filter as per EN779.

The schematic diagram of the circuitry inside the marshalling box be prepared and fixed inside the door under a prospone sheet.

1.28.8 Auxiliary Power Supplies

The following power supplies shall be available at site.

a) AC, 3 phase 415 volts 50 Hz earthed.

b) AC, 1 phase 240 volts 50 Hz earthed.

c) 110 volts DC ungrounded.

1.28.9 For Local Electrical Control

a) Raise lower selector switch with an intermediate ‘OFF’ position.

b) Auxiliary transformer (if necessary) along with MCB’s and links.

c) Step by step contactor

d) Thermal over-load relay for the motor

e) Reversing contactor

f) ON/OFF automatic trip air circuit breaker for motor supply

g) Local / Remote change-over selector switch.

1.28.10 Off Circuit Tap Changer

The off circuit Tap changer shall be operable by means of an operating handle brought outside the tank and operable from ground level. It shall be equipped with an indicating device to show the tap in use and shall be provided with a locking arrangement to lock the switch in position. The tap changer contacts and connections shall be accessible through an access hole having bolted gasketed cover.

1.28.11 Fittings

The following fittings shall be provided on the transformers:

a) Conservator with isolating valves, oil filling hole with cap and drain valve. The conservator vessel shall be fitted with constant oil pressure diaphragm oil sealing system.

b) Magnetic type oil level gauge (150 mm dia.) with low oil level alarm contacts.

c) Prismatic/toughned glass oil level gauge.

d) Silica gel breather with oil seal and connecting pipe complete with first fill of activated silica gel or Alumina mounted at a level of 1300 mm above ground level.

e) 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). A 5 mm dia. cooper pipe shall be connected from the relay test cock to a valve located about 1.25 meters 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.

f) Pressure relief device the necessary air equalizer connection between this and the conservator with necessary alarm contacts.

g) Air release plugs in the top cover.

h) Inspection cover, access holes with bolted covers for access to inner ends of bushing, etc.

i) Winding temperature (hot spot) indicating device for local mounting complete in all respects. Winding temperature indicator shall have two sets. of contacts to operate at different settings:

j) To provide winding temperature 'high alarm'.

k) To provide temperature too high 'trip'.

l) Dial thermometer with pocket for oil temperature indicator with one set of alarm and one set of trip contacts and maximum reading pointer.

m) Lifting eyes or lugs for the top cover, core, and coils and for the complete transformer.

n) Jacking pads

o) Haulage lugs

p) Protected type mercury / alcohol in glass thermometer and a pocket to house the same.

q) Top and bottom filter valves on diagonally opposite ends with pad locking arrangement on both valves.

r) Top and bottom sampling valves.

s) Drain valve with pad locking arrangement.

t) Rating and connection diagram plate.

u) Two numbers of tank earthing terminals with associated nuts and bolts for connections to purchaser's grounding strip.

v) Bi-directional flagged rollers with locking and bolting device.

w) Marshalling Box (MB)

x) Shut off valve on both sides of flexible pipe connections between radiator bank and transformer tank.

y) Cooling Accessories:

z) Requisite number of radiators provided with:

    i. One shut off valve on top.

    ii. One shut off valve at bottom.

    iii. Air release device on top

    iv. Drain and sampling device at bottom.

    v. Lifting lugs.

aa) Air release device and oil drain plug on oil pipe connectors:

    i. Terminal marking plates for Current Transformers and Main Transformer.

    ii. Neutral earthing to be brought down through tinned copper strip to purchaser's earthing grid via support insulators on tank.

bb) On load tap changer (OLTC), motor operated, complete in all respects, with separate oil chamber from main tank and provided with:

    i. Operating handle (for manual operation).

    ii. Surge relay.

    iii. PRV.

iv. Silica gel breather.

v. Conservator.

vi. Magnetic level gauge for low level alarm.

vii. Motor, terminals, heater with thermostat, lighting etc complete in all respects.

1.28.12 Control Connections and Instrument and Wiring Terminal, Board and Fuses

a) Normally no fuses shall be used anywhere instead of fuse 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.

b) 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 with wire.

c) 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 of the compression type. All wiring to a panel shall be taken from suitable terminal boards.

d) 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 below ground level.

e) When 415-volt connections are taken through junction boxes or marshalling boxes, they shall be adequately screened, and 415 volts Danger Notice must be affixed to the outside of the junction boxes or marshalling box. Proper colour code for red, yellow, blue wirers shall be followed.

f) All box wiring shall be in accordance with relevant IS. All wiring shall be of stranded copper (48 strands) of 1100-volt grade and size not less than 2.5 sq.mm.

g) All wires on panels and all multicore cables shall have ferrules which bear the same number at both ends, as indicated in the relevant drawing.

h) 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.

i) The same ferrule number shall not be used on wires in different circuits on the same panels.

j) 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.

k) 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.

l) 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.

m) Where apparatus is mounted on panels, all metal cases shall be separately earthed by means of stranded (48 No.) copper wire of strip having a cross section of not less than 2 sq.mm where strip is used, the joints shall be sweated. The copper wire shall have green coloured insulation for earth connections.

n) 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. The control relays with built-in fuse shall be of slim type 1CO SSR/EMR Type with UL approved electrical life of minimum 60000 cycles and temperature withstand capability of 85 Deg C.

o) Terminal board rows should be spaced adequately not less than 100 mm apart to permit convenient access to external cables and terminations.

p) Terminal boards shall be placed with respect to the cable gland (at a minimum distance of 200 mm) as to permit satisfactory arrangement of multicore cable tails.

q) Terminal boards shall have pairs to terminals for incoming and outgoing wires. Insulating barriers 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 adequately protect 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.

r) All fuses shall be of the HRC cartridge type, and these shall be properly labelled, wherever these cannot be replaced by MCB as normally only MCB’s shall be used.

s) 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.

t) The schematic diagram shall be drawn and fixed under a transparent prispane sheet on the inner side of the marshalling box cover. Louvre if required shall be UL approved and IP 55 type with G3 Filter as per EN779.

u) As a rule, the fuses shall be replaced by Miniature Circuit Breakers (MCBs) in the control and other supplies.

v) To avoid condensation in the MB, a UL approved DIN Rail Mountable encapsulated space heater with PTC shall be provided with an MCB and Hygro-thermostat.

w) Suitable 9 W, 1200 Lumens, UL approved industrial grade LED Light with Built-in PIR CFL light shall be provided in the Marshalling Box for lightning purpose, with Electrical Life of Minimum 60000 Hrs.

1.28.13 Radio Interference and Noise Level

Transformers shall be designed with particulars care to suppress at least the third and fifth harmonic voltages so as to minimise interference with communication circuits. Transformer noise level, when energised at normal voltage and frequency shall be as per NEMA stipulations.

1.28.14 Tests

The Transformers shall be completely factory tested before despatch in accordance with the standards and with such other tests as may be necessary to ensure that the equipment is satisfactory and is in accordance with this specification.

1.28.15 Routine Tests

Transformer routine tests shall include tests stated in latest issue of IS:2026 (Part-I). These tests shall also include but shall not be limited to the following:

a) Measurement of winding resistance.

b) Voltage ratio on each tapping and check of voltage vector relationship.

c) Impedance voltage at all tappings

d) Magnetic circuit test.

After routine tests, each core shall be tested for 1 minute at 2 KV between all bolts, side plates and structural steel work. Immediately prior to the despatch of the transformer, the magnetic circuit shall be pressure tested for 1 minute at 2 kV A.C. between the core and the earth.

e) Load losses.

f) No load losses and no-load current

g) Absorption index i.e. insulation resistance for 15 seconds and 60 seconds (R60/R15) and polarization index i.e. Insulation Resistance for 10 minutes and one minute (R10 mt / R1 mt)

h) Induced over voltage withstand test.

i) Separate source voltage withstands test (applied potential).

j) Tan delta measurement and capacitance of each winding to earth (with all other windings earthed) & between all windings connected together to earth.

k) Dissolved gas analysis test

l) Measurement of acoustic noise level

m) Measurement of Zero sequence impedance.

n) All routine & type tests should be done free of cost. If it is to be done on the cost basis, the same may be indicated in the schedule of prices and delivery and this will be considered for evaluation of prices.

1.28.16 Type Tests

Moreover, in addition to the routine tests, the transformer shall be subjected to the following type tests:

a) Lightning Impulse Test

b) This test shall be carried out in accordance with clause 12 of the latest issue of IS: 2026 (Part-III). The bidder shall quote separate price for lightning impulse test on HV and LV windings. (One limb only).

c) Temperature Rise Test

d) The temperature rise test shall be carried out in accordance with IS:2026 Part-II. The Temperature rise shall not exceed the values stated elsewhere in the specification.

1.28.17 Test Waival, Procedures and Costs

The purchaser, at his option, may waive impulse tests provided type test reports of impulse tests carried out on essentially identical units in their factory in India are furnished by the manufacture.

No load losses and exciting current shall be measured at rated voltage, rated frequency and at 90% and 110% of rated voltage, both before and after the lightning impulse tests.

The method of test loading shall be described in the test report for determination of both average and hottest spot temperature. Where the winding temperature equipment is specified, data shall also be included for calibration of hottest spot temperature indicator.

Resistance of each winding of each phase shall be measured at principal and at all the taps and corrected to 75°C.

Impedance voltage shall be measured at principal and at all taps.

No load Loss Measurement at 415 Volt.

The bidder shall indicate separately the cost of each of the following types tests:

Lightning impulse test separately for HV and LV winding

Temperature rise test.

1.28.18 Tests on Transformer Tank

Vacuum Test: One transformer tank of each size shall be subjected to the vacuum pressure of 760 mm of mercury. The tanks designed for full vacuum shall be tested at an internal pressure of 3.33 KN/m2 (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.

Pressure Test: One transformer tank of each size together with its radiators, conservator vessel and other fittings shall be subjected to pressure corresponding to twice the normal head of oil or to the normal pressure plus 35 Kn/m2 (5 1b/sq.in) whichever is lower measured at the base of the tank and will be maintained for one hour. The permanent deflection of flat plates after the excess pressure has been released shall not exceed the value specified in C.B.I.P. Manual on Transformers (Revised 1999).

The pressure relief device shall be subjected to increasing oil pressure. It shall operate before reaching the test pressure specified above. The operating pressure shall be recorded. The device shall seal off after the pressure in excess has been relieved (routine test).

Oil leakage test: All tanks and oil filled compartments shall be tested for oil tightness by oil of a viscosity not greater than that of insulating oil to IS: 335, at the specified ambient temperature and subjected to a pressure equal to the normal pressure plus 35 KN/m2 square (5 1b/sq.in) measured at the base of the tank. This pressure shall be maintained for a period of not less than 12 hours, during which time to leakage shall occur.

1.28.19 Test on Associated Equipment

Porcelain bushings, bushing current transformers, wherever provided, winding temperature indicating devices, dial thermometers, buchholz relays, OFF circuit tap changer, coolers, control devices, insulating oil and other associated equipment shall be tested by the supplier /contractor in accordance with relevant IS. If such equipment is purchased by the supplier/ contractor on a sub-contract, he shall have them tested to comply with these requirements.

1.28.20 Sequence of Testing on Assembled Transformer

Unless otherwise agreed, the sequence of testing shall be as follows:

a) Ratio and vector group

b) Winding resistance measurement

c) Insulation resistance measurement

d) Separate source voltage withstands test.

e) Measurement of Iron losses

f) Load losses and impedance voltage measurement.

g) Lightning impulse test

h) Temperature rise test.

i) Induced voltage withstands test.

j) Measurement of iron loss

k) Measurement of insulation resistance

l) Tests on OCTC

1.28.21 Test Measurements

The zero-sequence impedance, insulation power factor and capacitance for each winding and between windings shall be measured and recorded.

Certified test report and oscillograms shall be furnished to the Purchaser / Consultants for evaluation as per the schedule of distribution of documents. The Contactor shall also evaluate the test results and rectify the defects in the equipment based on his and the Purchaser’s evaluations of the tests without any extra charges to the Purchaser. 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. In case 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 testing's.

1.28.22 Witnessing of Tests and Excessive Losses

The Purchaser and / or his representative reserves the right to witness any or all tests, or to accord waival at its sole discretion.

The Purchaser reserves the right to reject the Transformer its losses exceed the declared losses beyond tolerance limits as per IS or if temperature rise of oil and winding exceed the values specified elsewhere.

1.28.23 Site Tests

After the transformer is installed, the following pre-commissioning tests and checks shall be done before putting the transformer in service.

a) Dry out test.

b) Megger test

c) Resistance measurement of windings

d) Ratio test

e) Phase relationship test

f) Tap changer test.

g) Buchholz relay alarm & surge operation test

h) Low oil level alarm

i) Temperature Indicators

j) Marshalling kiosk

k) Protective relays

l) Magnetising current

m) Tests on OCTC

n) The following additional checks shall be made:

o) All oil valves are in correct position closed or opened as required.

p) All air pockets are cleared.

q) Thermometer pockets are filled with oil.

r) Oil is at correct level in the bushing, conservator, divertor switch, tank etc.

s) Earthing connections are made.

t) Colour silica gel is blue.

u) Bushing arcing horn is set correctly, and gap distance is recorded.

v) CT polarity and ratio is correct.

1.28.24 Losses and Damages

Transformers with lower losses shall be preferred. The bidder shall indicate the values of load and no-load losses of the transformer in his bid. Losses quoted shall be firm, without any tolerance. If nothing is indicated regarding tolerance on losses, it will be considered that losses are subject to tolerance. In case no ceiling is specified, these will be taken as per IS and the offer shall be loaded as per Table 7 of latest issue of IS: 2026 Part-I or Table 1 of IEC 660076-1.

1.28.25 Rejection

The Purchaser may reject any transformer if during tests or service any of the following conditions arise:

a) No load loss exceeds the guaranteed value by 15% or more.

b) Load loss exceeds the guaranteed value by 10% or more.

c) Impedance value exceeds the guaranteed value by + 10% or more.

d) The difference in impedance values or any two phases during single phase short circuit impedance test exceeds 2% of the average value guaranteed by the vendor.

e) Oil or winding temperature rise exceeds the specified value.

f) Transformer fails on impulse test.

g) Transformer fails on power frequency voltage withstand test.

h) Transformer is proved to have been manufactured not in accordance with the agreed specification.

1.28.26 Instructions 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 others, the followings particulars:

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 tappings, 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 approve drawings.

f) Detailed O&M instructions with periodical check lists and proforma etc.

1.28.27 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 plant, shall be deemed to be included in the specification and shall be furnished by the supplier /contractor 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 the Purchaser under any circumstances.

All deviations from this specification shall be separately listed under the requisite schedules, in the absence of which it will be presumed that all the provisions of the specification are complied with by the bidder.

1.28.28 Tools & Tackles

All the necessary tools and tackles required for normal operation shall be supplied by the supplier or Contractor.

1.29 Technical specification for 11kv and 33kV Indoor gas insulated Switchgear (GIS)

The switchgear shall be an indoor gas-insulated and metal-enclosed 3-phase (R, Y, B) cubicle design (segregated SF6 insulated compartments for Circuit breaker and busbar systems). It shall be suitable for local and remote control. The switchgear shall be designed to ensure optimum continuity and reliability of supply as well as safety for operation. The high voltage section shall consist of two gas-tight non-magnetic stainless-steel / Aluminum tanks 2 mm thick and be built as a hermetically sealed pressure system. Each of the gas compartments shall have a filling valve, gas density monitoring by means of a temperature-compensated pressure sensor, and its own pressure relief system. The busbar connections between each panel are of nonbolded plug-in type. No additional gas filled box shall be used to connect two panels.

1.29.1 Standards

The design, manufacture, and performance of all the equipment and material provided under these specifications shall conform to the following IEC or Equivalent Indian Standards.

Table 1-20: Codes & Standards

Standard	Description
IS-5	Colors for ready mixed paints
IS-375	Marking and arrangement for switching, bus bars, main connection & auxiliary wiring.
IS-1554	PVC insulated cables up to and including 1100 Volts
IS-2147	Degree of protection provided by enclosures for LV switchgear and control gear
IS-3231	Electrical relays for power system protection
IS-3842	Application guide for protection relays (Part I to VIII).
IS-6005	Code of practice for phosphating iron & steel

IS-6867	Control switches
IS-8686	Specification for static protection relays.
IS-13010	Energy meters.
IEC-62271-102	Earthing switches.
IEC-62271-200	High Voltage Switchgear and Control gear
IEC 62271-100	High Voltage Alternating Current Circuit- Breakers
IEC- 62271-1	Common specifications for high voltage switchgear and control gear
IEC 61869-2	Current Transformers
IEC 60051	Direct acting indicating analogue electrical measuring instruments
IEC 61869-3	Inductive Voltage transformers
IEC 60265	High-voltage switches
IEC 62271-206:2011	High-voltage switchgear and control gear - Part 206: Voltage presence indicating systems for rated voltages above 1 kV and up to and including 52 kV
IEC 60071	Insulation Coordination
IEC 60073	Coding principles for indicating devices & actuators
IEC 62271-301	Dimensional standardization of terminals for high-voltage switchgear and control gear
IEC TS 62271-304:2008	Additional requirements for enclosed switchgear and control gear from 1 kV to 72,5kV
IEC TR 62271-300:2006	High-voltage alternating current circuit breakers - Guide for seismic qualification of high-voltage alternating current circuit breakers
IEC 60529	Degrees of protection provided by enclosures (IP-code)
IEC 60376	Specification and acceptance of new Sulphur hexafluoride

Unless otherwise specified, all the equipment and material shall conform to the latest applicable IEC Standards or its equivalent Indian Standards (IS). Equipment complying with any other International Standards will also be considered if it ensures performance of equipment equal to or superior to IEC/ IS.

1.29.2 System Details for Indoor 11kV & 33kV GIS Switchgear Panel.

a) 11 Kv/33kV systems shall be with solid grounding; therefore, switchgear shall be suitable for such an operating condition.

b) MV Switchgear Boards shall be of single bus bar type. The breakers shall be of fixed type on the floor and equipped with earth switches to earth the externally connected cables. The switchboard shall be installed in the switchgear room of the substation building. Detailed SLD shall be prepared by EPC Contractor for complete system understanding. Minimum 20% of spare feeders to be provided. Minimum one (1) spare feeder to be considered at each bus.

c) The two incoming feeders on the boards shall not run in parallel and shall be feeding the loads on the respective bus sections.

d) The substation where the indoor switchgear shall be installed and shall be suitable with conventional local operation as well as remote controlled through SCADA on IEC 61850

Protocol. For metering all the feeders at the respective board shall be operated on MODBUS for remote indications.

e) EPC Contractor shall submit CT/ PT parameter calculations.

1.29.3 General Design and Construction Requirement

The Switchboard shall have following features:

a) Fully Compartmentalized one (1) sets of 3 phase SF6 gas/ Solid silicon-insulated bus bar metal enclosures for each switchgear vertical, including the following:

   i. Three (3) phase, bar enclosures for each switchgear vertical.

   ii. Six (6) single-Phase two core Voltage Transformer three in each bus.

b) Bus coupler bay module comprising of:

   i. One (1) 3 phase, SF6 gas-insulated circuit breaker complete with dedicated operating mechanism including BCU and BPU.

c) Each Incomer / transformer bay modules comprising of:

   i. One (1), 3-phase SF6 gas-insulated Circuit breaker, complete with operating mechanism.

   ii. Three (3), 3 core, multi ratio, single phase current transformers

   iii. Three (3) single phase Surge Arrestors

   iv. One (1) 3 three position switch with inbuilt earthing mechanism, each complete with manual & motor driven operating mechanisms. SF6 Insulated VCB and 3-position switch shall be in same/ separate compartments as per type tested design.

   v. Three (3) single-phase terminal for direct connection with transformer through Inner/Outer cone bushings. 6. Bay mounted BCU and BPU.

d) Each Feeder Bay modules comprising of:

   i. One (1), 3 phase, SF6 gas insulated circuit breaker complete with operating mechanisms.

   ii. Three (3)-3 core, multi ratio, single-phase current transformers.

   iii. One (1), three position switches with inbuilt earthing, each complete with manual & motor driven operating mechanisms. SF6 Insulated VCB and 3-position switch shall be in separate compartments.

   iv. Three (3) single-phase terminals for connection through Inner/Outer cone bushings.

   v. Bay mounted BCU and BPU.

In both 33 kV and 11kV, Switchgear bus transfer scheme shall be provided for restoration of supply in case of supply failure from the respective incomer/Transformer. Manual/Auto live changeover with check synchronization as well as automatic slow changeover facility shall be provided as a backup. Both 33 kV and 11kV Station Switchboard shall have Auto/Manual live changeover provision.

1.30 Design Features of SF6 Gas Insulated Switchgear

1.30.1 General Description

The switchgear shall be an indoor gas-insulated and metal-enclosed 3-phase (R, Y, B) cubicle design (segregated SF6 insulated compartments for Circuit breaker and busbar systems). It shall be suitable for local and remote control. The switchgear shall be designed to ensure optimum continuity and reliability of supply as well as safety for operation. The high voltage section shall consist of two gas-tight non-magnetic stainless-steel / Aluminum tanks 2 mm thick and be built as a hermetically sealed pressure system. Each of the gas compartments shall have a filling valve, gas density monitoring by means of a temperature-compensated pressure sensor, and its own pressure relief system. The busbar connections between each panel are of nonbolded plug-in type. No additional gas filled box shall be used to connect two panels.

1.30.2 Switchgear operator interfaces

a) A standard user interface, ergonomically Positioned at a convenient height shall be provided. It must be visible directly without opening of doors etc. The user interface comprises all the mechanical, panel- related interfaces and continuous interrogating interlocks.

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

c) Mechanical mimic directly linked to mechanism shall be provided at the panel front door. The basic switchgear unit is to be designed for suitable freestanding installation within a switch room.

d) The Interlocking shall be provided, so that under no condition an earthed cable is changed.

1.30.3 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

The position of the individual elements has been selected according to their function, i.e. according to their allocation to the corresponding device functions.

1.30.4 Gas Compartment

a) SF6 Gas shall be the only insulating medium for the switchgear. In case of a gas leakage, the full insulation level shall be maintained in accordance with the requirements specified in IEC 62271 standard.

b) The gas-filled compartments are to be designed to be maintenance-free and hermetically sealed pressure systems in accordance with IEC 62271-200.

c) Each separate compartment or gas zone must be provided with its own device for monitoring continuously the gas density or alternatively pressure with a temperature compensated gas pressure monitor. These devices shall be arranged to give individual compartment indication in the local control units and initiation of remote alarm and automatic tripping. These shall be set in two stages. The first stage shall operate an alarm to warn that the gas pressure/density is falling to a critical level.

d) The second stage shall initiate automatic isolation of the gas section concerned by tripping associated circuit breakers as appropriate.

e) The maximum allowable loss of gas in a compartment shall not exceed 1% of pressure per annum during the lifetime of the switchgear.

f) No gas filling is required at site during bus bar connection & installation.

1.30.5 Enclosure and segregation

The bus bar system shall be designed with either one three phase or three single phase bus bar compartments.

Each cubicle shall be divided into at least under listed metal enclosed compartments with the following insulating medium:

a)	Busbar	Gas/ touchproof solid silicon insulated.
b)	Three position isolating switch	Gas insulated.
c)	Circuit breaker	Gas insulated.
d)	Connecting bushings for power cables	Gas insulated
e)	Cable compartment	Air insulated.
f)	Low voltage compartment	Air insulated.
g)	Drive Mechanism	Air Insulated

1.30.6 Circuit Breaker Interrupter

a) The MV switchgear interrupters shall be with vacuum bottles conforming to IEC 62271. The ratings shall be to meet the requirement as per scheme of operation.

b) The MV Switchgear shall be enclosed in the main tank using SF6 gas as insulating and vacuum as arc quenching medium or SF6 gas as both insulating and arc quenching medium. The main tank shall be stainless steel sheet of minimum 2.5mm thickness and robotically welded with a pressure relief arrangement.

c) Vacuum circuit breakers shall be designed with low switching over voltages (not exceeding 2.2 pu) and long switching life.

d) The vacuum interrupter shall be leak free and with highest degree of tightness.

e) It shall perform at least 100 operations at specified full short circuit current and up to 10,000 operations under all operating conditions. The circuit breaker mechanical & electrical endurance shall be as per IEC 62271-103

f) Necessary documentary proof and guarantees shall be provided in this regard to purchaser.

1.30.7 Auxiliary Contacts

a) The breakers and earthing switches shall have at least 5 normally open and 5 normally closed spare auxiliary contacts for Bay Control Units or RTUs, interlocks etc. over and above internally used by manufacturer. All auxiliary contact shall be wired to the terminal block. Auxiliary contacts and limit switches shall be in dust tight enclosures.

b) Auxiliary contacts shall be capable of carrying the maximum estimated current. In any case their rating must not be less than 10A-for 230 V A.C. at a power factor between 0.3 inductive and 1, and 2A for 110 V DC.

1.30.8 Drive Mechanism and Interlocks

a) The operating mechanism should be simple, rigid with operation at very low energy. The circuit breaker drive mechanism shall be designed for both manual and motor operation and shall allow auto reclosing.

b) The operating mechanism shall be equipped with push buttons controlling the circuit breaker and the three-position isolator switch. The mechanical operating and indicating elements shall be integrated in a mimic diagram, which shall be visible, when all doors are closed. Operation shall also be possible when all doors are closed.

c) The auxiliary voltage for motors and all kind of control circuits shall be 110V DC.

d) It shall be possible to charge the springs manually, if required, and in that case, motor shall be disconnected, and operator fully protected.

e) In case the limit switch fails to cut out the spring charging motor when the springs are fully charged, the motor shall be automatically decoupled and annunciation for this shall be provided.

f) Breakers shall be trip free and shall have an anti-pumping device.

g) The breaker shall be provided with closing solenoid, tripping 'solenoid and mechanical operation counter.

h) Mechanical trip push buttons shall be provided on each breaker.

i) The following mechanical operating and indicating elements shall be provided:

i. For circuit breaker:

ii. Mechanical push-button ON (close)

iii. Mechanical push-button OFF (trip)

iv. Mechanical indicator Spring charged/ discharged.

v. Mechanical switch position indicator

vi. Mechanical operations counter

j) For three position switch, isolator function:

i. Opening for inserting lever for manual ON/ OFF operation

ii. Mechanical switch position indicator

k) For three position switch, cable earthing function:

i. Opening for inserting lever for manual ON/ OFF operation

l) Provisions for padlocks shall be provided on the switchgear for locking the low voltage compartment and other live parts of the switchgear to be opened during maintenance for individual functions padlocks shall be provided as listed below (three ordinary keys for each lock shall be supplied).

m) Locking the Isolator/ Earthing Switch in the isolated and earthed position

n) Locking the C.B. control switch

o) Locking the local/ remote switch

p) Suitable wall mounted metal cased key cabinet shall be provided. In each key box provisions shall also be foreseen to keep permit books and danger boards.

q) A copper earth bus of minimum 50x6 sq. mm shall be provided at bottom in each panel. Doors and moving parts shall be earthed through flexible copper wires.

1.31 Space Heaters

The cubicles shall be provided with encapsulated DIN Rail Mountable UL approved PTC type space heaters to prevent moisture condensation and to maintain cubical temperature 5°C above the ambient. The space heaters shall be located at the bottom of the switchboards and shall be controlled through a UL approved Hygro-thermostat with an adjustable setting and an MCB. The thermostat shall be located in the metering/relay chamber.

1.31.1 Base Frame

The panels shall be suitable to be installed on a base frame supplied in one piece along with foundation bolts and the same shall be in the scope of supply.

1.31.2 Interlocking System

The interlocking system regarding mechanical operating lever actuation shall be such that an operating lever can only be inserted or that actuating forces may only act on the components of this is permitted by the appropriate operating condition of the function unit.

The interlocking system should comply with the following interlocking conditions:

a) Interlock between busbar isolator and outgoing earthing switch.

b) Interlock between busbar isolator and circuit-breaker.

c) mechanical interlock between the switch disconnector and the outgoing earthing switch(es)

d) Interlock between the cable compartment cover and the outgoing earthing switch(es) (for cable testing, specific equipment must be provided to eliminate the outgoing earthing)

e) mechanical interlock between the coupled outgoing earthing switches and the metallic power cable chamber covers

f) The power cable are only accessible when the earthing switches are ON.

g) It must only be possible to remove or insert actuating levers in clearly defined positions “CLOSE” or “OPEN”.

1.31.3 Cable compartment & termination

a) The incoming and outgoing power connections shall be through three core XLPE cables with entry from bottom and from the front/ rear of the Board.

b) All equipment connections and cabling shall be designed and arranged to minimise the risk of fire and damage which may be caused by it.

c) Earth strip shall also be brought to this box for armour earthing.

d) The cable chamber should be at the front/rear of panel and suitable to terminate at least 3 number of three core (or single core if required) aluminium cables of size 300 mm2, from bottom. No depth wise extension shall be acceptable.

e) Cable compartment shall be preferably on the outside of the switchgear with cable outlet down warts to the bottom. The compartment and the termination as well as the gland plate shall be designed for connection of single as well as three core power cables. It shall also be possible to connect two or three single core cable per phase. Furthermore, it shall be possible to connect plug-in surge arresters in sockets for power cables.

f) The cable compartment shall be designed to connect power cables in cable terminations via plug-in cable sealing ends. Connection of different sizes and numbers of cables per system as already mentioned above must be possible. Suitable cable plug-in sealing ends have to be provided. Details regarding size and number of necessary sealing ends shall be co-ordinated with design and size of power cables and the necessary surge arresters.

1.32 Metering, Protection, Indication & Auxiliary Switches

1.32.1 General Requirements for Instruments

Multifunctional Measuring instruments, with an accuracy of class 0.5S or better shall be of digital type, with minimum 3-line LED display and conforming to relevant IS / IEC & shall be of an approved type & design suitable for tropical climate and condensing type humidity. Measurement shall include voltage, current, pf, KW, KVA, KVAR and Neutral current. It shall have NFC feature with RS 485 communication port.

All instruments shall be back connected, and instruments cases shall be earthed.

The instruments safety factor shall be equal to or less than 5.

1 Protection MV & LV

a) Line Feeder

i. One three pole three position switch

ii. One three pole circuit breaker

iii. Three current transformers

iv. Three voltage transformers

b) Transformer Feeder

i. One three pole three position switch

ii. One three pole circuit breaker

iii. Three current transformers

iv. Three voltage transformers

c) Bus Coupler/ Busbar Section

i. One three pole circuit breaker

ii. Three current transformers

d) Station Supply Feeder

i. As per transformer feeder.

e) Measuring Cell

i. Three voltage transformers complete with secondary circuit protection for voltage measurement of busbar.

ii. Busbar earthing switch (part of Buscoupler)

iii. Function of the measuring cell may be integrated in another panel.

2 Low Voltage Compartment

The cubicles shall be equipped with the following devices, which can also be grouped in one or several multifunctional units:

a) Transformer Incomer

i. One bay control unit

ii. One three-phase kWh-meter with maximum demand indication (15 min.) complete with required time switch.

iii. One three-phase kVArh-meter

iv. Protection relays as specified.

v. Auxiliary relays as required.

vi. Time relays as required.

vii. Terminal blocks as required.

b) Line Feeder

i. One bay control unit

ii. One three-phase kWh-meter with maximum demand indication (15 min.) complete with required time switch.

iii. Protection relays as specified.

iv. Auxiliary relays as required.

v. Three voltage indicators

c) Bus Coupler/ Busbar Section

i. One bay control unit (The BCU may contain all necessary control and indication functions for the busbars)

ii. Protection relays as specified.

iii. Auxiliary relays as required.

iv. Three voltage indicators

d) Station Supply Feeder

i. Three ammeters 0-120% scale (to match the C.T. ratio) with maximum indicator.

ii. Terminal blocks as required.

e) Measuring Cell (if applicable)

i. One semaphore position indicator for earthing-switch of Busbar

ii. One voltmeter with selector switch for star/ delta measurement of busbar voltage

iii. One signalling combination relay for 10 signals to serve all requirements for the MV switchboard.

iv. One annunciating table for at least 10 signals (5H x 2W) to serve all requirements for the MV switchboard.

v. Terminal blocks as required.

(One or more indication and measuring functions may be included in the BPCU for the related bus coupler or the bus section).

The trip circuit supervision scheme shall continuously monitor the trip circuit before and after closing of each breaker panel.

3 Instrument Transformers

The instrument transformers required for the switchgear shall conform with the respective standards specification.

4 Voltage Transformers

The Voltage Transformers (VT) shall be of dry compound epoxy insulated inductive type. The VT shall be protected on their primary sides by current limiting fuses or through Damping resistance. On the secondary side, the circuit shall be protected by MCB's. Provision shall be so made that the primary fuses can be handled only in the PT drawn out position. The particulars of the voltage transformer are:

Type	:	Cast Resin.	
Rates Voltage	:		
Accuracy	:	1.0	3P
Burden	:	50 VA or as per system requirement.	

Note: Contractor shall design the voltage transformer as per system requirements, and alternate arrangement, if any, shall also be considered. PT calculations shall be submitted for the required protection.

5 Current Transformers

a) The CTs shall be cast resin ring type, suitable for metering and protection requirements, air insulated and shall be able to withstand the thermal, dynamic, and mechanical stresses resulting from the maximum short circuit and short time current rating of the switchgear. CT should be suitable for continuous operation at 130% of its rated current.

b) CTs shall have polarity marks engraved on each transformer and at the associated terminal blocks. Facility shall be provided for short circuiting and earthing the CT secondary at the terminal blocks by the use of shorting type terminals.

c) CT ratio, burden, accuracy [1.0 for metering and 5P for protection] and other requisite parameters shall be suitable for the required protection function relay. CT calculations in this regard shall be submitted.

1.32.2 LV Compartment

This shall house relays, control switches, instruments, bay control units or Input/ Output cards etc. as given below.

All operating instruments, resetting flags, switches, setting and adjustment points shall be at a convenient height, easy to operate and read and in no case beyond 1700 mm and less than 700 mm from ground. Only MCBs shall be used for control and auxiliary supplies. No fuses shall be used in LV schemes.

The sub-station can be an unattended one and remote controlled from Load Despatch Centre (LDC) via SCADA or from a PC in the control room. Besides it, the switchgear shall be controlled from local panel in the switchgear room.

The following are the minimum requirements for L V Compartment.

1 Metering for 11kV switch boards.

a) All indicating meters shall be digital of 96x96 mm size and with four-line graphic LCD display.

b) Each feeder shall have the multi-function, combined type digital three phase meters of three wire type having accuracy class of 0.5 or better. Each incomer, outgoing line, and transformer feeders to have at least, provision for display of MW, MVA, Power factor, current, voltage, MWH and MVARH, meter with 15-minute maximum demand. Meter shall also measure harmonics. Minimum display update shall be at least of 1 sec.

c) The auxiliary supply voltage shall be 110V DC.

d) Each bus section shall have two indicating digital four line voltmeters of 0.5 or better accuracy with a selector switch to measure phase to phase and phase to neutral voltage for each section of bus bar. One frequency meter shall also be provided on each bus with 1% accuracy to display system frequency. In addition, the transformer feeder shall have an additional digital voltmeter to indicate transformer-incoming voltage.

e) Test terminals blocks shall be provided so that the meters can be calibrated without disconnecting the CT/ PT wires.

2 SCADA Control

In each panel, switchgear manufacturer shall make provision for bay control protection unit (BCPU) and MODBUS for remote metering, for the digital remote control, monitoring, and data acquisition.

3 Protective Relays

a) All protective relay schemes should be with numerical relays and complete in all respects with hardware and software. Only relays of internationally reputed companies shall be acceptable and shall need the prior approval of purchaser. For SCADA communication the standard applicable shall be IEC 61850.

b) The numerical relays shall be with programmable logics capable of communicating with Substation RTUs via fibre optic serial bus through IEC Standard 61850. All the features inherently available with the numerical relays shall be brought out so as to utilize them at no additional cost to purchaser.

c) All relays shall be mounted at a convenient height for easy accessibility. All relays shall conform to the requirement of IEC 60255 in addition to IS: 3231.

d) Relays shall be suitable for semi flush mounting with only flanges projection on the front with connections from the rear. Relays shall be rectangular in shape and have dust tight transparent covers removable from the front. Relay cases shall be painted with dull black or black enamel paint. However type tested & established design shall be acceptable.

e) Relays shall be in draw out cases or plug in type/modular cases with plug in type test blocks, with proper testing facilities. Necessary test plugs shall be provided and included in scope of supply. All AC relays shall be suitable for operation on 50 Hz.

f) VT Voltage operated relays shall be suitable for 110 volts phase to phase or as specified.

g) Relays shall have contacts and flags as required to complete the scheme. No control relays shall trip the circuit breaker when relay is de energised.

h) All relays shall be self-reset or electrically reset type as per scheme requirements.

i) Provision shall be made for easy isolation of the trip circuit for each relay for the purpose of testing and maintenance.

j) All relays shall withstand a voltage of 3.0 kV, 50 Hz voltage dry for one minute.

1.32.3 Protection schemes for MV switchgears

Detailed SLD shall be prepared by EPC contractor with required protection schemes. The details given below refer to main protection schemes and shall be deemed to include all timers, auxiliary relays, tripping/ lock out relays, alarms, indications etc. so as to complete the schemes in all respects for the feeders.

1 Incoming Panels:

Three over current and one earth fault (directional and non-directional relays) having IDMTL, other current vs time characteristics, along with instantaneous elements.

2 Outgoing transformer feeder: (33/11 kV, Dyn11)

a) Three O/C (50/51), IDMTL (50 to 200%), all with Instantaneous elements (400 - 1600% to infinity along with an earth fault relay for transformer faults.

b) One transformer differential relay with second harmonic restraint and over fluxing feature for transformer above 5MVA.

c) One Restricted earth fault relay for 11 kV winding (line CT to match neutral CT)

d) Auxiliary relays etc. for all the protections mentioned on the transformer.

3 Bus Coupler Panel

Three over current relays (50 to 200%), and one earth fault relay (20 to 80%), non-directional, IDMTL (50/51).

4 Outgoing line feeders:

Over current (50 to 200%) and one earth fault (20 to 80%) IDMTL, directional, with high set units typically 4 to 16 times/ to infinity (50/51/50N/51N).

1.32.4 Protection Schemes for 11 kV switch Board

1 Incoming Panels:

Three over current and one earth fault (directional and non-directional relays) with IDMTL characteristics.

One standby earth fault relay fed from transformer neutral CT.

2 Bus Coupler Panel

Three over current relays (50 to 200%), and one earth fault relay (20 to 80%), non-directional, IDMTL (50/51). If required load shedding relays shall also be installed for each bus section.

3 Outgoing line feeders:

Over current (50 to 200%) and one earth fault (20 to 80%) IDMTL, directional, with high set units typically 4 to 16 times/ to infinity (50/51/50N/51N).

4 Station Supply Feeder

a) Three ammeters 0-120% scale (to match the C.T. ratio) with maximum indicator.

b) Terminal blocks as required.

5 Control & Indications

Breaker tripping, closing, spring charging motor, alarms and indicating devices shall be suitable for operation at 110 V DC. For feeding space heater, lamps & internal panel lighting 230 V, 50Hz, single-phase AC supply shall be used. SCADA and communication shall be fed from 48V DC supply.

Breaker/ earth switch positions (ON/OFF, Spring charged/ service position) shall be indicated mechanically and electrically.

Electrical LED indications with colours as below shall also be provided.

a)	Breaker / earth switch 'ON/ closed'	Red lamp.
b)	Breaker/ earth switch 'ON/ closed'	Green lamp.
c)	Breaker 'Auto Trip'	Amber lamp
d)	Trip circuit healthy	White Lamp
e)	DC fail	Yellow Lamp
f)	Spring charge	Blue Lamp
g)	Breaker in remote	as per manufacturer

For the above contacts for indication at remote via SCADA system shall also be provided. Above indications, if provided in switch mimic, or otherwise on the switchgear panels as per standard design of manufacturer can also be considered.

6 Other Items

For each board the following shall be provided.

a) One control switch for circuit breaker operation.

b) One switch for local/ remote operation

c) Trip supervision relays, both with breaker open and closed.

d) Test terminal block for testing of meters.

e) Test terminal block for testing of relays.

f) Set of auxiliary relays, timers and tripping and lockout relays required to complete the scheme.

g) Inter tripping of LV side breaker with HV side breaker and vice versa wherever required for transformer breakers.

With two incomers and bus coupler, changeover scheme, if required, shall also be provided.

h) Push buttons for auto trip reset & D.C. supply failure test etc.

i) Panel power supply socket and panel light.

j) Cut outs for SCADA items.

k) Providing complete wiring up to terminal boards for all required signals for SCADA.

l) MCBs of approved make (no fuses shall be used)

Any other indication, relay, alarm not indicated above, but required to complete the scheme shall be provided without any financial liability to purchaser.

Note: Annunciation scheme for the board shall be approved during detailed engineering.

External Control Cable Termination

m) Control cables shall enter the switchgear from the bottom.

n) Cable lugs and requisite cable glands (double compression type, chrome plated brass) for these cables are also included in the scope of supply of the switchboard.

o) Supports shall be provided for clamping the control cables.

p) 3mm thick, Aluminium gland plate shall be provided.

1.32.5 Lightning Arresters

a) The lightning arresters shall be of the hermetically sealed plug-in type (metal encapsulated) with metal oxide material having non-linear resistance, with provision to measure leakage currents.

b) They shall be attached to the cable terminations of the related feeders. The lighting arresters shall be maintenance free and shall have a pressure relief device for failure protection. However OEM specific touch-proof design without pressure relief device shall be accepted.

c) Connection to the substation grounding system shall be by stranded copper wires of adequate cross-section.

d) The lightning arresters shall be constructed and tested in accordance with the latest edition of the relevant IEC/ IS standards for metal-oxide surge arresters.

e) The tests shall be carried out at factory.

f) The Contractor is requested to examine the detailed requirements given thereafter and shall complement any components found necessary to establish a correct working neutral grounding system.

1.32.6 Accessibility

Checking and removal of components shall be possible without disturbing adjacent equipment. All equipment shall be easily accessible. It shall be possible to set all 'measuring' relays 'in-situ' without de-energizing the switchboard. All mounted equipment shall have 'identification' tags in the rear in addition to the identification numbers painted on the panel wall, to give permanent identification mark. Mounting of relays for a particular breaker panel shall be limited to that particular panel only.

Under no condition it shall be possible to have accidental contact with live terminals.

1 Auxiliary wiring, terminal blocks, and External connections

Inside the cubicles wiring for control, signalling, protection, and instrument circuits shall be done with PVC insulated FRLS, electrolytic, tinned copper stranded (minimum 80 strands) conductors. The insulation grade for wires and terminal blocks shall be 1.1 kV.

2 Auxiliary wiring

a) The panel wiring shall be as follows:

   i. 2.5 mm² for CTs, lighting and heater circuits up to 10A

   ii. 1.5 mm² for instrument, all control wiring circuits and voltage transformers.

   iii. 0.5 mm² for all others

   The bare ends of stranded wires shall be provided with squeezed sleeves.

b) Wiring shall be neatly run in PVC rigid non-flammable plastic wire-ways, clear of any metal panels and filled not more than 70 % or bundles with no bunch containing more than 12 wires.

c) All power and control cables used for less than 60 V DC shall be laid and terminated separately. Where power and control cables cannot be laid separately, suitable metallic barriers shall be provided.

d) All panel wires shall be identified at both ends with numbered ferrules according to the wiring diagrams. Ferrules shall be of insulating materials with glossy finish to prevent adhesion of dirt. They shall be clearly and permanently marked. Temporary marking shall not be used.

e) All internal control wiring shall be done. The inter panel wiring shall be taken through PVC sleeves or suitable grommets. Multi pin plug provided should have scraping earth terminal.

f) All power circuits, control and protection wiring and low-level signal wiring shall be physically separated. Separate raceways shall be provided for power cables and the working voltage of each power circuit shall be marked on the associated terminal boards.

g) All Interposing relays if used shall be with slim design and built in fuse of SSR/EMR Type 6A with electrical life of 60000 cycles and temperature rating of 70 Deg C

h) As far as reasonably possible, all outgoing wiring should be grouped by function (CT, VT, Trip, Alarm, etc.) with those going to a common destination allocated to adjacent terminal blocks Labels shall be provided on the fixed portion of the terminal boards showing the function of the group.

i) Connections for indicating instruments and for the telecommunication circuits from transducers or modem outputs shall use individually twisted wires pairs and the pairs shall be shielded. One (1) extra terminal per pair of terminals shall be provided to connect the shield to ground.

j) If wiring is provided between swinging panels, bundled conductors shall be used on the hinged doors or panels with extra/flexible wire, arranged as such that a twisting rather than a bending motion is imparted to the moving bundled conductors. Each bundle shall be anchored such that the moving bundled length is the maximum available without loops.

k) All secondary wiring for connection at Site shall enter the terminal block at one side only.

l) Internal wiring between instruments or other devices not using the terminal block shall be permitted within the same compartment only.

m) Whenever required and necessary, armoured, and shielded cables and/ or groups of cores shall be provided for control, protection, and supervisory equipment.

n) Generally, for wiring, the cable tails shall be bound as such that each wire may be traced back to its associated cable without difficulty. Cores in pairs or groups shall be terminated together.

o) All incoming control cables shall contain minimum 20 % spare cores and be connected to terminal blocks, with 20 % spare terminals of each type. Any further spare cores shall be numbered and connected in further spare terminals.

p) All spare contacts of auxiliary relays, timers etc. shall be wired up to the terminals.

1.32.7 Terminal blocks

a) Terminal blocks (Phoenix make preferred) shall be mounted so as to give easy access to wire terminations.

b) The AC, DC, current and voltage transformer inputs shall be separately grouped and adequately protected. Each wire shall be connected to an individual terminal, which shall have a clearly lettered marking strip corresponding to the wiring diagram.

c) Only one external wire shall be connected to each outgoing terminal point.

d) Current transformer or voltage transformer circuit shall be connected to a single terminal block; they shall not split between two blocks.

e) Terminal blocks shall consist of single "insertion" type terminals of non-tracking, non-inflammable synthetic plastics of an approved type, lined up in one row.

f) Polycarbonate terminals are not acceptable.

g) All terminals shall have two separate pressure clamping plates suitable for connection of incoming or outgoing stranded or solid conductors, however only one wire per terminal will be accepted.

h) Terminals with clamping screws in direct contact with the conductor are not acceptable.

i) The following minimum categories of terminals shall be used:

j) Terminals for power circuits of 2.5 mm² size

k) Terminals with short circuit and isolation facilities for C.T. circuits of 4 mm² size, provided with insulated testing sockets and earthing link terminals.

l) Terminals with isolation facilities for V.T. and tripping circuits, provided with insulated testing sockets.

m) Terminals for wiring of 1.5 mm² and 0.5 mm² size with bridging facilities to neighbour terminals.

n) Insulating barriers shall be provided between each group of power circuit terminals and between the terminal categories, the height and the spacing being such as to give adequate protection to the terminals.

o) There shall be a minimum clearance of 250 mm between the first row of terminal blocks and associated cable gland plate. Also, the clearance between two rows of terminal blocks shall be a minimum of 150 mm.

p) Control terminal blocks shall be got approved from purchaser before use.

1.32.8 Earthing in LV Compartment

a) All metallic cases of relays, instruments and other panels mounted equipment shall be connected to earth bus by independent copper wires of size not less than 2.5 sq. mm. The colour code of the earth wire shall be green. Earthing wire shall be connected on terminals with suitable clamp connectors and soldering shall not be acceptable.

b) Shunt looping of earth connections to provide alternative paths to earth bus shall be provided.

c) The VT and CT secondary neutrals or common lead shall be earthed at one place only at the terminal blocks where they enter the panels. Such earthing shall be made through links so that earthing may be removed form one group without disturbing continuity of earth to other groups.

1.32.9 MCBs

a) Each control panel shall be provided with MCBs for receiving, distribution and isolation for DC and AC supplies for various control, signalling, lighting, and space heater circuits. The incoming and sub circuit shall be separately provided with the separate MCBs.

b) Potential circuits for relaying and metering shall also be protected by MCBs.

c) Selection of the main and sub circuit MCB rating shall be such so as to ensure selective clearance of sub-circuit faults with alarms wherever required through auxiliary contacts.

d) No fuses shall be used in the panel and make of MCBs shall be subject to approval of purchaser.

e) Push Buttons

i. Push button colours shall be as follows:

ii. Start, close — Red

iii. Stop, open — Green

iv. Trip circuit 'Healthy' check — Black

v. Red push buttons shall be on the right side and green push buttons on the left side.

vi. Push button ratings shall be '5A at 220 VAC' & 0.25 pf and 5A at 110 V DC (inductive load).

1.32.10 Indicating Lamps

If required, on the panels low power consumption indicating lamps of LED type shall be used. Indicating lamps shall be suitable for the voltage indicated in Technical Particulars. Lamps shall be provided with translucent lamp covers to diffuse light and duly tested for its rating. Bulbs and lenses shall be interchangeable and easily replaceable from the front of the panel.

Tools if any required for replacing the bulbs and lenses shall be supplied with the panels.

1.32.11 Name Plates

a) A nameplate with the switchgear designation shall be fixed at the top of the central panel. A separate nameplate giving feeder details shall be provided at front and rear for each panel also. The nameplates should be bold and large in size especially at the rear.

b) Nameplates shall be provided for each equipment (lamps, push buttons, switches, relays,

c) Auxiliary contactors etc.) mounted on the switchboard. Special warning plates shall be provided on all removable covers or doors giving access to high voltage cables/bus bars. Special warning labels shall be provided inside the switchboard also, wherever considered necessary. Identification tags shall be provided inside the panels matching with those shown on the circuit diagram.

d) Engraved nameplates shall preferably be of 2-ply (Red- White- Red or Black- White-Black) limacoid sheets or anodised aluminium. However, black engraved Perspex sheet nameplates will also be acceptable. Engraving shall be done with square groove cutters. Hard paper nameplates will not be acceptable. Nameplates shall be fastened by 'Screws' and not by adhesives. The label designation and size of the lettering on the labels shall be typically with letter height of 4mm and lying 0.3 mm thick shall be subject to approval of the Purchaser.

1.32.12 Painting

1 General

a) All sheet steel work shall be phosphate in accordance with IS: 6005 'Code of practice for phosphating iron and steel, through seven tank process. Oil, grease, dirt shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water, and drying. After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying.

b) The phosphate coating shall be sealed with the application of two coats of ready mixed stoving type zinc chromate primer. The first coat may be air dried while the second coat shall be stove dried.

c) After application of the primer, two coats of finishing synthetic enamel, paints

d) shall be applied, each coat followed by stoving. The second finishing coat shall be applied after completion of tests.

e) Panels shall be painted with epoxy paint of superior quality.

f) ALTERNATIVELY, the panels shall be painted with electrostatic epoxy powder coating process (preferred) to have paint of hard coating. Necessary details shall be provided to purchaser in this regard for approval.

2 Paint Thickness

The final finished thickness of paint film on sheet shall be approximately 60 to 80 micrometeor.

The finished painted surface of panels shall present aesthetically pleasing appearance free form dents and uneven surfaces.

3 Paint Shade

The colour for finishing paint shall be Siemens grey as per RAL 7035. Unless otherwise desired the same shall be got confirmed from the purchaser before taking up painting. Each coat of primer and finishing paint shall be of slightly different shade to enable inspection of the painting.

4 Spare Paint

A small quantity (one litre per board) of finishing paint shall be supplied for minor touching up required at site after installation of the panel.

5 Tools & Plants

All the necessary tools and plants, handles and other required items for the operation and maintenance of the switchgear, SF6 gas handling & instrumentation spring charging and contact travel shall be brought out and provided separately for each board.

6 Earthing & Safety

a) An earthing arrangement shall be provided in each panel to earth the external cables and mechanically interlocked to open covers for cable when switchgear is tripped.

b) The earth switch short circuit rating shall be same as that of the switchgear.

c) It must not be possible to earth a live feeder or bus bars under any condition.

d) Captive voltage indicators shall be provided to continuously monitor the cable charging.

e) All panels shall be equipped with an earth bus securely fixed along inside base of the panel. The material and the size of the bus bar shall be at least 50x10 mm copper strip when several panels are mounted adjoining each other. The earth bus bar shall also be suitable for connection to future adjoining panels on either side. Provisions shall be made on the earth bus bar on both end panels for connecting to purchaser's earthing grid. These shall be at least two earth points to comply with IE Rules.

f) Necessary terminal clamps and connectors of adequate size and current carrying capacity for this purpose shall be included in the scope of supply.

7 Locking Arrangement

Whenever permit to work is taken on switchgear all the items of switchgear, earth switches including switches from local/ remote position which can make system live or operate it, shall have provision for locks.

Manufacturer shall provide details in this regard during detailed engineering.

8 Surge Arrestors

All the panels shall have surge arrestors as given in technical particulars. These shall be connected in the cable chamber to the incoming/ outgoing cables and grounded independently.

1.32.13 Inspection & Testing

Equipment can be inspected during manufacture. Type and Routine tests shall be conducted as below:

1 Type tests.

Equipment should be type tested one as per latest IEC. The test certificates more than five years old shall not be acceptable. However CEA/ MSEDCL norms for type test validity shall prevailed.

Type test certificates must be submitted for the following.

a) Impulse test

b) Short circuit rating test

c) Temperature rise test.

d) Mechanical endurance test

e) Degree of protection test.

f) Internal arc test.

2 Routine Tests

All routine tests shall be conducted as per relevant IEC and witnessed by purchaser.

1.32.14 Completeness of Equipment

The switchgear shall be operated from a microprocessor-controlled workstation or locally from switchgear. In this regard all the necessary requirements of the microprocessor system such as low electromagnetic noise levels, special internal cabling, earthing etc. or of the relays provided on the panel board for communication with microprocessor system, which are specifically to be met by switch gear manufacturer for the items supplied/ manufactured, shall be provided without any financial liability to purchaser.

Besides the above if any other item not specifically indicated here but required to complete the switchgear, or required for its satisfactory operation (such as spring charging handles, contact travel gauge, etc.) or to complete the protection schemes or required to earth the switchgear or external feeders shall be brought out and its price indicated separately failing which it shall be deemed to be included without any financial liability to the purchaser under any circumstances.

1.32.15 Documentation Requirements

All the information and documents related to the project shall comply with the latest edition of the IEC 62271-200 standard. The manufacturer shall submit the following documents at the delivery of the equipment's. Both paper & electronic copy (6 copies) in Auto cad & word / PDF shall be supplied.

Following documents to be supplied with quote:

a) General arrangement drawings

b) Sectional plans

c) Dimension & weight

Following documents shall be submitted along with the equipment:

d) General arrangement floor plan drawings.

e) Single line diagrams drawings.

f) Logic diagram, detailed schematic & wiring diagrams, and bill of material for each functional unit.

g) Complete details for all loops, interfaces, connection diagrams, terminal diagrams and wiring of all circuits.

h) Evidence of type test reports and complete routine test reports.

3 Instruction manual including

a) General characteristics of switchgears

b) Foundation detail

c) Handling, transport, and storage manual

d) Installation manual

e) Operation & Maintenance instruction manual

4 A "USER'S MANUAL" CD including:

a) Catalogue of the switchgears

b) Animation based on 3D drawings and voice to explain how to perform all the operations with the switchgears.

c) Animations based on 3D drawings and voice to explain how to perform all the storage, handling, and tests of the switchgears on site.

d) All the necessary MV panel board layout, switch gear, external power cable termination, external control cable connections, etc. along with plan and side sections as appropriate shall be supplied by the manufacturer.

1.32.16 Make of Items

All the auxiliary items of equipment shall be of proven design and of international standards. The purchaser shall approve make of all such major items before fabrication.

1.33 Drawings and Manual

1.33.1 Main Technical Particulars

Table 1-21: Technical particulars for 11KV GIS

S.No.	Particulars	11kV	33kV
1	Standards	IEC 62271-100 & 200	IEC 62271-100 & 200
2	System Earthing	Solidly earthed	Solidly earthed
3	Operating voltage (U0/U), kV	6.35/11	19/33
4	Rated ambient temperature, °C	50	50
5	Rated voltage, kV	12	36
6	Rated short-time withstand current (1s), (kA)	25	25 for 3 sec
7	Rated peaks withstand current, kA	62.5	62.5
8	Frequency, Hz	50	50
9	Degree of protection	IP4X	IP4X
10	Insulation medium	SF6 Gas	SF6 Gas
11	Conductor material	electrolytic copper	electrolytic copper
12	Impulse withstands voltage (peak)	95	170
13	One Minute Power frequency withstand RMS voltage, kV	28	70
14	Bus bar rated current at 50°C. (40 °C/24 h average), A	As per design calculations	As per design calculations
15	Operating sequence:	O-0.3s-CO-180s-CO	
16	Temperature rise over design ambient	As per relevant IEC	

1.34 Technical Specification for 11KV & 33KV Ring Main Unit

1.34.1 General

a) The RMU for the compact substation shall be 3 way or 4 way or 5 way or 6-way, 12 kV/36kV, extendable type, free standing, indoor / outdoor, metal clad SF6 insulated Ring Main Unit (RMU) along with metering, PTs, CTs etc.

b) The indoor type 11kV RMU shall form a part of CSS in an unattended substation, which includes a transformer & LT Board also and all the three equipment shall be housed in an enclosure.

c) The outdoor type 11kV/33kV RMU shall be extendable type and stand alone.

d) Two numbers, fault making / load breaking, motor operated, line side switches, fitted with indications for phase and earth fault along with associated CTs. The load break switches shall be connected via underground XLPE Cables.

e) Outgoing feeder of RMU shall have, Tee-off, spring operated, Circuit breaker with sealed for life vacuum interrupter complete with meters, CTs, Protective and self-powered relays to control desired number of 11/0.433 V or 33/0.433 V distribution transformer or equipment's with complete arrangement to connect the tee-off circuit breaker to the 11 kV or 33kV side of the power transformer.

f) The springs for closing the load break switches & tee-off circuit breaker shall be motor operated.

g) The opening & closing for the load break switches as well as tee-off circuit breaker shall be carried out electrically from remote via SCADA connected by FOC, besides local / hand operation. Built in compact battery [with no maintenance of any type] with charger shall be part of supply for this purpose.

h) The breaker shall have necessary over current and low sensitivity earth fault protection on the delta connected, 11 kV or 33kV side of the distribution transformer. It shall have basic metering features also to monitor these in RMU.

i) RMU shall also be equipped with necessary Remote Terminal Units, transducer's etc. complete in all respects, since these RMU's shall be having provision for SCADA with remote control. The provision for requisite control & indications shall be provided in the RMU's & substations.

j) Fault passage indicators, Feeder Remote Terminal Units, with self-healing feature, communicating with each other in the Ring circuit shall ensure automatic isolation of faulty cable and restoration of supply in case of cable fault in the system, using Fibre-Optic based communication.

k) There shall be continuous monitoring of supply on 12 kV/36kV cables via capacitive voltage indicators.

l) The RMU shall be complete in all respects including elbow type cable termination arrangement [with shrouds] in air from bottom, gland plate, foundation channels, bolts, inter connection arrangement etc.

m) The external dimensions shall be identical throughout the length of the 11kV/33kV board.

n) The operation of any of the switching functions shall be simple with only three possible positions viz. closed, open and earthed. The earthing switch shall be placed on cable side. The earthing of cable is to be done by an independent fault making switch.

o) All the necessary safety interlocks between switching devices, earthing switch and cable box covers shall be integrated.

p) The accessories and LV auxiliaries (i.e. motor mechanism, coils, auxiliary switches etc.) shall be the same for the entire range of switching functions, load break switches or circuit breakers. They can be installed on site without any dedicated tool and training.

q) Any other item not included above but required to complete the works shall be deemed to be included in RMU, without any financial liability to the purchaser.

1.34.2 Standards

Unless otherwise specified, all equipment and material covered in this specification shall conform to the latest applicable Indian / IEC Standards. Equipment complying with any other international standards will also be considered if it ensures performance of equipment equal to or superior to Indian Standards. Copy of such a standard shall also be supplied.

Table 1-22: List of applicable standards for RMU

S.No.	Standard Number	Description
1	IEC 62271-1	High-voltage switchgear and control gear – Part 1: Common specifications
2	IEC 62271-200	High-voltage switchgear and control gear - A.C. metal-enclosed switchgear and control gear for rated voltage above 1 kV and up to and including 52 kV.
3	IEC 62271-103	Switches for rated voltages above 1 kV and less than 52 kV
4	IEC 62271-100	High-voltage switchgear and control gear – Part 100: High-voltage alternating current circuit breakers.
5	IEC 62271-102	High-voltage switchgear and control gear – Part 102: High-voltage alternating current disconnectors and earthing switches
6	IEC 61958	High-voltage prefabricated switchgear and control gear assemblies – Voltage presence indicating systems.
7	IEC 60529	Degrees of protection provided by enclosures (IP Code)
8	IS:722	A.C. electricity meters
9	IEC 60044-8	Instrument transformers – Part 8: Low Power Current Transducers
10	IEC 60044-1	Instrument transformer – Part 1: Current transformer
11	IEC 60044-2	Instrument transformer – Part 2: Voltage transformer
12	IEC 60255	Electrical relays
13	IS: 5	Colours for ready mixed paints and enamels
14	IS:1248	Electrical Indicating Instruments
15	IS:1554	PVC insulated cables up to and including 1100 volts
16	IS:4794	Push Button Switches
17	IS:6005	Code of practice for phosphate coatings of iron and steel
18	IS:2099	Bushings for alternating voltages above 1000 V
19	IEC:62271-202	Prefabricated Substation
20	IS:13118, IS:3427, IEC:60694.	Switchgear cubicles
21	IS:9920, IEC:60265	Ring main unit

S.No.	Standard Number	Description
22	IS:10118	Code of practice for selection, installation, and maintenance of Switchgear
23	IS: 2026	Distribution Transformer
24		Indian Electricity Rules
25		Indian Electricity Act
26	IS:13072	Sulphur hexafluoride for electrical purposes

1.34.3 Technical Particulars (Standard Values)

The Ring Main Unit (RMU) should consist of three phase, two load break switches and one or two or three or four (depending on type no. of outgoings) tee off VCB, Circuit Breaker Compact Unit, SF6 insulated and sealed for life complying to latest version of IEC 622-71-200

a)	Rated system voltage (kV)	12/36
b)	Rated current for load break switch [A]	up to 630 Amps.
c)	Rated current for tee-off Breaker [A]	up to 630 Amps.
d)	Nominal system voltage [kV]	11/33
e)	System Earthing	Solid
f)	Basic Insulated level	
g)	Lightning Impulse withstand voltage (kV)	As per Indian Standard
h)	Power frequency withstand voltage for One minute (kV rms)	As per Indian Standard
i)	Frequency (Hz)	50
j)	Bus bar rated current (A)	up to 630 Amp.
k)	Rated short time symmetrical three phase current.	
l)	(kA for 3 sec for load break switches & tee-off breaker)	20
m)	Earth switch for load break switches (kA for 3 sec)	20
n)	Earth switch for tee-off breaker (kA for 3 sec)	20
o)	Rated making current (kA peak)	65.75kA for 33kV & 52.5kA for 11kV.
p)	Rated breaking current for 11kV circuit Breaker [kA for 3 s]	20
q)	Filling & rated gas pressure	<1 bar, gauge
r)	Internal arc test [kA for 1 sec]	20
s)	Interrupting time in millisecond less than	40
t)	Operating Duty:	O-3 min-CO-3min-CO
u)	Degree of protection for enclosure	IP 54
v)	Paint thickness (micron)	60 to 80 microns

w) Notes:

x) Type, routine, internal arc test reports shall be supplied by the contractor along with tender.

y) RMU for CSS shall be non-extendable type and RMU for outdoor distribution shall be extendable type. Storage [without heaters, in humid environment]: from 0°C to +50°C

z)	Operation:	0°C to +50°C
aa)	Partition class:	PM
bb)	Main HV circuit:	IP67

cc) Front connection in cable box, suitable for armoured, XLPE insulated Aluminium cable, as per calculated & specified size. Termination with elbow type plugs in bushings with insulating boots.

1.34.4 Load Break Switch

a) The switch shall be combining the functions of a load break switch, disconnector and associated earthing switch. It shall have three positions (closed, open / disconnected, earthed). The mechanism shall be anti-reflex, lever-operated type, with intuitive operation and clear micron panel indications.

b) Switch shall have built-in fail-safe interlocks between main switch and earthing switch. Standard built-in padlocking facility for main switch, earthing switch and interlock shall be provided.

c) Switch shall have a provision for remote opening and closing through SCADA also. Earthing switch operation shall be locally.

d) It shall carry rated current continuously and short circuit current for the duration specified without exceeding the permitted temperature rise as per relevant IEC / Indian standard. Switch should not be damaged even when closed on a dead short circuit for the permitted period of short circuit.

e) Each load break switch shall be of the triple pole, gang operated, with quick break contacts.

1.34.5 Circuit breaker for Transformer

a) The Circuit Breaker shall have a switch disconnecting the circuit breaker with an associated earthing switch. It shall have three positions (closed, open / disconnected, earthed). Circuit Breaker shall have a provision for remote opening and closing through SCADA. Earthing switch operation shall be locally.

b) It shall carry rated current continuously and short circuit current for the duration specified without exceeding the permitted temperature rise as per relevant IEC / Indian standard.

c) Circuit breaker shall be opened with a push button and closed with the “closing lever”. The mechanism shall be anti-reflex, lever-operated type, with intuitive operation and clear mimic panel indications. Switch shall have built-in fail-safe interlocks between main switch and earthing switch. Standard built-in padlocking facility for main switch, earthing switch and interlock shall be provided. The circuit breaker and load break switch can be locked in the open, close or earth position by 1 to 3 padlocks of ESI size.

d) Breaker should not be closed when cable cover is open.

e) In case of fault the breaker shall be tripped through a self-powered relay.

1 Circuit Breaker Interrupting Unit:

a) Tee-off Circuit breaker shall have Vacuum interrupting arrangement.

b) The design & construction of the Vacuum circuit breaker shall be compatible with the latest Vacuum circuit breaker technology.

c) The Vacuum interrupter bottles shall be completely maintenance free & mechanically strong for 30 years life. Test certificate to be provided.

d) Suitable interlock shall be provided against breaker operation in the event of loss of Vacuum.

e) Circuit breaker should allow low chopping current level.

f) Graph showing short circuit Vs tripping permitted for Circuit Breaker.

2 Duty Requirement:

a) The circuit breaker shall be totally restrike free under all duty conditions and shall be capable of performing the duties satisfactorily.

b) The circuit breaker shall meet duty requirement for any type of fault location, also for line charging current. The operating duty of the circuit breaker shall be as follows:

c) O-0.3s-CO-3min-CO

d) The circuit breaker shall be suitable to break the required induction current in accordance with the BIS / IEC standard. The value thereof shall be clearly specified at the time of offer.

e) The circuit breaker shall meet its duty requirement in case of application for controlling U/G cables, power transformer.

f) The rated transient recovery voltage for terminal fault and short line faults shall be as provided in the relevant IEC / BIS.

3 Constructional Details:

a) Complete switchgear including bus bars shall be contained in an earth screened stainless steel tank, filled with SF6 gas, degree of protection not less than IP-67, as per requirement of IEC standards. To prevent gas leakage the gas pressure shall be maintained low within one atmospheric gauge. The filled gas shall provide the required insulation and also current breaking for load break switches.

b) There should not be any condensation of SF6 gas on internal insulating surface of the circuit breaker and Load Break Switches. Temperature compensation shall be provided, and the system shall be an integral part of breaker.

c) SF6 gas shall be sealed for life in the compartment so as to satisfy “Sealed Pressure Systems” requirement of IEC-60694 (Clause 5.15.3). Throughout the life of the equipment there shall not be any “topping up” of SF6 gas. The rated life of the equipment must not be less than 30 years as per IEC-60694. During this operational life of the switchgear, absolutely no gas filling is required. The container should be evacuated before gas filling, and it should be diffusion-tight. The design of the RMU housing shall be such that in the event of an internal arc fault, the safety of the operator shall be ensured. All the safety requirements as required in IEC 62271-200 shall be provided.

d) The switchboard when charged must not have any access to live parts so as to endanger the life of operating personnel.

e) The RMU shall be so designed that the position of different devices is visible to the operator in front of the switchboard. The operating switches, handles etc. shall be at a height at which these or easy to operate, without any extra effort. All the items in the equipment shall be identified with long life labelling, cautions etc. The labelling must clearly indicate the required function.

f) All the items in the equipment shall be identified with long life labelling, precautions etc. The labelling must clearly indicate the required function.

g) There shall be operation counters for Load Break Switches and breaker with a provision to sound an alarm when the permitted operations are approaching.

h) It shall be possible to lock the operating mechanism in any of the three positions when the contacts have fully homed and also to independently lock the “ON” and “EARTH” positions. The position “ON”, “OFF” and “EARTH” of the switch shall be clearly indicated such that the direction of movement of the operating handle(s) from one position to another is readily apparent.

i) The operating mechanism shall be maintenance free without the need of any lubrication during its lifetime of 30 years. The operating mechanism shall undergo a mechanical endurance test as specified in IS/ IEC 62271-200.

j) The ring main shall be dust, moisture & vermin proof and suitable for indoor or outdoor installation. All the cabinets shall be free standing floor mounting type and shall be provided with double hinged doors with padlocking arrangements.

k) All door panels, removable covers shall be gasketed all round with PU Foam gaskets. All louvers shall have screen and filters. Vent opening shall be covered with mesh and so arranged that hot gases or other material shall not be discharged, injuring operating personnel or surrounding apparatus and cables.

l) Metal enclosure unit shall comprise of rigid welded structure frame enclosed completely by metal sheet of thickness not less than 2 mm. The sheet should be cold rolled with smooth finish, levelled & free from flaws. However, the structural frame & all load bearing members of the enclosures shall have a minimum thickness of 2.5 mm or more. All members shall be properly braced to prevent webbing.

m) Ring main design shall comprise full compartmental execution having separate vertical sections for each circuit having internal barriers. Compartment with doors for access to operating mechanism shall be so arranged as not to expose high voltage circuit. The ring main cubical compartment shall be provided with hinged doors on the front with facility for padlocking door handles.

n) All corresponding components of circuit breaker / load break switch cubicles of same ratings shall be interchangeable with one another.

o) The board shall be wired with the connection brought on to the terminal boards for remote operation.

p) The equipment shall also be as compact as possible so as to occupy minimum space in the sub-station room. Such type of equipment will have preference.

q) Temperature rise in the unit shall not exceed as prescribed in IS/IEC.

r) Minimum clearance between the phases and between live parts & grounded objects in the switchgear/ load break panels shall be in accordance with IEC.

4 Operating Mechanism:

a) Circuit breaker as well as load break switches shall be provided with suitably designed spring charged motor operated mechanism. It shall be possible to charge the spring manually, if required. The closing/ opening shall be through remote or through locally operated push button or operating switch.

b) It should be “trip free” mechanically under every method of closing (except during closing for maintenance).

c) The operating mechanism shall be such that the failure or any auxiliary spring will not prevent tripping. When the circuit breaker is already closed it shall not cause damage to the breaker or endanger the operator.

d) The breaker / load break switch shall also be hand operated, if so required.

e) Electrical as well as mechanical indicator shall be provided to show open & close positions of the breaker / load break switches. It shall be located in a position where it will be visible to a man standing on the ground with the mechanism housing closed. An operation counter shall also be provided with each breaker / load break switch.

f) Working parts of the mechanism shall be of corrosion resisting material. Bearings, which require grease, shall be equipped with pressure type grease fittings. Bearing pin, bolts, nuts and other parts shall be adequately pinned or locked to prevent loosening or required adjustment with repeated operation of the breaker / load break switch. The mechanism shall be maintenance free.

g) The closing mechanism should be able to be operated by one man standing on the ground & direction of rotation of the handle for charging / closing shall be clearly defined.

h) Arrangement shall be made to de-couple/ trip the motor in case of failure of limit switch to cut out motor when the springs are fully charged and annunciation for this shall be provided.

i) The mechanism shall be complete with opening spring, closing spring, auxiliary contacts & all other necessary accessories to make mechanism a complete operating unit. A continuous sequence of closing and opening operation shall be possible.

j) Besides the requirements of auxiliary switches used by the manufacturer, at least 4 NO + 4 NC shall be provided for the use of the purchaser.

1.34.6 RMU to be Maintenance free.

a) The RMU's life and its operation must not be affected by environmental conditions such as foggy atmosphere, extremes of cold, seismic conditions such as corrosive / winds, 100% relative humidity (condensing type) with hot and humid environment, temporary flooding etc.

b) The equipment shall be of "fit & forget" type requiring little maintenance, (practically no maintenance), during its life.

c) RMU should have reliable switching devices and maintenance free drives.

1.34.7 Insulating Medium

a) The RMU shall comply with the requirements of IEC standard for "Sealed Pressure System", for which no filling of gas is to be carried out during the life span of the switchgear. The SF6 gas shall be as per IEC-60376 / IS:13072 and shall be suitable for its application in the switchgear. It should continue to have high insulating and arc quenching properties throughout the switchgear life of 30 years.

b) The SF6 gas shall be self-regenerating after the interruption of arc due to breaking load currents. The gas tank should have material in the tank to absorb the moisture from SF6 gas.

c) The use of organic seals on the equipment, grease and oil in the drives requiring periodic maintenance are not to be used.

1.34.8 SF6 Gas Monitoring & Pressure Relieving

a) SF6 gas in the RMU tank shall be constantly monitored through a gas pressure indicator, which should be duly temperature compensated. In case the pressure is not adequate it should block its operation and give a warning to isolate the RMU.

b) The pressure sensors shall feed a microprocessor based analysing unit. By this system the gas pressure (temperature compensated) should be recorded to measure the dielectric strength of the gas in the compartment.

c) A loss of gas should be signalled via two contacts one to initiate the low alarm of gas and second to trip the whole system.

d) If the gas pressure exceeds the permissible limit, such as during short circuit clearing, the pressure relief device should operate in the underside of the module. This area must be partitioned from the cable connection apartment.

1.34.9 Voltage indicator lamps, phase comparators and Monitoring of RMU Bus Voltage

It shall be possible for each of the functions on the RMU to be equipped with a continuous voltage indication, to indicate whether or not there is voltage on the cables. The capacitive dividers will supply low voltage power to sockets at the front of the unit, an external lamp shall be provided to indicate live cables. Three outlets can be used to check the synchronization of phases with the use of an external device. This device shall follow IEC 1958 standard. Besides this the voltage monitoring of bus bar shall be provided continuously.

1.34.10 Earthing of RMU Circuits

a) The cables in the RMU on the load break switch sides shall be earthed (only when these are dead) through integral earthing switch having the short circuit capacity of the RMU.

b) The earthing switch should be mechanically interlocked so that it can only be operated when the main switch is in open condition and circuit is fully de-energized. Necessary voltage monitoring device in such a case shall be provided.

c) The earthing switch shall be operated through the main circuit mechanism and manual closing shall be through a fast-acting mechanism.

d) Mechanical interlocking system shall be provided to ensure that the switch is turned to ‘OFF’ position before being turned from ‘ON’ to ‘EARTH’ condition.

e) Cable box interlocking is to be provided to ensure that before the removal of the unit cable box cover, the unit earth is applied.

1 General Earthing Requirement:

a) All metal parts not intended for carrying current shall be connected to duplicate earthing system and suitable terminals shall be provided on each equipment or part of equipment in conformity with the relevant standards.

b) The earth continuity conductor shall be of tinned copper and shall have sufficient cross-sectional area so as to afford a low resistance path for the full fault current corresponding to the circuit breaker ratings.

c) The size of earth continuity conductor shall be adequate, so as to restrict the temperature rise to the limit without causing any damage to the earth connection, while short circuit current flows through it for the short time rating of the equipment.

d) The size of earth continuity conductor shall be as large as possible to reduce to the barest minimum the potential rise of the metal frame of the circuit breaker.

e) No sweated / riveted joints in current conducting path shall be permitted.

1.34.11 Cable end Termination box

a) Cable-end termination box shall form an integral part of the equipment. The cables shall be convenient to install.

b) There shall be elbow type connection for cable termination with insulating boots. The boots shall form part of supply.

c) Each Cable compartment shall be provided with three bushings to terminate the incoming and outgoing 33kV or 11kV, 3 Core or single core cables as the case may be. There shall be minimum 700 mm height from the base of the mounted switchgear so that the cables can be bent and taken vertically up to the bushings. The Cable termination shall be done by Heat shrinkable Termination method so that adequate clearances shall be maintained between phases for Termination.

d) The arrangement for earthing the termination point of cables shall form a part of supply and should be of adequate rating. The standard size of 33kV or 11 kV XLPE cable being used is as specified for load break switches as well as for the tee-off transformer.

e) The cable mounting arrangement on the load break switches shall be over the trench and no special arrangement is required for installation of the cables and their terminations. These shall enter directly from the cable trench through cable glands in gland plate to the load break switches. The ring type air insulated CTs shall be provided.

f) All of the cable boxes shall be air insulated suitable for dry type cable terminations. Compound filled cable boxes are not acceptable.

g) The cable boxes at each of the two ring switches suitable for accepting H.V. cables approaching from below or as per site requirement. The tee-off circuit breaker shall be suitable for either of the following termination arrangements:

   i. Direct coupling to a transformer flange
   ii. Cable entry from below via a tee-off cable box
   iii. Cable entry from above via a tee-off cable box

h) The extended function shall be suitable for cable entry from either above or below only.

i) Double compression type, chrome, plated cable brass glands shall be provided in the gland plate, with necessary cable clamping and earthing arrangement.

j) Support frames shall be provided whose height shall be such that cable connections can be conveniently made after allowing for bending radius of cables.

k) Note: The XLPE, outgoing & incoming 12 kV 33kV power cables to LBS are not in the scope of the RMU manufacturer. However, elbow type termination kits for these cables (including two sets of new cable termination tools) are included in the scope of supply.

1 Testing of Cables:

a) It shall be possible to test the core or the sheath insulation of the network cables while the RMU remains energized at rated voltage. It shall be preferable to carry out the phase-by-phase testing through a built-in-facility without necessity to have access to cable compartment. The maximum test voltage shall be less than 38 kV DC for 10 minutes.

b) Any cable test access facility which requires the use of an additional loose devise shall not be acceptable.

c) Any switching unit, load-break switch or circuit breaker, shall be able to receive a dedicated device for cable testing, allowing the cable test bench to be connected from the front of the cell without opening the cable compartment. This cable test device must be fully interlocked with the earthing switch.

1.34.12 Bushings

a) Bushing shall be homogeneous, free from laminations, cavities & other flaws or imperfection that might affect the mechanical or di-electric quality & shall be tough and impervious to moisture.

b) Silicon type bushings shall be used.

c) Bushings shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be subjected.

d) When operating at normal rated voltage there shall be no electric discharge between the conductors & bushings, which could cause corrosion or injury to the conductors, insulators or supports by the formation of substances produced by chemical action.

e) All iron parts shall be hot dip galvanised (not less than 75 micon) & all joints shall be airtight. Surfaces of the joints shall be smoothened up. Bushing design shall be such as to ensure a uniform compressive pressure on the joints.

f) All current carrying contact surfaces shall be sliver plated; silver plating shall not be less than 1 mil in thickness.

g) The creepage distance of the bushings shall be suitable for condensing type humidity atmosphere.

h) Bushings shall be tested for type tests & routine tests in accordance with stipulation of IS: 2099. Routine as well as type test reports in conformity with above SHALL be furnished to the purchaser.

1.34.13 Caution Notice

Caution name plates shall be provided at all points where such safety requirements are to be met as per Indian Electricity Rules.

1.34.14 Safety Interlocks

a) Disengagement of a circuit breaker or switch shall not be possible unless it is in open position. Suitable interlocks shall be provided.

b) The position of the circuit breaker, whether in open or close position shall be indicted through suitably designed fail-safe mechanical indicators.

c) The operating position of circuit breakers or isolators, either on bus-bar side or for earthing, shall be clearly indicted by a reliable indicating device.

d) Integral earthing facility, when provided, shall be suitable to make earthing connections only when the associated circuit breaker is in tripped position. The current rating of earthing facility should be commensurate with the short circuit rating of the circuit breaker.

1.34.15 Metering, Protection, Indication & Auxiliary Switches

1 General Requirements for Instruments:

a) Multifunctional Measuring instruments, with an accuracy of 0.5S or better shall be of digital type, with minimum 3-line LED display and conforming to relevant IS / IEC & shall be of an approved type & design suitable for tropical climate and condensing type humidity. Measurement shall include voltage, current, pf, kW, kVA, kVAR and neutral current. It shall have RS 485 communication port.

b) All instruments shall be back connected, and instruments cases shall be earthed.

c) The instruments safety factor shall be equal to or less than 5.

2 Protection:

a) The protection on the circuit breaker shall comprise the following arrangement:

b) The Tee-off, Circuit breaker unit fitted with 3 protection CTS of suitable ratio and burden [considering power transformer rating], a low burden trip coil and auxiliary switch assembly allowing the use of a self -powered, numerical relay with an open protocol having three over current and one sensitive earth fault elements. The relay should be housed within a cubicle box, accessible from the front. This relay shall also communicate with Feeder Remote Terminal Unit.

c) The protection curves and all other settings shall be adjustable in software through laptop, which when viewed from the front clearly show the unit settings. (Note DIL type switches are not acceptable). The protection setting range and minimum pick up current shall be in accordance with the protection of transformer rating. Typically, the primary settings may be in the following range:

   i. Overcurrent: 20A to 200A

   ii. Earth Fault: 2A to 50A

d) The relay should give local indication of a fault operation and should differentiate between overcurrent and earth fault.

e) It should be possible for the relay to perform a self-check.

f) Other auxiliary relays to give trip / alarm [local as well as remote] in case of operation of transformer protections, gas leakage, ON, OFF & Earth status of RMU load break / breaker, spring charged etc. shall be provided.

g) Besides the requirements of auxiliary switches used by the manufacturer, at least 4 NO + 4 NC shall be provided for the use of the purchaser.

3 Instrument Transformers:

The instrument transformers required for the switchgear shall conform with the respective standards specification.

4 Voltage Transformers

The Voltage Transformers (VT) shall be of dry compound epoxy insulated. The VT shall be protected on their primary sides by current limiting fuses. On the secondary side, the circuit shall be protected by MCB's. Provision shall be so made that the primary fuses can be handled only in the drawn-out position. The particulars of the voltage transformer are:

a) Type : Cast Resin.

b) Rates Voltage : volts

c) Accuracy Class : 1.0

d) Burden : 50 VA or as per system requirement.

Note: Contractor *shall design the voltage transformer as per system requirements, and alternate arrangement, if any, shall also be considered*.

5 Current Transformers:

a) The CTs shall be cast resin ring type, suitable for metering and protection requirements, air insulated and shall be able to withstand the thermal, dynamic and mechanical stresses resulting from the maximum short circuit and short time current rating of the switchgear. CT should be suitable for continuous operation at 130% of its rated current.

b) CTs shall have polarity marks engraved on each transformer and at the associated terminal blocks. Facility shall be provided for short circuiting and earthing the CT secondary at the terminal blocks by the use of shorting type terminals.

c) CT ratio, burden, accuracy [1.0 for metering and 5P for protection] and other requisite parameters shall be suitable for the self-powered relay. CT calculations in this regard shall be submitted.

1.34.16 Control of the RMU and CSS

a) Remote & local operation of the RMU's line switches and Circuit breaker should be provided using motors fitted to the operating mechanism.

b) The provision of the motors to the mechanism must not in any way impede or interfere with the manual operation of the switches or Circuit breaker.

c) The Contractor or Relays with UL approvals shall provide all necessary equipment for remote control and monitoring of the RMU including other important equipment items in CSS.

1.34.17 Fault Circuit Indicator

a) To pinpoint the faulty section between a number of series connected, load break switches, of RMU's a Fault Circuit Indicator (FCI) shall be provided with each RMU. This indicator shall operate for earth faults and phase to phase short circuits between any two RMU's.

b) The indicator should be suitable for use on 12 kV RMU's in an open ring main system. In case of fault in a cable section between two RMU's. It shall be possible to pinpoint the faulty section and communicate with Feeder Remote Terminal Unit for automatic faulty cable isolation and supply restoration.

c) The FCI supplied should be complete in all respects, with all the necessary components e.g. LED lamp, Fault Indicator Unit, CTs cabling etc. and shall form part of RMU. It shall be with display to indicate current loading & type of fault.

d) Since RMU's shall be SCADA compatible, the FCI indications shall also be displayed on the central control room. Therefore, these FCI's shall have additional provision for remote indication besides local indication.

e) FCI shall be of proven type and in the manufacturing range of RMU supplier.

1.34.18 Feeder Remote Terminal Unit (FRTU) For RMU

Make of FRTU shall be same as that of the RMU manufacturer. It shall have peer to peer communication and with the remote switchgear / SCADA at the controlling substation through fibre optic cable to initiate the required switching operations.

1 Main Requirements:

FRTU cubicle shall be equipped to meet the following main requirements for compact substation. It shall be possible to mount it on wall if required.

a) Monitoring and control of 11kV LBS and VCB feeders

b) In conjunction with FCI, detection and isolation of faulty cable for phase to phase and phase to earth cable short circuits and automatically ensure supply restoration in less than 60 seconds.

c) Multifunction measurements.

d) Transmit data to the remote-control centre.

e) The system shall have necessary redundancy in communication.

f) To incorporate self-healing grid logic for faster restoration of supply even in the absence of control centre SCADA.

g) Data storage.

h) Provision for Maintenance

i) FRTU shall be capable to monitor and control 3 Way /4Way/ 5 Way/6 ways RMU.

j) Chronological time stamped event recording.

k) Data storage, in the event of mains failure, shall be for at least 8 hours. The minimum storage shall be for about 40000 events.

2 Control unit:

Control Unit shall perform all the required control and monitoring functions as isolated unit or as part of Compact Substation and shall be equipped with a remote and local control mode switch on its front panel.

3 Operation in Local Mode:

a) Transmission of data for remote measurements and time-stamped events shall not be disturbed.

b) Opening and closing operation after validation.

c) Inhibition of opening / closing from remote.

d) Operation in Remote Mode:

e) Transmission of measurements and time stamped events.

f) Local electrical control shall get blocked.

g) Opening and closing operation from remote control centre.

All data shall be available locally on the front panel of the enclosure and remotely from the control centres. LBS / breaker open and close status can be had from the front mimic of FRTU respectively with the green / red LED indication. It shall be possible to retrieve and display the time-stamped events recorded at the enclosure locally as well as at the remote-control Centre on a lap top computer.

4 Power Supply:

Compact, built in sealed for life 12V battery with a long life and no maintenance of any kind for 5 to 7 years or more along with charger [to be supplied 230 V, 50 Hz from CSS and in case of stand-alone RMU supply arrangements shall be made by manufacturer] is to be provided in the unit. The supply shall be conditioned to provide power at required voltage for motor operation and communication for local and remote SCADA. The transmission output shall be able to supply a conventional radio [without battery power of RTU] to inform the remote-control centre of a battery failure. Power from the unit shall be sufficient to supply control power to all the switch cubicles in the CSS, radio, and the electronics in the enclosure. The standby power unit shall be with a minimum autonomy of at least 8 hours for 10 opening and closing cycles. The battery current shall be monitored via an NFC programmable Current Monitoring Relay with electrical life of 100000 cycles to be checked at regular intervals by the slave station and an alarm shall be generated and transmitted to the remote-control centre in the event of a fault. The unit shall be protected against overvoltage and overloads.

5 Time-tagged data archiving:

a) All the archived data shall be retrieved locally and remotely by means of the configuration and operating software supplied with the control unit. The data shall also be downloaded locally or remotely to a PC as a.CSV file.

b) Event and measurement timestamping shall be accurate to one millisecond [ms] and the discrimination between two events shall be 10 ms.

6 Communication with the remote-control centre

a) FRTU shall have IEC 870-5-101 / 104 protocol to transfer information to control center SCADA and Modbus protocol to communicate with field MFM [Multifunction Meters] on RS485. The Modbus protocol shall be open. Security & communication package provider shall only lay the fibre optic cable for the same and further connections, repeaters, boosters, and any other communication equipment shall be included in the scope of supply.

b) It shall be possible to configure each measurement to be transmitted spontaneously to the remote-control centre with 100% redundancy. Failure of one channel should have an automatic changeover to second channel.

c) Data shall be configured using a PC connected to the control unit via an Ethernet and / or USB port. It shall also be possible to configure data remotely.

7 Software

The software shall not require a special license, and it can be used and copied freely.

8 Indications

The slave stations shall process at least the following information for remote indication and for local display purposes:

a) Open / closed position of each LBS

b) Earth status

c) Absence of AC voltage,

d) Local / remote control operating mode,

e) Detection of phase-to-phase or earth fault current flow,

f) Load current measurement.

g) Charger fault

h) Battery fault

i) motor drive DC supply fault

j) Internal fault

k) Detailed diagnosis of the status of the uninterruptible power supply (charger, batteries).

l) Indications for LT side status of switches, alarms as required.

9 Erection / construction / Operating Tools and Tackles

a) Each RMU will be provided with operating lever and other such equipment which are necessary for the normal operation of the equipment. It should also include any spring charging handles for the manual charging of closing springs. The tenderer shall separately list out in the tender in the given schedule, sets of tools required for initial erection/construction and subsequent maintenance. The price of those should be included in the cost of equipment.

b) An anti-reflex mechanism on the operating lever shall prevent any attempts to re-open immediately after closing of the switch or earthing switch.

c) All manual operations will be carried out on the front of the switchboard.

d) The effort exerted on the lever by the operator should not be more than 250 N for the switch and circuit breaker.

e) The overall dimensions of the RMU shall not be increased due to the use of the operation handle. The operating handle should have two workable positions 180o apart.

1.34.19 Mimic Diagram:

The front shall include a clear mimic diagram which 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 indicted in the mmici diagram. The manufacturer’s plate shall include the switchboard’s main electrical characteristics.

1 Labels and Marking of Connections:

All apparatus, control gear and the apparatus mounted thereon shall be clearly labelled, indicating where necessary, their purpose and the ‘ON’ ‘OFF’ and ‘EARTH’ position. The labels shall be clearly lettered on enamelled surface or other approved materials. Brass should not be used for labels. Each phase of alternating current and connections shall be coloured to distinguish phases, neutral and earth. The colouring shall be red, yellow, blue, black, and green respectively.

2 Bus Bars:

a) Bus bars shall be of uncoated tinned conductor grade electrolytic copper.

b) The tenderer shall furnish calculations establishing thermal and dynamic adequacy of bus bar sizes with reference to its short circuit ability. The bus bar shall be integrated completely into the gas filled compartment including the coupling chambers between two adjacent modules.

c) The insulating ability of the entire bus bar system should be monitored along with the gas filled cladded compartment of the module. The bus bar size shall be so chosen so as to limit the current density to within permissible limit and if the fault current restricts the current density less than that, then lesser density shall be used. Calculations shall be submitted for this purpose.

3 Temperature rise:

The temperature rise and the maximum temperature on any part of the equipment when in service at site under continuous full load condition or under short circuit shall not exceed the permissible limit as per relevant IEC or IS: 13947. This shall not be exceeded when corrected for the difference between the ambient temperature at site and the ambient temperature specified in the relevant standard.

4 RMU Indications

Indication of spring charge, ON, OFF trip etc shall be provided by means of LED which shall be fed from control supply arrangement designed by contractor If LED’s are provided, the indicating lamps shall have covers of following colours.

a) Red closed position of breaker/ load break switch

b) Green open position of breaker /load break switch

c) Blue spring charge condition of breaker / load break switch

d) Amber auto tripped position of breaker.

e) Yellow Earth position

5 Terminal boards and Secondary Wiring

a) Connection to switchgear, operating mechanism indicating relays and all instruments shall be deemed to form a portion of equipment of panel.

b) Panel connections shall be insulated and shall be healthy and securely fixed to back of the panel. The wiring must run on porcelain or non-rusting metal cleats or metal flexible tubes as may be approved by engineer. All wiring in the vicinity shall be insulated and shall run in non-rusting flexible tubes from terminal boards conveniently situated. All control connections instruments and relay wires shall be provided with numbered ferrules at each terminal and the numbering shall be in accordance with an approved system. All wiring diagrams shall be clearly marked with the numbers corresponding with those on the ferrules of the individual cores. Each set of current and voltage transformer secondary connection shall be complete and shall be earthed at one point only. Each such earthing shall be made through links which can be opened for insulation testing.

c) All the internal control wiring shall be through fire-resistant tinned stranded copper wires of 1.5 mm2 and for CT circuits these shall be with 2.5 mm2. The strands in the copper wire shall not be less than 48.

d) The CT circuits shall be provided with isolating type of links, to check the current in the CT circuits during testing. Similar it shall be possible to isolate PT's without disconnecting wires to check & test the meters. All CTs must have provision for shorting through link.

e) The air insulated control cabinet shall have provision for lighting.

f) As the equipment is to be installed in a tropical and humidity zone, the air insulated control cabin shall be provided with suitable DIN Rail Mountable space heater of PTC type with touch proof design UL approval and controlled via UL approved Hygro-thermostat.

1.34.20 Type and routine tests.

All the routine and type tests shall be carried out as per relevant IEC / Indian Standard. For type test certificates Engineer may consider test certificates at its absolute discretion.

All the routine tests on the switchboard shall be witnessed by the Site Engineer or its authorized representative.

The following type & routine test certificates shall be supplied / carried out on the RMU:

a) Impulse withstands test.

b) Temperature-rise test

c) Short time withstand current test.

d) Mechanical operation test

e) Checking of degree of protection

f) Switch, circuit breaker, earthing switch making capacity.

g) Switch, circuit breaker breaking capacity.

h) Internal arc withstand test.

i) Checking of partial discharge on individual components.t

In addition, for switches, test reports on rated breaking and making capacity shall be supplied.

For earthing switches, test reports on making capacity, short time withstand current and peak short circuit current shall be supplied.

The routine tests carried out by the manufacturer shall be backed by test reports signed by the factory's quality control department. They shall include the following:

j) Conformity with drawings and diagrams,

k) Measurement of closing and opening speeds & times

l) Measurement of operating torque

m) Checking of filling pressure

n) Checking of gas tightness

o) Checking of partial discharges on individual components

p) Dielectric testing and main circuit resistance measurement

All of the major type tests shall be certified by an independent authority and an internationally acceptable test house for the tests carried outside the country of manufacture.

1.34.21 Configuration of Ring Main Unit

Each non / extendable ring main unit shall comprise of three or four configurations, with a continuous bus bar, SF6 insulated, sealed for life, CTs and PTs as per requirement, pad locks for locking with a universal key, complete in all respects.

The main items of RMU are given below any other item not specifically mentioned but required for the successful operation of the equipment shall be deemed to be included without any financial liability to purchaser.

Each load break switch panel shall be equipped with rating of 12 kV/33kV, 630 Amps. 21kA / 3s, & 25kA/1s Gang operated, SF6 insulated, manual / motor operated, fault making, load breaking switch, along with associated bus bars, CTs, PTs [as required] and the same shall consist of the following main items:

a) Metal clads in door type weatherproof housing.

b) 12 kV/33kV, 630 Amps, fault making, load breaking, manually / motor operated, self-aligning, gang operated.

c) One set of 630 Amp, bus bar as specified.

d) Isolating plug & socket for main & auxiliary contacts if required.

e) Mechanical interlocks to prevent switching on with cable in earthed position.

f) One set of triple pole gang operated cable earthing contacts.

g) Load Current measurement.

h) Air Insulated cable box for Cable end termination suitable for 3 core, 12 kV/36kV, XLPE armoured cable of specified size, with AL conductor, along with glands, suitable Gland plate and Cable support.

i) Mechanical On/Off/Earth/Test Indicators.

j) Cable Testing Sockets

k) Capacitive Voltage indicator lamps.

l) Cable clamps

m) Feeder Remote Terminal Unit [FRTU]

n) Fault Circuit Indicator along with CTs.

o) Indicating lamps & auxiliary contacts.

p) Auxiliary relays (if required).

q) Interlocked earthing arrangement.

Tee-off Circuit Breaker Panel, with SF6 insulation, suitable for transformer feeder shall be equipped with minimum 12 KV/36kV, up to 400 Amps, 20 kA/25kA, for 3/1 sec rated circuit breaker with associated C. Ts, PTs, spring operated mechanism, bus bars, compete with instruments, relays, terminal blocks. It shall comprise of the following main items:

r) Metal clad / indoor type weatherproof housing.

s) Vacuum circuit breaker, trip free

t) One set of 630 Amps. Bus bars (integral part with load break bus bar).

u) CTs for protection & Metering to match the transformer – 3 Nos.

v) 3-overcurrent & one earth fault IDMT relays, direct operating.

w) Termination suitable for connection to 11/0.433 kV transformer of specified rating.

1 Multifunction meter

a) P.T. 11000 or 33000 /√3 - 110/ √3 - 110/ √3, as required.

b) On/Off indicator

c) Mechanical interlocks

d) Tripping, closing coils.

e) Indication lamp & spare auxiliary NO/NC contacts.

f) Auxiliary relays for alarm and trip for transformer protections

g) Earthing arrangement duly interlocked.

h) Mechanism with spring charging motor.

The common system for the above shall consist mainly of:

a) Channels, nuts, bolts, glands, gland plates, interconnecting arrangement of tee-off breaker with transformer, cable termination kits & supporting arrangement of cable, with the load break switches etc.

b) Cable termination kits to be included for each RMU. It should be heating shrinkable, humid environment proof, touch proof

c) Gas monitoring device for sealed gas unit.

d) Pad locks for locking the panels.

e) Handles for normal operation, spring charging & other tools required for normal operation.

f) Arrangement of control supply for breaker / load break closing / tripping, motor charging indications etc.

g) All the necessary indicating lamps.

h) SF6 pressure monitoring unit.

i) Analysis unit for dielectric monitoring of SF6 gas.

j) Any other item not included above but required for the operation shall be deemed to be included though specifically not mentioned, without any financial liability to purchaser.

Two sets of cable termination and jointing tools for all the substations at various locations.

Any other item mentioned in text, or any other item required for successful operation but not included here shall be deemed to be included.

1.35 Technical Specification For Compact Substation

1.35.1 Scope

This specification covers the design, engineering manufacture, Shop testing packing, transportation to site, site storage, installation, testing and commissioning of a SCADA operated, prefabricated, factory assembled and fitted, Compact Sub Station [CSS] consisting of following main components.

a) 12 kV, non-extendable, metal clad SF6 insulated switchgear, sealed for life, Ring Main Unit (RMU)

b) Dry type 11/0.433kV distribution transformer

c) LV switch board.

d) Prefabricated weatherproof enclosure.

e) SCADA connection by FOC for remote control and monitoring.

f) All termination and connections to high voltage and low voltage side of distribution transformer, earthing, and any other work to complete the works in all respects whether specifically mentioned or not in this specification.

g) Portable Fire extinguishers for electrical fires

h) Complete Documentation

i) Training to Owners personnel

j) The CSS is to be totally free from any external deposit (dust, condensation etc.) and suitable to operate in highly humid, hot environment without any preventive maintenance, cleaning etc. It shall be of "fit and forget" type. All nut bolts, frames etc. shall be rust proof, typically of stainless steel or materials not prone to rusting, in site environmental conditions.

k) CSS can be placed indoor or outdoor as per detail design and requirement. Scope shall also include design, engineering of all the civil and all other related site works so as to complete the works in all respects.

l) The prefabricated substation unit is required for fast installation, to be maintenance free and with life expectancy of thirty years under site conditions.

1.35.2 Climate and Isocerunic Conditions

For Dighi area Project, the electrical equipment selected shall be such so as to give trouble free operation during the life of the equipment, under the most stringent atmospheric conditions prevailing at site.

1.35.3 Basic Design Criteria

The CSS shall be designed with the following design criteria:

For design purpose maximum ambient temperature of 50° C shall be considered.

a) It shall be factory built and tested and preferably transported as such so that it is ready for site installation. Only external connections need to be done at site.

b) Design to comply with latest version of IEC 62271-202.

c) Maintenance free Ring Main Unit [RMU] with SF6 insulation sealed for life as per IEC standard.

d) Dry type, epoxy insulated transformer with HV side metering.

e) LV Switchboard with Capacitor bank for automatic power factor correction [APFC].

f) Enclosure to have independent compartments for RMU, transformer and LV Board with suitable entry doors.

The electrical equipment including the enclosure, its supporting structure etc. is to be rust and corrosion proof throughout its life. In case there is no alternative to items such as mild steel sheet, and other structural items, the same shall be hot dip galvanized [minimum 610 gm zinc

/m2] and epoxy painted. Nut, bolts, washers and other similar items shall be of rust proof material such as stainless steel.

Cables shall be mostly in trenches of concrete, as per site conditions.

The Enclosure consisting of High Voltage switchgear, Low Voltage switchgear & Transformer of the Unitized substation shall be designed to be used under Indoor or outdoor service condition.

1.35.4 Quality of Material:

a) All material used shall be new and of best quality and of class most suitable for working under the conditions specified herein without distortion or deterioration.

b) Galvanization of steel shall only be done by hot dip process after the parts are ready for the purpose of assembly. Alternatively stainless steel of the quality suitable for site shall be used.

1.35.5 Design and Standardization

a) The equipment shall be designed to ensure satisfactory operation in which continuity of service is the first consideration and shall also be designed to withstand sudden load variations due to short circuits and other fault conditions.

b) The design shall incorporate every reasonable precaution and shall have necessary provision for the safety of all those concerned in the operation and maintenance of the switchgear.

c) All mechanism shall be made of such materials as to prevent sluggishness due to rust or corrosion. All Connections and contacts shall be of ample section and surface for carrying continuously the specified current without undue heating and shall be secured rigidly and locked in position.

d) Standard sizes of bolts, screws, pipes, and other fittings are to be used and number of sizes is to be kept to the minimum.

e) Cast iron shall not be used for any part of the equipment which may be subjected to mechanical stresses.

f) All apparatus shall be so designed and constructed as to obviate the risk of short circuits of the live parts by reptiles, rodents etc. Metal cubicles, housings and covers shall be 100% weather / vermin proof.

g) All parts shall be manufactured in accordance with relevant standard specifications. Corresponding parts of similar equipment and apparatus shall be mutually interchangeable.

h) All apparatus, connections, and cabling [FRLS type] shall be designed and arranged to minimize the risk of fire and any damage, which might be caused in the event of fire.

i) Design should take into consideration that equipment is to be operated under rainy, hot and humid atmospheric conditions, and surroundings with reptiles and rodents.

j) Certification offering evidence for the satisfactory operation under such environmental conditions shall be provided.

Table 1-23: Technical Data for CSS

S. No.	Description	Technical Data
1	Applicable Standard	IEC 62271-202
2	Design Ambient Temperature	50° C
3	Type of Ventilation for Normal Condition Hot Condition	 Natural Natural
4	Compartmentalized	Yes
5	Rated temperature enclosure class	10
6	Degree of protection for external enclosure for Transformer compartment	IP34
	Degree of protection for external enclosure for HV compartment	IP54
	Degree of protection for external enclosure for LV compartment	IP54
7	Location	Indoor / Outdoor
8	Rated HV	12kV, RMU, with metering
9	Transformer	≤500 KVA, Dry Type
10	Nominal rated voltage rating on LV	415V
11	LV Board	Incomer ACB + Outgoing MCCB
12	Enclosure material	Resistant to rusting
13	Thickness of sheet (minimum)	2mm for enclosure.
14	Base	4mm hot-dip galvanized
15	Enclosure Paint	nanoceramic coating , followed by electrophoretic dip coat and powder coat to RAL 7035
16	SCADA system / Remote Control	yes

1.35.6 Painting

Since the local environment is harsh, even galvanized steel will rust after a few years. Therefore, paint of suitable quality to protect the equipment is of utmost importance.

All sheet steel work shall be phosphated in accordance with IS: 6005 'Code of practice for phosphating iron and steel, through seven tank process. Oil, grease, dirt shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water, and drying. After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying.

The phosphate coating shall be sealed with the application of two coats of ready mixed zinc chromate primer. The first coat may be air dried while the second coat shall be stove dried. Panels shall be painted with epoxy paint of superior quality. ALTERNATIVELY, nanoceramic coating , followed by electrophoretic dip coat and powder coat to RAL 7035 , the panels shall be painted with electrostatic epoxy powder coating process to have paint of hard coating. Necessary details shall be provided to Engineer in this regard for prior approval.

Paint Thickness

The final finished thickness of paint film on sheet shall be approximately 60 to 80 microns. The finished painted surface of panels shall present aesthetically pleasing appearance free form dents and uneven surfaces. Paints shall not scale off or wrinkle or be removed by abrasion due to normal handling. The colour for finishing paint shall be Siemens grey as per RAL 7035. Unless otherwise desired the same shall be got confirmed from the Engineer before taking up painting. Each coat of primer and finishing paint shall be of slightly different shade to enable inspection of the painting.

1 Spare Paint

A small quantity (one litre per board) of finishing paint shall be supplied for minor touching up required at site after installation of the panel.

1.35.7 Drawings and Manuals

The contractor shall furnish all drawings & manuals as called for and given below and also those which are not specifically included but are necessary for proper operation and maintenance.

a) Complete assembly drawing of the Packaged & Ring Main Unit showing plan, elevations, side & typical sectional views giving complete dimensions.

b) Assembly drawings & weight of main component parts.

c) Foundation drawings showing the load on the foundations.

d) Schematic control & wiring diagram in accordance with BIS / IEC practice.

e) Bushing drawings & their specification.

f) Cable termination details & drawings along with terminal connection drawings.

g) General arrangement drawing of the complete panels showing CTs, PTs together with dimensions.

h) Maintenance Manual.

i) Graph indicating short circuit Vs number of tripping for Vacuum Circuit Breaker.

j) Permitted mechanical opening and closing operations.

k) Besides above drawings, the contractor shall submit type test certificates, leaflets & instruction manuals.

Within 60 days after contract award, the contractor shall furnish to the engineer three sets of following drawings for approval. No manufacture of equipment shall commence until the drawings are approved:

l) General arrangement drawing of complete assembly of packaged & individual RMU including giving dimensions & their salient features.

m) Schematic wiring diagram.

n) Foundation drawings.

o) Locations of cables slots, cable terminations, CTs, PTs & terminal connections.

p) Any other necessary detail.

q) Instruction manuals for erection/construction, maintenance, and operation.

r) Height of centre line of HV and LV connectors of transformers from the rail top level as well as from the roof of enclosure.

1.35.8 Quality Control

All material shall be new and of best quality and of class, most suitable for working under the environmental conditions specified herein without distortion or deterioration of equipment during the lifetime of not less than twenty-five years.

1.35.9 Quality Assurance

Manufacturer shall submit its quality assurance plan for the approval of Engineer prior to fabrication.

1.35.10 12kV/36kV Ring Main Unit

Specifications same as mentioned in Section 3 “Technical Specifications for Ring Main Unit”.

1.35.11 Dry Type Transformer

1 General

The distribution transformer in CSS shall be indoor Dry Type Transformer, complete with all accessories / fittings and spare parts as specified herein.

Three-phase transformers shall be with cast resin type, class F insulation system with natural (AN) cooling for indoor installation, for use in three-phase HV/LV distribution systems.

2 Specific Technical Requirements (Standard Value)

a) Rated KVA : up to 500kVA rd. Number of phases Three

b) Type of installation : Indoor

c) Frequency : 50 Hz

d) Cooling medium : AN

3 Rated Voltage

a) High voltage windings : 11 kV (DELTA)

b) Low voltage : 0.433 kV (STAR) with Neutral

4 Highest Continuous System Voltage:

a) High Voltage : 12 kV

b) Low Voltage : 0.415 kV

5 Method of System Earthing:

a) High Voltage : Unearthed

b) Low Voltage : Solidly grounded.

c)	Type of tap changer	:	OFF CIRCUIT GANG OPERATED	
d)	Range of tapping kV side	:	+5% to -10% with 7 steps of 2.5% on 11	
e)	Impedance at rated KVA at 75oC	:	As per relevant IS.	
f)	Insulation and level	:	HV LV	
g)	Type of insulation	:	Uniform	Uniform
h)	One minute power frequency withstands.			
i)	test voltage (kV)	:	28	3
j)	Impulse withstands test voltage (kVp)			
k)	Winding	:	75	8
l)	Connection	:	Delta (HV)	Star (LV)
m)	Material	:	Aluminium	
n)	Vector group	:	Dyn-11	

6 Terminal details

a)	HV Termination	:	Suitable for tee-off Breaker of RMU
b)	LV Termination connection between insulated copper enclosed in a - neutral bus all	:	Suitable for phase and neutral transformer and LT board through an busbar or a sand witched copper bus bar non segregated bus duct. The size of the shall be same as phase bus.
c)	LT Neutral earthing for earthing.	:	A separate Neutral point to be provided
d)	Minimum Clearance in Air	:	11 kV 0.433 kV
e)	Phase to phase (mm)	:	As per IEC
f)	Phase to earth (mm)	:	As per IEC
g)	Design Ambient temperature	:	50°C.
h)	Maximum Temperature Rise of winding over an ambient of 50°C and 1000m altitude, not to exceed 90°C.		
i)	Maximum Temp of insulation	:	150°C
j)	Overload capacity	:	As per IEC
k)	Noise level at rated voltage & frequency	:	As per NEMA Pub. Tr-1

7 Transformer Losses

The guaranteed losses of the transformer shall not exceed as given in the Energy Conservation Building Code [ECBC], as per latest guidelines of the Bureau of Energy

Efficiency [BEE] for the required rating of distribution transformer or as per the Bureau of Indian Standards [BIS] for transformers having energy efficiency level 3. Transformers not complying with BEE / BIS loss guidelines shall not be accepted. The guaranteed values of no-load losses and load losses shall be stated in the bid, and these shall be firm.

8 Performance

a) Transformer shall be capable of withstanding for two seconds the short circuit at its terminals as per requirements of IS-2026 without any damage. Source short circuit power on the primary of the 11/0.433 kV transformer shall be assumed as 500 kVA for the short circuit capability of the transformer. The thermal ability withstand due to short circuit shall be demonstrated by calculation.

b) The maximum flux density in any part of the core and yoke at normal voltage and Frequency shall be such that the flux density under 10% over voltage condition shall not exceed 1.9 Tesla.

c) 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.

d) The transformer may be operated continuously without danger on any particular tapping at the rated KVA ±10% of the voltage corresponding to the tapping.

9 Miscellaneous

Complete hardware for fixing the transformer as a part of packaged RMU substation shall be provided whether specifically mentioned or not.

10 Delivery

The equipment shall be delivered, erected, and commissioned at site as a part of the packaged RMU substation.

11 Conflict in Clause

In case of any conflict between the Specific Technical Requirements and General Technical Requirements, the requirements indicated as Specific Technical Requirement shall prevail over the General Technical Requirements.

1.35.12 Environment: Climatic, Environmental, and fire-resistant Requirements

a) As the equipment is to be installed in humid atmosphere the equipment and material provided must resist the corrosion likely to occur in any case.

b) Further the transformer must comply to the following class requirements of clause 13 of IS 2026-11 / IEC 60076- 11.

   i. Class C1: Operation, transportation, and storage at ambient temperature as low as -5ºC

   ii. Class E2: Frequent condensation combined with high pollution.

iii. Fire Class F1: Limited flammability, Self-extinguishing of the fire and to be free from halogens, emission of toxic gases, and minimum of thick smoke.

iv. The above classes will be indicated on the rating plate.

v. Note: The manufacturer must produce a test report, complying to above clauses as per test procedure of IEC-60076-11. Test report shall be from an accredited laboratory acceptable to Engineer, for a transformer of the same design.

1 Name Plate

Transformer rating plate in English and Hindi language shall contain the information as given in Clause 15 of IS: 2026 (Part-I) / IEC 60076-11. The details on rating plate shall be finalised during the detailed engineering.

1.35.13 General Technical Requirements

a) Dry type transformer will be manufactured in accordance with a quality system in conformity with ISO 9001 and complying to latest version of IEC 60076-11

b) Environmental management system is to be in conformity with ISO 14001, which shall be certified by an independent recognized organization acceptable to Engineer.

1.35.14 Codes & Standards

The design, material, fabrication, inspection, testing before dispatch, erection/construction, testing, commissioning, and performance of distribution transformers shall comply with all currently applicable statutory regulations and safety codes in the locality where the equipment will be installed. Nothing in this specification shall be construed to relieve the contractor of this responsibility.

Transformers shall conform to the latest applicable standards and codes of practice as given below.

Table 1-24: List of applicable standards for CSS

S.No.	Standard Number	Description
1	IS: 5	Colour for ready mixed paints and enamels.
2	IS: 104	Ready mixed paint, brushing, zinc chrome Priming
3	IS: 2026- [Part 1 to 11]	Transformers
4	IS: 1180	Outdoor type three phase distribution transformer
5	IS: 1271	Thermal evaluation and classification of Electrical Insulation
6	IS: 1363	Hexagon head bolts, screws, and nuts of Product grade C
7	IEC: 60076-11	Dry Type Transformers
8	IS: 2016	Plain washers
9	IS: 2026 (Part I to IV)	Specification for Power Transformers
10	IS: 2071	Method of high voltage test techniques
11	IS: 2074	Ready mixed paint, air drying, red oxide-zinc chrome, primary
12	IS: 2099	High voltage bushing for alternating voltage above 1000 V.

S.No.	Standard Number	Description
13	IS: 2633	Methods for testing uniformity of coating of zinc coated articles
14	IS: 2932	Enamel, synthetic, exterior (a) undercoating (b) finishing
15	IS: 3043	Code of practice for earthing
16	IS: 3347	Dimensions for transformer Bushings
17	IS: 3639	Fittings and accessories for power transformers
18	IS: 4257	Dimension for clamping arrangements for porcelain transformer bushings
19	IS: 5216	Guide for safety procedures and practices in electrical work
20	IS: 5561	Electric power connectors
21	IS: 7421	bushing for alternating voltage up to and including 1000 V.
22	IS: 10028	Code of practice for selection, installation, and maintenance of transformers.
23	IS: 12360	Voltage bands for electrical installation including preferred voltages and frequency.
24	C.B.I.P. Publication	Manual on Transformers

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

1.35.15 Drawings

The contractor shall furnish, within fifteen days after issuing of Letter of Intent, the following drawings / documents incorporating name of project and transformer rating for approval.

Detailed overall general arrangement drawing showing front and side elevations and plan of the transformer and all accessories including 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 LV terminals and ground etc.

a) Foundation plan showing loading on each wheel and lifting lugs.

b) GA drawings / details of bushing and terminal connectors.

c) Name plate drawing with terminal marking and connection diagrams.

d) Wheel locking arrangement drawing.

e) Transportation dimensions drawings.

f) Interconnection diagrams both on HV & LV sides.

g) Over fluxing withstand time characteristic of transformer.

h) Technical leaflets of major components and fittings.

i) As built drawings of schematics, wiring diagram etc.

j) Setting of winding temperature indicator.

k) Completed technical data sheets.

l) Details including write-up of tap changing gear.

m) H.V. bushing.

n) Bushing Assembly.

o) B-metallic connector for connection to specified conductor / bus-bar /in bus-duct.

p) Assembly.

q) Two earthing terminals & core earthing

r) Thermometer pockets

s) Inspection cover

All drawings / documents, technical data sheets and test certificates / results / calculations shall be furnished.

Any approval given to the detailed drawings by the Engineer shall not relieve the contractor of the responsibility for correctness of the drawing and in the manufacture of the equipment for the packaged substation.

1.35.16 General Constructional Features

a) All material used shall be of best quality and of the class most suitable for working under the conditions specified and shall withstand 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.

b) Similar parts, particularly removable ones, shall be interchangeable.

c) Screws, studs, nuts, and bolts used for external connections shall be as per the relevant standards. Bolts and nuts exposed to atmosphere shall be of stainless steel.

d) Exposed parts shall not have pockets where water can collect due to moisture or otherwise.

e) Labels, indelibly marked, shall be provided for all identifiable accessories. All label plates shall be of in-corrodible material.

f) All internal connections and fastenings shall be capable of operating under overloads allowed as per specified standards without injury.

g) Transformer and accessories shall be designed to facilitate proper operation, inspection, maintenance, and repairs.

h) No patching, plugging, shimming or other such means of overcoming defects, discrepancies or errors will be accepted.

i) The galvanizing if required shall be of minimum 610 gm zinc per square meter and it should be hot dip galvanized.

1.35.17 Painting [as applicable]

a) The structural steel work shall be cleaned of all scale and rust by shot blasting. Steel surfaces exposed to the weather shall be thoroughly cleaning and have a priming coat of zinc chromate applied. The second coat shall be of a glossy oil and weather resisting nonfading, paint of shade No. 631 as per IS: 5.

b) Metal parts not accessible for painting shall be made of corrosion resistant material.

c) All paints shall be carefully selected to withstand heat, rain, hot humid atmosphere, and extremes of weather. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling.

d) In case finish paint chips off or crinkle during transit or installation, the contractor shall arrange for repainting transformer at site at his cost. The paint for repainting shall be supplied by the contractor.

1.35.18 Under Carriage

The transformer shall be supported on non- corrosive steel structure with forged steel flanged wheels suitable for moving the transformer completely. Wheels shall be provided with suitable bearings which will resist rust and corrosion and shall be equipped with fittings for lubrication.

1.35.19 Magnetic Core

a) The magnetic circuit shall be constructed from prime quality high grade cold rolled, non-ageing, grain-oriented silicon steel lamination. The manufacture shall submit the following documents to prove only Prime quality Core are used:

   i. Invoice of the supplier
   ii. Mill’s test Certificate
   iii. Packing list
   iv. Bill of loading
   v. Bill of entry certificate to custom

b) The manufacturers shall indicate whether they have in-house core cutting facilities or not, if not, they shall indicate place of cutting.

c) To reduce the noise produced by the magnetic core, it is to be equipped with noise-damping devices.

d) To reduce the no-load losses, the magnetic core is to be stacked using overlapping-interlocking technology.

e) The laminations shall be free of all burns and sharp projections. Each sheet shall have an insulating coating.

f) The insulation structure for the core to bolts and core to clamp plate shall be such as to withstand a voltage of 2000 V for one minute.

g) The completed core and coil shall be so assembled that the axis and the plane of the outer surface of the core stack shall not deviate from the vertical plane by more than 25 mm.

h) All steel sections used for supporting the core shall be thoroughly shot or sand blasted, after cutting, drilling, and welding.

i) The finally assembled core with all the clamping structures shall be free from deformation and shall not vibrate during operation.

j) The core clamping structure shall be designed to minimize eddy current loss.

k) The core shall be carefully assembled and rigidly clamped to ensure adequate mechanical strength.

l) The core shall be provided with lugs suitable for lifting the complete core and coil assembly.

m) The design of magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or to the earthed clamping structure and production of flux component at right angle to the plane of the lamination which may cause local heating. The construction is to be of 'core' type.

1.35.20 Internal Earthing

a) All internal metal parts of the transformer, with the exception of individual laminations, core bolts and their individual clamping plates shall be earthed.

b) The magnetic circuit shall be connected to the clamping structure at one point only and this shall be brought out. A dis-connecting link shall be provided on transformer to facilitate disconnections from ground for IR measurement purpose.

c) 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.

1.35.21 Winding

1 LV windings

The LV winding shall be of Aluminium foils in order to cancel out axial stress during short circuit. This foil will be insulated between each layer using a heat-reactivated class F pre-impregnated epoxy resin film including the ends of the winding. The whole winding assembly is to be polymerized at suitable temperature to ensure high level of resistance environment and to have excellent dielectric strength.

2 HV windings

a) HV winding shall be separated from the LV winding to give an air gap between the MV and LV circuits for easy maintenance.

b) HV winding shall have linear potential gradient from top to bottom to have low stress between adjacent conductors, with high dielectric strength and low partial discharge.

c) HV winding shall be of Aluminium wire with class F insulation cast in vacuum with fireproof / flame retardant epoxy resin.

d) The interior and exterior of the windings will be reinforced with a combination of glass fibre or similar material to provide thermal shock withstand.

3 HV winding support spacers.

a) Winding support spacers are meant to provide sufficient support in transport, operation, short circuit, and earthquake conditions.

b) These spacers will be circular in shape for easy cleaning. They will give an extended tracking line to give better dielectric withstand under humid or high dust conditions.

c) These spacers will include an Elastomer cushion that will allow it to absorb expansion as peer load conditions. This Elastomer cushion will be incorporated in the spacer to prevent it being deteriorated by air or UV.

4 HV Connections

a) The connections shall be of copper and made from the top to give a safe and neat connection. A terminal plate shall be provided.

b) The HV connections will be made from the top connection bars. Each bar will be drilled with a hole for connection of cable lugs on terminal plates.

c) The HV connection bars will be in rigid copper bars protected by heat shrinkable tubing.

d) HV connections in cables are not allowed, in order to avoid all risk of contact, due to cables flapping.

e) Depending upon the design of the manufacturer the arrangement shall be approved by the Engineer.

5 LV Connections

a) The LV connections with copper bars will be made from top of coils on the opposite side to the HV connections.

b) Connection of the LV neutral will be directly made to the LV terminals between the LV phase bars. There shall be a separate earth point connected to neutral.

c) Depending upon the design of the manufacturer the arrangement shall be approved by the Engineer.

1.35.22 Transformer Thermal and Overload Protection

a) PTC type sensors [minimum 6] shall be placed in the winding to measure the winding temperature.

b) The transformer shall be equipped with an overload and thermal protection device with sensors to continuously monitor the LV and HV winding temperature for each phase.

c) Digital monitoring thermometers shall be installed locally in the CSS on LV Board, with a provision for monitoring the temperatures at remote SCADA. Necessary alarms and trip contacts along with warning LEDs shall be provided to protect the transformers from high temperature.

d) Sensors shall be so placed that it shall be possible to replace the same very easily. All sensors along with enclosures, digital thermometers, transducers, sensing relays, connecting leads, etc. complete in all respects shall be in the scope of supply. For this purpose, Security & Communication contractor shall lay a fibre optic cable from CSS to SCADA control Centre, termination of which to such devices shall be in the scope of contractor.

e) Provision shall be made that in case of fire the transformer circuit breaker should be tripped.

1.35.23 Off Circuit Tap Changer

There shall not be a bolting arrangement for selecting the taps and shifting the copper bars. Instead, the off circuit tap changer shall be operatable by means of an operating handle / ring brought out-side the tank operable from ground level. It shall be equipped with an indicating device to show the tap in use and shall be provided with a locking arrangement to lock the switch in position. The arrangement shall be such that an operator can change the tap while standing at ground level with complete ease. There shall be separate cover for tap changer.

1.35.24 Safety of Personnel

Transformer shall be properly fenced/protected in case the maintenance personnel are likely to come near the live parts while carrying out normal maintenance or monitoring activities near the transformer.

1.35.25 Fittings

The following fittings shall be provided on the transformers:

Separate LV neutral point, with two joined points for double earthing of neutral along with tinned copper strip compatible to transformer short circuit current rating for earthing.

1.35.26 One danger Plate

Temperature indicating device, sensors etc. complete in all respects with contacts for remote/ local indication.

Lifting eyes or lugs for the top cover, core, and coils and for the complete transformer.

Platform lugs / haulage lugs on under carriage.

1.35.27 Marshalling box.

1 Rating and connection diagram plate.

Two numbers earthing terminals on opposite sides, associated nuts, bolts, and tinned copper earth strip of suitable section for connections to purchaser’s grounding strip.

2 4 bidirectional rollers.

Thermal and overload protection devices and equipment, along with necessary transducers, sensors etc. for local and remote SCADA indication, Alarm / trip contacts, LED indicators complete in all respects.

Note: 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.

1.35.28 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.

1.35.29 Mandatory Spare Parts

The mandatory spare parts shall be included in the bid along with costs. These shall be considered in evaluation.

1.35.30 Recommended Spare Parts

Contractor shall provide a list of recommended spare parts for 5 years operations. The cost of these spare parts shall not form part of contractor proposal.

1.35.31 Tests

The Transformers shall be completely factory tested before dispatch in accordance with the standards and with such other tests as may be necessary to ensure that the equipment is satisfactory and is in accordance with this specification.

1 Routine Tests

Transformer routine tests shall include tests stated in latest issue of IS: 2026 / IEC 60076-11. These tests shall also include but shall not be limited to the following:

a) Measurement of winding resistance.

b) Voltage ratio on each tapping and check of voltage vector relationship.

c) Impedance voltage at all tapping.

d) Magnetic circuit test

e) (After routine tests, each core shall be tested for 1 minute at 2 kV between all bolts, side plates and structural steel work. Immediately prior to the dispatch of the transformer, the magnetic circuit shall be pressure tested for 1 minute at 2 kV A.C. between the core and the earth).

2 Load losses.

a) No load losses and no-load current.

i. Absorption index i.e. insulation resistance for 15 seconds and 60 seconds (R60/R15) and polarization index i.e. Insulation Resistance for 10 minutes and one minute (R10 mt/R1 mt).

b) Separate source voltage withstands test (applied potential).

c) Induced voltage test.

d) Measurement of partial discharges.

i. Partial discharges less than or equal to 10 pC at 1.30 Un, or

ii. Partial discharges less than or equal to 5 pC at 1.30 Un (Special test)

e) Measurement of acoustic noise level.

f) Measurement of Zero sequence impedance.

g) All routine and type tests should be done free of cost. If it is to be done on the cost basis, the same may be indicated in the schedule of price and delivery and this will be considered for evaluation of prices.

h) When transformers are equipped with a protection enclosure, these shall be tested in their enclosure.

i) Moreover, in addition to the routine tests, the transformer shall be subjected to the following type tests:

3 Lightning Impulse Test

This test shall be carried in accordance with clause 12 of the latest issue of IS: 2026 (Part-III). The contractor shall quote separate price for lighting impulse test on HV and LV windings. (one limb only).

4 Temperature Rise Test

The temperature rise test shall be carried out in accordance with IS: 2026 /IEC-60076. The Temperature rise shall not exceed the values as in the IS: 2026 / IEC 60076-11

5 Noise Level Test:

It shall be carried out as per IEC-60076-10

6 Environmental and Firefighting tests

Certificates for tests carried out for Compliance to Class C1, E2 and F1 as per IEC 60076-11.

7 Short Circuit Test

It shall be carried out as per IEC 60076-5. Alternatively, employer at its discretion can ask for calculations instead of actual test.

8 Test Waiver, Procedures and Costs

a) The Engineer, at his option, may waive impulse tests, provided type test reports of impulse tests, carried out on essentially identical units in their factory in India or at an accredited lab overseas, during the last three years are furnished by the manufacturer and are acceptable to Engineer.

b) No load losses and exciting current shall be measured at rated voltage, rated frequency and at 90% and 110% of rated voltage, both before and after the lightning impulse tests.

c) The method of test loading shall be described in the test report for determination of both average and hottest spot temperature. Where the winding temperature equipment are specified, data shall also be included for calibration of hottest spot temperature indicator.

d) Resistance of each winding of each phase shall be measured at principal and at all the taps and corrected to 750C.

e) Impedance voltage shall be measured at principal and at all taps.

f) No load Loss Measurement at 415 Volt.

g) The contractor shall indicate separately the cost of each of the following type tests:

h) Lightning impulse test separately for HV and LV winding.

i) Temperature rise test.

9 Test on Associated Equipment

Bushings, Transformer thermal and overload protection devices, sensors, digital thermometers, OFF LOAD tap changer, control devices, and other associated equipment shall be tested by the contractor in accordance with relevant IS or IEC. If such equipment is purchased by the contractor, he shall have them tested to comply with these requirements.

10 Test Measurements

a) Certified test report and oscillograms shall be furnished to the Engineer for evaluation as per the schedule of distribution of documents. Manufacturer's Test Certificates in respect of all associated auxiliary and ancillary equipment shall be furnished.

b) The contractor shall state in his proposal the testing facilities available at his works. In case full testing facilities are not available, the contractor shall state the method proposed to be adopted so as to ascertain the transformer characteristics corresponding to full capacity testing.

11 Witnessing of Tests

The Clients' Engineer reserves the right to witness any or all tests. If required, visits can be made to the works of manufacturer to ensure that the approved quality ensuring programme is being followed. In this regard all the necessary facilities shall be arranged by manufacturer at his end and cost borne by the contractor.

12 Site Tests

a) After the transformer is installed, the following pre-commissioning tests and checks shall be done before putting the transformer in service.

b) Visual checks for connections etc.

c) Dry out test.

d) PI / Resistance measurement of windings

e) Ratio test

f) Tap changer test.

g) Temperature Indicators & alarms

h) Magnetizing current

i) Earth connections are made.

13 Rejection

a) The Engineer can reject any transformer if during tests or service any of the following conditions arise:

b) No load loss exceeds the guaranteed value.

c) Load loss exceeds the guaranteed value.

d) Impedance value exceeds the guaranteed value by ± 10% or more.

e) The difference in impedance values of any two phases during single phase short circuit impedance test exceeds 2% of the average value guaranteed by the vendor.

f) Winding temperature rise exceeds the specified value.

g) Transformer fails on impulse test.

h) Transformer fails on power frequency voltage withstand test.

i) Transformer is proved to have been manufactured not in accordance with the agreed specification.

1.35.32 Instructions Manual

Six 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/construction, testing, operation, and maintenance of the transformer. The manuals shall include amongst others, the following particulars:

a) Marked erection/construction 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 tapping's, 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 check lists etc.

1.35.33 Completeness of Equipment

All fittings and accessories, which may not be specifically mentioned in the specification but are necessary for the satisfactory operation of the equipment, shall be deemed to be included in the specification. These shall be furnished by the contractor without extra charges. The equipment shall be complete in all details, whether such details are mentioned in the specification or not.

All deviations from this specification shall be separately listed under the requisite schedules, in the absence of which it shall be presumed that all the provisions of the specifications are accepted by the contractor.

1 Tools & Tackles

All the necessary tools and tackles required for the normal operation shall be supplied by the bidder.

1.35.34 Prefabricated Enclosure for Packaged RMU Substations

1 General

The enclosure for the compact substation also includes the base frame/ channels and all the necessary fixing hardware accessories required at site. The enclosure shall be compartmentalized and house RMU, dry distribution transformer, LV distribution board with capacitor bank and their interconnections both external and internal. Engineer at its sole discretion may also consider the alternate designs given by the contractor, if the same are found to be better or equivalent to the ones given hereunder.

2 Standards

Typical size	**2 x 2.5 m (5 m2) with 2 m height [Contractor may quote its own size, if different]**
Construction	Self- standing on concrete base
Steel base frame	4mm thick base [hot dip electro-galvanized steel, with epoxy paint]- suitable for local e
Lifting eyes	4 Nos from the bottom.
Housing enclosure	2 mm corrosion resistant Zinc / Aluminum alloy coated sheet steels
Degree of Protection	HV Compartment : IP-54 Transformer Compartment : IP-23 LV Compartment : IP-54
All hinges, supports Nuts, washers etc.	Stainless steel
Paint	Epoxy
Roof Design Load [min]	250 Kg/m2
Roof Design	Slanting on the sides
Top of Roof	Removable
Ventilation	With louvers (no exhaust fans shall be used)
Sound Level	60 dB
Standard Applicable	IEC 62271-202
Number of earths	Two (at opposite ends)
Compartments	Three with independent doors

The equipment shall conform (but shall not be limited) to IEC 6227-202 standard. The requirements of standards for necessary clearances, ventilation etc. shall also be complied with.

1.36 Specific Technical Requirements

1.36.1 Construction

1 General

a) The enclosure shall be self-standing on a concrete base. Necessary civil requirements to be satisfied for the concrete base shall be provided by the contractor. The levelling of ground and construction of the concrete base and associated civil works shall also be in the scope of the contractor.

b) The compact substation is completely self-contained, mounted upon a 4 mm thick galvanized steel base frame, epoxy painted, factory assembled in a totally enclosed, aesthetically acceptable metal cladding, vandal-proof and weatherproof housing ready for placing into position upon a concrete base.

c) The lifting arrangement should be with four lifting eyes from the bottom of the enclosure & not from the top.

d) The structure of the substation shall be capable of supporting the gross weight of all the equipment & the roof of the substation compartment shall be designed to support adequate loads. In case of relocation of the Package Substation, the entire substation should be capable of getting lifted and placed as a Single Unit without dismantling of any of the major equipment inside the enclosure. The complete housing assembly with four lifting eyes should be easy to lift and position the whole unit at the site by the use of crane. The substation can be lifted without damage or distortion. The transformer is located in the middle of the substation while the HV and LV compartments are located at both ends of the substation adjacent to the corresponding bushings of the transformer. The arrangement is subject to the approval of the Client or site Engineer.

e) There shall be adequate ventilation inside the enclosure so that hot air inside enclosure is directed out by help of duct. Louvers having UL approvals with G3 Filters as per EN 779 in apertures shall be provided so that there is circulation of natural air inside the enclosure. The Package Substation should be designed & engineering to have natural cooling & ventilation only. No forced cooling / ventilation is acceptable.

f) The enclosure must be weatherproof installation with proper measures against rusting.

g) The enclosure must also be vermin proof to prevent the entry of rodents, reptiles, & flying insects, which are prevalent in the area.

h) The enclosure should be prefabricated such that fire from one compartment MUST NOT spread to other compartments.

i) It should have easy access to all the equipment inside the enclosure, viz RMU, transformer, LV switchboard, capacitor bank, connections, and terminations of HV & LV cables.

j) The metal base and all supporting channels shall be hot dip galvanized. These should ensure rigidity, ease in transportation to sites and installation.

k) The outdoor panel envelope may be made of electro-galvanized mild steel with nominal thickness of not less than 3 mm. The housing of the enclosure shall be made of 2 mm corrosion resistant Zinc / Aluminium alloy coated steel sheets.

l) All hardware such as hinges, supports, screws, nuts, bolts, washers etc. should be made of stainless steel. All locking bolts shall be accessible from inside to prevent the unauthorized dismantling.

m) All the enclosures shall be or of similar type & design.

n) The colour of the enclosure shall be decided by Engineer during detailed engineering, if different from the one given. The last finish coat shall be of epoxy paint.

o) The roof of the substation enclosure shall be designed to support loads up to 250 kg/m2. The roof shall be sloped on the sides so that the rainwater cannot stay on roof during rainy days.

p) The prefabricated roof of the enclosure shall be removable whenever required. The locking nuts, bolts to allow the removal of roof shall be only accessible from inside the enclosure.

2 Covers & Doors

a) Covers & doors are part of the enclosure. When they are closed, they shall provide the degree of protection specified for the enclosure. All covers, doors or roof shall be provided with locking facility, or it shall not be possible to open or remove them before doors in normal operation have been opened. The doors shall open outward at an angle of at least 90degrees & be equipped with a device able to maintain them in an open position. Proper padlocking facility shall be provided for doors of each compartment. Transformer compartment doors must be open from both the sides.

b) Door closing shall be by means of a three-point linkage arrangement (i.e. Centre, top and bottom) and controlled by a centrally located stainless steel operating handle. Pad locking facilities along with Master pad locks shall be provided. Master pad locks shall be operated by a master key for all the substations.

c) The outer doors of the enclosure shall be wide and provided with heavy duty hinges to prevent distortion and misalignment. A robust door restraint shall be provided to hold each door in the 950 open positions. The restraint shall be of a captive design so that it cannot be easily removed and shall be self-strong when the door is closed such that it cannot rattle. With the door in this position, operation of LV and HV switchgear shall be possible without endangering operator’s hands, etc.

d) When doors are closed, they are firmly locked; as such entry of dust, vermin and rainwater is completely prevented. PU Foam gaskets are to be used.

e) The HV doors are provided with a drawing pocket to keep drawing inside.

f) A weatherproof nameplate shall be provided on the door.

g) The edges of the doors are bended at both sides to assure they fit properly so that the door jams and misalignment is prevented.

h) The transformer, low voltage and HV compartments are completely separated by steel sheet. The barrier between the HV switchgear and the transformer is provided with pressure relief flaps.

i) All compartments are individually accessible by their own doors from outside.

j) Labyrinthine louvers form the sidings of the transformer room to assure free entry and exhaust of air, as such the inside temperature is kept within limits. Openings located at the lower and upper sides of the slanted roof shall allow air circulation as part of the ventilation design.

k) No exhaust fans shall be used. Ventilation louvers having UL approvals with G3 Filters as per EN 779 shall be required to provide sufficient ventilation.

l) All compartments are equipped with internal lighting consisting of 9W 25 watts UL approved 1200 lumens LED lamps with electrical life of 60000 hours minimum to be controlled by the built-in PIR sensor without any need for their respective door micro switches. MCB shall be provided to control the supply.

m) UL approved PTC Type DIN Rail Mountable encapsulated Space heaters shall be provided to control condensing type humidity via UL approved DIN Rail Mounted Hygro-thermostat.

n) Labels for warning, manufacturer’s operating instructions etc. & those according to local standards & regulations shall be pasted / provided inside and shall be durable & clearly legible.

o) The substation forms a complete metallic structure bolted together and each compartment is to be provided with tinned copper, grounding busbar. Bonding and interconnection of the grounding buses shall be made of 70 mm2 bare stranded copper tinned conductors. The ring main unit shall have 25x8 mm grounding bus while the low voltage switchgear shall have 30 x 10 mm tinned copper grounding buses to which connection to the grounding system at site can be made. At least two grounding points for bolting to ground conductor shall be provided on opposite ends.

p) All metallic components shall be earthed to a common earthing point. It shall be terminated by an adequate terminal intended for connection to the earth system of the installation, by way of flexible jumpers/strips & Lug arrangement. The continuity of the earth system shall be ensured considering the thermal & mechanical stresses caused by the current it may have to carry. The components to be connected to the earth system shall include:

   i. The enclosure of Unitized / prefabricated substation.

   ii. The enclosure of High voltage switchgear & control gear from the terminal provided for the purpose.

   iii. The metal screen & the low - high voltage cable earth conductor.

iv. The transformer tank or metal frame of transformer.

v. The frame &/or enclosure of low voltage switchgear.

3 Dimensions

The overall typical dimensions of the enclosure may be around 2.5 m x 2.0 m (or 5m2) having height of about 2 m. To achieve necessary clearances, contractor may propose alternate size of the enclosure depending upon the dimensions of the equipment supplied.

4 Enclosure Requirements

The enclosure must be totally safe to the personnel in the populated areas as the packaged substation shall be established in the residential townships.

a) The equipment in the enclosure must be accommodated with necessary clearances, easy access to the RMU, and transformer, LT switchgear and capacitor bank for testing, maintenance, removal, and normal operation (including operation with normal switchgear handles).

b) There shall be unhindered access to the transformer, operation of OFF load tap changer and other normal operating requirements. Similarly, termination & removal of cables, withdrawals of ACB from LV board should be easy & comfortable.

c) It shall be the sole responsibility of the contractor to satisfy all the statutory clearances and to provide safety measures against all possible hazards to the equipment in the enclosures, such as internal arcing faults in the enclosure considering environmental conditions existing at site.

d) Failure within the unitized substation due either to a defect, or mal operation may initiate an internal arc. Such an event may lead to the risk of injury if persons are present. It is desirable that the unit shall be tested for Internal Arc fault test to the tune of at least 20KA for 1 second as per latest IEC 62271-202 standard. The enclosure must be so designed that internal arc faults are directed away from places where personnel or public may be present. Test certificates from a recognised national/international test house [acceptable to Engineer] shall be supplied for internal arc.

e) Testing of incoming & outgoing cables and use of testing equipment for the same shall not entail the dismantling the sides or the roof of the enclosure.

f) There shall be sufficient space for termination & removal of cables from Load Break Switches & also from the LV board.

g) Sufficient clearance must be kept between the top of any equipment installed in the prefabricated substation and the roof of the substation for ventilation and operational purposes.

5 Interconnection

a) The equipment inside the enclosure shall be interconnected as follows:

b) The RMU shall be directly coupled by VCB feeder to distribution transformer through insulated copper bars or cables as per manufacturer standard.

c) The LV side (three phases plus one neutral conductor) of distribution transformer shall be connected to LV incomer Air Circuit Breaker via flexible insulated copper bars or through a four-conductor sand-witched insulated bars or with bus duct enclosure.

d) The HV termination to Load Break Switches shall be from 11 kV, Al. armoured XLPE cables, fitted with termination kits, for the ring system. It should be heat shrinkable, humid environment proof, touch proof

e) The earthing of pre-fabrication station shall be provided at two opposite ends for connection to the outside earth rods. It shall be a bolted connection.

6 Drawings

The following drawings shall be submitted with the tender.

a) The detailed sketch of the enclosure indicating general view, position of louvers etc.

b) The drawing showing the layout of HV, transformer & LV switchgear along with interconnections.

c) Size & position of doors in the enclosure.

d) Fixing details of the enclosure including civil foundations (if any).

7 Safety Measures

The enclosure shall have the following safety measures:

a) Electric shock treatment chart duly framed shall be fixed in a conspicuous position inside the enclosure.

b) Danger notice in English/ Hindi/ Kannada language conforming to IS: 2551 shall be fixed on all the four sides of the enclosure.

c) Electric insulated rubber mat (non-skid type) with flouted top and plain border end, 12 mm thick to withstand 12kV di-electric strength shall be provided in front of HV/LV boards where people have to work.

d) Two number portable fire extinguisher typically 2 litres, suitable for transformer / cable and other electrical equipment fires shall be placed & fixed in a suitable location in the enclosure, away from the place where fire is expected.

8 Tests

The following tests shall be carried out on the enclosure as per IEC standard at the works of the manufacture:

a) The complete prefabricated substation unit will be tested at full load for temperature rise. The maximum temperature rise on any part of the equipment placed inside the enclosure shall not exceed the value as specified in IEC 62271-202.

b) Test to verify the sound level of the pre-fabricated substation, which shall be less than 60 db.

c) Test to verify the degree of protection of enclosure for various compartments.

d) For the internal arc fault test on the enclosure the following need to be observed and tested as below:

e) Internal Arc Fault tested to 20 kA 1 sec.

f) Test to accessibility of Type "B" that is with unrestricted accessibility including that of the general public (Annex. AA.2 IEC). Although test to accessibility of Type "A" is not required, tenderers shall also provide adequate measures to have any hot gases directed away from the operator during switching with the door open.

g) Arc initiation is made inside the SF6 gas compartment of the RMU (Annex. AA.3 IEC).

h) Assessment of the internal arc fault test is based on the fulfilment of all 6 criteria as stated in Annex. AA.6 of IEC.

9 Other Checks

a) Inspection of conformity with the specification & approved drawings.

b) Inspection of devices locking out and interlocks.

c) Inspection and checking electrical continuity of metallic frame and earthing system.

d) Dielectric tests of M.V. and L.V. bus bar.

e) Provision of two earths as per Indian Electricity Rules.

f) Tests as per IEC standard

1.36.2 LV Switchboard for CSS

1 General

The LV switchboard for CSS shall be indoor 3-Phase, 4-wire, 415 V, 50 HZ, neutral solidly grounded, complete in all respects including base channels, foundation bolts and other hardware required for installation in CSS.

2 Standards

The equipment covered in these specifications shall conform to the latest revisions / replacements of the following Indian Standard Specifications.

The equipment complying with other internationally accepted standards shall also be considered if they ensure performance equivalent to or superior to Indian Standards.

Table 1-25: List of applicable standards for LV switch board

S. No.	Standard Number	Description
1	IS: 5	Colors for ready mixed paints & enamels
2	IS: 722	AC Electricity Meters
3	IS: 1554	PVC insulated (heavy duty) electric cables
4	IS: 2147	Degrees of protection provided by enclosures for Low-voltage switchgear and control gear
5	IS: 2419	Dimensions for panel mounted electrical indicating & recording electrical instrument
6	IS: 2551	Danger notice plates

S. No.	Standard Number	Description
7	IS: 2633	Methods for testing uniformity of coating of Zinc coated articles
8	IS: 2705	Current Transformers
9	IS: 3156	Voltage Transformers
10	IS: 3231	Specification for electrical relays for power system protection
11	IS: 4237	General requirements for Switchgear & Control gear for voltage not exceeding1000 volts.
12	IS: 4794	Push buttons
13	IS: 5082	Wrought Aluminum and Aluminum alloy bars rods, tubes, sections plates, sheets for electrical application
14	IS: 5578	Guide for making of insulated conductors
15	IS: 6005	Code of practice for phosphate coatings of iron and steel (First Revision)
16	IS: 6875	Control switches (switching devices for control and auxiliary circuit including contractor relays) for voltages up to and including 1000 V AC and 1200 V DC
17	IEC 61439 part 1&2 edition 3	Low voltage Switchgear and Control gear assemblies
18	IS: 8828	Electrical accessories circuit breakers for over current protection for home load and similar installations.
19	IS: 9000	Basic environmental testing procedures for electronic and electrical items
20	IS: 10580	Service conditions for electrical equipment
21	IS: 11353	Guide for uniform system of marking and identification of conductors & apparatus terminals
22	IS: 13703	Low voltage fuses for voltages not exceeding 1000 V AC or 1500 V DC
23	IS: 13942	Low voltage switchgear and control gear
24	SP: 39	Guide for insulation coordination within low voltage system
25	IEC -60364 IEC: 60664	Low Voltage Electrical Installations [All applicable series of IEC-60364] Insulation coordination within low voltage system including clearance and creepage distance for equipment.

IEC: 60664 Low Voltage Electrical Installations [All applicable series of IEC-60364]

Insulation coordination within low voltage system including clearance and creepage distance for equipment.

1.36.3 System Details

The L.V. Distribution Board for CSS substation shall be fed from adequately rated transformer to be decided during engineering. Only the standard size of transformer shall be selected.

1 Connection to LV side of Transformer

Connection to LV side of distribution transformer shall be through insulated, three phase, four wire tinned Copper bars. Alternatively tinned Copper bars may be considered with a non-segregated three phase four wire bus duct, or with sand-witched bus bars, conforming to relevant IS Standard as per current requirements for LV Switch boards of CSS.

2 Incomer and Board Bus bar

For CSS LV switch board Incomer shall be Air Circuit Breaker, draw out type, electrically operated, equipped with microprocessor based electronic trip units, complete with CTs & metering. It shall be possible to operate this breaker from remote through SCADA also. Transformer incomer rating shall be same as that of bus rating. LV Bus bars shall be three phases, 4wire, and of tinned copper. Size of neutral conductor shall be same as of phase bars. The LV Board shall be designed for fault level as given in the Specific Technical Requirements.

3 Outgoing Feeders

No HRC fuses are envisaged. All the outgoing feeders shall be equipped with Moulded Case Circuit Breakers of appropriate rating. Outgoing feeders of LV panels of CSS shall be provided with MFM, which shall be interfaced with respective substation SCADA system.

4 External Cabling

The external, three phase, LV cables of required size shall be terminated to the outgoing terminals of LV switch board. Necessary cable supports shall be provided in the cable alley of the board.

1.37 Design and Standardization

1.37.1 General

a) The equipment shall be designed to ensure satisfactory operation of the system in which continuity and quality of service is the first consideration. It shall also be designed to withstand sudden load variations due to short circuits and fault conditions or for any other reason.

b) All the LV switch boards shall be compartmentalized in design and form of separation shall be 4B. All mechanism shall be made of such materials as to prevent sluggishness due to rust or corrosion. All connections and contacts shall be of ample section and have sufficient surface area for carrying continuously the specified current without undue heating and shall be secured rigidly and locked in position. Standard sizes of stainless-steel bolts, screws, pipes and other fittings are to be used and number of sizes is to be kept to the minimum.

c) Cast Iron shall not be used for any part of the equipment which may be subjected to mechanical stresses.

d) All apparatus shall be so designed and constructed as to obviate the risks of short circuits of the live parts by lizards, vermin’s etc. Metal cubicles, housing and covers shall be 100% weather / vermin proof and shall be able to provide the degree of protection IP-54 in accordance with latest version of IS-2147.

e) All parts shall be manufactured in accordance with relevant standard specifications of IEC / I.S. Corresponding parts of similar equipment and apparatus shall be mutually interchangeable.

f) All apparatus, connections and cabling shall be designed and arranged to minimize the risk of fire and any damage which might be caused in the event of such an eventuality.

g) Minimum 20% of spare feeders to be provided apart from Working and Standby feeders provided already.

1.37.2 Specific Technical Particulars

The standard technical particulars (which must be modified considering the climatic conditions as given in relevant standards) for the LV Switchboard, are given below:

1 AC System: 3 phases, 4 wire, solidly earthed

a) Transformer secondary Voltage : 433V

b) System Nominal Voltage : 415 volts ± 6%

c) Frequency : 50 Hz ± 5%

d) Combined variation in absolute sum of Voltage & frequency : ±10%

1.37.3 Constructional detail: Compartmentalized, Form-4B form of separation

Bus bar

1 Electrolytic Copper, tinned, Continuous rating [as per transformer rating and as indicated in Single line diagram]

a) Fault withstanding capacity : 50 kA rms for 1 s

2 One Minute Power Frequency / Impulse Withstand Voltage

a) Power circuits : 2.5 kV (rms)

b) Control circuits : 2.5 kV (rms)

c) Basic Insulation Level, kVp : 8

3 Moulded Case Circuit Breaker (MCCB, 4P) with rotary handle AC

a) Voltage : 3-Phase, 415 V ± 6%

b) Frequency : 50 Hz, ± 5%

c) Release : With OC, SC & EF release

d) Short Circuit Capability : 50 kA (rms) for 1 Sec.

e) Making capacity : 62.5 kAp

f) Operating Mechanism : Manual, trip free

g) Temperature rise : As per IS: 2516

h) Mechanical : As per IS: 2516

i) Auxiliary contacts : 4 No., 4 NC

j) Current Rating : As per Single Line Drawing

4 Multi-function Meters

a)	Accuracy class	:	1
b)	One Minute Power	:	2 kV (rms)

Frequency Withstand Voltage

5 Current Transformers

a)	Type	:	Cast resin, Bar primary
b)	Secondary circuit	:	1 Amp.
c)	Voltage class and Frequency	:	1100 v, 50 Hz
d)	Class of insulation	:	E or better
e)	Accuracy	:	
f)	Accuracy class &VA of metering CT	:	Class 1, 10 VA
g)	Accuracy class of VA of protection CT	:	5 P 15, 10 VA
h)	Short time current rating	:	50 kA (rms) for 1 sec.
i)	Dynamic rating	:	120 kA (peak)
j)	One Minute Power	:	2.5 kV (rms)

Frequency Withstand Voltage

6 Voltage Transformers

a)	Type	:	Cast resin
b)	Rated voltage		
c)	Primary	:	415 V / √3
d)	Secondary	:	110 V / √3
e)	Accuracy class and VA burden		
f)	Metering	:	1.0, 25 VA
g)	Protection	:	3 P, 25 VA
h)	Method of connection		
i)	Primary	:	Star
j)	Secondary	:	Star
k)	Rated voltage factor	:	1.1 continuous, 1.5 for 3 sec.
l)	Class of insulation	:	E or better
m)	One minute power	:	2.5 kV (rms)

Frequency withstands voltage.

a) **Relay if any.One Minute Power : 2.0 kV (rms)**

b) Frequency withstands Voltage.

c) Cubicle Colour Finish

d) Interior : Glossy RAL 7035

e) Exterior : RAL7035

f) Accessories

g) Plug point with MCB.

h) Space heater PTC type.

i) Name plate on front & rear.

j) Danger plates.

k) Cubicle

l) Minimum thickness of CRCA sheet steel for Door 2 mm

m) Rear & Side Panel 1.5 mm

n) Base Frame channel 100mm x 50mm x 6mm

o) Degree of protection IP-54

p) Rubber mat between Panel & base 15mm

1.37.4 Clearance and Creepage Distances

The clearances and creepage distances shall be in accordance with Indian Standard for condensing humidity and highly polluted environment.

1.37.5 Labels and Marking of Connections

All equipment, control gear and the apparatus mounted thereon shall be clearly labelled indicating, their purpose and the 'ON' 'OFF' and "EARTH' positions. The labels shall be clearly lettered on enameled surface or other approved materials. Brass should not be used for labels. Each phase of alternating current and connections shall be coloured to distinguish phase, neutral and earth. The colouring shall be respectively for red, yellow, blue for phases black for neutral and green for earth.

Each phase of alternating current and connections shall have coloured heat shrinkable sleeve. The LT switchboards shall be labelled as per designation shown in the single lien diagram. The labelling shall be finalised after the arrangement for the same, is got approved by the successful contractor during detailed engineering.

1.37.6 Drawings and Literature

Four sets of tentative G.A., Schematic drawings and detailed literature of equipment shall be submitted with the tender clearly giving the scope of supply and bill of material to enable the Engineer to scrutinise all aspects of design including arrangement and support of cable accessibility for maintenance work and future additions, cable connections, general appearance etc. In addition, the contractor shall submit drawings & literature are to be furnished by successful tenderer / bidder within 2 weeks after the award of contract, which shall include the following:

a) Complete assembly drawings of the boards, showing plan, elevation, typical section, location of terminal blocks for external wiring connections and mounting details of various devices with dimension.

b) Foundation plan, embedment channel frame with associated holes and suitable size of bolts for fixing to channel frame.

c) Wiring diagrams including terminal wiring design and cable schedule.

d) Schematic control diagram, details of relays, instruments, space heaters, cubicle illumination and receptacle etc.

e) Bill of material of each LV board.

f) Layout plan of each LV board.

1.37.7 Bought out Items.

All bought out items such as switches, MCCBs, MCB's meters, terminal blocks, cables etc. shall be of reputed make. Engineer reserves the right to accept only materials of proven make at its sole discretion.

1.37.8 Constructional Details

a) The Switchboard shall be made of cold rolled sheet steel of 16 folded profile frames with rear & side panel, 1.5 mm & door 2 mm having different compartments for bus-bars, cable alley and instrumentation. The board shall be floor mounted, self-supporting.

b) The bus-bars shall be rectangular, of tinned electrolytic copper and of approved size for current rating for phases as well as for neutral. The bus bars shall be suitably supported on non-hygroscopic insulators to withstand forces arising from short circuits in the system. These shall be suitable for harsh environmental conditions.

c) Separate cable alley shall be provided and accessible from front only. Cable entry shall be from Bottom.

d) The switch boards shall be of compact design. All doors and covers shall be fully gasketed (PU Foam). Individual feeder compartments shall be provided with stainless steel hinged doors, bolted type doors shall not be acceptable. Indicating instruments shall be of 96x96 mm.

e) The interconnections between bus-bars and MCCBs unit shall be solid insulated, tinned copper strip permanently bolted with the bus-bars and MCCBs. The bus-bar joints shall be given a thin coating of conducting grease after fully cleaning both the surfaces. The terminals shall be of substantial mechanical strength & shall provide adequate electrical contact area and the contact pressure is maintained permanently. The bus-bars / tee off shall be insulated with heat shrinkable sleeve tapes with red, yellow, blue colours for 3 phases and black for neutral. All the bus-bar tapping & markings shall be in accordance with relevant IS.

f) The gland plate shall be of GI/Aluminium minimum thickness of 3 mm and detachable type. A strong supporting channel of 100 x 50 x 6 mm shall be provided beneath the switchboard shell besides anti-vibration rubber gasket of 15 mm thickness.

g) The bus-bars shall have non-hygroscopic support insulators. The bus bar shall be insulated with heat shrinkable insulating kits.

h) The short circuits withstand capacity of all the bus-bars and tap-connection shall be 50 KA for one second.

1 Details of Circuits

Each switchboard shall have the following circuit arrangement.

a) Incoming

b) For CSS LV switch boards 1 no. 3 phase, 4 wire incomer four pole air circuit breaker, electrically operated with microprocessor-based trip circuit release for O/C, E/F, S/C. The breaker shall conform to IEC 61439.

c) It shall be withdrawal type. The control supply can be provided from a line connected PT control transformer from the LV connection from the transformer or any other arrangement given by contractor can also be considered during detailed engineering.

d) 3 Nos. – Metering CTs of required ratio, 10 VA Class 1, with ISF less than 5.

e) 3 Nos. – Protection CTs

f) 1 no. 96 x 96 mm flush mounted multi-function meter. Meter shall measure unbalanced neutral current also along with three phase currents simultaneously.

g) 1 no. digital bus voltmeter scale 0-500 V with three-line reading.

h) If required, 1 no. Automatic Power factor controller [APFC], connected to y-phase metering CT, with SCADA communication, and five steps to switch on capacitor banks for power factor improvement to 0.95.

i) Note: Number of steps is tentative and shall be finalised during detailed engineering.

j) LED type lamps to indicate breaker closed, open, auto trip, protection operation, spring charged etc. indications.

k) Outgoing feeders

l) 3 phases, 4 wire, outgoing cable circuits are envisaged from the switchboard and each circuit shall have the following items, indicating instruments, terminal connectors etc.

m) 4 pole withdrawable type Moulded Case Circuit Breakers of appropriate, rating as indicated in the single line diagrams.

n) Earth leakage relay.

o) 3 nos. metering current transformers of secondary rating 1A & 1.0 accuracy class having primary current as per SLD.

p) 1 no. 96x96mm flush mounted multifunction meter as per CT rating.

q) Termination points for 4C XLPE, Al. Armoured cables with lugs.

r) The LV board must have sufficient space of not less than 100 mm between two termination points for external cables.

s) Cable alley along with necessary clamping arrangement for the outgoing feeder cables.

t) Indicating LED lights – red, yellow, and blue for the supply.

1.37.9 Capacitor Bank & Automatic Power Factor Controller [APFC] (If required)

a) Considering the transformer capacity and load power factor as 0.8, a suitable size of switched capacitor bank shall be mounted inside the LT compartment to improve the power factor to 0.9. Necessary calculations, number of steps and switching details shall be provided for approval.

b) Capacitor units shall be fuse-less, with loss not exceeding 0.5W / kVAR, with metallised polypropylene film, double casing insulation, self-healing feature, non-flammable and with nontoxic material. Reactors shall be non- resonance, dry type resin embedded. Capacitor unit shall with automatic operation steps as required, built in discharge resistor, and mounted on stainless steel frame. APFC shall also be supplied by the same manufacturer. APFC shall have LCD display, programmable, with monitoring of all parameters locally as well as at remote SCADA on mod bus via fibre optic cable. It shall be with built in cabinet placed in the cubicle of LV board with easy access doors.

c) Each Circuit for Panel space heater, Panel Indication lamp and internal socket etc shall be provided with dedicated MCB for circuit isolation.

1.37.10 Earthing

a) The LV switchboard shall be provided with two separate earthing terminals at the ends. With minimum rated for 50kA for 3 sec running in the board. All metal parts, enclosure, transformer and neutral have to be interconnected and ready for connection to the external earthing arrangement.

b) The earthing terminals shall be identified by means of proper embossed sign marks adjacent to the terminals.

c) In the cable gland area provision shall be made at cable gland for armour earthing and then connecting it to main earth bar in a proper way. There shall be a continuous tinned copper earth bus bar in the board. The size of the earth bus bar shall be suitable to carry 50 kA for 3 second. The bus bar shall not be visible or removable from outside the switchboard. The earth bus bar shall have necessary holes, nuts & bolts including washers for making earth connection of cable glands / armouring of the cables.

1.37.11 Switchboard Lighting & Heating

A lamp holder with a UL approved 9 W LED lamp having 1200 lumens and operated by an internal PIR sensor powered by SP-MCB shall be fitted for internal illumination. In addition, a 3 pin 6A/25A socket shall also be provided with a separate SP-MCB. DIN Rail Mountable UL Approved Encapsulated Space heater of suitable rating of PTC type, and with Hygro-

Thermostat powered by SP MCB shall also be provided to avoid any moisture condensation inside the switchboard.

1.37.12 Danger Notice Plates

An enamelled sheet steel danger plate of approved design as per IS: 2551 shall be fixed on the middle upper front of the switchboard.

1.37.13 Tests

All tests as required in relevant Indian standard shall be carried out on the LV switchgear. Engineer shall witness the tests at the works of the manufacturer.

1 Type Tests

a) The purchaser may ask the manufacturer to conduct the following type tests on one of the AC Boards.

b) Verification of temperature rise limits test.

c) Verification of rain test to determine the degree of protection against rain.

d) Verification of dielectric properties.

e) Necessary type tests as per IS on all the individual items such as ACB's, MCB's, MCCB's, instruments, links etc.

2 Short circuit test

The Engineer, at its option, may waive the above type tests provided type test reports of the above type tests carried out on essentially identical unit in their factory / approved testing laboratory are furnished by the manufacturer.

3 Routine Tests

The switchboard shall be subjected to all the routine tests as per Indian Standard [IS] and witnessed by the Engineer. For power frequency voltage the test voltage to be applied shall be for a period of one minute. Insulation tests with 500 volts megger before and after the high voltage test shall be carried out on the switchboard.

Routine tests, as per SHALL be carried out on the bought-out items viz. MCCB's, MCBs, meters etc.

4 Verification of wiring & earth continuity

a) Voltage test on auxiliary circuits.

b) Tests for mechanical operation, control & interlocks.

c) Commissioning Site Tests

d) Necessary site tests at site shall be carried out to ensure its satisfactory operation after installation at site.

1.37.14 Terminations of Incoming and Outgoing Circuits

a) The cable termination arrangements shall be located at the lowest point above the cable clamps, for ease of termination.

b) Cable support shall be provided by a suitable clamp at the bottom of the panel. These cable supports shall be adequate to support the outgoing cable in normal service and when subjected to the short circuit current specified. The distance between these cable supports, and the gland plate shall be at least 200 mm.

c) The outgoing cables to be terminated in the switchboard shall be XLPE insulated PVC sheathed armoured and with aluminium conductors. The cables shall have bottom entry to the switchboard.

1.37.15 Air Circuit Breaker (ACB)

415 V four pole air circuit breakers shall be withdrawal type with manually / electrically operated mechanism. It shall be supplied for controlling the LV side of the 11/0.433 kV, distribution transformer. Air circuit breakers shall have symmetrical short circuit rating of 50 kA for 1 sec. The circuit breaker shall be fitted with direct acting DIGHI processor based electronic release. It shall be provided with instantaneous and adjustable short circuit trip. The adjustment of the setting should be possible without disrupting the supply. The releases shall be ambient temperature compensated type. The release shall have IEC IDMTL characteristics. The breaker mechanism should be robust, quick making quick breaking and trip free. It should be possible to close and trip the breaker without opening the compartment & door. It shall have auxiliary contacts for indications along with spare contacts.

The detailed specifications of Air Circuit Breaker shall be as under:

a)	No. of poles	Four
b)	Service voltage	415 Volts
c)	Normal current	as per design calculation
d)	Frequency	50 Hz
e)	Rated Symmetrical Breaking	50 kA for 1 Sec.
f)	Capacity at 415 V AC/50 Hz	
g)	Making current	120 kA
h)	Rated insulation voltage	1000 V
i)	Max Breaking time	30 ms
j)	Max Making time	80 Ms.

5 ACB Connection to Transformer

The air circuit breakers shall be suitably earthed with the main earth bus. The air circuit breakers of the LV board shall be connected to the LV side of the distribution transformer as specified. In case bus duct is provided the connections at both the ends shall be through proper clamps preferably bimetallic. Suitable arrangement shall be provided in the bus duct to take care of the expansion.

6 LV Moulded Case Circuit Breaker

a) All the LV outgoing underground feeders from the sub-station shall be controlled by 4 poles draw out type moulded case circuit breakers, provided in the LV switchboard.

b) The moulded case circuit breakers shall be of robust construction and shall comprise of switching mechanism, contact system, arc extinguishing device and a tripping unit contained in a compact moulded case and cover. The insulating case and cover shall be made of high strength, heat-resistance and flame-retardant thermo-setting insulating material.

c) The switching mechanism shall be quick-make / quick break type and should be trip-free.

d) The arc extinguishing device shall comprise of a series of grid plates mounted in parallel between supports of insulating material. The arc shall be drawn from the moving contact into the divide chamber and extinguished.

e) The moulded case circuit breakers shall have a thermo-magnetic type tripping mechanism, where the heating effect and the electromagnetic effect of current are made use of to provide protection against overload and short-circuit conditions respectively. The heated-bimetal strip in each phase of the MCCB shall actuate the tripping system following on inverse-time-current characteristics depending upon the severity of the overload current. During short-circuits, the system shall trip instantaneously. The tripping element provided on each pole of the MCCB shall operate on a common trip bar, thereby preventing single phasing in the event of fault occurring on any of the phases. The tripping device shall be ambient temperature compensated type.

f) The MCCB shall have a minimum Ics rupturing capacity of 50 kA. Positive indication about the position of the MCCB i.e. whether ‘ON’ ‘OFF’ or TRIPPED shall be provided.

g) The short circuit breaking capacity and operation mechanism of the MCCB shall be supported by test certificates.

h) All the MCCBs used in LV switchboards for controlling the outgoing feeders shall have a Thermal current setting of 50 to 100% of its rated current and magnetic setting of 500% to 1000%.

i) The rated currents given are provisional and shall be finalised during detailed engineering.

j) The detailed specifications of the MCCBs shall be as under:

i.	No. of poles	4 pole
ii.	Service voltage	415 Volts
iii.	Normal current [In]	As per SLD
iv.	Frequency	50 Hz

v. Service [Ics] Breaking capacity at 415V AC, 50 Hz: 50 kA.

vi. Making current 120 kA

vii. MCCB shall be provided with rotary handle for manual operation.

7 Internal Wiring

a) The LV AC distribution boards shall be supplied with complete internal wiring. The central wiring shall be of 1100 V grade, FRLS, PVC insulated. Stranded tinned (not less than 48 strands) copper conductor cables of 1.5 mm2 size shall be used for control circuits and 2.5 mm2 for CT circuits. 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. Terminal blocks shall be one piece moulded and suitable for 500 V and of recommended make. Terminals shall be adequately rated for the short circuit current. Typically, terminals of 'Phoenix' make shall be provided which shall be approved by Engineer during detailed engineering.

b) For CT circuits, shorting type terminals shall be provided. It shall be possible to measure the CT current through clip-on-ammeters.

1.38 Pre-fabricated Enclosure for Packaged RMU Substations

1.38.1 General

The enclosure for the compact substation also includes the base frame/ channels and all the necessary fixing hardware accessories required at site. The enclosure shall be compartmentalized and house RMU, dry distribution transformer, LV distribution board with capacitor bank and their interconnections both external and internal. Engineer at its sole discretion may also consider the alternate designs given by the contractor, if the same are found to be better or equivalent to the ones given hereunder.

1.38.2 Standards

The equipment shall conform (but shall not be limited) to IEC 6227-202 standard. The requirements of standards for necessary clearances, ventilation etc. shall also be complied with.

1.38.3 Specific Technical Requirements

Typical size	**2 x 2.5 m (5 m2) with 2 m height [Contractor may quote its own size, if different]**
Construction	Self- standing on concrete base
Steel base frame	4mm thick base [hot dip electro-galvanized steel, with epoxy paint]- suitable for local e
Lifting eyes	4 Nos from the bottom.
Housing enclosure	2 mm corrosion resistant Zinc / Aluminum alloy coated sheet steels
Degree of Protection	HV Compartment : IP-54 Transformer Compartment : IP-23 LV Compartment : IP-54
All hinges, supports Nuts, washers etc.	Stainless steel

Paint	Epoxy
Roof Design Load [min]	250 Kg/m2
Roof Design	Slanting on the sides
Top of Roof	Removable
Ventilation	With louvers (no exhaust fans shall be used)
Sound Level	60 dB
Standard Applicable	IEC 62271-202
Number of earths	Two (at opposite ends)
Compartments	Three with independent doors

1.38.4 Construction

1 General

a) The enclosure shall be self-standing on a concrete base. Necessary civil requirements to be satisfied for the concrete base shall be provided by the contractor. The levelling of ground and construction of the concrete base and associated civil works shall also be in the scope of the contractor.

b) The compact substation is completely self-contained, mounted upon a 4 mm thick galvanised steel base frame, epoxy painted, factory assembled in a totally enclosed, aesthetically acceptable metal cladding, vandal-proof and weatherproof housing ready for placing into position upon a concrete base.

c) The lifting arrangement should be with four lifting eyes from the bottom of the enclosure & not from the top.

d) The structure of the substation shall be capable of supporting the gross weight of all the equipment & the roof of the substation compartment shall be designed to support adequate loads. In case of relocation of the Package Substation, the entire substation should be capable of getting lifted and placed as a Single Unit without dismantling of any of the major equipment inside the enclosure. The complete housing assembly with four lifting eyes should be easy to lift and position the whole unit at the site by the use of crane. The substation can be lifted without damage or distortion. The transformer is located in the middle of the substation while the HV and LV compartments are located at both ends of the substation adjacent to the corresponding bushings of the transformer. The arrangement is subject to the approval of the Client or site Engineer.

e) There shall be adequate ventilation inside the enclosure so that hot air inside enclosure is directed out by help of duct. Louvers having UL approvals with G3 Filters as per EN 779 in apertures shall be provided so that there is circulation of natural air inside the enclosure. The Package Substation should be designed & engineering to have natural cooling & ventilation only. No forced cooling / ventilation is acceptable.

f) The enclosure must be weatherproof installation with proper measures against rusting.

g) The enclosure must also be vermin proof to prevent the entry of rodents, reptiles, & flying insects, which are prevalent in the area.

h) The enclosure should be pre-fabricated such that fire from one compartment MUST NOT spread to other compartments.

i) It should have easy access to all the equipment inside the enclosure, viz RMU, transformer, LV switchboard, capacitor bank, connections, and terminations of HV & LV cables.

j) The metal base and all supporting channels shall be hot dip galvanized. These should ensure rigidity, ease in transportation to sites and installation.

k) The outdoor panel envelope may be made of electro-galvanised mild steel with nominal thickness of not less than 3 mm. The housing of the enclosure shall be made of 2 mm corrosion resistant Zinc / Aluminium alloy coated steel sheets.

l) All hardware such as hinges, supports, screws, nuts, bolts, washers etc. should be made of stainless steel. All locking bolts shall be accessible from inside to prevent the unauthorised dismantling.

m) All the enclosures shall be or of similar type & design.

n) The colour of the enclosure shall be decided by Engineer during detailed engineering, if different from the one given. The last finish coat shall be of epoxy paint.

o) The roof of the substation enclosure shall be designed to support loads up to 250 kg/m2. The roof shall be sloped on the sides so that the rainwater cannot stay on roof during rainy days.

p) The pre-fabricated roof of the enclosure shall be removable whenever required. The locking nuts, bolts to allow the removal of roof shall be only accessible from inside the enclosure.

2 Covers & Doors:

a) Covers & doors are part of the enclosure. When they are closed, they shall provide the degree of protection specified for the enclosure. All covers, doors or roof shall be provided with locking facility, or it shall not be possible to open or remove them before doors in normal operation have been opened. The doors shall open outward at an angle of at least 90degrees & be equipped with a device able to maintain them in an open position. Proper padlocking facility shall be provided for doors of each compartment. Transformer compartment doors must be open from both the sides.

b) Door closing shall be by means of a three-point linkage arrangement (i.e. Centre, top and bottom) and controlled by a centrally located stainless steel operating handle. Pad locking facilities along with Master pad locks shall be provided. Master pad locks shall be operated by a master key for all the substations.

c) The outer doors of the enclosure shall be wide and provided with heavy duty hinges to prevent distortion and misalignment. A robust door restraint shall be provided to hold each door in the 950 open positions. The restraint shall be of a captive design so that it cannot be easily removed and shall be self-strong when the door is closed such that it cannot rattle. With the door in this position, operation of LV and HV switchgear shall be possible without endangering operator's hands, etc.

d) When doors are closed, they are firmly locked; as such entry of dust, vermin and rainwater is completely prevented. PU Foam gaskets are to be used.

e) The HV doors are provided with a drawing pocket to keep drawing inside.

f) A weatherproof nameplate shall be provided on the door.

g) The edges of the doors are bended at both sides to assure they fit properly so that the door jams and misalignment is prevented.

h) The transformer, low voltage and HV compartments are completely separated by steel sheet. The barrier between the HV switchgear and the transformer is provided with pressure relief flaps.

i) All compartments are individually accessible by their own doors from outside.

j) Labyrinthine louvers form the sidings of the transformer room to assure free entry and exhaust of air, as such the inside temperature is kept within limits. Openings located at the lower and upper sides of the slanted roof shall allow air circulation as part of the ventilation design.

k) No exhaust fans shall be used. Ventilation louvers having UL approvals with G3 Filters as per EN 779 in shall be required to provide sufficient ventilation.

l) All compartments are equipped with internal lighting consisting of 9W 25 watts UL approved 1200 lumens LED lamps with electrical life of 60000 hours minimum to be controlled by the built-in PIR sensor without any need for their respective door micro switches. MCB shall be provided to control the supply.

m) UL approved PTC Type DIN Rail Mountable encapsulated Space heaters shall be provided to control condensing type humidity via UL approved DIN Rail Mounted Hygro-thermostat.

n) Labels for warning, manufacturer's operating instructions etc. & those according to local standards & regulations shall be pasted / provided inside and shall be durable & clearly legible.

o) The substation forms a complete metallic structure bolted together and each compartment is to be provided with tinned copper, grounding bus-bar. Bonding and interconnection of the grounding buses shall be made of 70 mm2 bare stranded copper tinned conductors. The ring main unit shall have 25x8 mm grounding bus while the low voltage switchgear shall have 30 x 10 mm tinned copper grounding buses to which connection to the grounding system at site can be made. At least two grounding points for bolting to ground conductor shall be provided on opposite ends.

p) All metallic components shall be earthed to a common earthing point. It shall be terminated by an adequate terminal intended for connection to the earth system of the installation, by way of flexible jumpers/strips & Lug arrangement. The continuity of the earth system shall be ensured considering the thermal & mechanical stresses caused by the current it may have to carry. The components to be connected to the earth system shall include:

q) The enclosure of Unitized / prefabricated substation.

r) The enclosure of High voltage switchgear & control gear from the terminal provided for the purpose.

s) The metal screen & the low - high voltage cable earth conductor.

t) The transformer tank or metal frame of transformer.

u) The frame &/or enclosure of low voltage switchgear.

3 Dimensions

The overall typical dimensions of the enclosure may be around 2.5 m x 2.0 m (or 5m2) having height of about 2 m. To achieve necessary clearances, contractor may propose alternate size of the enclosure depending upon the dimensions of the equipment supplied.

4 Enclosure Requirements

a) The enclosure must be totally safe to the personnel in the populated areas as the packaged substation shall be established in the residential townships.

b) The equipment in the enclosure must be accommodated with necessary clearances, easy access to the RMU, and transformer, LT switchgear and capacitor bank for testing, maintenance, removal, and normal operation (including operation with normal switchgear handles).

c) There shall be unhindered access to the transformer, operation of OFF load tap changer and other normal operating requirements. Similarly, termination & removal of cables, withdrawals of ACB from LV board should be easy & comfortable.

d) It shall be the sole responsibility of the contractor to satisfy all the statutory clearances and to provide safety measures against all possible hazards to the equipment in the enclosures, such as internal arcing faults in the enclosure considering environmental conditions existing at site.

e) Failure within the unitized substation due either to a defect, or mal-operation may initiate an internal arc. Such an event may lead to the risk of injury if persons are present. It is desirable that the unit shall be tested for Internal Arc fault test to the tune of at least 20KA for 1 second as per latest IEC 62271-202 standard. The enclosure must be so designed that internal arc faults are directed away from places where personnel or public may be present. Test certificates from a recognized national/international test house [acceptable to Engineer] shall be supplied for internal arc.

f) Testing of incoming & outgoing cables and use of testing equipment for the same shall not entail the dismantling the sides or the roof of the enclosure.

g) There shall be sufficient space for termination & removal of cables from Load Break Switches & also from the LV board.

h) Sufficient clearance must be kept between the top of any equipment installed in the pre-fabricated substation and the roof of the substation for ventilation and operational purposes.

5 Interconnection

a) The equipment inside the enclosure shall be interconnected as follows:

b) The RMU shall be directly coupled by VCB feeder to distribution transformer through insulated copper bars or cables as per manufacturer standard.

c) The LV side (three phases plus one neutral conductor) of distribution transformer shall be connected to LV incomer Air Circuit Breaker via flexible insulated copper bars or through a four-conductor sand-witched insulated bars or with bus duct enclosure.

d) The HV termination to Load Break Switches shall be from 11 kV, Al. armoured XLPE cables, fitted with termination kits, for the ring system. It should be heat shrinkable, humid environment proof, touch proof

e) The earthing of pre-fabrication station shall be provided at two opposite ends for connection to the outside earth rods. It shall be a bolted connection.

6 Drawings

The following drawings shall be submitted with the tender.

a) The detailed sketch of the enclosure indicating general view, position of louvers etc.

b) The drawing showing the layout of HV, transformer & LV switchgear along with interconnections.

c) Size & position of doors in the enclosure.

d) Fixing details of the enclosure including civil foundations (if any).

7 Safety Measures

The enclosure shall have the following safety measures:

a) Electric shock treatment chart duly framed shall be fixed in a conspicuous position inside the enclosure.

b) Danger notice in English/ Hindi/ Marathi language conforming to IS: 2551 shall be fixed on all the four sides of the enclosure.

c) Electric insulated rubber mat (non-skid type) with flouted top and plain border end, 12 mm thick to withstand 12kV di-electric strength shall be provided in front of HV/LV boards where people have to work.

d) Two number portable fire extinguisher typically 2 litres, suitable for transformer / cable and other electrical equipment fires shall be placed & fixed in a suitable location in the enclosure, away from the place where fire is expected.

8 Tests

The following tests shall be carried out on the enclosure as per IEC standard at the works of the manufacture:

a) The complete prefabricated substation unit will be tested at full load for temperature rise. The maximum temperature rise on any part of the equipment placed inside the enclosure shall not exceed the value as specified in IEC 62271-202.

b) Test to verify the sound level of the pre-fabricated substation, which shall be less than 60 db.

c) Test to verify the degree of protection of enclosure for various compartments.

d) For the internal arc fault test on the enclosure the following need to be observed and tested as below:

e) Internal Arc Fault tested to 20 kA 1 sec.

f) Test to accessibility of Type “B” that is with unrestricted accessibility including that of the general public (Annex. AA.2 IEC). Although test to accessibility of Type “A” is not required, tenderers shall also provide adequate measures to have any hot gases directed away from the operator during switching with the door open.

g) Arc initiation is made inside the SF6 gas compartment of the RMU (Annex. AA.3 IEC).

h) Assessment of the internal arc fault test is based on the fulfilment of all 6 criteria as stated in Annex. AA.6 of IEC.

9 Other Checks

a) Inspection of conformity with the specification & approved drawings.

b) Inspection of devices locking out and interlocks.

c) Inspection and checking electrical continuity of metallic frame and earthing system.

d) Dielectric tests of M.V. and L.V. bus bar.

e) Provision of two earths as per Indian Electricity Rules.

f) Tests as per IEC standard.

1.39 Technical Specifications for LT Auxiliary Switchboards

LT Auxiliary switch board for Substation auxiliary loads and (PMCC/ MCC) for various process plants like STP/ CETP etc. shall be considered for feeding the respective process loads. The Switch board shall have 3 Incomers. For LT Switch boards of Substation Aux. 2 nos. Incomer shall be fed from ZSS and one (1) shall be fed from adequately rated DG set for emergency loads. For STP/ CETP etc. process plants two (2) incomers will be fed through 11/.433KV transformer of adequate KVA rating from nearest RMUs of the plant. Another incomer shall be fed from DG set, used to feed the emergency loads during normal power failure. The LT switch board shall have 2 bus section with 1 bus coupler. All the incomer and bus coupler shall be properly electrically and mechanically interlocked. Typical Single line diagram for LT Aux. Switch board for Substation auxiliary and STP/CETP/WTP/ SWM plants shall be referred for arrangement detail. Type of outgoing feeders shall be decided as per process requirement. Generally, for Substation aux. boards outgoing feeders shall be power feeder and for process plants requisite number of outgoing Power, DOL, Star/ Delta, Soft starter, VFD feeders shall be considered as per requirement. Minimum 20% of spare feeders to be provided apart from Working and Standby feeders provided already. Spare shall be considered accordingly, so that minimum 1 no. of each type of feeder (like DOL, Star-Delta, Soft starter, VFD) shall be provided.

1.39.1 Standards

List of applicable standards for LV switch board as mentioned in table 7.26shall be referred, also mentioned in CSS section.

Table 1-26: List of applicable standards for LV switch board

S. No.	Standard Number	Description
1	IS: 5	Colors for ready mixed paints & enamels
2	IS: 722	AC Electricity Meters
3	IS: 1554	PVC insulated (heavy duty) electric cables
4	IS: 2147	Degrees of protection provided by enclosures for Low-voltage switchgear and control gear
5	IS: 2419	Dimensions for panel mounted electrical indicating & recording electrical instrument
6	IS: 2551	Danger notice plates
7	IS: 2633	Methods for testing uniformity of coating of Zinc coated articles
8	IS: 2705	Current Transformers
9	IS: 3156	Voltage Transformers
10	IS: 3231	Specification for electrical relays for power system protection
11	IS: 4237	General requirements for Switchgear & Control gear for voltage not exceeding1000 volts.
12	IS: 4794	Push buttons
13	IS: 5082	Wrought Aluminum and Aluminum alloy bars rods, tubes, sections plates, sheets for electrical application
14	IS: 5578	Guide for making of insulated conductors
15	IS: 6005	Code of practice for phosphate coatings of iron and steel (First Revision)
16	IS: 6875	Control switches (switching devices for control and auxiliary circuit including contractor relays) for voltages up to and including 1000 V AC and 1200 V DC
17	IEC 61439 part 1&2 edition 3	Low voltage Switchgear and Control gear assemblies
18	IS: 8828	Electrical accessories circuit breakers for over current protection for home load and similar installations.
19	IS: 9000	Basic environmental testing procedures for electronic and electrical items
20	IS: 10580	Service conditions for electrical equipment
21	IS: 11353	Guide for uniform system of marking and identification of conductors & apparatus terminals
22	IS: 13703	Low voltage fuses for voltages not exceeding 1000 V AC or 1500 V DC

S. No.	Standard Number	Description
23	IS: 13942	Low voltage switchgear and control gear
24	SP: 39	Guide for insulation coordination within low voltage system
25	IEC -60364 IEC: 60664	Low Voltage Electrical Installations [All applicable series of IEC-60364] Insulation coordination within low voltage system including clearance and creepage distance for equipment.

IEC: 60664 Low Voltage Electrical Installations [All applicable series of IEC-60364]

Insulation coordination within low voltage system including clearance and creepage distance for equipment.

1.39.2 Constructional Features

a) LV switch board shall be Compartmentalized in design. Form of separation shall be Form- 4B. All cubical panel shall be fabricated out of cold rolled sheet steel, thickness of 16 folded profile with rear & side panel 1.5 mm & door 2 mm. Internal Partition panel thickness shall be 1.6mm.

b) Panels shall be totally enclosed dust and vermin proof PU foam rubber gasket shall be provided around doors, covers and other cut outs. Degree of protection shall be IP – 42 as per IS standards for LT panels.

c) All floor mounting panels/ boards shall be provided with 50 mm high channel base frame. Total height of all floors mounting cubicles / panels shall be 2500 mm (maximum). Operating height of component shall be Minimum- 350 mm and maximum 1800 mm from finished floor. All Power panels should be compliant with IEC 61439, 1& 2 and Arc fault compliances as per IEC 61641 for 70kA/300ms.

d) Metal clad switchgear shall be extensible on both ends.

e) Switch handles shall be provided with padlocking facility in off position.

f) All steel work used in the construction of LT Switch board shall be given degreasing, derusting, phosphatizing and passivation treatment followed by the coats of nano ceramic coating, electrophoretic dip followed by powder coating RAL 7035.

g) Each Switchgear cubicles shall be fitted with a label on the front and rear of the cubicle Each Switchgear cubicles shall be fitted with a label indicating the switchgear rating and duty.

h) Metal clad Switchgear shall comprise separate, segregated modules for each circuit.

i) Bus ways, cable ways and wire ways in Switchgear shall be run separate, segregated compartments. Cable’s way width shall be less than 250 mm.

1.39.3 Bus Bars

a) Bus bars shall be of aluminium complying with the requirements of grade E91E of IS:50252 and shall be located in air insulated enclosures non-flammable, resistant proof for acid and alkalis.

b) Bus bar joints shall be bolted type and insulated spring washers shall be provided to ensure good contact at the joints.

c) All Power panels should be compliant with IEC 61439, 1& 2 and Arc fault compliances as per IEC 61641 for 70kA/300ms.

Pane Internal wiring detail shall comply with LV Switch board of CSS. 230V Control supply for outgoing feeders shall be arranged from 2 nos. 415/230V control transformer of adequate capacity with auto change over facility.

1.39.4 Unit Module

1 Incoming Unit

Incoming unit shall be provided with ACB/ MCCB. Incomer rated above 630A shall be ACB. ACB and MCCB shall be provided with microprocessor-based O/C, S/C, E/F release. Refer specification of LV Switchboard for CSS for other details.

2 Outgoing unit

Various types of outgoing feeders shall be considered as per the applications (like Power feeder, DOL, Star delta, soft starter, VSD etc.) Minimum 20% spare feeder shall be provided. Spare feeder shall be such that minimum 1 no. of each type of feeder (like DOL, Star delta, soft starter, VSD, power) of same rating used shall be provided. Specification of various types of motor starter feeders shall be as follows -

The DOL and Star-Delta starter shall be provided in the main LT panel of the individual units. However, a local remote selector switch shall be provided to either start/stop the motor from local (i.e. near the motors) or from remote (i.e. from the panel).

3 Direct Online (DOL)

Fully automatic Air brake – DOL starters for Operation on 415 V, Voltage, 3 phases, 50 hz. AC supply. The details of equipment/ accessories for the starter shall be as per the vendor’s standard design and shall broadly cover the specifications give below.

4 SCPD, Contactor, OLR/ EOCR/ Motor protection relay (MPR)

MPCB/ MCCB shall be used as SCPD. SCPD, Contactor, OLR/ EOCR/ MPR shall be selected based on the component manufacturer’s type-2 co-ordination chart. MPCB/ MCCB shall be used for motor feeders rated up to 7.5 kW. Above 7.5kW MCCB shall be provided. Contactor shall be of AC-3 duty. OLR shall be provided for motor feeder up to 3.7 kW. EOCR shall be provided for motor feeder above 3.7 kW -up to 75 kW. Above 75 KW composite motor protection relay (MPR) shall be provided. CBCT shall be provided for earth fault protection.

5 Indicating Lamp and Push buttons, Ammeter

LED indicating lamp shall be provided for ON, OFF, TRIP, E/F indication. Red, Green, Black push button shall be provided for stop, start and overload reset respectively. 96 sq. mm. size, suppress scaled, C.T. operated, ammeter shall be provided. A selector switch shall also be provided.

6 Star Delta Starters

Fully Automatic Air Brake Star – Delta Starters for Operation on 415 V, 10% Voltage, 3 phases, 50 Hz. AC supply.

7 SCPD, Contactor, OLR/ EOCR/ Motor protection relay (MPR)

MPCB/ MCCB shall be used as SCPD. SCPD, Contactor, OLR/ EOCR/ MPR shall be selected based on the component manufacturer's type-2 co-ordination chart. MPCB/ MCCB shall be used for motor feeders rated up to 7.5 kW. Above 7.5kW MCCB shall be provided. Required number of AC-3 duty contactor, timer shall be provided for star delta starter application. OLR shall be provided for motor feeder up to 3.7 kW. EOCR shall be provided for motor feeder above 3.7 kW up to 75 kW. Above 75 KW composite motor protection relay (MPR) shall be provided. CBCT shall be provided for earth fault protection.

8 Indicating Lamp and Push buttons

LED indicating lamp shall be provided for ON, OFF, TRIP, E/F indication. Red, Green, Black push button shall be provided for stop, start and overload reset respectively. 96 sq. mm. size, suppress scaled, C.T. operated, ammeter shall be provided. A selector switch shall also be provided.

9 Soft Starter feeders

The soft starters shall comply with the requirements of IEC 60034, 60947 including those standards referred to therein.

10 Constructional and Performance Features

Motor soft starters shall be switched or electronic type. Soft starter module shall have

a) Electronic type solid state soft starter

b) Semi-conductor fuse for protection of soft starter

c) control, metering and current transformers for differential protection, if specified

d) shorting (bypass) arrangement

e) bus bars.

f) power cable terminations.

g) push buttons with indicating lamps.

Soft starter shall achieve smooth starting by torque control for gradual acceleration of the drive thus preventing jerks and extending the life of equipment. Starting current shall be limited to 2.5 to 3 times the rated current of the motor. The soft starter manufacturer shall co-ordinate with motor manufacturer for this purpose. All the required motor protection function like o/l, s/c, e/f. locked rotor etc. shall be available in soft starter as a standard function. Each cubicle shall be fitted with a label in the front and rear of the cubicle, indicating the panel designation, rating, and duty. Each relay, instrument, switch, fuse, and other devices shall be provided with separate labels. Necessary wiring diagram shall be provided considering starting interlock, trip circuit, starting and running mode signal. It shall be possible to manually start the motor locally from the starter panel or in Auto mode through PLC. Soft starter shall have built in by-pass facility. Necessary LED indication lamps, push button shall be provided and finalized during detail engineering. The DC and AC auxiliary supply shall be distributed inside the panel with necessary isolating arrangements at the point of entry and with sub-circuit MCBs as required.

11 Variable Frequency Drive (VFD)

VFD shall be provided for motor as per process requirement. VFD feeds of lower rated motor shall be part of PMCC/ MCC. Stand-alone VFD panel shall be considered for higher rated motors. For details of applicable standard, VFD specification, design features, output power, component of VFD feeders, metering, protection and control, accessories.

1.40 Technical Specification Of Induction Motor

This specification covers the requirements of three phases of induction motors. Suitable induction motor in TEFC enclosure foot mounted type construction for indoor and outdoor installation and for operation on 3 phase, 415V 50 c/s, AC supply having continuous rating and ‘F’ class of insulation, with temperature rise limited to class B, with at least 20% power margin on the maximum power absorbed in the entire operating range 15% at duty point whichever is higher are to be provided for driving various pumping sets/ other equipment covered under the contract.

The tender while quoting should furnish the power factor at no load, 50%, 75% and full load.

1.40.1 Performance

a) Motors shall be capable of satisfactory operation for the application and continuous duty as required by the driven equipment. Motors shall be capable of giving rated output without reduction in the expected life span when operated continuous under either of the following cases of supply conditions:

   i. Variation of supply voltage from the rated Voltage: +/- 10%

   ii. Variation in supply frequency from the rated frequency: +/- 5%

   iii. Combined voltage and frequency variation: +/- 10%

b) Motor shall be designed as per IEC: 60034 and IS 12615 and will be IE2/IE3 type.

c) Motor shall be suitable for the method of starting specified. All electric motors are to be operated through suitable starters complete with single phase protection device. For motors up to 3.7KW starters should be D.O.L and for all other motors above 3.7KW starters should be star/ delta air brake type with protective devices suitable for 400/415

d) Volts, 50c/s, AC supply. For motors above 75KW suitable soft start type starters should be quoted. The starters should be complete with suitable cable end box and glands for cable entry.

e) The starters should be complete with suitable cable end box and glands for cable entry. Degree of protection of motor along with terminal box shall be IP-55. Terminal box shall be suitable to rotate at 90 Degree. Terminal box shall be mounted at side of the motor. No top mounted cable terminal boxes are acceptable. Terminal boxes shall be suitable for Bottom cable entry. Insulation class of Motor shall be Class F and temperature rise limited to Class B. Separate terminal box should be provided for power and space heater terminal box. For VSD fed motors 2 nos. RTD/ phase and 1 no. BTD/ bearing shall be provided. Motor rating above 30KW shall be provided with space heater.

f) Motors shall be capable of starting and accelerating the load with the applicable method of starting without exceeding acceptable winding temperature when the supply voltage is 85% of the rated voltage. The locked rotor current of squirrel cage motors shall not exceed 600% rated current.

g) Motors shall be designed to allow the required number of consecutive starts.

1.40.2 Direction of Rotation

Motors shall be suitable for either direction of rotation. Ample space shall be provided at the terminal box for interchanging external lead for change of direction of rotation.

The degree of protection for motor shall be IP-55 standards.

1.40.3 Insulation

a) Any joints in motor insulation such as at coil connections or between slot and end winding section shall have strength equivalent to that of the slot section of coil.

b) The insulation shall be given tropical and fungicidal treatment for successful operation of motor in hot, humid, and tropical climate as per the applicable standard.

c) For motors specified for outdoor execution the account shall be taken of heating due to the direct solar radiation.

d) Motors shall be provided with class F insulation with temperature rise tested to B class insulation.

1.40.4 Construction

a) For squirrel cage motors the rotor bars shall not be insulated in the slot portion between the iron core lamination and the bars. Also include for moisture detector, temperature indicator and temp sensor for bearing.

b) Bearing shall permit running of motor in either direction.

c) If oil lubricated type bearings are provided, a drain plug, and oil level slight glass shall be provided.

d) Terminal box shall be of weatherproof construction suitable for outdoor service. Gaskets shall be provided at the cover joints and between box and the motor frame.

e) Terminal box shall be suitable for side entry of cables, and it shall be mounted on top of the motor. Further it shall be capable of being turned through 360-degree C. in steps of 90-degree C.

f) Terminal box shall be complete with stud type terminals, plain washer, spring washer, check nuts, cable glands and lugs.

g) When TEFC type of enclosure is specified, fans mounted on the motor shaft shall be provided.

h) Unless specified otherwise the motor shall be provided with a bare shaft extension having a key slot and a key at the driving end.

i) Two (2) numbers drain holes at the bottom of stator frame shall be provided.

j) Motors shall have grease lubricated bail or roller bearings. Bearing shall be adequate to absorb axial thrust from the driven load together with any thrust produced by the motor itself. Bearing shall be capable of grease injection from outside without removal of covers with motor in running condition. The bearing boxes shall be provided with labyrinth seals to prevent loss of grease or entry of dust.

k) All TEFC motors shall be self-ventilated fan cooled. The fans shall be cast iron, diecast aluminium or poly propylene. The fan shall be corrosion resistant. They shall be suitable for rotation in either direction without affecting the performance of the motor. The rotor shall be dynamically balanced to provide a low vibration level.

l) All motors of 30 KW and above shall be provided with lifting hooks of adequate capacity. All motors of 30 KW and above shall have anti-condensation heaters operated on 240 V supply.

m) Two earth terminals shall be provided for each motor. These shall be located outside the terminal box. These terminals shall preferably be on diametrically opposite points. A separate earth terminal shall be provided inside the terminal box.

n) All outdoors motors shall have a canopy on the top.

o) All mounting dimensions shall conform to IS 1231.

1.40.5 Painting

a) External parts shall be finished and painted to produce a neat and durable surface which will prevent rusting and corrosion. The equipment shall be degreased and all rust, sharp edges, scales are removed and treated with two coats of premier and finished with two coats of final paints.

b) Unless otherwise agreed, the motors shall be painted with shade 631 of IS 5.

c) Tests: All routine tests shall be conducted on motors (as per IS).

d) Nameplate: A stainless-steel name plate shall be provided on each motor. The inspection details shall be as per IS 325.

1.40.6 Tests

The following routine tests in accordance with IS: 325 of latest edition shall be performed in presence of the Engineer.

a) Insulation resistance test

b) Measurement of no load current and speed at rated voltage and rated frequency.

c) Measurement of locked rotor current at reduced voltage or rated voltage and at rated frequency.

d) High voltage test.

e) Reduced voltage running up test at no load to check the ability of motor to run up to full speed at no load in both the directions of rotation with one third of rated line voltage applied to stator terminals.

The following additional test shall be performed to verify the performance, characteristics and guarantees. They shall be in accordance with IS: 325 of latest edition.

f) Measurement of stator resistance.

g) Temperature rise test.

h) Momentary overload in torque test

i) High voltage test

j) Over speed test

Each type and rating of the motors should have been type tested in accordance with IS: 325. In absence of type test certificates, type tests shall be carried out without any extra cost to the Employer/ PMC.

1.40.7 Induction Motor for submersible pumps

1 Performance and Characteristics

a) The submersible motor shall conform to IS: 325/IS:9283 and the submersible cable shall conform to IS:9968.

b) The motor shall be three phase dry induction type with non-overloading characteristics, energy efficient motors.

c) Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously under the following supply conditions:

i. Variation of supply voltage ±10%

ii. Variation of supply frequency ±5%

iii. Combined voltage and frequency variation ±10%

d) The starting current of motor shall not exceed 200% of rated full load current for star/delta starting and 600% of rated full load current for DOL starting, under any circumstances.

e) Motors shall be suitable for full voltage direct-on-line starting or star-delta starting.

f) Motors shall be capable of starting and accelerating the load with the applicable method of starting, without exceeding acceptable winding temperatures, when the supply voltage is in the range 85% of the rated motor voltage.

g) Motors shall be designed to withstand 120% of rated speed for two minutes without any mechanical damage, in either direction of rotation.

h) The motor vibrations shall be within the limits specified in the relevant standard.

i) Except as mentioned herein, the guaranteed performances of the motor shall be met with tolerances specified in applicable standard, IS: 9283-1979.

j) The enclosure for motor shall be IP-68.

k) Minimum three number thermistors in series are to be provided to sense the stator winding temperature.

l) Bimetallic thermal switch to trip the motor against increase in temperature shall be provided.

m) The power rating of the motor shall be larger of the following:

i. 115% of the power input to the pump at duty point.

ii. 105% of the power input to the pump at 75% head.

2 Submersible Cable

The cable shall be EPR insulated, CPS sheathed, round, multi core, flexible, unarmoured, conductors composed of annealed tinned copper, suitable for 650 / 1100 volts grade and conforming to IS: 9968.

The size of the conductor and length of cable should be suitably selected so that the voltage drop at motor terminals does not exceed 3 percent of the rated voltage.

3 Earthing

Earthing of the motor shall be done in accordance with the relevant provisions of IS: 3043:1966.

For the purpose of earthing these motors, earthing connection may be made to discharge pipe.

4 Insulation

The stator winding shall be made from high conductivity annealed copper conductor; winding insulation shall be of class-F insulation, conforming to IS: 325. The stator winding shall be of high conductivity annealed copper enameled insulated wires conforming to IS: 4800 (Part-VII): 1970 for dry type motors.

5 Constructional Features

a) The motor shall be suitable for continuous duty as well as intermittent duty with or without full submergence of the motor.

b) Aluminium die cast rotor to be provided for better starting torque characteristics.

c) The electric motor shall be suitable for 10 starts & stops per hour.

d) Single phasing and overload protection system shall be provided.

e) The motor degree of protection shall be IP68.

f) Each motor shall be provided with minimum 25 m length of power & control cables and 15 m length of lifting chain.

g) Junction box (i.e.) for terminating power & control cables for each motor.

1.40.8 Induction Motor Characteristics for other pumps except Submersible pumps

1 Performance and Characteristics

All motors shall comply with IEC 60034, 60072 and IS-325, 4029, 4722 including standards referred to therein.

Description	Unit	Particulars
Type		Squirrel Cage Induction Motor
Rating	kW	(*)
Rated Voltage	kV	0.415
Synchronous Speed	RPM	(*)
Quantity	Nos.	(*)
Type of Mounting		Horizontal/Vertical (Depending on application and Process)
Duty type		Continuous (S1)
Method of Starting		Self-Starter/Star-Delta starter/ Direct online (depending on application and Process)
Type of System		Effectively Earthed
Class of Insulation		F
Design Ambient Temperature	Deg C	50
Location		Indoor/Outdoor (depending on application and process requirement)
Degree of Protection		IP55
Cooling designation		IC411
Terminal Box		LHS-looking from NDE end.
External cable details		1.1kV, 3Cx(*) Sq.mm Aluminum XLPE armoured.
Space heater for motor		Required if motor rating is 30kW and above.

a) To be furnished by Contractor. Contractor should ensure that all the equipment ratings are based on their system requirement and subject to Engineer approval.

b) Motors rating up to and including 3.7 KW shall be started by DOL starter, Motor ratings above 3.7KW and up to or equal to 75 kW shall be started by Star/Delta Starter and above 75 kW shall be started by soft starter.

c) Motors shall be energy efficient (Category –2 or better) squirrel cage induction motors (TEFC type) with degree of protection for enclosure of IP 55. They shall be capable of starting and accelerating the load for the method of starting, as per SLD without exceeding acceptable winding temperatures, when the supply voltage is 80% of the rated voltage. Main conductor and insulation shall be non-hygroscopic and in accordance with Class F of IEC 60085.

d) Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously under the following supply conditions:

i. Variation in supply voltage ±10%

ii. Variation in supply frequency ±5%

iii. Combined voltage and frequency variation ±10%

e) Motors shall be capable of starting and accelerating the load with the applicable method of starting, without exceeding permissible winding temperatures, when the supply voltage is 80% of the rated voltage. Motors shall be capable of satisfactory operation at full load at a supply voltage of 80% of the rated voltage for 5 minutes, commencing from hot condition.

f) The Power rating of the motor shall be the larger of the following:

g) 115% of the power input to the pump at duty point.

h) 105% of the power input to the pump between 110% to 75% head.

i) Motors shall withstand the voltage and torque stresses developed due to the vector difference between the motor residual voltage and the incoming supply voltage equal to 150% of the rated voltage, during fast changeover of buses. The duration of this condition is envisaged for a period of one second.

j) The locked rotor withstand time under hot conditions at 110% rated voltage shall be more than the starting time at minimum permissible voltage by at least two seconds or 15% of the accelerating time, whichever is greater. The locked rotor current of motors shall not exceed 600% of full load current of motor which is inclusive of 20% tolerance.

k) The motors shall be provided with class F insulation with temperature limited to that of class B insulation.

l) Motors when started with the drive imposing its full starting torque under the specified supply voltage variations shall be capable of withstanding at least two successive starts from cold conditions and one start from hot condition without injurious heating of windings. The motors shall also be suitable for three equally spread starts per hour under the above referred supply conditions.

2 Constructional Features

a) Motors weighing more than 25 kg shall be provided with eyebolts, lugs or other means to facilitate safe lifting.

b) The motor construction shall be suitable for easy disassembly and re-assembly. The enclosure shall be sturdy and shall permit easy removal of any part of the motor for inspection and repair.

c) The rotor bars shall not be insulated in the slot portion between the inner core laminations for squirrel cage motors.

d) All bearings shall be fitted with oil or grease lubricators. Motor bearings shall not be subjected to any external thrust load. Unless otherwise specified, motor bearings shall have an estimated life of at least 40,000 hrs. It shall be possible to lubricate the bearings without dismantling any part of the motor. All terminals shall be of the stud type of adequate size for the particular duty, marked in accordance with an approved standard and enclosed in a weatherproof box.

e) The equipment shall be thoroughly degreased, all rust, sharp edges and scale removed and treated with one coat of primer and finished with two coats of grey enamel paint.

3 Terminal Box

a) Terminal boxes shall be of weatherproof made of sheet metal with single sheet construction of not less than 1.5 mm construction designed for outdoor service. To eliminate entry to dust and water, gaskets of PU Foam, or approved equivalent shall be provided at cover joints and between box and motor frame. It shall be suitable for bottom entry of cables. It shall be capable of being turned through 360 degrees in steps of 90 degree.

b) The terminals shall be of the stud type with necessary plain washers, spring washers and check-nuts. They shall be designed for the current carrying capacity and shall ensure ample phase to phase and phase to ground clearances. Suitable cable glands and cable lugs shall be supplied.

c) Separate terminal boxes shall be provided for each of the following:

i. Stator Leads

ii. Space Heaters

4 Accessories

Drain Plugs

Motors shall be provided with drain plugs, so located to drain water, resulting from condensation or due to other causes, from all pockets in the motor casing.

5 Heating during Idle Period

For motors rated below 30 kW, during idle periods, the stator winding will be connected to required single phase, 50 Hz, AC supply for heating and elimination of moisture. The supply will be connected between any two terminals.

Motors rated 30kW and above shall have space heaters suitable for 230V, single phase, 50 Hz, AC supply. Space heaters shall have adequate capacity to maintain motor internal temperature above dew point to prevent moisture condensation during idle period. The space heaters shall be placed in easily accessible positions in the lowest part of the motor frame.

6 Earthing Pad

Two independent earthing pads of non-corrodible metal shall be welded or brazed at two locations on opposite sides complete with suitable bolt and washers for earthing. These earthing pads shall be in addition to earthing stud provided in the terminal box.

7 Rating Plate

The following details, in addition to those specified in applicable standards shall be included on the rating plate.

a) Rated voltage, kW rating, frequency, efficiency, power factor, temperature rise of windings in degree centigrade at rated load, and ambient conditions.

b) Type of bearings, recommended lubricant, lubricating interval & re-lubricating quantity.

8 Tests

Motor shall be subjected to all the type test (one from similar rating of each lot) and routine tests as per applicable standard, in the presence of the Engineer. Copies of test certificates for all brought out items shall be furnished at the time of inspection for the Employer's approval. The Contractor shall ensure to use calibrated test equipment / instruments having valid calibration test certificates from standard laboratories traceable to National / International standards.

1.41 Technical Specification of Variable Speed Drive (VSD)

This specification covers the general requirements for design, manufacture, assembly, inspection and testing of variable voltage and variable speed (VSD) drives and control systems used to control the speed of low voltage, 3 phase AC induction motors continuously and at low losses.

1.41.1 Codes and Standards

The design, manufacture, and performance of VSD drives and control systems shall comply with all current statutes, regulations, and safety codes in the locality where equipment will be installed. Nothing in this specification shall be construed to relieve the Contractor of his responsibility.

Unless otherwise specified, the VSD drives shall conform to the relevant Indian, IEC or British Standards: -

The relevant Standards are:

a) IEC 297 : Dimensions of panels and racks

b) IEC 352 : Solderless wrapped connections

c) IEEE 444 : Protection standards for Thyristor convertors

d) IEC 446 (1989) : Semi-conductor converters

e) IS 3700 (1972) : Essential ratings and characteristics of semi-conductor devices.

f) IS 4411 (1967) : Codes of designation of semi-conductor devices.

g) IS 5469 (1973) : Codes of practice for the use of semi-conductor junction devices.

h) IS 10482 (1986) : Connectors for printed wiring board.

i) IS 12448 (1988) : Basic testing procedures and measuring methods for electro- mechanical components.

1 For electronic equipment

a) IS 12970 (1990) : Semi-conductor devices - Integrated circuits.

b) IS 13648 (1993) : Power electronic capacitors.

c) IS13947 (1993) : Low voltage switchgear and control gear

d) IEEE519 : Recommended practice and requirement for Harmonic Control in Electric Power System

1.41.2 Environment

Storage ambient temperature range: -10 to 50 degrees centigrade.

Operating ambient temperature range: 5 to 50 degrees centigrade without derating.

1.41.3 Output Power

The output voltage should be adjustable from 0 to rated input voltage. The output frequency range should be adjustable from 0 to 50Hz. The inverter section shall produce a pulse width modulated (PWM) waveform using latest generation techniques.

1 General arrangement

a) The VSD drive shall consist of the following: -

i. Incomer - MCCB (4P)

ii. Power module

iii. Transistorized Inverter Unit

iv. Motor protective devices

v. Indicating/metering/control circuits and accessories

b) VSD drive shall be designed such that the maintenance/replacement of drive shall be easy. Hence rack-out type drives may be considered. The VSDs fault shall be taken as contact input to PLC as Digital Input. Other important parameters like speed, power (KW), etc shall be connected to PLC by suitable mode of communication.

c) The VSD drive shall be provided as a complete package and shall be controlled from three different locations viz., (a) VSD panel (b) Local operator panel and (c) PLC.

i. A four-position lockable selector switch shall be provided on the VSD panel for selecting operation from VSD panel/local operator panel/PLC/STOP position.

ii. 4-20mA signal from PLC shall be connected to VSD drive. All control schemes for process control shall be implemented in PLC only.

d) Local operator panel shall be conventional motor LCSs only consisting of start/stop push buttons, remote/local start selection switch and ammeter etc as discussed elsewhere and the same shall be adequately protected from rain. Speed control from local station shall not be provided.

e) VSD panel shall be provided with the following:

i. Standard options (to be stated by contractor)

ii. Incomer – ACB or MCCB (4P)

iii. Power module

iv. Transistor inverter unit

v. AC reactor

vi. Motor starting/protective devices.

vii. Selector switch (4 position)

viii. START / STOP P.B.

ix. Speed controller.

x. Input voltmeter and ammeter.

xi. Output KW meter/Ammeter and frequency meter.

xii. Instrument, current, potential and control transformers.

xiii. Auxiliary relays

xiv. Audio-visual alarms/fault indicators

xv. Alarm acknowledge/reset/test PBs.

xvi. Provision for wiring external sequential/process interlocks/signals for starting/running/tripping.

xvii. Space heater

f) Besides VSD panel shall include the following operating adjustments:

i. Acceleration and deceleration time-range in seconds.

ii. Current limit-range in percent of rated output current.

iii. Maximum and minimum frequency range in Hertz.

iv. Volts/Hertz ratio

v. Voltage boost ratio in percentage.

vi. Starting torque setting adjustment.

vii. Starting current setting adjustment

g) Contractor shall propose setting ranges consistent with the operating conditions required.

h) Motor winding temperature detectors shall be monitored on VSD panel.

2 Design features.

a) The unit shall be capable of proper operation for voltage variations of ±10%, frequency variations of ±5%, and combined variations of ±10%. Besides, the VSD unit shall be able to ride through voltage dips down to 80% of nominal, such as those experienced during motor starting. Also, VSD shall be capable of riding through voltage outages of minimum 2 seconds duration.

b) The mains voltage 415V, 50 Hz, 3 phase + Neutral supply given at one point in VSD panel will be rectified by a controlled mains rectifier and injects an adjustable direct current through intermediate circuit choke and inverter. The speed of the motor is proportional to the switching rate of the inverter.

c) The VSD inverter shall be of voltage/current fed type. A current fed type shall have a current limiting reactor in the dc link and the rectifier output voltage is variable. Forced commutation type inverter is preferred.

d) In case of voltage fed inverter, input voltage from the rectifier shall be constant and current from the rectifier is uncontrolled. The inverter output voltage and frequency shall be controlled electronically within the inverter by using pulse-width modulation (PWM) technique. Insulated Gate Bi-polar Transistor (IGBT) elements shall be preferred for switching in the inverter.

e) The inverter shall be used as a speed regulator in open loop control. In case of closed loop control, suitable feedback system shall be used.

f) The VSD unit shall return the motor to operating speed upon restoration of power following an extended voltage interruption on the ac incoming line. Automatic restart shall be disabled after an adjustable time period.

g) The VSD unit shall be able to restart a rotating motor.

h) Regulation of output voltage shall not be more than ±2% under steady state and ±8% under transient conditions. Maximum drift in set frequency shall be ±0.1%. The unit should be able to hold a set speed, regardless of load torque variations. The unit shall be suitable for 150% overload capacity for one minute.

i) The maximum noise level of the unit shall not exceed 85 dB (A) at a distance of 1 meter.

j) The unit shall have independently adjustable/automatic load dependent voltage boost at low end of frequency. There should not be any torque fluctuations at low speed.

k) The unit shall operate at automatically produced fixed ratio of V/F through the complete speed range of motor.

l) The VSD unit shall provide an analogy ungrounded signal (4 to 20mA) directly proportional to motor current. Range shall be 0 to 115% of motor full load current.

m) Contractor shall be responsible for the co-ordination of motor and inverter with the load/speed requirements for the following:

   i. To ensure that motor and VSD drives are both adequately rated and sized for the required duty and if necessary, recommend alternative configurations (like separate cooling fan, choice of frequency range etc.).

   ii. To arrange necessary testing of motor-VSD drive unit to confirm compliance with requirements of load, noise, vibration, temperature rise etc.

   iii. To recommend any additional motor protection arrangements which may be necessary to prevent motor winding damage.

1.41.4 Constructional features

a) VSD panel shall be metal enclosed self-supporting type with hinged 16 folded profile with 25 mm pitch and made of 1.5mm thick sheet steel for rear, side and top cover with door 2 mm thick, all over encloser lockable doors and shall be dust proof and suitable for indoor use. The colour and finish of cubicle shall be as per manufacturer's standard, unless otherwise stated.

b) All-important configuration data shall be printed/painted on the inner side of front door.

c) All sheet steel work shall be phosphates by removing oil, grease, dirt etc., by emulsion cleaning. This shall be followed by pickling with dilute acid for removing rust and scalp. After this, it shall be washed with running water, rinsed with slightly alkaline hot water and dried. Nanoceramic coating, electrophoretic dip coating followed powder coating of RAL7035.

d) All other parts such as handles, levers and fasteners that are not stainless steel shall be Tin, Cadmium, Nickel or Chrome plated.

e) Printed circuit boards shall be identified by type number and shall not be mounted on the front door of the enclosure. Components requiring manual adjustment shall be mounted to allow readjustment without removing the board from its socket. Printed circuit boards and printed circuit card cages shall be designed to prevent improper insertion of a board into the incorrect slot. Connections shall be maintained by pressure contact plugs. If connections are not properly made, electronic protection circuits shall prevent operation or switch OFF the inverter without component damage. Standardization of common circuit boards between multiple units shall be maintained.

f) All PCBs (electronic cards) of VSD drives shall be designed against the corrosive environment condition.

g) Power bus bars shall be rated to withstand short-circuit current stresses and shall be suitably insulated.

h) All non-current carrying metal work shall be bonded together and connected to an adequately sized earth bus provided inside the panel. Facility for external earth connection shall be provided at two points of earth bus.

i) Cubicles and components shall be identified by labels.

j) All equipment shall be suitable for the specified area of occupancy.

k) All wiring, using 650/1100V grade insulated copper wires, shall be brought out to individual terminals on a readily accessible terminal block. All terminals shall be shrouded.

l) All 3 phase MCBs or MCCBs shall be 4P type. All Single phase MCBs shall be of DP type.

m) Each VSD motor starter section shall comply with IEEE519. Complete VSD panel should be supplied by VSD panel manufacturer as listed in proposed/preferred vendor list. Fabrication of VSD panel by non- proposed/preferred vendors using reputed VSD module are not acceptable. Each VSD should have DOL bypass arrangement. All VSDs shall be SCADA compatible.

1.41.5 Protection, Metering and Control

The following minimum protection/alarms shall be provided-

a) Internal short circuit protection

b) Over and under voltage and over current protection

c) Earth fault of main/auxiliary circuits

d) Loss of control voltage protection

e) Over-temperature protection of inverter elements.

f) ±0.5% deviation from set point.

g) V/F ratio or over fluxing protection

h) Over speed/under speed protections

i) Stalled motor protection

j) Auxiliary system protection and failure identification.

Instruments, motors and control logic and their associated wiring shall be isolated from the power module. Potential and current transformers shall have relaying and metering class accuracy to provide satisfactory performance for the specified burden. Current transformers shall be designed to withstand mechanical and electrical stresses. The primary circuits of all potential transformers shall include current-limiting fuses. Control power transformer shall supply power to all space heaters and other components. The primary and secondary circuits shall be fused. Protection shall be provided such that failure of a part does not cause damage elsewhere in the system. Contractor shall furnish the signal response at each test pin for a standard test signal input to the card. Indicating meters shall be flush mounting type, SIF 96 size or as per manufacturer's standards.

1.41.6 Accessories

a) The VSD drives configuration shall be done from both front panel and also from personal computer. Hence VSD drives shall have PC interface ports. It should be possible to download the configurations from PC to VSD in case the VSD is removed and replaced.

b) A complete set of accessories normally used for operation, breakdown/routine maintenance and testing of the specified equipment shall be furnished, including special wrenches and tools.

c) Contractor shall also quote for additional maintenance and test equipment (such as inbuilt diagnostic test module) individually.

1.41.7 Spare Parts

Contractor shall quote itemized prices for the spare he recommends for trouble free operation for two years.

1.41.8 Inspection and Testing

Tests and inspection shall be carried out in accordance with relevant Indian Standards, and enclosed Inspection and Test plan (ITP). Routine tests at works will be witnessed by PMC/Owner. Type test certificates if available shall be furnished along with the offer. Contractor shall quote unit rate for witnessing type tests, if specified in Specific Job requirements.

1.42 Power Capacitor with APFC Panel

Capacitors shall comply with IEC 60871 and IS 5553, 13925 including those standards referred to therein. APFC panel shall be provided for LV switchboard of Process plants.

1.42.1 Construction of Power Capacitor

a) The internal elements of the capacitor unit shall be made of synthetic films or Kraft paper sandwiched between synthetic films as an insulator and aluminium foil as an electrode.

b) After congregating several numbers of these elements, the capacitor unit shall be thoroughly dried under high temperature and vacuum condition and impregnated with synthetic insulation oil of high purity which has been beforehand completely degreased of harmful impurities not to leave any gas in the container which may cause deterioration of the dielectrics.

c) The container shall be metal enclosed having ample strength and flexibility and shall be capable of adjusting the volume in the container against expansion and contraction of the impregnating oil due to change of temperature.

d) The power capacitor shall have suitable mechanical fault detector to protect the capacitor from internal faults.

e) The detector shall be provided with the capacitor.

f) Upon detection, the faulted capacitor shall be removed from the circuit to prevent container rupturing.

g) Discharge device shall have function to discharge of residual electric charge can be reduce to 50V or less within five (5) seconds at the capacitor terminal.

h) Power factor compensation above 300 KVAR is to be provided with synchronous motor and condenser.

i) All 3 phase MCBs or MCCBs shall be 4P type. All Single phase MCBs shall be of DP type.

1.42.2 Feature of APFC Panel

a) The APFC panel shall be connected on main panel and the pF improvement panel shall have separate capacitors to improve the pF of the system up to 0.98 during no load and full load conditions.

b) At least five steps shall be provided for switching.

c) Auto control is preferred to eliminate the human error.

d) The capacitor banks shall be complete with all parts that are necessary or essential for efficient operation.

e) The capacitor bank shall be complete with the required capacitors along with the supporting post insulators, steel rack assembly, copper bus bars, copper connecting strips, foundation channels, fuses, fuse clips, etc. The steel rack assembly shall be hot dip galvanized.

f) The capacitor bank may comprise of suitable number of single-phase units in series parallel combination. However, the number of units in series shall be such that failure of one unit shall not create an over voltage on the units in parallel with it, which will result in the failure of the parallel units. The complete banks with its accessories shall be metal enclosed (in sheet cubicle), indoor floor mounting and free-standing type.

   i. The assembly of the banks shall be such that it provides sufficient ventilation for each unit. Necessary louvers shall be provided in the cubicle to ensure proper ventilation.

   ii. Each capacitor case and the cubicle shall be earthed to a separate earth bus in the cubicle.

g) Each capacitor unit/bank shall be fitted with directly connected continuously rated, low loss discharge device to discharge the capacitors to reduce the voltage to 50 volts within one minute in accordance with the provisions of IS:13295.

h) Each unit shall be non-inflammable dielectric immersed self-cooled and hermetically sealed.

i) Each unit shall satisfactorily operate at 135% of rated KVAR including factors of over voltage, harmonic currents, and manufacturing tolerance. The units shall be capable of continuously withstanding satisfactorily any over voltage up to a maximum of 10% above the rated voltage, excluding transients.

j) The capacitor shall be of the self-healing type with a very low loss dielectric.

k) All the material employed in the manufacture of capacitor shall be nontoxic and biodegradable.

l) The expected life of the capacitor shall not be less than 1, 60, 000 hours.

m) The p. f. correction capacitor shall be designed in such a way that they, not only, withstand high RMS current, but also to work under sustained harmonic overloads.

n) The capacitors shall be characterized by the dielectric impregnated with biodegradable synthetic oil.

o) The dielectric shall consist of films of polypropylene and paper.

1.42.3 Unit Protection

a) Each capacitor unit shall be individually protected by an MCB/Contactor suitably rated for load current and interrupting capacity, so that a faulty capacitor unit shall be disconnected by the fuse without causing the bank to be disconnected. Thus, the fuse shall disconnect only the faulty unit and shall leave the rest of the units undisturbed. An effected fuse shall give visual indication so that it may be detected during periodic inspection.

b) The fuse breaking time shall co-ordinate with the pressure built up within the unit to avoid explosion. Mounting of the individual fuse may be internal or external to the capacitor enclosure.

c) The fuse unit and the wires and cables chosen for the capacitors of double the current carrying capacity of the normal permissible current. Similarly, the ammeter and current transformer shall also be designed accordingly.

1.42.4 Power Factor Correction Relay

a) The relay shall be DIGHI processor based digital solid-state type and switching device shall be solid state relay giving signal to contactors for switching ON/OFF preset number of capacitor units.

b) The relay shall be suitable for automatic/manual control of power factor correction capacitors on three phase system. It shall detect the power factor lagging and leading reactive power (KVAR) component above present levels and then switch the appropriate number of capacitors "IN" or "OUT" to achieve the optimum average power factor without system operating under leading power factor condition.

c) This relay/device shall have low VA burden and final switching of approximate capacitor banks shall be achieved by switching on the contractors/breakers through initiation of this device.

d) The relay shall be provided with facility to automatic self-adjustment to any capacitor step value.

e) The relay unit shall be provided with digital indication of power factor, preset parameters and specified installation data, no-volt relay feature to immediately disconnect all capacitor in the event of power failure, over temperature / over voltage/ harmonic over load protection, remote fault alarm indicator, power factor correction fault, LEDs for banks on inductive load, capacitive load, manual mode indication, remote alarm tripped, multiplication factor indication, and power on, manual bank and programming on button, manual bank and programming off button, manual / automatic button, alarm reset button, data scrolling button and 3 digit display.

1.42.5 Tests

All tests shall be conducted in accordance with the latest edition of IS: 22534 and as applicable for the controls. Type test certificates for similar capacitor units shall be furnished.

1.43 Technical Specification for HT & LT Power and Control Cables

This specification covers the design, manufacture, testing at manufacture's work before despatch, packing and transportation to site, laying, termination, testing and commissioning of HT, LT Power, control, and instrumentation Cables required for various sub-stations.

All cables shall comply with relevant Indian standards.

1.43.1 Make

The cables shall be procured from experienced and reputed manufacturers (as are approved by purchaser), with proven experience in manufacture of cables for substations and having capability to develop, test and timely supply of cables as specified in the tender specification. The manufacturer shall have arrangements for carrying out all the routine, type and acceptance tests including special tests (such as flammability test, smoke generation test, HCL gas evaluation test) as per the standards specified and have furnished satisfactory test results.

1.43.2 Design Criteria

1 Standards

The cables under this specification shall comply with the requirements of latest edition of the following standards including amendments:

Table 1-27: Applicable standard for cable

S. No.	Standard Number	Description
1	IS: 1554 (Part-I)	PVC insulated (heavy duty) electric cables for working voltage up to and including 1100 V.
2	IS: 1753	Recommended current rating for PVC insulated and PVC sheathed heavy duty cables.
3	IS: 3961 (Part II)	Metal steel wires, strips, and tapes for armoring of cables
4	IS: 3975	Methods for random sampling.
5	IS: 4905	PVC insulation and sheath of electric cables.
6	IS: 5831	Cross linked polyethylene insulated PVC sheathed cables for working voltages up to & including 1100 V.
7	IS: 7098 (Part II)	Cross linked polyethylene insulated PVC sheathed cable for working voltage from 3.3 kV to 33kV.
8	IS: 8130	Conductors for insulated electric cables and flexible cords.
9	IS: 10418	Wooden drums for electric cables.
10	IS: 10810	Method of tests for cables.
11	ASTMD- 2863	Standard method for measuring the minimum oxygen concentration to support candle like combustion of plastic.
12	IEEE: 383	Standard for type test of IE class of electric cables.
13	IEC-332 (Part-I)	Tests on electric cables under fire conditions.
14	IEC-754 (Part-I)	Test on gases evolved during combustion of electric cables.
15	ASTMD – 2843	Test method for density of smoke from the burning on decomposition of plastic.

1.43.3 Cable Design

The cables shall be designed considering the following:

1 HT Cables

HT cables will be 6.35/11 kV & 19/33kV of earthed grade suitable for use in solidly earthed system, stranded & compacted electrolytic aluminium conductor, extruded semi conducting screen over conductor, XLPE insulated, armoured, semi-conducting followed by copper tape screened for 600 A, extruded PVC, Type ST–2 inner sheathed, overall FRLS, PVC outer sheathed, conforming to IS 7098 (Part II), IEC 60502 for constructional details and tests.

2 LT Power Cables

LT Power Cable will be 1100 V grade, single / multi core, stranded electrolytic aluminium/copper conductor, XLPE insulated, with PVC inner sheath, armoured and outer sheath made of FRLS PVC compound, generally conforming to IS-7098 (Part-II). The cables used for DC system will be of two core type. Minimum conductor cross section of power cables will be 10 mm2 for aluminium cables and below 10 mm2 it will be copper conductor. Minimum conductor cross section of power cables shall be 4 Sq.mm for Copper.

3 Control Cables

Control cables will be 1100 V grade, multi core, minimum 2.5 mm2 cross section, stranded copper conductor having XLPE insulated, PVC inner sheathed / galvanized steel wire armoured, overall FRLS, PVC outer sheathed generally conforming to IS 1554 Part-I. In situations where accuracy of measurement or voltage drop in control circuit warrants, higher cross sections as required will be used. The number of cores will be standardized as 2,3,4,5,7,10,14,19,24.

4 Instrumentation Cables

The instrumentation cables will be annealed, tinned stranded copper conductor, 0.5 mm2, twisted into pairs, overall screened (L1 type) for digital signals, individual and overall screened (for L2 type) for low level analogue signals, individual triplet and overall screened (type L3), PVC insulated, inner PVC sheathed, GS wire armoured and overall sheathed with FRLS PVC. The insulation will be strippable manually as well as by mechanical stripping devices without damage to the conductor.

5 Lighting Wires

a) 1100 V grade, single core, stranded, copper conductor, PVC insulated wires conforming to IS 694 / IEC 60227 Part 1 to 5 / IEEE-719. Minimum cross section of copper wires shall be 2.5 mm2 for lighting circuits and 4 mm2 for receptacle circuits.

b) These shall be suitable for installation in a monsoon area having 100% relative humidity, which is likely to accelerate rusting in steel. However, for reference the ambient temperature may be taken as -5 °C (minimum) and 50° C (maximum) with RH of 100%. The galvanising of steel armour has to be of the highest quality for such ambient conditions.

c) The user shall consider the derating factor for the various conditions of installation including the following while choosing the conductor size.

  i. Maximum ambient air temperature.

  ii. Maximum ground temperature.

  iii. Depth of laying wherever applicable.

iv. Grouping of cables.

d) The minimum size of all 33 kV, 11 kV and 415 V Power Cable shall be chosen considering the following:

i. Maximum fault level

ii. Full load current of the circuit.

iii. Maximum permitted time as dictated by system protections, switchgear etc.

e) The allowable voltage drop at the terminal of the connected equipment shall be maximum 3% at full load for LV and 4% for HV.

f) For PVC insulated cables continuous conductor temperature and allowable maximum conductor temperature during short circuit be taken as 70°C and 160°C and for XLPE insulated cables the corresponding values shall be 90°C and 250°C respectively.

Frequency variation ± 3%, voltage variation ±6% and combined frequency and voltage variation of ±9%.

1.43.4 General Technical Requirement

a) The cables shall be suitable for laying in racks, ducts, covered trenches, conduits, and underground buried installation with chances of flooding by water.

b) Cables shall be designed to withstand mechanical, electrical, and thermal stresses developed under steady state and transient operating conditions.

c) The aluminium / copper wires used for manufacturing the cables shall be true circular in shape before stranding and shall be of uniformly good quality free from defects. All aluminium used in the cables shall be of H2 grade.

d) The conductor of control cables shall be manufactured from plain annealed copper. The conductor shall be multi-stranded or solid as per data sheet.

e) Allowable tolerance on the overall diameter of the cables shall be + 2 mm maximum, over the declared value in the technical data sheets.

f) The cable cores shall be laid up with fillers between the cores wherever necessary. It should not stick to insulation and inner sheath. All the cables, other than single core unarmoured cables shall have distinct extruded PVC inner sheath black in colour as per IS 5831.

g) The fillers and inner sheath shall be of non-hygroscopic. Flame retardant material shall be softer than insulation and outer sheath shall be suitable for the operational temperature of the cable.

h) For single core armoured cables, armouring shall be of aluminium wires. For multi-core armoured cables, armouring shall be of galvanized steel as follows.

Size & diameter of cable	Type of armour
Up to 13 mm	1.4 mm día GS wire
Above 13 up to 25 mm	0.8 mm thick GS strip / 1.6 mm día GS wire
Above 25 up to 40 mm	0.8 mm thick GS strip / 2.0 mm dia GS wire

Above 40 up to 55 mm	1.4 mm thick GS strip/2.5 mm dia GS wire
Above 55 up to 70 mm	1.4 mm thick GS strip/3.15 mm dia GS wire
Above 70 mm	1.4 mm thick GS strip/4 mm dia GS wire

i) The gap between armour wire/ strip shall not exceed one armour wire/strip space and there shall be no cross over/over-riding of armour wire/strip. The minimum area of coverage of armouring shall be 90%. The breaking load of armour joint shall not be less than 95% of that of armour wire/strip. Zinc rich paint shall be applied on armour joint surface.

j) Suitable chemicals shall be added to the outer sheaths of all cables to protect them from entry of water, UV light, rodent and termite attack. These chemicals shall not have any harmful effect on the human being.

k) The normal current rating of all PVC insulated cables shall be as per IS-3961 and should suit the duty requirements for which it is intended.

l) Outer sheath shall be of black PVC colour for power cables and of grey colour for control cables.

m) In plant repairs to the cables shall not be accepted.

n) As far as feasible, separate cables shall be provided for circuits of different plant and auxiliaries, for circuits of different voltages, and for circuit used separately. Power, control, and instrumentation circuit shall invariably be taken through different routes, which shall not be laid together on the same cable tray.

o) At least 20% cores shall be kept as spares in the multi core control cable.

1.43.5 Identification of cores

The insulated cores of HT and LT power cables shall be identified by colour code.

Cores of the cables of up to 5 cores shall be identified by colour of insulation with the following colour scheme.

No. of cores	Colour
1 Core	Red, Black, Yellow & Blue
2 Core	Red & Black
3 Core	Red, Yellow & Blue
4 Core	Red, Yellow, Blue & Black
5 Core	Red, Yellow, Blue, Black & Grey

a) For reduced neutral conductors the core shall be black

b) For cables having more than 5 cores, core identification shall be done by numbering insulation of core sequentially, starting by number 1 in the inner layer (e.g. say for 10 core cable, core numbering shall be from 1 to 10). The numbers shall be printed in Hindu-Arabic numerals on the outer surfaces of the cores. All the numbers shall be of same colour, which shall contrast with the colour of insulation. The colour of the insulation for all the cores shall be grey only.

c) The control cables shall have identification by means if indelible printing of numbers on its cores at intervals not more than 75 mm.

d) The numerals shall be legible and indelible. The numbers shall be repeated at regular intervals along the core, consecutive numbers being inverted in relation to each other. When number is a single numeral, a dash shall be placed underneath it. If the number consists of two numerals, these shall be disposed one below the other and a dash placed below the lower numeral. The spacing between consecutive numbers shall not exceed 50 mm.

e) All EHT, HT and LT cable shall have embossing at interval of 1 meter for Owner 's name, size / core type and length.

f) In addition to manufacturer's identification on cables as per IS, following marking shall also be embossed over outer sheath.

i. Cable voltage grade.

ii. Sequential marking of length of the cable in meters at every one meter.

iii. The embossing shall be progressive, automatic, online and marking shall be legible and indelible.

1.43.6 Copper Cables

Copper cables shall be used for the following services.

a) DC cables from batteries to DC boards

b) DC emergency lighting cables for main building

c) Battery and battery chargers

d) Actuator motors, wherever provided.

e) All other essential system wherever necessary

1.43.7 Constructional Requirements for HT Cables

1 Type of Cable

The cable shall be multi core/ single core XLPE insulated type as specified.

2 Conductor

The cable conductor shall be made from stranded electrolytic Copper as specified to form compact conductor having a resistance within the limits specified in IS.8130.

All the cables of size 25mm2 and above shall have sector-shaped conductors. The minimum number of strands in conductor shall be 7 (seven) except as otherwise specified. Power cables shall be of stranded Aluminium conductor with a minimum size of 10 mm2 and the control cables shall be of stranded or solid copper (electrolytic) conductor with a minimum size of 1.5 mm2 as specified.

3 Conductor Semi-Conducting Layer

The conductor having a semi-conducting screen shall ensure perfectly smooth profile and avoid stress concentration. The conductor screen shall be extruded in the same operation as the insulation and the semi-conducting polymer shall be cross-linked for XLPE cables.

4 Insulation

The insulation of the cable shall be extruded type and shall be designed and manufactured for the specified system voltage. The manufacturing process shall ensure that insulation shall be free from voids. The insulation shall withstand mechanical and thermal stresses under steady state and transient operating conditions. The extrusion method should give very smooth interface between semi-conducting screen and insulation. The insulation of the cables shall be of high standard quality. The minimum volume resistivity of the PVC insulation of all the PVC insulated cables shall be 1 x 1014-ohm cm at 27° C and 1 x 1011-ohm cm at 70° C.

5 Insulation Shield

a) In XLPE cables to confine electrical field to the insulation, a non-magnetic semi-conducting shield shall be put over the insulation. The XLPE cable insulation shield shall be strippable. Metallic screening, as given in this specification for the various power and control cables shall be provided.

b) The conductor screen, XLPE insulation and insulation screen, shall all be extruded in one operation by 'Triple Extrusion' process to ensure perfect bonding between the layers. The core identification shall be by coloured strips or by printed numerals.

c) The insulation shielding shall consist of non-metallic extruded semi-conducting compound in combination with a non-magnetic metallic screening of copper.

d) The copper screen shall be capable of carrying the single line to ground fault current for the duration specified for the protection employed. Vendor shall furnish calculation in support of selection of the size of copper screen.

6 Inner Sheath

a) The sheath shall be suitable to withstand the site conditions and the desired temperature. It shall be of adequate thickness and applied by a continuous process to produce a sheath of consistent quality free from all defects. PVC sheath shall be extruded.

b) The inner sheath shall be applied over the laid-up cores by extrusion and shall conform to the requirements of type ST2 compound of IS: 5831. The extruded inner sheath shall be of uniform thickness.

c) The dimensions of the insulation, inner sheath and armour materials shall be governed by values given in Tables 2,3 & 4 (Method 3) of IS: 7098 Part-II).

7 Armour

Armouring shall be provided wherever specified. Generally, cables laid in say in underground ducts need not be armoured. For multi core cables, the armouring shall be by galvanised steel wire/ tape. If armouring is specified for single core cables, the same shall be with hard drawn aluminium round wire of 2.5mm diameter.

The hard drawn aluminium wire for armour shall be of H4 grade, as per IS:8130 (having tensile strength above 150 N/mm2). The diameter of the aluminium wire shall be as per the table for the dimensions of the galvanised steel wire armour given in the relevant standard. All cables directly buried shall be armoured.

8 Serving/ Outer Sheath

Extruded PVC serving as per IS:5831 or as specified otherwise shall be applied over the armouring with suitable additives to prevent attack by rodent and termites. All serving must be given anti-termite treatment.

The outer sheath of the cables shall be applied by extrusion over the armouring and shall be of PVC compound conforming to the requirements of type ST2 compound of IS: 5831. The thickness of outer sheath shall be as per amendment no. I of table 5 of IS: 7098 Part-2 (Column 3 & 5 for both armoured and unarmoured cables).

9 Fillers for Multi Core Cables

Cable shall have suitable fillers laid up with the conductors to provide a substantially circular cross-section before the sheath is applied. Fillers shall be suitable for the operating temperature of the cable and compatible with the insulating material. All materials shall be new, unused and of finest quality. Workmanship shall be neat, clean and of highest grade.

1.43.8 Cable Types

1 11kV/ 33kV System - Power Cable

The cable shall be for 11 kV/ 33kV earthed system, heavy duty, three or single core, stranded Aluminium conductor, XLPE insulated, provided with conductor screening and insulation screening, aluminium armouring for single core, extruded PVC of Type ST2 outer sheathed, as per system requirement. The cables shall conform to IS:7098 (Part II.

2 415V System

The cable shall be 1.1 kV, grade, heavy duty, stranded Aluminium conductor, XLPE insulated as specified, 4 or 3 1/2 core, galvanised steel wire/strip armoured, extruded PVC type STI outer sheathed.

3 Control Cables

The cable shall be 1.1 kV grade, XLPE, heavy duty, multi core stranded (7 wires) tinned copper (annealed) conductor, PVC Type-A insulated, galvanised steel wire/strip armoured, flame retardant low smoke (FRLS) extruded PVC of type-STI outer sheathed. The following sizes shall be used.

Cable Size (mm^2)	1.5/ 2.5	4	6	16
No. of Cores	2,5,7,10,14,19,27	3,5	2,4	4

4 LV Power and Control Cables

a) LV power and control cables shall be XLPE, heavy duty type, 1100 V grade with electrolytic Aluminium conductor, PVC inner sheathed, armoured, if specified and overall PVC sheathed, as specified in bill of quantities.

b) Copper conductor for control cables shall be PVC insulated whereas for power cables it shall be XLPE as given in bill of quantities.

c) The conductors shall be stranded. The minimum number of strands shall be 7 (seven) except as otherwise specified. Conductors of nominal area less than 25 sq. mm shall be circular only. Cables of nominal area 25 sq. mm and above may be circular or shaped. Cables with reduced neutral conductor shall have sizes as per Table 1 of IS:1554 (Part-I).

d) Power cables shall be of stranded Aluminium conductor with a minimum size of 10 mm2 and control cables shall be stranded copper conductor with a minimum size of 2.5 mm2.

e) If armouring is specified for multi core cables, the same shall be by single round galvanized steel wires where the calculated diameter below armouring does not exceed 13 mm.

1.43.9 Cable Accessories for HT Cables

a) The termination and straight through jointing kits for use on the system shall be heat shrinkable type and suitable for the type of cables offered as per these specifications.

b) The accessories shall be supplied complete in all respects and should be supplied in kit form. Each component of the kit shall carry the manufacturer's mark of origin.

c) The kit shall include all stress grading insulating and sealing materials apart from conductor fittings and consumable items. An installation instruction sheet shall also be included in each kit.

d) The contents of the accessories kit including all consumables shall be suitable for storage without deterioration at a temperature of 50°C with shelf life extending more than 5 years.

e) A set of tools for making joints shall be provided (both for indoor and outdoor joints).

1.43.10 Termination Kits

The heat shrinkable terminating kits shall be suitable for termination of the HT cables to an indoor switchgear or to a weatherproof cable box of an outdoor transformer or to a 4-pole structure. For outdoor terminations whether shields/sealing ends and any other accessories required shall also form part of the kit. For RMU cable termination shall be with plug in type. All HT terminations shall be heat-shrinkable, Humid environment proof and touch-proof.

1.43.11 Requirement of XLPE Joints & Termination

The straight through jointing kit shall be suitable for installation on overhead trays, concrete lined trenches, ducts, and for underground burial with uncontrolled backfill along with possibility of flooding by water and chemicals. These shall have protection against any mechanical damage and suitably designed to be protected against rodent and termite attack. For ducts suitable manholes shall be provided for joints. Joint in cables shall meet the following requirements.

a) Conductivity of the jointed conductor shall not be less than that of the main conductor of the cable.

b) Joints between two conductors or conductor lugs shall have a mechanical strength not less than that of the conductor.

c) Adequate insulation level free from voids and impurities.

d) Sufficient stress relief provision.

e) Adequate creepage paths to eliminate system tracking.

f) Ability to withstand electromagnetic thermal stress during flow of short circuit Current.

g) Proper seals for water, dust, and chemical fumes for checking their ingress under all conditions.

h) Inner semi-conducting layer with a smooth surface & good contacts and insulation.

i) Outer semi-conducting layer to adhere firmly to the insulation.

j) Earth continuity connection of adequate size shall be a part of the kit.

k) Heat shrinkable technique shall be used for termination kits. It shall be fit for humid environment, touch proof. This system shall be based on the use of heat shrinkable radiation vulcanised cross linked polyethylene tubes (semi-conducting and insulation grade) and skirts. These tubes shall be fitted to the cable and/or joints and set in position by shrink fitting by application of heat by a gas torch or kerosene blow lamp.

l) The heat shrinkable tubes, designed as stress control tubing, insulating tubing and screen tubing shall meet the requirements of temperature, flexibility, stress grading, long life, resistance to corrosion and chemical etc. Complete list of various items required for making various type of joints shall be furnished with the offer.

1.43.12 Cable Drums

a) Cables shall be supplied in non-returnable wooden or steel drums of heavy construction in proper and suitable packing for shipment to site. For wooden drums the wood used for construction for the drum shall be properly seasoned, sound, and free from defects. Wood preservative shall be applied to the entire drum.

b) Contractor shall indicate in the offer the standard length for each size of power and control cable which can be furnished on one drum. The cable length per drum shall be subject to tolerance of ± 5% of the standard drum length agreed between purchaser and contractor.

c) Cable Joints shall be avoided as far as possible by use of proper cable lengths.

d) The Engineer shall have the option of rejecting cable drums with shorter lengths.as the cable drums shall be selected so that through joints are eliminated.

e) A layer of waterproof paper shall be applied to the surfaces of the drums and over the outer most cables layer. A clear space of at least 40 mm shall be left between the cables and the logging.

f) Each drum shall carry the manufacturer's name, the purchaser/ supplier’s name and contract number, owner's name, address, item number, type, size, length of cable, net and gross weight stencilled on both sides of drum. A tag containing the same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wordings shall be marked on one end of the reel indicating the direction in which it should be rolled.

g) On the drum the number of cores, type of cable, voltage rating, code, direction of drum rotation, BIS certification mark and year of manufacture shall also be mentioned.

h) Packing shall be sturdy and adequate to protect the cables from any injury due to mishandling or other conditions encountered during transportation handling and storage.

i) Both cable ends shall be sealed with PVC/ Rubber caps so as to eliminate ingress of water during transportation, storage, and erection/ construction.

1.43.13 Cable Installation

Cables shall be laid by skilled and experienced workmen using adequate rollers to minimize stretching of the cable. The cable drums shall be placed on jacks before unwinding the cable. Great care shall be exercised in laying cables to avoid forming kinks. Cable shall be laid in accordance with relevant Indians Standards.

1 Laying of Cables on Cable Trays

a) The relative position of the cables laid on the cable tray shall be preserved, and the cables shall not cross each other. At all changes in direction in horizontal and vertical planes, the cable shall be bent smooth with a radius as recommended by the manufacturers. All cables shall be laid with minimum one diameter gap and shall be clamped at every meter to the cable tray. Cables shall be tagged for identification with aluminium tag and clamped properly at every 20M. Tags shall be provided at both ends and all changes in directions both sides of wall and floor crossings. All cable shall be identified by embossing on the tag the size of the cable, place of origin and termination.

b) All cables passing through holes in floor or walls shall be sealed with fire retardant Sealant and shall be painted with fire retardant paint up to one meter on all joints, terminations and both sides of the wall crossings.

2 Laying of Cables in Ground

a) The minimum width of trench for laying single cable shall be minimum 350 mm. Where more than one cable is to be laid in horizontal formation, the width of the trench shall be workout by providing minimum one cable diameter gap between the cables, except where otherwise specified. There shall be clearance of minimum half a cable dia or 25mm whichever is greater between the end cable and the side wall of the trench. The minimum depth of the cable trench shall not be less than 750 mm for single layer of cables. When the cables are laid in more than one tier the depth of the trench shall be increased by 300 mm for each additional tier.

b) Excavation of trenches: The trenches shall be excavated in reasonably straight lines. Wherever there is a change in direction, suitable curvature shall be provided. Where gradients and changes in depth are unavoidable, these shall be gradual. The excavated soil shall be stacked firmly by the side of the trench such that it may not fall back into the trench. The bottom of the trench shall be levelled and shall be made free from stone, brick bats etc. The trench shall then be provided with a layer of clean, dry sand cushion of not less than 100 mm in depth.

c) Prior to laying of cables, the cores shall be tested for continuity and insulation resistance. The cable drum shall be properly mounted on jacks, at a suitable location, making sure that the spindle, jack etc. are strong enough to carry the weight of the drum and the spindle is horizontal. Cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains. The entire drum length shall be laid in one stretch.

d) However, where this is not possible the remainder of the cable shall be removed by `Flaking' i.e. by making one long loop in the reverse direction. After the cable has been uncoiled and laid into the trench over the rollers, the cable shall be lifted off the rollers beginning from one end by helpers standing about 10 meters apart and laid in a reasonably straight line.

e) Cable laid in trenches in a single tier formation shall have a cover of clean, dry sand of not less than 150 mm. above the base cushion of sand before the protective cover is laid. In the case of vertical multi-tier formation after the first cable has been laid, a sand cushion of 300 mm shall be provided over the initial bed before the second tier is laid. Finally, the cables shall be protected by second class bricks before back filling the trench. The buried depth of uppermost layer of cable shall not be less than 750mm.

f) Back Filling: The trenches shall be back filled with excavated earth free from stones or other sharp-edged debris and shall be rammed and watered, if necessary, in successive layers not exceeding 300 mm. Unless otherwise specified, a crown of earth not less than 50 mm in the centre and tapering towards the sides of the trench shall be left to allow for subsidence.

3 Cables inside Building

Cables inside buildings shall be laid on the cable trays. All cables passing through walls shall run through GI Pipes sleeves of adequate diameter 50 mm apart maintaining the relative position over the entire length.

4 Laying of Cables in Concrete Trench

The minimum width of trench for laying single cable shall be minimum 350 mm. Where more than one cable is to be laid in horizontal formation, the width of the trench shall be workout by providing minimum one cable diameter gap between the cables, except where otherwise specified. There shall be clearance of minimum half a cable dia or 25mm whichever is greater between the end cable and the side wall of the trench. The minimum depth of the cable trench shall not be less than 500 mm for single layer of cables. When the cables are laid in more than one tier the depth of the trench shall be increased by minimum 300mm for each additional tier. Cables shall be laid on FRP Cable trays supported by MS angles at intervals.

Route Marker

a) Route marker shall be provided along straight runs of the cables not exceeding 30 meters also for change in the direction of the cable route and underground joints.

b) Route marker shall be of cast iron painted with aluminium paint. The size of marker shall be 100 mm dia with “Cable” and voltage grade inscribed on it.

1.43.14 Inspection

a) Before dispatch the cables offered shall be made available for inspection by the Engineer. Inspection may also be made at any stage of manufacture at the option of the purchaser and the cables found unsatisfactory due to the material used or poor workmanship shall be rejected.

b) The contractor shall guarantee free access to the places of manufacture to the Engineer at all times when the work is in progress. The contractor shall inform the Engineer in advance the time of starting of manufacture and the progress of manufacture of the cables offered by him so that arrangement can be made for inspection.

c) Inspection and acceptance of cables by the Engineer shall not relieve the contractor of his obligation of furnishing cables in accordance with the specification and shall not prevent subsequent rejection if such cables are later found to be defective.

d) The cables shall comply with type tests stipulated in prescribed section and the relevant standards. Test reports for all type tests shall be submitted with the tender.

e) All type and sizes of cables shall be subjected to routine and acceptance tests as stipulated in relevant standards without any extra cost to the purchaser. Cables should not be dispatched until the test reports are duly approved by the Purchaser or his authorized representative and specific instructions to despatch the inspected items issued.

f) The purchaser reserves the right of having any other special tests of reasonable nature carried out at site or at manufacturer's works or at any other place in addition to the aforesaid type and routine tests to satisfy himself that the cables comply with the specification, without any financial liability.

g) Six copies of test reports (or as indicated in the Schedule of Vendor Drawings) shall be supplied for approval. The reports shall clearly indicate the governing standards and the standard values specified for each test to facilitate checking of the test reports. Six bound copies of the test reports shall be submitted after approval of test reports along with the cables.

1.43.15 Tests

a) All types and sizes of cables being supplied shall be subjected to type tests, routine tests and acceptance tests as specified below and according to relevant standards.

b) The Engineer at its discretion may ask the contractor to conduct any or all the type tests for which at least 15 days advance notice shall be given.

c) Charges for acceptance test and routine test shall be deemed to be included in the bid price of individual cables.

1 Type Tests

a) Type tests shall be carried out on all the types and sizes of cables if desired or alternatively test certificates shall be supplied at the sole discretion of purchaser.

b) The following shall constitute type tests:

2 For Conductor

a)	Annealing test	for copper conductor only
b)	Tensile test	for aluminium conductor only
c)	Wrapping test	for aluminium conductor only
d)	Resistance test	For Armour Wires/Strips

3 Measurement of Dimensions

a)	Tensile test	
b)	Elongation test	
c)	Torsion test	for round wires only
d)	Winding test	for strips only
e)	Resistance test	
f)	Zinc Coating test	For G.S. strips/ wires only
g)	For PVC/ XLPE Insulation &PVC Sheath	

4 Test for thickness.

a)	Tensile strength and elongation test before aging and after aging	
b)	Aging in air ovens	
c)	Loss of mass test	For PVC insulation & sheath only.
d)	Hot deformation test	-do-
e)	Heat stock test	-do-
f)	Shrinkage test	-do-
g)	Cold bend/cold Impact test	-do-
h)	Colour fastness to	-do-
i)	Thermal stability test	-do-
j)	Bleeding and blooming test	-do-
k)	Hot set test	For XLPE insulation only
l)	Water absorption test	For XLPE insulation only

5 For Completed Cables

a) Insulation resistance test

b)	High voltage test	For HT cables
c)	Partial discharge test	-do-
d)	Bending test	-do-
e)	Dielectric Power factor test:	-do-
f)	As a function of voltage	-do
g)	As a function of temperature	-do-
h)	Heating cycle test	-do-
i)	Impulse with stand test	-do-
j)	Measurement of eccentricity and ovality.	-do-

6 Short Circuit test

a) Short circuit test on conductors shall be carried out on cable samples.

b) During each short circuit test, the cable shall be subjected to thermal (rms) and dynamic (peak) short circuit current of specified duration.

c) The test sample shall be subject to following tests before carrying out the short circuit test and after completion of short circuit test (when cable has cooled down to ambient temperature).

i. Conductor resistance measurement.

ii. High voltage test.

iii. Tan delta measurement.

iv. Partial discharge measurement (for HT cables).

v. Volume resistivity.

d) Before applying the short circuit current, the test sample shall be heated up to the specified maximum conductor temperature. This may be done by eddy current heating or by giving intermittent high current impulses as per the convenience of test station. After establishing specified conductor temperature, the cable shall be subjected to short circuit test.

7 Acceptance Criteria

After the short circuit test the test specimen shall meet the following requirements:

a) HV Test

b) Pd test

c) Tan delta values as per standard.

d) Conductor resistance not more than ±5%.

e) Volume resistivity shall not be below the standard acceptance value.

8 Acceptance Test

Acceptance tests shall be carried out on each type and size of the cable on the cable drums selected at random.

The following shall constitute acceptance test:

a) Annealing test

b) Tensile test

c) Wrapping test

d) Resistance test

e) Test for thickness.

f) Tensile strength and elongation test before aging and after aging

g) Aging in air ovens

h) Hot set test

i) Insulation resistance test

j) High voltage test

k) Partial discharge test

l) Measurement of eccentricity and ovality.

9 Routine Test

Routine test shall be carried out for each drum of cables of all type and sizes.

Following shall constitute routine tests:

a) Resistance test.

b) Insulation resistance test.

c) High voltage test.

1.43.16 Technical Particulars

1 HT Cables

a)	Voltage Grade UE	:	220,132,33, & 11kV as per IS-7098 (Part 2).
b)	Type	:	3 core, XLPE, armoured, screened cables.
c)	System earthing	:	Solid grounded
d)	Size	:	As per requirement
e)	Conductor	:	Aluminium stranded conductor
f)	Conductor Screening		
g)	by extrusion	:	Semi conducting compound.

h)	Insulation Properties & application by extrusions.	:	Table 1 of IS-7098 (Part-II) process of application and
i)	Nominal thickness of		
j)	Insulation screening	:	As per IS:7098 Cause 11.3 insulation & tolerance.
k)	Non-metallic part 1	:	Semi- conducting compound over the insulation
l)	Metallic part where both sheath shall be 7098 (Part-II).	:	Armouring may constitute metallic part of screening. metallic screen & armouring are used, extruded inner there in between and its thickness as per Table 3 of IS
m)	Core Identification colours of XLPE numbered strips or	:	Coloured strips application on cores or different insulation or by numeral (1,2,3) either by applying by printing on the cores.
n)	Armouring	:	Galvanized steel round wire/strips
o)	Outer Sheath thickness of IS 7098.	:	Not less than value specified in Column 5 of Table 5

2 L.T. Power & Control Cables

a)	Size of Cable	As per requirement
b)	Voltage rating	650/1100 V

Cable Accessories

Description	HT Cables	LT Cables
Voltage Rating	As per cable rating	As per cable
Type of termination	Heat shrinkable	Compressed
Clamps/ terminals	Aluminum compression	Aluminum material

1.44 Technical Specification for EHT Cables (132kV & 220kV)

The scope under this section covers design, manufacture, testing, packing, supply, delivery and laying of 132kV and 220 KV, XLPE, insulated power cable for use with effectively earthed distribution systems.

1.44.1 Standards

Unless otherwise specified, the cables shall conform, in all respects, to IEC-62067 and IS:7098 (Part-III)/1993 with latest amendment or latest edition for cross linked polyethylene insulated PVC sheathed cable for working voltage of 220 KV.

1.44.2 Climatic conditions

The climatic conditions under which the cable shall operate satisfactorily are as follows:

Description	Details
Maximum ambient Temperature	50°C

Minimum Ambient Temperature	3.5°C
Maximum Design Ambient Temperature	50°C
Relative Humidity	100%
Average number of Thunderstorms (days /annum)	20
Altitude of operation	Less than 1000 meters
Average annual Rainfall	>1450mm
Wind speed	20miles/hr

1.44.3 Principal Parameters

a) 220 KV (E) grade XLPE single core power cable of conductor electrolytic grade copper of single length, Aluminium sheathed, overall PE sheathed UG cable (E) grade, Single core, circular, stranded, playing annealed compacted copper conductor, screen on extruded semi conducting compound, XLPE insulation, insulation screen of semiconducting compound, non-woven swellable semi conducting tape extruded lead alloy (E) sheath, semi conducting bedding tapes helically applied copper wires open helix copper tape, non-woven swellable tape, extruded PVC ST2 sheath conductive coating & antisemite treated high density poly-ethylene outer sheathed copper cable confirming to IEC-62067 with latest amendment or latest edition for construction and also confirming to IS:7098 (Part-III)/1993 or any latest amendments thereof

b) 132kV (E) grade, Single core, Circular, stranded, plain annealed Segmental compact type, Milliken copper conductor, conductor screen on extruded semi conducting compound, cross linked polyethylene (XLPE) insulation, core screen, semi-conducting water swellable layer, extruded Aluminium (E) sheath, semi conducting bedding tapes, helically applied plain round copper wire screen, plain copper tape I open helix, water swellable tape with overall extruded high density polyethylene sheath, coated with graphite etc. confirming to IEC-62067 with latest amendment or latest edition for construction and also confirming to IS:7098 (Part-III)/1993 or any latest amendments thereof.

c) Outer sheathing should be designed to afford high degree of mechanical protection and should also be heat, oil chemicals and weather resistant. Common acid. Alkalis and saline solution should not have adverse effect on the PVC sheathing material used.

d) The cable should be suitable for laying in covered trenches and/or underground for outdoor.

e) The sheath/screen bonding system shall provide a continuous current path through the cable sheath and jointing kits and shall be bonded. The bonding ends shall be suitably earthed with/without SVL as per approved configuration/design. The sheath voltage under full load condition shall not exceed the voltage specified/allowed in relevant standard for safety of personal as well as satisfactory working of cable. Sheath shall be solidly grounded at suitable location with or without SVL. Bidder must indicate details of configuration proposed along with sufficiency calculation with the bid so as to limit induced voltage of sheath within 65V.

f) Cable Parameters

S. No.	Description	132kV	220kV

1	Voltage Grade (U0/U)	76kV/132kV	127kV/220kV
2	No of Cores	Single	Single
3	Size (mm2)	As per calculation	As per calculation
4	Nominal system voltage kV	132	220
5	Highest system voltage kV	145	245
6	System Frequency, Hz	50	50
7	Variation in Frequency	± 3%	± 3%
8	Fault level individually for Conductor Cu Screen Armour	 40kA for 1 Sec 40kA for 1 Sec 40kA for 1 Sec	 50kA for 1 Sec 50kA for 1 Sec 50kA for 1 Sec
9	Maximum allowable temperature Design continuous operation at rated full load current, the max, temp of conductor shall not exceed. The conductor temperature after a short circuit for 1.0 sec shall not exceed	90 °C 250 °C	90 °C 250 °C
10	Basic Insulation level (1.2/50 DIGHI or second wave)	650 KVP	1050 KVP
11	1-min power frequency withstand voltage (rms)	275 kV	460 kV
12	System Earthing	Effectively earthed	Effectively earthed

1.44.4 Construction

a) All materials used in the manufacture of cable shall be new unused and of finest quality. All materials should comply with the applicable provision of the tests of the specification. IS, IEC, Indian Electricity Rules, Indian Electricity Act and any other applicable statutory provisions rules and regulations.

b) **Current Rating**: The cable will have current ratings and derating factors as per relevant standard IEC.

c) The one-second short circuit rating values each for conductor, screen & armour shall be furnished and shall be subject to the purchaser's approval.

d) The current ratings shall be based on maximum conductor temperature of 90 deg. C with ambient site condition specified for continuous operation at the rated current.

1.44.5 Operation

a) Cables shall be capable of satisfactory operation under a power supply system frequency variation of plus minus 3% voltage variation of plus, minus 10% and combined frequency voltage variation of 10% (absolute sum).

b) Cable shall be suitable for laying in ducts or buried under ground.

c) Cable shall have heat and moisture resistance properties. These shall be of type and design with proven record on transmission network service.

d) **Lengths**: The cable shall be supplied in standard drum lengths of 500Mtr ± 5% tolerance.

1.44.6 Identification Marking

Identification of cable shall be provided extremally at three meters intervals to identify as under:

Name of Manufacture

Year of Manufacture

Voltage grade to be printed/embossed at the interval of one meter length. The identification, by printing or embossing shall be done only on the outer sheath. Name of purchaser shall also be embossed.

1.45 Tests

1.45.1 Type Tests

The equipment offered should be type tested. Type test report should not be more than seven years old, reckoned from the date of bid opening, in respect of the following rests, carried out in accordance with IS:7098/IEC-871, from Govt/Govt. approved test house, shall be submitted along with bid:

a) Physical tests for insulation and outer sheath.

b) Bending Test

c) Di-electrical power factor test

d) Heating cycle test followed by di-electrical power factor as a function of voltage and partial discharge test.

e) Impulse withstand test.

The remaining type test report as per clause 3 of ISS-7098/IEC-871/IEC-62067 shall be submitted by the successful bidder within three months from the date of placement of order. These type test reports shall be from Govt./Govt. approved test house and shall not be more than seven years old, reckoned from the date of placement of order. The failure to do so will be considered as a breach of contract.

1.45.2 Routine Tests And Acceptance Tests

All routine and acceptance tests shall be carried as per relevant ISS in the presence of Nigam's representative.

1.45.3 Inspection

The material shall be inspected and tested before dispatch by an authorized representative MSETCL/MSEDCL/MITL/Client

1.45.4 Test Certificates

The supplier shall supply test certificates from a Govt. agency in respect of quality as per IS:7098(part-III) 1985 with latest amendments thereof for approval of the purchaser.

1.45.5 Packing

The cable shall be supplied in non-returnable wooden drum as per IS: 10418:1982 so constructed, as to enable the cable to be transported on each drum. The cable wound on such drum shall be one continuous length. The ends of cables shall be sealed by means of non-hygroscopic sealing material.

1.45.6 Marking

The marking on the drum shall have the following information: -

a) Reference to Indian Standard & cable code.

b) Name of the manufacturer & trade name.

c) Nominal cross section area of conductor for the cables.

d) Number of cores.

e) Sequential No. at each meter.

f) Type of the cable & voltage for which it is suitable.

g) Length of cable on the drum.

h) Approximate gross weight.

i) Net weight of the cable.

j) Drum identification number.

k) P.O. No. and date.

l) Consignee’s name with designation.

m) Year of manufacture.

1.45.7 Drawings & Instruction Manual

The tenderer shall supply the following drawings with the tender: -

Detailed drawing of the cable showing conductor, screening insulation, Armouring, outer sheath etc.

Detailed drawing showing jointing of cable and sealing of end boxes.

Copies of instruction manuals for testing, installation jointing operation and maintenance of cables, shall also be submitted with the offer for reference of the purchaser.

1.45.8 Technical & Guaranteed Particulars

The tenderer shall furnish guaranteed technical particulars as required. Particulars, which are subject to guarantee, shall be clearly marked. Offer not containing this information will not be considered.

1.46 Technical Specification For Low Voltage Feeder / Service Pillars And Street Lighting Pillars

This specification covers the design, engineering, manufacture, testing at works, packing, supply, delivery and storage at site of low voltage outdoor type feeder and lighting pillars for lighting of streets, area lighting with high mast, parking areas landscaped/developed area including all mounting bolts and other accessories required to make the pillars operable for 3 phase, 4-wire, 415 volts, 50 Hz. Neutral grounded distribution system. The pillars shall be complete with links, MCCBs, MCBs, Bus bars, Ammeter with CTs, Voltmeter / indicating lights, MFM & all such other accessories as required, even though specifically not mentioned. High masts shall be provided with dedicated HM feeder pillar.

1.46.1 Standard and System Conditions

1 Standard

The equipment covered in this specification shall conform to the following updated I.E.C. Publications / ISS

Table 1-28: Applicable standard for feeder pillar

Standard Number	Description
IS : 375	Marking and arrangement for switchgear bus-bars, main Connectors and auxiliary wiring.
IS : 589	Basic climatic & Mechanical durability test for components for electronic & electrical equipment.
IS : 1336	Push buttons
IS : 1554	PVC insulated (Heavy duty) electric cables
IS : 2147	Degree of protection provided by enclosure
IS : 3202	Climatic proofing of electric equipment
IS : 4064	Air brake switches, air brake dis-connectors, air break switch disconnectors and fuse combination units for voltages not exceeding 1000V.
IS : 5039 - 1991	Distribution pillars for voltage not exceeding 1000 Volts.
IS : 8623 (Part I-3)	Specification for switchgear & control assemblies.
IS : 8828	Specification for MCBs
IS :3947 (Part-II)	Low voltage switchgear and control gear
IEC 664 A-1980	Insulation co-ordination within low voltage systems including clearance and creepage distance for equipment.
IS : 2551	Danger plate
IS : 0580	Service conditions for electrical equipment
SP : 39-987	Guide for insulation coordination within low voltage systems.

The equipment complying with other internationally accepted standards shall also be considered if they ensure performance equivalent to or superior to Indian Standards.

2 System Details

The distribution system to be provided shall be underground. The electrical sub-transmission system is fed through 11kV CSS. Each distribution transformer in CSS is being fed from 11/0.433 V, delta star transformer, with neutral solidly grounded which feeds a 415 V, LV board. Each LV board feeds a number of feeder/ service pillars of 3 phase, 4 wire, 415 V rating.

3 Climatic Conditions

As per Design Criteria

4 Ambient Conditions for Design

As per Design Criteria

5 Quality of Material

All material used shall be new and of best quality and of class, most suitable for working under the conditions specified herein without distortion or deterioration.

1.46.2 Design and Standardization

1 General

a) The equipment shall be designed to ensure satisfactory operation in which continuity of service is the first consideration and shall also be designed to with stand sudden load variations due to short circuits and fault conditions. The design shall incorporate every reasonable precaution and shall have necessary provision for the safety of all those concerned in the operation and maintenance of the pillars.

b) The mechanism shall be made of such materials as to prevent sluggishness due to rust or corrosion. All connections and contacts shall be of ample section and contact surface for carrying continuously the specified current without undue heating and shall be secured rigidly and locked in position. Standard sizes of stainless bolts, screws, pipes and other fittings are to be used and number of sizes is to be kept to the minimum.

c) Cast Iron shall not be used for any part of the equipment which may be subjected to mechanical stresses.

d) All apparatus shall be so designed and constructed as to obviate the risks of short circuits of the live parts by lizards etc. Metal cubical, housings and covers shall be 100% weather / vermin proof & shall be able to provide the degree of protection IP 45 in accordance with latest version of IS:2147.

e) All parts shall be manufactured in accordance with relevant standard specifications of IEC/IS, corresponding parts of similar equipment and apparatus shall be mutually interchangeable.

f) All apparatus, connection and cabling shall be designed and arranged to minimise the risk of fire and any damage which might be caused in the event of fire.

g) The distribution feeder / service pillars shall be suitable for working outdoor in the conditions given herein. As the feeder / service pillar will be installed normally on footpaths adjoining to the roads, these shall be made robust and capable of withstanding the vibrations normally experienced due to vehicular traffic.

2 Clearance & Creepage Distances

The clearance & creepage distance shall be in accordance with IS: 13947 Part-I updated & corrected for operation under environmental conditions of site.

3 Labels and Marking of Connections / Feeder Pillars

All apparatus, control gear and the apparatus mounted there on shall be clearly labelled indicating, their purpose and the 'ON' 'OFF' and 'EARTH' positions, as applicable. The labels shall be clearly lettered on enamelled surface or other approved materials. Brass should not be used for labels. Each phase of alternating current and connections shall be coloured by heat shrinkable sleeves to distinguish phase, neutral and earth. The colouring shall be red, yellow, blue for phases black for neutral and green for earth. Feeder pillar shall be labelled as per designation shown in the single line diagram. The labelling shall be finalised after the samples and arrangement for the same is approved by the contractor during detailed design/engineering phase.

4 Drawings & Literature

a) Four sets of tentative G.A., schematic drawings and detailed literature of equipment shall be submitted within 120 days after contract award clearly giving the scope of supply and bill of material to enable the Engineer to scrutinise all aspects of design including arrangement and support of cable accessibility for maintenance work and future additions, cable connections, general appearance etc.

b) Further sets of drawings & literature are to be furnished by successful tenderer / bidder within 2 weeks after the award of contract by the Engineer, which shall include the following:

c) Complete assembly drawings of the pillars, showing plan, elevation, typical section, location of terminal blocks for external wiring connections and mounting details of various devices with dimension.

d) Foundation plan showing embedment channel frame in the floor with associated holes and suitable size of bolts for fixing to channel frame of feeder pillars.

e) Wiring diagrams including terminal wiring design and cable schedule.

f) Schematic control diagram for controls, relays, instruments, space heaters, cubicle illumination and receptacle etc.

g) Detailed bill of material of each feeder pillar.

h) Layout plan of feeder pillar.

5 Bought Out Items

All bought out items such as switches, MCCBs, MCB's meters, terminals, cables etc. shall be of reputed make. Engineer reserves the right to accept only materials of proven make at its sole discretion.

1.46.3 Specification of LT Feeder pillars

1 Constructional Details

a) A totally enclosed cubicle shall be fabricated out of Min 1.5 mm single sheet construction of stainless-steel sides brushed grain 400 and mounted on angle iron frame or Aluminum with coating of nonrusting and non-corrosive material. The boards shall be designed Form-2B form of separation. A set of double hinged doors shall be provided on front, to enable installation, maintenance and inspection of cable connection and other equipment inside the cubicle from the front side. Three heavy-duty stainless-steel hinges (not visible from outside) shall be provided per door in such a way so that interior gasketing of the doors shall be continuous. Good quality PU Foam gaskets, weather resistant shall be used. The design shall permit the doors being completely removed when necessary. The doors shall be so fitted as to provide the interior with maximum protection from atmospheric conditions. The doors shall get closed as in case of a steel almirah through a handle so as to have a tight fitted door.

b) The door handles shall be of rectangular shape made out of 12 mm round or equivalent size of flats.

c) A pad lock of suitable size, rust proof, operatable in outdoor humid conditions shall be welded to one of the doors. All the locks on the feeder pillars shall be opened and closed by a single master key.

d) The ammeter, LT CTs, voltmeter, selector switches, MCCB shall be provided on the incoming side of the MCCB on an openable and separate inside the pillar and not on the main door leaves. SCADA compatible Multifunction meter MFM also to be considered at the incomer, the same shall be interfaced with respective substation SCADA. MCCBs shall be provided with OC, SC, EF release and for 3- phase circuit 4P type.

e) The top of the pillar shall have a sloping canopy having necessary slope so that rainwater does not accumulate there. The canopy shall project over the sides of the pillar shell which shall be lower than the top section.

f) The pillar is to be mounted on brick and cement concrete plinth by the roadside and the dimensions should be such that it does not obstruct the normal traffic on the footpath.

g) The lower part i.e. apron should be covered with 3.0 mm sheet on all sides. The sheet covers shall be welded to the frame on three sides except on the front side where it should be bolted so that it can be removed for fixing cables. Ingress of water or any other insects etc. does not take place from this portion as well.

h) The stand shall be made of rust proof angle of 75x35x6mm and shall have adequate height to provide a strong supporting structure to the shell.

i) Suitable ventilation louvers with wire mesh inside shall be provided at the side sections of the shell in a flat frame welded inside so that no object, lizard etc. can enter the pillar through the ventilation louvers.

j) The gland plate shall be of thickness 3.0 mm thick Aluminium & detachable type. All the cable glands shall be chrome plated and double compression type and shall be supplied with the pillar box for the cable sizes given.

k) The bus bars shall be rectangular and of electrolytic aluminium.

l) Phase as well as neutral size shall be suitable for continuous current rating. The bus bars shall be insulated with heat shrinkable tapes with red, yellow, and blue colours for the 3 phases and black for neutral. All bus bar tapping, and markings shall be in accordance with relevant IEC/IS, 374-1963. The bus bar shall be mounted on insulators. The inter-connections between bus bars and MCBs units shall be solid electrolytic Aluminium / strip/Aluminium conductor permanently riveted with the busbar. The connections between outgoing side of MCBs and outgoing cable shall be through an isolating link so as to ensure a physical isolation of outgoing circuit whenever needed. These shall be suitably taped with colours as that of bus bars. Thimbles, nuts & bolts etc., (which must be non-rusting) for the incoming and outgoing cables terminals shall be included & provided with the pillar. Only external cables shall be brought from outside for making connections to the pillars at site. The bus bar joints shall be given a thin coat of conducting grease after fully cleaning both the surfaces. The terminals shall be of substantial mechanical strength & shall provide adequate electrical contact for the cable size used & shall be capable of receiving the size of cable. It will be ensured that necessary contact pressure is maintained permanently.

m) The above arrangement shall be got approved by contractor by designer / client / site engineer prior to fabrication.

2 Outgoing Feeders

Outgoing circuits fed by DP MCB’s of suitable ratings for controlling the outgoing cable circuits from feeder pillar shall be provided. A 4-pole disconnecting link of the rating corresponding to the rating of MCB shall also be provided between the cable connection terminals and MCB. This link shall provide visible disconnection in the case of any maintenance work required to be carried out on the outgoing cable circuit.

3 Earthing

a) The distribution feeder pillar shall be provided with two separate earthing terminals on its casing for copper earthing.

b) The earthing terminals shall be easily accessible and so placed that the earthing connection of the distribution pillars is maintained when the cover or any other moveable part is replaced.

c) The earthing terminals shall be identified by means of proper indelible green sign marks adjacent to the terminals.

d) The feeder pillar shall also have an inside earth bus bar for connecting the cable gland earthing and the armouring to it. The size of the earth bus bar shall be suitable to carry 50 kA for one second. The bus bar shall not be visible or removable from outside the cubical. The earth bus bar shall have necessary holes, nuts & bolts including washers for making earth connection of cable glands / armouring of the incoming / outgoing cables. Mild steel galvanised or otherwise is not acceptable due to harsh environment.

4 Feeder Pillar Lighting & Heating

A lamp holder with a 9 W 11 1200 lumens LED lamp with LU approval and electrical life of 60000 hours operated by an internal PIR Sensor powered by SP-MCB shall be fitted in the canopy of the feeder pillar for internal illumination. In addition, a 3 pin 5A socket shall also be provided with a separate SP-MCB onside of the pillar box. DIN Rail Mountable UL approved touch proof PTC Type Space heater of suitable rating, with hygro-thermostat and SP-MCB shall also be provided inside the pillar near the bottom to avoid any moisture condensation inside the cubicle.

5 Danger Plate

An enamelled sheet steel danger plate of approved design as per IS: 2551 shall be fixed on the left upper front door of the pillar.

6 Painting

a) All sheet steel work shall be phosphatised in accordance with the relevant IEC/IS: 6005 Code of Practice of phosphatizing Nanoceramic coating, electrophoretic dip coating followed by powder coating with C5H painting if required

b) After application of the primer, two coats of finishing synthetic enamel epoxy paint of reputed make shall be applied, each coat followed by stoving. The second finishing coat shall be applied after completion of tests. The colour for the finishing paint shall be light grey as per shade no. 631 of IS:5 or other equivalent standard shade. Each coat of primer and finishing paint shall be with slightly different shade to enable inspection of the painting.

c) The finishing painted surface of pillars shall present aesthetically pleasing appearance free form dents and uneven surface.

d) A small quantity of finishing paint shall be supplied for minor touching up required at site after the installation of the pillars.

1.46.4 Tests

1 Type Tests

The Engineer may ask the manufacture to conduct the following type tests on one of the feeder pillars out of any of the consignment, considering site conditions.

a) Verification of temperature rise limits test.

b) Verification of rain test to determine the degree of protection against rain.

c) Verification of dielectric properties.

d) Necessary type tests as per IS on all the bought-out items such as MCB's, MCCB's etc.

The Engineer, at his option, may waive the above type tests provided type test reports of the above type tests carried out on essentially identical unit in their factory / testing laboratory of repute in India are furnished by the manufacturer.

2 Routine Tests

a) The pillars shall be subjected to high voltage tests described in the relevant ISS. The test voltage to be applied shall be for a period of one minute.

b) Meggar tests with meggar of 500 volts before and after the high voltage test shall be carried out on the feeder pillars and the recorded readings shall be furnished to the Engineer prior to the despatch of feeder pillar.

c) Routine tests, as per SHALL be carried out on the bought-out items viz. MCCB's and MCBs etc.

3 Site Tests

Engineer at its sole discretion reserves to carry out the necessary tests at site to ensure that the equipment is not disturbed / damaged during transportation.

4 Cable Terminations

Incoming and outgoing cables to be terminated in the feeder pillar shall be Aluminium or copper XLPE insulated PVC sheathed armoured / unarmoured.

Horizontal angle iron bars shall be provided with bolted holes so that the cables could be clamped by 'U' bolts of 12 mm diameter, so that no pull is exerted on the terminals due to the weight of the cable. U bolts of necessary size to clamp the cables shall be supplied fitted with nuts & washers, fitted on the bars.

5 Specification for LT Street lighting pillars

The L.T. street lighting service pillars shall be manufactured suitable for outdoor installation and shall have all constructional details, earthing arrangement, danger plate, painting, other features, and tests as specified under various paras above for L.T. feeder / service pillars. The final paint on the street lighting service pillars shall be red. The L.T., street lighting pillars shall have circuits as detailed below:

6 Incoming

One No. 3 phase, 4 wire incoming circuit placed on the left-hand side having 4-pole MCCB of suitable rating complying with IS: 13947-2 as updated with 50-100% adjustable thermal release and & breaking capacity of 50 kA suitable for incoming XLPE Aluminum conductor cable. Incomer shall be provided with MFM. Each MFM shall be SCADA compatible with RS 485 communication port.

7 Outgoing circuits

Adequate Number of Single phase 2 wire outgoing circuits with voltage rating of 240 volts & current rating of 25A having 2 poles, MCB of 16 A rating, suitable for outgoing aluminium cable of size provided.

8 SCADA Controlled Dimmer and Astronomical Switch

The above shall be provided to automatically switch OFF and switch ON the supplies in line with sunrise and sunset with astronomical clock. Further there shall be automatic dimming arrangement with reference to time at night. Also proposed Street lighting feeder pillar and High mast feeder pillar shall be SCADA compatible and shall be monitored and controlled from lighting SCADA to be located at common control room building by another package contractor.

9 LT Moulded Case Circuit Breakers (MCCB'S)

a) The incoming underground cable to the feeder pillar from the LT AC Board in the substation shall be controlled by DRAW OUT, CURRENT LIMITING type moulded case circuit breaker.

b) The moulded case circuit breakers shall be of a robust construction and shall comprise of a switching mechanism, contact system, arc extinguishing device and a tripping unit contained in a compact moulded case and cover. The insulating case and cover shall be made of high strength, heat-resistant and flame-retardant thermo-setting insulating material.

c) The switching mechanism shall be quick-make / quick break type and should be trip-free.

d) The arc extinguishing device shall comprise of a series of grid plates mounted in parallel between supports of insulating material. The arc shall be drawn from the moving contact into the divide chamber and extinguished.

e) The moulded case circuit breakers shall have a thermo-magnetic type tripping mechanism, where the heating effect and the electromagnetic effect of current are made use of to provide protection against overload and short-circuit conditions respectively. The heated-bimetal strip in each phase of the MCCB shall actuate the tripping system following on inverse-time-current characteristics depending upon the severity of the overload. During short-circuits, the system shall trip instantaneously. The tripping element provided on each pole of the MCCB shall operate on a common trip bar, thereby preventing single phasing in the event of fault on any of the phases. The tripping device shall be ambient temperature compensated type.

f) The MCCB shall have a minimum rupturing capacity of 25.8 MVA. Positive indication about the position of the MCCB i.e. whether 'ON', 'OFF' or 'TRIPPED' shall be provided.

g) The short circuit breaking capacity and operating of the MCCB shall be supported by test certificates.

h) The detailed specifications of the MCCBs shall be as under:

i. 3-phase, 4 wire, neutral earthed system

ii.	No. of pole	:	4 Pole
iii.	Service voltage	:	415 volts.
iv.	Normal current	:	Rating shown in SLD.
v.	Frequency	:	50 Hz.
vi.	Short circuit current rating [Ics]	:	36 KA

i) Crimp type cable lugs shall be used on the outgoing side of the MCCBs and the 4-pole links for each of the outgoing feeder.

j) All the MCCBs, used in LT feeder / service / street lighting pillars for controlling the LT feeders shall have a current setting of 50 to 100% of its rated current.

10 Miniature Circuit Breaker (MCB)

a) The outgoing underground feeders / service lines from the LT feeder pillars shall be controlled by MCBs. It shall provide protection against overloads and short circuit.

b) The MCBs shall be of robust construction with insulating case made of self-extinguishing, thermoplastic material. The switching mechanism shall be quick make / quick break.

c) The details specification of the MCBs shall be as under:

i.	No. of poles	4 and 2 poles as required.
ii.	Service voltage	415 / 240 volts
iii.	Normal current	Rating shown in SLD.
iv.	Frequency	50 Hz
v.	Breaking capacity	20 kA (as per clause no. 5.3.4.2 of IS: 8828-1996)

1.46.5 Specific Technical Parameters

1 Low Tension A.C. Feeder Pillar

a) Feeder Pillar Rated Voltage : 3 Phase, 4 wire 415 volts ±10%

b) Rated current at 50oC (A) : as per design.

c) Frequency (Hz) : 50

d) Symmetrical short circuit withstand (kA rms) : 36 current for 1 sec at rated voltage

e) Degree of protection as per IS: 2147 for Outdoor IP: 45

2 Material of Cubical

a) Cubical sheet metal for panel : CRCA, Nanoceramic coating, electrophoretic dip coating followed by powder coating with C5H painting if required.

b) Electrically Aluminium Coated or other non- rusting material except galvanised]

c) Thickness, structural frames and load bearing.

d) members for panel (mm) : 1.5

e) Thickness, front & rear (mm) : 1.5.

f) Thickness sides & top (mm) : 1.5.

g) Size of non-rusting Angle Support frame : 75 mm x 35 mm x 6 mm

h) Painting shade as per IS : 5

i) External surfaces : RAL 7035

j) Internal surfaces : White

3 Minimum clearance air (bus-bars)

a) Between phase : As per relevant Indian Standard

b) Between phase & earth -do-

c) Bus-bar Details L.T. feeder pillar : Electrolytic Aluminium used for bus bar & Construction shall be preferably equivalent to E91 E of BS-2398 with mechanical strength properties approximating closely to that of copper.

Protection against accidental Contact: Heat shrinkable sleeving with requisite dielectric properties leaving no voids or pin holes. Sleeving to be permanent & non removable by hand. Busbars joints and tee off, where possible to be provided with removable shrouds for complete isolation.

d) Temperature rise over design ambient : As per relevant BIS / IEC Temperature of 50°C for continuous current rating deg.

e) Indicating lamps : 240 V

f) Space Heater rated voltage : 240 V

Components

4 MCCB

a) No. of Pole : 4 Pole

b) Rating (A) : As per design

c) Rupturing capacity (kA)-Ics : 36

d) Thermal Tripping range : 50 to 100%

e) Short circuit release : To be fixed for 36 kA

5 MCB

a) No. of Pole : 4/2 Pole

b) Rating (A) : As per design

c) Rupturing capacity (kA) : 20 kA

d) Tripping : Thermal overload

1.47 Technical Specification for Diesel Generator Set

a) The specification covers the design, manufacture, inspection, testing at manufacturer's works/production site, supply & delivery, transportation, installation and testing and commissioning of Diesel Generator set enclosed in an outdoor nonrusting type [acoustic enclosure. It shall be equipped with an “Auto Mains Failure” panel along with AC distribution panel for the Project as detailed in the schedule of requirement. The complete supply shall also include the necessary civil works, plumbing, cabling, and other electrical works as required at site for each set. The set shall be interfaced with respective substation SCADA.

b) The contractor is required to quote for the complete Diesel Generator Sets in line with the specified requirement.

c) The DG Set and its control panel, switch board etc. shall be all unattended i.e, it shall be an unattended station. However, periodically the operator may access the equipment. Therefore, the equipment must be HIGHLY RELIABLE, and contractor must give sufficient proof of reliability in this regard.

d) The scope of supply shall include all parts, accessories, etc. which are necessary for construction, operation, and maintenance of complete equipment even though these are not individually and specifically started or enumerated. Corresponding parts of all the equipment and spares shall be of the same material, dimensions, workmanship, and finish and shall be interchangeable. All the materials and workmanship shall be of suitable quality having been used in similar services and under similar conditions.

1.47.1 Qualifying Requirements

Once a DG set is planned and proposed in the bid, the contractor shall provide to Engineer a list of customers in India where the DG set supplier has installed or provided similar DG sets.

1.47.2 System Details

DG Set is required as a standby source of Power Supply to meet the essential load requirements of the project in case of the power failure. The load consists of light & power for Substation, utility areas, street lighting etc.

1.47.3 Site Conditions:

As per CSS or transformer rating the DG set rating shall correspond to operation at 50ºC.

1.47.4 Standards

All materials and equipment shall comply with all the applicable provisions of the latest revision of Indian Standards, Indian Electricity Rules and other applicable statutory provisions, rules, and regulations. Where no Indian Standards are available, the material and equipment shall comply with all applicable provisions of the latest revisions of the relevant International Standards and regulations. Some of the Standards (latest shall be applicable) to the specification are given below;

Table 1-29: List of applicable standard Diesel generator set.

Standard number	Description
IS : 1248	Direct acting indicating analogue electrical measuring instruments and their accessories.
IS : 1554	PVC insulated (heavy duty) electrical cables for working voltages up to and including 1100 V
IS : 1651	Stationary cells and batteries, lead acid type
IS : 2147	Degree of protection provided by enclosures for low voltage switchgear and control gear.
IS : 2705	Current Transformers
IS : 3043	Code of practice for earthing
IS : 3231	Electric relays for power system protection
IS : 4722	Rotating electrical machines
IS : 8623	Low voltage switchgear and control gear assemblies

IS : 10002	Performance requirements for constraint speed compression ignitions (diesel) engine for general purposes (above 20 KW)
IS : 10118	Code of practice for selection, installation and maintenance of switchgear and control gear
IS : 13703	Low voltage fuses for voltage not exceeding 1100 V AC or 1500 V DC Pt-2/Sec-1
IS : 13947	Low voltage switchgear and control gear
BS : 159	Bus bars and Bus bar connections
BS : 5514	Diesel Engines for general purposes.

The appropriate standards applicable shall be clearly stated and the salient points of difference between the standards adopted and the Standards listed above shall be clearly brought out in the bid.

1.47.5 Technical Details of Diesel Engine

1 Type & rating

The diesel engine shall be stationary type, four stroke with vertical in line or “V” type cylinder arrangement, turbo charged, water cooled. The continuous engine BHP rating at the specified site conditions (refer design Basis) shall be 5% greater than the drive horsepower required for rated output from alternator after allowing for derating due to power consumption for the auxiliaries of the engine. The deration due to site conditions shall be considered by the contractor as per relevant standard. The contractor shall furnish the calculations for selection of capacity of engine after derationing and shall also furnish the details of power consumed by each auxiliary of engine.

2 Overload capacity & reliability

The diesel engine is required to run an alternator directly coupled to the engine. The alternator shall provide the A.C supply in case of failure of Normal Supply. Hence it should be capable of quick starting and taking the full load all of a sudden, notwithstanding the fact that engine was at rest for a very long time under complete cold conditions. The engine shall also be capable of satisfactorily driving the alternator at 10% overload at rated speed for one hour in any period of 12 hours of continuous running. The material of component parts of the engine shall ensure a long service life and highest reliability of operation.

3 Short time capability

The diesel generator shall be capable of supplying the starting current of induction motor (water pump motors, fridges, air conditioners etc.) connected to the control board. The diesel generator shall also be capable of short time overload of at least 1.5 times the rated capacity for 15 seconds.

4 Rated Speed

The engine shall be of low speed and the rated speed shall not exceed 1500 rpm.

5 Engine Starting

a) The engine starting shall be electrical by self-starting device. The source of starting supply shall be 24 volts maintenance free Ni-Cd batteries along with built in float & boost charger which are to be supplied, installed, and commissioned by the contractor. The cranking device shall be so designed that engine starts automatically, reaches the rated speed within 30 seconds from the instant of receiving a starting impulse in case of failure of normal supply. Engine starting shall be through “Auto Mains Failure” (AMF) panel.

b) The fuel oil system and lubricating oil system shall also start simultaneously and automatically as soon as the staring impulse is received, to obviate any chance of seizure of piston and bearing as well as air locking in the fuel supply system.

c) Engine shall be supplied with DC starter of suitable rating, 24 V, Ni-Cd, high discharge performance; sealed type maintenance free batteries of suitable ampere hour capacity & reputed make complete with supporting racks & connecting leads with connectors will be included in the offer. The float charger to keep the battery floating and boost charger for charging the battery will also be included in the scope of supply. For ascertaining the battery voltage, digital voltmeter shall also be provided along with digital Ampere meter for current monitoring.

6 Engine Governor

The engine shall be equipped with electronic governor in order to take care of heavy-duty motor starting and it shall be capable of adjusting the delivery of fuel in response to variation in the load in order to maintain the speed substantially constant. Frequency shall not vary more than 1% under conditions of generator load from 0% to 100%.

7 Speed Regulation

a) The speed regulation shall not be more than the following:

b) On suddenly taking off the rated load

i.	Temporary speed regulation	Not more than 15%
ii.	Steady speed regulation	Not more than 5%
iii.	Maximum recovery time	Not more than 8 sec.

c) On suddenly taking in the 70% of the rated load

i.	Temporary speed regulation	Not more than 10%
ii.	Maximum recovery time	Not more than 8 sec.

8 Fly wheel

The speed drop shall be adjustable during operation from 0 to 5%. The engine shall have suitable balanced fly wheel of cast iron to smoothen the transient load variation.

9 Air Intake system

The diesel engine shall be provided with oil bath type air filters having low resistance to air passage, high dust retaining efficiency and provision for easy cleaning. Filters shall be suitable for achieving satisfactory engine operation under tropical humid conditions with sulphur dioxide and trioxide fumes, abrasive dust of 5 to 100 microns present in the atmosphere.

10 Fuel oil system

The engine shall be provided with fuel oil system suitable for high-speed diesel oil marketed by Indian Oil Corporation or any other reputed oil company in India and should have workable and replaceable type primary and secondary fuel filters, injection equipment delivering correct quantity of fuel oil to the cylinders as needed by load. The fuel injection system shall be designated to permit manual adjustment of individual cylinder loading so that the vibration of exhaust, temperature and firing pressure shall be within the acceptable limits as recommended by the engine manufacturer.

11 Fuel oil tank

The engine shall be provided with fuel oil service tank with a capacity of not less than that required for 10 hours continuous full load operation of engine and it shall be provided on a suitable fabricated nonrusting steel platform. The tank shall be complete with level indicator marked in litters, filling inlet with removable screen, a drainage plug, an air vent and necessary piping and valves. The tank and all piping shall be painted both from inside as well as outside.

12 Lubricating System

a) The engine shall be provided with an integrated lubricating system with electric/engine driven lub, oil pump for feeding oil circulation during normal operation. It should also be equipped, if required with D.C. electric priming pump for lub, oil circulation during automatic starting and coasting down period after receiving the starting/stopping impulse. The engine lub, oil system shall be suitable to lubricate the required working parts of the engine effectively with recommended grade of oil marketed by the Indian oil Corporation or any other Indian Oil company under the climatic conditions as referred to above.

b) The necessary lub. Oil filters and coolers shall also be supplied. The lub. Oil system shall have adequate capacity of oil pumps fitted with arrangement for adding and draining oil to and from the system with necessary lub. Oil pressure sensing device, which shall cut off fuel supply to the engine as soon as the lub, oil pressure falls below the recommended level. The sensing device shall also act as soon as oil inlet and outlet temperatures of beyond the normal ratings.

c) The engine shall be fitted with primary and secondary lub, oil filtering arrangements with replaceable type lub, oil filtering elements. The lub, oil filters shall be suitable for a period of more than 500 hours of use without the necessity of its replacement or cleaning.

d) Differential pressure gauge across the filters or pressure gauge on either side of the filters may be provided to monitor the cleanliness of filters for lub. Oil as well as fuel oil filters.

13 Cooling system

The engine shall be air/water cooled type with two section radiators. One of them shall be used for jacket water and turbo charger. The other shall be used for air cooler and lubricating oil cooler. Forced water circulation by means of a pump, driven by engine shaft shall be provided. The filtered water shall be circulated through engine block, cylinder head, water manifold, lub. oil coolers and radiator to restrict rise of temperature. Radiator fans operated by diesel engine shall be provided for cooling of radiators.

14 Turbo Charger

It shall be robust construction suitable of being driven by engine exhaust having a common shaft for turbine and blower. It shall draw air from oil-bath type with adequate capacity to suit engine requirements.

15 Exhaust system

The exhaust gases of turbo-charged shall be taken out above the engine through piping adopter etc. the engine shall be provided with an exhaust manifold in sections, suitable flanges, expansion joints with least bends and drain plug. The route of exhaust is discharged into atmosphere on top of the DG room avoiding the surrounding equipment being directly in front of it.

16 Environmental pollution control measures

It shall be the responsibility of the contractor to supply the DG set which shall comply with the statutory government regulations relating to environmental pollution control relating to exhaust emissions, cooling water etc.

17 Quietness of operation

The engine shall be designed to achieve maximum quietness of operation. The efficient silencer shall be provided for the exhaust as well as air intake. The noise level of DG set shall not exceed the permissible limits as per state authorities. The contractor shall furnish the maximum noise level at 110% load of the engine. Necessary means shall be adopted to minimize the vibration level during operation.

18 Engine warming:

Arrangement has to be provided to supply the hot water up to a temperature of 60 deg. C to 70 deg. C into the engine jacket and oil coolers of the engine for keeping it sufficiently warm for the purpose of quick starting of the engine under cold condition.

19 Piping, valves, and fittings

The engine shall be supplied with all piping, valves and fittings for fuel oil, lubricating oil, air inlet and engine exhaust system along with expansion joints, drain plugs, flanges, and all other accessories. All pipes shall be painted.

20 Foundation bolts

The foundation bolts of stainless steel for engine and alternator shall be supplied along with the machine. Base frames, where necessary for equipment is also to be supplied along with the machine.

21 Instruments

The instruments to be supplied by the contractor shall include but shall not limited to the following:

22 Digital thermometers for measuring

a) Lubricating oil temperature at bearing outlet

b) Lubricating oil temperature at oil cooler outlet

c) Jacket water temperature at bearing outlet

d) Jacket water temperature at cylinder outlet

e) Jacket water temperature at radiator outlet

f) Jacket water temperature at oil cooler outlet

23 Pressure gauge

a) At lubricating oil cooler outlet

b) At jacket water inlet to cylinder

c) On discharge of all auxiliary pumps provided with the engine

d) Differential pressure gauge across the lubricating oil and fuel oil filters or separate pressure gauges on either side of the filters.

24 Pressure switches

For automatic starting of the DG motor driven stand—by lub. oil pump on low lubricating oil pressure

On the lubricating oil system to give an alarm if pressure falls below a pre-set value and subsequently trip the engine when the safe limit has been exceeded.

25 Thermostats

At the lubricating oil outlet from engine bearing for alarm as the temperature rises above pre-set and subsequently trip the engine when the safe limit has been exceeded. For this contractor shall furnish the details of the interlocks.

26 Tachometer

Primary sensing devices-control valves etc. for

a) Lubricating oil temperature and pressure

b) Fuel oil pressure

c) Engine jacket water temperature

d) Fuel oil service tank low level

e) Lubricating oil low level

f) Items of Guarantee Performance:

The following items shall be guaranteed by the tenderer in respect of diesel engine set and auxiliaries when operating under specified site conditions.

g) Net electrical output at site conditions specified.

h) Fuel oil consumption at ½, ¾, full load and 10% overload, as specified

i) Lubricating oil consumption at full load

j) Jacket water temperature to and from engine

k) Lubricating oil temperature to and from engine

l) 10% overload for one hour without over-heating and showing signs of undue stresses within specified frequency variation during any time within 12 hours of continuous running.

m) Freedom from vibration and noise as specified

n) Governor response, over speed trip and over speed capacity.

o) The extra fuel oil consumption at 10% overload.

Contractor shall also state the codes and standards according to which tolerances on the performance will be applicable.

1.47.6 Technical Details of Generator

1 Type & rating

a)	Generator continuous output (net) rating	:	As per design calculation
b)	Power factor	:	0.8 lagging
c)	Overload capability for operations	:	a) 50% for 15 seconds of Continuous
d)			b) 10% for one hour in 12 hours
e)	Rated voltage	:	415 V
f)	Rated frequency	:	50 HZ
g)	Number of phases	:	3

2 Type of insulation

a)	Armature winding	Class F	(Temp. rise limited
b)	Field winding	Class F	to Class B
c)	Connections	Class F	Insulation)
d)	Core connections	Class F	

3 Type of enclosures

Screen protected preferably totally enclosed.

4 Grounding method

Neutral solidly grounded

a) The transient reactance shall be as low as possible consistent with the need to limit voltage drop on sudden application of load.

b) The generator set shall be so designed that it is capable of taking full load instantaneously. All parts of the generator shall be designed to withstand all electrical, mechanical, and other stresses which may be experienced during operation, including short-circuit and over speed conditions.

c) The generator shall withstand an over speed of 20% and a critical speed which is not less than over speed in an emergency condition without incurring any mechanical damage. The rotor shall remain in electrical balance for all speeds up to 120% of rated speed.

d) The alternator shall be self-excited and automatic regulated type.

e) The alternator shall be having ball and roller bearings on the end shields.

5 Excitation system

The excitation system shall be electronic type exciter having excellent response characteristics. The excitation transformer of suitable rating shall be included for static excitation equipment. The brushes type excitation system may also be offered as an alternative, which shall be preferred.

6 Voltage Regulation

An automatic electronic type of Voltage regulator [AVR] shall be supplied complete with cross current compensation. The regulator shall be supplied complete with voltage adjusting rheostat, CTs for compensation and all accessories for successful operation including mounting and wiring, AVR shall be capable of maintaining 95% to 105% of the rated voltage under condition of rated capacity and power factor. AVR shall be fully encapsulated to give protection against moisture, sand, salt, and vibration.

7 Terminal Arrangement

The line and neutral side of each phase winding of the generator shall be brought out on six terminals located on terminal box mounted on the generator. Formation of star point and earthing of neutral lead for the alternator shall be carried out after mounting the CTs for protection. Two nos. diametrically opposite grounding terminals with suitable clamps shall be provided on the generator.

a) Terminal Box and Connection

b) The alternator output terminals shall be enclosed in a terminal box mounted in an accessible position on the alternator frame. Cable glands and lugs shall be provided for all power and control cables which have to be terminated on the equipment supplied under this package. The connection for the AC and DC circuits shall be segregated from each other.

c) Suitably rated 240 volts single phase, thermostatically controlled space heaters shall be provided on the lower part of the stator frame. The connections of the space heaters shall be brought out to a separate terminal box. When the generator is running, the space heaters shall be automatically cut off and put on when the generator is in idle position. An isolating switch shall be provided in the heater circuit.

d) Control Equipment: Auto Mains Failure (AMF) Control Panel

e) The control equipment for the DG set shall be designed to automatically start and switch ON the DG set to the connected load in case of mains supply failure and to switch it 'OFF' as soon as the mains supply is restored back.

f) Even if mains AC supply is available, it shall be possible to automatically start/stop the diesel set by push button control from the panel to test the set.

g) In interconnecting mode of power supply, where AC supply form the outside source is available the diesel generator set will normally be at rest. On failure of normal AC supply as sensed by the under-voltage relay, the starting circuit of the Diesel Generator set will be automatically energised and all the sequences involved in the complete start-up of the diesel generator set, bringing it to the rated speed and voltage shall take place automatically without the help of any operator. The contractor shall provide all the necessary control & switchgear equipment required for the purpose of automatic starting of diesel generator set involving various stages of generation in the engine auxiliary systems.

h) The diesel generator set shall be designed to reach its rated speed and voltage within a period not exceeding 30 sec. The voltage and frequency relays for the purpose shall be included in the scope of supply of contractor. The diesel switchboard/control panel complete with electrically operated air circuit breaker rated for 650 V, 800 A continuous current and 35 KA rupturing current of suitable rating along with adjustable thermal and short circuit protective devices, for the incoming feeder and MCB/MCCBs for the outgoing feeders, current transformers, protective relays for protection of diesel generator, ammeters, voltmeter, frequency meter, indicating lamps, annunciator relays, selector switch for selection of auto/manual control etc. shall be included in the scope of supply. MFM may be provided for various measurements.

i) In the existing switchgear mains 3 – phase, 415 V supply bus bars, are fed from a dedicated 11 kV/415 V transformer. It has outgoing 3 phases, 4 wire feeders and single phase, 2 wire feeders. In case of mains failure, it is proposed to feed the loads of these three phases and single-phase feeders from the DG set. Besides it the provision of four three phase and four single phase spare feeders shall also be provided. Four 3-phase feeders shall have MCCB, and the rest shall have MCB's of rating up to 63A TPN/SPN. The DG set along with its supply board panel shall be located near to the existing mains switchboard. The successful contractor shall provide the necessary interconnection by ACB / MCCB's during detailed engineering.

j) On restoration of Mains A.C. supply from the source of normal supply stopping impulse will be given to trip the diesel generator automatically.

k) It shall also be possible to start/stop the DG set manually through local push button [from remote on SCADA] provided on control panel. Auto-manual selector switch and local/remote selector switch for the purpose shall be mounted on the control panel.

l) A three-attempt starting facility for the engine shall be provided in the automatic mode and in case the diesel engine fails to start and reach its rated speed within 30 seconds, it shall be disconnected and locked out automatically. Provision of remote alarm and other signals shall be provided at remote.

m) The diesel generator set shall be tripped under the following abnormal conditions:

i. DC control supply failure.

ii. Over speed of diesel engine sensed by tachometer and/or mechanical over speed device.

iii. Low lubricating oil pressure after engine has attained 90% speed.

iv. High jacket water temperature

v. Generator fault

n) For the abnormal conditions mentioned above, an alarm shall also be given at remote.

o) The contractor shall provide all the sensing devices on the diesel set and necessary relays on the control panel to achieve the above tripping conditions. These devices shall be suitable for operation on 24 volts DC supply. The DC supply will be made available at the control panel by the contractor from the battery provided.

p) Window type annunciator shall be provided on control panel to give visual indication of any one or more of the following abnormal conditions. One more potential free contact of each of the alarm conditions listed in this clause shall be provided and if required wired out for getting alarm on for SCADA.

i. Trip Alarms

ii. High jacket water temperature

iii. Lubricating oil pressure

iv. Loss of 24 Volts DC control supply

v. Engine over-speed

vi. Generator fault

vii. Failure to start the engine

viii. Over voltage

ix. Non-trip Alarms

x. Lubricating oil tank level low

xi. Sub-Fuel oil tank low

xii. Fuel oil tank level low

xiii. Excitation failure

xiv. Spare windows (4 nos.)

q) The annunciator panel shall be modular in construction complete with visual indication. The panel shall be suitable for working on 24-volt DC supply. The initiating contacts shall be potential free. The annunciator circuit shall be provided with common accept and rest push buttons and test facility if required.

r) On occurrence of fault the appropriate window shall light up. The visual indication shall, however, persist until the relevant fault contact has been reset after which the visual indication can be reset by the “RESET” push button.

s) After acknowledgment of one fault by the “acknowledge” push button, the alarm circuit shall be ready to operate for another fault.

t) The control panel shall be of fabricated construction made of best quality stainless sheet steel of minimum thickness of 2.5 mm and shall be free standing floor mounting type. The panel shall be totally enclosed, completely dust-tight and vermin proof. Gaskets shall be provided between all openings and joints. The control panels shall be of folded construction compact neat and provided with double door with locking arrangement at the back. The control panel shall be epoxy painted and with the finished colour of the panel shall be light grey paint as per share 631 of IS: 5.

u) All cable entries shall be from bottom. Separate cable chamber suitable for XLPE cables per phase and XLPE cable for neutral shall be provided in the control panel with cable termination facilities complete with cable glands, lugs, etc. for all incoming and outgoing cables. Enough space shall be provided in the control panel for easy access during maintenance and repairs. The contractor shall also furnish a clear-cut drawing of cable connections. The size of cable shall be approved during detailed engineering.

v) The control panel shall be provided with 2 nos. earth terminals with accessories for connection to the earthing mat. The copper earth strip connecting the earth terminals to earth mat shall be supplied by the contractor and size of this earth strip shall be subject to Engineer’s approval.

w) Degree of protection of control panel shall be minimum IP 54. The contractor shall furnish test certificates for similar panel conforming to IP 54 with the offer.

x) Flush mounted digital instruments conforming to industrial grade “A” as specified in IS: 1248 shall be provided. The indicating instruments shall be of 96x96 mm size. They shall have accuracy class of 1.5 or better. Case of the instruments shall be dust and moisture proof.

y) Indicating lamps shall be panel mounted, LED type and of low watt consumption. The cap of lamp indicating shall preferably be of screw type and made of unbreakable & heat resistant moulded material.

z) All the wiring of control panel shall be carried out with 1100 volts grade PVC insulated stranded (48) coper wire of cross section not less than 2.5 sq.mm. The wiring shall be identified at both ends by means of V plastic ferrules. Suitable internal lights shall be provided along with control switch.

aa) Control switches and push buttons shall also be flush mounted on the front of the control panels.

bb) The panel shall contain or shall have mounted on it the automatic voltage regulator, field breaker and field discharge resistor with associated control switches and indicating lamps, or this may be provided in a separate matching cubicle to be mounted alongside of the control panel.

cc) The control panel shall also be provided with but not limited to the following accessories.

dd) 1 No. 650 V, (rating as per calculation) draw out type, spring charged, electrically operated air circuit breaker/contractor for incoming circuit from Diesel set with adjustable thermal and instantaneous trip units, electrically operated complete with necessary relays, switches indicating lamps etc. The bidder shall quote consider both the options.

i. 1 no. digital AC ammeter of suitable range with three-line arrangement without selector switch.

ii. 1 no. digital AC voltmeter of suitable range without selector switch

iii. 1 no. multifunction meter to read 3 phase power, maximum demand, energy, PF, and other parameters.

iv. 1 no. Tachometer

v. 1 no. digital frequency meter

vi. 1 no. counter to indicate number of times the DG set has been operated.

vii. Red lamp for diesel generator breaker in closed position

viii. Green lamp for diesel generator breaker in open position

ix. White lamp for diesel generator breaker in spring charged position

x. DC ammeter and DC voltmeter for diesel generator field circuit / battery charger

xi. Battery charger of adequate rating

xii. 1 no. local / remote / test selector switch with status indication

xiii. 1 no. auto OFF-MANUAL Selector switch with status indication

xiv. Voltage and frequency sensing relay

xv. Over speed, speed & under speed relay

xvi. Protection relays for the alternator

xvii. Battery ON/ OFF switch

xviii. Alarm annunciator with provision for remote annunciation

xix. Lamps for 24 V DC ON/ OFF

xx. Start, stop, push buttons

xxi. Emergency stop switch

xxii. Alarm accepts, reset, test push buttons

xxiii. Lamp test push button

xxiv. Automatic voltage regulator

xxv. Other components such as contactors, timers, auxiliary relays, fuses etc. required as per approved schemes.

xxvi. Provision for remote indication of Diesel Generator Circuit Breaker ON/ OFF/ Auto trip

MCBs/ MCCBs with ON/ OFF indications for outgoing feeders. (The details shall be given during detailed engineering). The incomer MCCB, shall be of rating with provision for setting the range.

8 Protection of Alternator

The control panel shall also contain all protective and auxiliary relays for electrical protections / metering recommend by the supplier for the alternator including (but not limited to) the following digital relays: -

i. Over current & E/F protection

ii. Restricted Earth Fault protection

iii. Reverse power protection

iv. Over-voltage protection

v. These shall be SCADA compatible.

The protective devices shall be selectively coordinated so that sufficient time is given to the immediate protective device to clear the fault before the operation of back-up protection. All relays shall be suitable for the type of protection required and the contractor shall replace the relay at a later date without any extra charges if found unsuitable for this type of application.

The contractor shall furnish complete protection scheme indicating CT parameters, setting range, type of relays for each protection specified above as called for in schedule of guaranteed and other technical particulars, non-compliance of which may be sufficient reason to reject the bid. The protection provided including CT parameters and relay, shall be subject to the Engineer’s approval.

9 Co-ordination of Protection

Complete protection schemes and curves demonstrating the selective coordination of the protective elements and recommended relay settings for each type of protection with operating characteristics shall be furnished by the contractor for approval. It shall be the responsibility of the contractor to provide adequate protection to the alternator / equipment connected to it. This aspect shall be clearly confirmed by the contractor in his offer.

10 Relays General Requirement

The relays shall be of reputed make and type which shall be subject to Engineer’s approval. The relay shall be enclosed in a flush or semi-flush, dust-tight, draw out case finish with dull black enamel paint. Relays shall have self-contained test facilities and provision for removing relay mechanism for inspection and maintenance. The relays shall be self-reset type, tropicalized and have silver contacts with a wiping action. The relay contacts shall be capable of making, carrying, and breaking currents of associate circuit. All necessary provisions for easy testing of relays shall be incorporated and specifically brought out in the bid. Suitable devices shall be provided along with an easily accessible resetting device.

1.47.7 Circuit Breakers

1 Air Circuit Breakers

a) The Air Circuit Breakers if provided shall be preferably draw out type, suitable for automatic, remote electrical, local electrical as well as manual operation.

b) The circuit breakers shall have the following ratings:

i.	No. of Poles	:	4
ii.	Nominal voltage	:	650 volts
iii.	Service voltage	:	415 volts
iv.	Continuous current	:	As required
v.	Frequency	:	50 C/S
vi.	Breaking current capacity [Ics]	:	35 KA
vii.	Short time current rating	:	35 KA for 1 sec.
viii.	Making capacity	:	87.5 KA
ix.	Operating duty	:	0-0.3 sec.- CO-3 Sec-CO
	Nominal control circuit voltage for closing		
	Oil, Auxiliary devices, relays etc.	:	24 V DC
	Nominal control circuit voltage for trip coil:		70-110% rated control circuit voltage

c) The closing of the circuit breakers if provided shall be affected by a compression spring automatically charged after each closing operation by an electric motor. The electric motors shall be suitable for 240 V, AC. The motor shall be able to charge the spring from fully changed condition in not more than 5 seconds. The spring once fully charged shall be capable for trip, close and trip operation successfully. It shall be possible to charge the spring manually with manual handle. A position indicator shall be provided on the respective based serving the condition of spring.

d) The circuit breaker shall be provided with adjustable temperature compensated thermal overload and instantaneous over current tripping device with setting to suit full load to 40% of the current of the individual circuit. The circuit breaker shall be tripping free type and shall be provided with anti-pumping device. The closing coil and other auxiliary devices shall operate satisfactorily at all voltage between 70 – 110% of the rated control voltage. The circuit breaker shall be provided with “ON” “OFF” “AUTO TRIP”, Trip circuit healthy and spring charged indicating lamps. Sufficient number of auxiliary contacts for interlocking, alarms and annunciation on the DG control panel and remote panel shall be provided. Lockable Auto / Manual and local/ remote selector switches for selection of circuit breaker control point shall be provided on the panel.

e) The provision for following controls, indicator, instrumentation, and annunciation on the remote panel for each circuit breaker shall be made.

i. Close / Open push button
ii. ON / OFF Auto trip indicating lamps
iii. Trip circuit supervision lamps
iv. Breaker trip alarm & Indication.

2 Moulded Case Circuit Breakers (MCCB)

MCCBs shall be draw out type provided with on/off indication and thermal overload & short-circuit releases. It should be possible to set the overload, setting between 70 to 100% rating.

MCCBs shall be plug in type and shall be suitable for manual operation. The circuit breaker shall have the following rating.

a)	No. of pole	:	4
b)	Nominal voltage	:	650 volts
c)	Service voltage	:	415 volts
d)	Continuous current	:	To be indicated during detailed engineering
e)	Breaking current capacity	:	35 KA
f)	Short time current rating	:	35 KA for 1 sec.

3 Current Transformers

All CTs shall be of reputed make and type which shall be subject to Engineer 's approval. The CTs shall be dry cast resin type suitable for indoor mounting. The CTs shall have suitable short time current rating, rated transformation ratio and adequate VA burden output to suit the connected relays/instruments. The CTs for restricted earth fault protection shall of PS accuracy class and shall have knee point voltage, secondary resistance, and excitation current value to suit the protection. Typically, the CTs for other protection shall have 15 VA, 5P10 rating. The CTs for metering shall be of accuracy class 1.0 rated VA output not less than 5 VA. All, the current transformers shall conform to the requirements of latest issue of IS: 2705 (Part I to IV).

4 Voltage Transformers

The voltage transformers shall conform to the requirements of IS: 3156/IEC 186. Voltage transformer shall be dry cast resin type suitable for indoor mounting. The potential transformer shall be single phase type and shall be suitably connected for form the specified winding connection.

The technical particulars of voltage transformer are as below:

a)	Rated primary voltage	: 415 volts
b)	Rated secondary voltage	: 110/√ 3 volts
c)	Winding connection	: STAR/STAR

d) Frequency : 50 HZ

e) Accuracy class : 1 for metering 3P for protection

One minute power frequency withstands test voltage

f) Primary winding : 3 KV

g) Secondary winding : 3 KV

5 D.C. Control Supply

For control, protection, and indication, 24 V maintenance free type battery of suitable capacity, along with float charger and boost charger shall be included in the scope of offer. The step-down transformer to step down single phase/three phase 415V/240 V A.C. supply for float charger and boost charger circuits shall be included in the scope of offer.

6 Cabling

a) All the power and control cables for connection between Diesel Generator and its control panel/switch board shall be included in the scope of the tenderer. Necessary accessories such as crimping lugs, compression glands etc.is included in the scope of supply of tenderer.

b) All the power cables shall be single core/3 core (with neutral conductor wherever applicable), XLPE, insulated AL conductor and shall be of suitable size to carry continuous, overload and short circuit currents. The cable size shall be subject to approval of the Engineer. The cables shall conform to IS 1554. All control cabling shall be done with 1100 volts grade PVC insulated XLPE cable with copper conductor of cross section not less than 2.5 sq.mm.

c) The cables shall be subjected to routine tests, type tests and acceptance tests as per IS: 1554 Part – I and test reports for the same shall be furnished for approval.

i. Test reports for tests conducted on similar type of cables shall be furnished with the bid.

ii. To ward off the incidence of fire the cables shall be FRLS type

7 Soundproof Acoustic Enclosure

To reduce noise pollution, the DG set should be enclosed in a soundproof acoustic enclosure. This enclosure should be made out of cold rolled stainless steel or other non-rusting type material and epoxy painted.

It should consist of a suitable designed ventilation system, high quality acoustic insulation material as per IS-8183 which should withstand the internal temperature. The noise level should not exceed 70 dB (A) [or lower to meet statutory requirements] at a distance of 3 m.

8 Earthing

The alternator neutral shall be brought out as per of the specification and shall be earthed solidly. Proper earthing for alternator frame, diesel engine frame, diesel generator control panel, shall also be done by the contractor by suitable size of copper flat as per I.E. rules and relevant Indian Standards. The size and material of earthing strip shall be subject to Engineer's approval.

9 Testing and Inspection

Diesel engine, alternator, control and switchgear panels, DG board, AVR battery, circuit breaker, battery and battery chargers, cables, instruments, busbars, relays, CTs, contactors and all accessories etc. shall be subject to routine, type and acceptance tests in accordance with the requirements of the latest issue of relevant Indian Standards in the presence of Engineer. The contractor shall clearly state the testing facilities available at his works for testing the complete equipment with all fittings and accessories offered.

Each complete wired control panel and board shall be tested to ensure that all its protective, control interlock systems are satisfactorily functioning as per requirements. Test certificates for functional tests shall be furnished to the Engineer.

The tests to be carried out on diesel generator set shall include (but not limited to) the following:

10 Diesel engine

a) Power output at full throttle on auto governor.

b) RPM, torque, fuel rate, fuel pressure, lubricating oil pressure, intake manifold pressure blow by exhaust temperature and smoke checks.

c) Performance parameters measurements at full load, half load, ¾ load and ¼ load shall be noted.

d) RPM and lubricating oil pressure at high idle and low idle shall be noted.

e) Engine washing for leakage check

f) Performance parameters at 10% overload

g) Calculations for horsepower and efficiency at full load, ½ load, ¾ load, ¼ load and 10% overload shall be furnished.

h) Time from initiation of start command to rated speed shall be noted.

11 Alternator

a) Phase sequence and polarity marking tests

b) Check of direction of rotation

c) Insulation resistance measurement both before and after high voltage tests

12 Vibration test

a) Measurement of resistance of field winding, main armature winding, space heaters etc. and leakage reactance measurement.

b) Open circuit test

c) Short circuit test

13 Temperature rise test and 50% overload test for 15 seconds after temperature rise tests

a) High voltage tests

b) Wave form test

c) 120% over speed

d) Momentary overload test

e) Regulation test

f) Efficiency test

g) Exciter

h) Nominal exciter response test

i) Load characteristic measurements

j) Momentary overload

k) Temperature rise test

l) High voltage test

m) Measurement resistance

n) Measurement of insulation resistance

o) Regulation and efficiency tests

p) Voltage regulator

q) Response time tests

r) Sensitivity tests

s) Control panel/board

t) Physical dimension check

u) Verification of apparatus

v) Control wiring verification

w) A.C. and D.C. wiring check

x) Functional tests

y) High voltage tests

z) Insulation resistance (Megger) test

14 Tests on completely assembled DG set

a) Functional checks for local, manual, auto start, stop, speed and voltage control

b) Tests to check the starting time from completely cold conditions

c) Vibration and noise tests

d) One hour at full load, one hour at ¾ load running

e) Four hours at full load followed by one-hour continuous load of 110%

f) Fuel consumption tests at efficient load

g) Automatic starting and interlocks checks

h) Governor response

i) Over-speed test and over-speed trip test

15 Site tests

a) Tests to prove the guaranteed performance of the diesel generating set shall be carried out at site after proper installation.

b) The Contractor shall give fifteen (15) days' notice for readiness for inspection and testing so that the Site Engineer/ Client representative may be deputed to witness the tests. Before the notice of testing, the contractor shall furnish the schedule of tests with procedure which shall be followed during the testing.

c) Six copies of the test reports, duly signed by the Engineer who have witnessed the tests, shall be furnished for approval. No material shall be despatched to site without taking Engineer's approval. Should the inspection be waived off by the Engineer, such waiver shall be not relieving the contractor, in any manner, from his entire obligation under the contract.

d) All requisite testing meters, instruments, and equipment for carrying out the site tests shall be arranged by the Contractor.

e) Should be results of any test indicate any defect, the contractor shall rectify these at his own cost and retest shall be done till satisfactory results are obtained. Should the equipment ultimately fail to pass the specified tests, the Engineer shall have the right to reject the material.

16 Operation and Maintenance Manuals

a) Operation and maintenance manuals in respect of Diesel Generator set shall contain the following information.

b) Technical details of the diesel engine such as ratings, construction, governor, fuel oil system, lubricating oil system, cooling water system, starting system, air system (after cooler turbo-charged etc.) exhaust system etc.

c) Technical details of the generator such as ratings, construction, stator, rotor, ventilation, insulation of windings, stator terminals, space heaters, temperature detectors, excitation system, neutral earthing details, automatic voltage regulator, protection etc.

d) Technical details of the control panels/boards such as type, construction, functions that are performed in sequence of operation, details of accessories and equipment mounted on it, annunciator panel, earthing details etc.

e) Technical details of other equipment such as CTs location, type, technical particulars and functions, starting lead acid battery and charger rating, type, location, technical particulars. Fuel oil tanks capacity, material, location etc.

f) Instructions for maintenance of each component of DG set and associated accessories.

g) General arrangement drawings of all equipment.

h) Approved control and protection schematic diagram of control panel

i) Approved bill of material with make type and rating of each component

j) Descriptive literature, catalogues of all accessories

k) Assembly drawings identifying the component parts

l) Technical details of acoustic enclosure

m) Twelve sets of bound volumes of above manuals shall be supplied to the Engineer before commissioning and handing over. Two sets of the same manual shall be supplied to the consultants.

17 Painting

a) All materials included in the scope of supply shall be epoxy painted as per requirements. After fabrication of panels, tanks, piping, support structures etc. all surfaces shall be thoroughly cleaned by sand, chemically treated etc. scrapped and painted with primer coating and enamel / epoxy coating. The colour of the finished paint for panels etc. shall be shade No. 631 of IS: 5.

b) After installation all the equipment painted shall be inspected for chipping-off paint and touch up paint, wherever required, shall be done at site.

18 Performance Requirements

a) The diesel generator and its accessories shall be designed to meet the following performance requirements which shall be guaranteed by the contractor:

b) The unit shall be capable of starting from cold conditions reaching synchronous speed and taking up full load within 30 seconds from the instant of giving start impulse without wear or stress on engine. In case of main supply failure, within 3 seconds it should be possible by AMF panel to switch on automatically the DG set to the connected load. Similarly, as soon as the main supply is restored the DG set shall automatically trip to permit the connected load to be fed by the main supply.

c) The unit shall be capable of delivering continuously at generator terminals rated output (net power) at rated p.f. This output shall be obtained after necessary derating of engine due to site conditions and with auxiliary power requirements have been considered.

d) The unit shall be capable of delivering peak output of 10% in excess of rated output for a period of one hour, without exceeding the permissible temperature rise limits.

e) With the unit running at No. load with rated voltage and speed, the transient voltage drop at its terminals shall not exceed 10% of rated voltage on simultaneous starting of direct online motors and other loads which were already connected to the station service board.

19 Erection / Construction / Maintenance Tools & Equipment

One set of all special tools & equipment required for installation, testing, operation, and maintenance of Diesel Generator set & associated accessories shall be supplied by the contractor.

20 Spare Parts

The contractor shall furnish a list of recommended spare parts required for five years satisfactory operation of all equipment to be supplied by him.

Full details of spare parts, their relationship to the equipment and itemized price shall be given in the price bid.

The contractor shall guarantee that they shall supply spare parts whenever required on the mutually agreed terms & conditions for the lifetime of the equipment.

21 Mandatory spare parts

The contractor shall provide the following:

a)	Generator & engine		
b)	Shaft bearing set	:	1 no. set
c)	Gland packing & gaskets	:	1 set of each type
d)	Crank pin bolt assembly	:	1 set
e)	Liner ring	:	1 set
f)	Oil seals	:	1 set of each type
g)	Mechanical seals	:	1 set of each type
h)	Filter elements (air, water, fuel, oil)	:	4 sets of each type
i)	Ignition sets	:	2 Nos.
j)	Piston ring & oil ring	:	1 set of each type of rings
k)	Valves (air inlet, exhaust)	:	1 set of each valve
l)	Piston pins	:	1 set
m)	Heaters (air, water)	:	1 set of each type
n)	Current transformers	:	1 no. of each type of control panel
o)	Relays and base	:	1 no. of each type
p)	Indicating lamps	:	10% of total
q)	Emergency stops push button	:	1 no.
r)	Ammeter	:	1 no. of each type & range

s) Voltmeter : 1 no. of each type & range

Any of the above items may be increased or decreased or deleted at the absolute discretion of the client.

22 Fire Protection

All equipment connections, cable etc. shall be designed and arranged in such a manner as to minimize the risk of fire and any damage which may be caused in the event of fire. The contractor may suggest the fire protection, measures necessary for the equipment.

23 Deviation from Specifications

a) All fittings, apparatus, accessories & components which may not be specifically mentioned in the specifications but are required for completeness of equipment shall be deemed to be included in the scope of these specifications.

b) All deviations from the specifications shall be brought presented to the Engineer for evaluation and approval, if any. The deviation shall be given in full along with the clause numbers and reasons for the same.

c) In the absence of any deviation schedule, it shall be presumed that requirements of the specifications are fully complied with by the contractor and any deviation shall not be considered later on.

24 Civil works for DG sets

DG set shall be placed in a plinth (along with enclosure) and covered by a shed. Plinth height shall be 300mm or more if required due to flooding study at the location. It shall be covered all around with a mesh fence and provided with a shutter. This design / layout shall be provided by contractor for approval of Engineer.

1.48 Technical Specification For External Illumination

a) The specification covers the design, engineering, material, fabrication testing, inspection, packing, forwarding supply, delivery and installation of Poles composite streetlight, LED lights fittings complete in all respects for the street lighting system by underground cables under the project. Exterior lighting shall be provided for streets, parking areas, open areas developed areas, as per following items of work.

b) The components of street lighting shall be supplied and installed, complete in all respects. All the equipment's and materials used for installation shall be brand new and of high quality in design and performance. Unless otherwise specified, all the items should be tested and installed as per the latest Indian Standards Specification.

1.48.1 Power Supply

The voltage available for the street lighting and security lighting will be 415 volts three phase and neutral 50Hz AC from the main external lighting board located in outdoor area.

1.48.2 Wiring of Fixtures

The street light fixtures shall be wired from terminal block by means of flexible (3 * 2.5 sq mm) copper conductor, PVC insulated cable through a rewire-able MCB and neutral or suitable sized MCB.

1.48.3 Cable

All cables shall be aluminium conductor (unless copper wire is specifically asked for), PVC insulated, PVC sheathed, armoured of 1100 V grade. The wire of different colours should be used for quick identification of phase wire and neutral. The cable shall be of approved make as specified in the list of makes

1.48.4 General

a) All light luminaires shall conform to the relevant Indian Standard Specification. The assembly of light luminaires shall be such that it is easy to handle, install, operate, and maintain them. The equipment shall be reliable in operation.

b) All the hardware used in the assembly of the luminaires, shall be either galvanised or painted with corrosive paint.

c) The internal wiring of the luminaires, from the junction box shall be done with wires of adequate size. All the accessories of the fittings shall be clamped/supported suitably at the entry to the luminaires.

d) All light luminaires and the associated control gear shall be rated for operation at 230 V, 50 Hz. A.C. supply unless otherwise specified in this specification.

e) The supplier shall supply all the technical features, light distribution diagrams; zonal luminous flux diagram and isocandala diagram of the luminaries. A dimensional drawing giving the overall dimension of the luminaires shall also be supplied.

f) The lighting circuits are generally of three phase and neutral 500 V distribution with Aluminium conductor PVC insulated armoured cables.

g) Installation price of cables buried underground shall include excavation and back filling, supplying of sand, brick, protective cover, identification tags. Termination of lighting cables at both ends and all accessories are grouped together The installation price of lighting poles shall include all necessary foundation work including concreting, mounting of loop-in and loop-out box. Lighting luminaires fixing along with a PVC insulated copper conductor cable from the looping and loop-out box to fittings is taken together in one item.

h) The installation price of earthing electrode shall include burying of the electrode and the termination of the earthing conductor.

i) For all the installation work necessary materials, accessories, hardware etc. as required to make the installation complete in all respects shall be included in the offer.

j) While loading, transporting, unloading, and erecting the poles, care shall be taken so that the poles do not get bent out of shape and where necessary, such defects shall be rectified before the poles are erected in position. The poles shall be erected in plumb line and correct level as indicated in drawing and to the satisfaction of the Engineer-in-charge. They shall be kept in this position with the help of manila ropes until the foundations are constructed, (for a minimum period of 7 days) and the backfilling is complete.

k) At road crossing, the cables shall be taken through RCC Hume pipe to be buried at a depth of 1 meter below the finished round level and shall cover and run below the drainages on both sides of the road. The trenches excavated for embedding the RCC Hume pipe shall be back filled with the excavated earth and compacted to same degree as that of the surrounding area.

l) The protection of cement mortar for brick work to be used shall be CM: 1:4 for covering the hume pipe at the road crossing.

1.48.5 Route Marker

Cable route marker marked "CABLE" shall be provided along route of the cable and location of loops. The route markers shall be of tapered concrete slab of 60 * 60cm at bottom and 50 * 50cm at top having a thickness of 10cm having 1:2:4 mix. Cable marker shall be mounted parallel to and 50 cm away from the edge of the trench. The concrete marker shall be laid over the trench projecting over the surrounding surface.

1.48.6 Steel Tubular Poles

The steel tubular poles shall be Galvanised octagonal types.

1.48.7 Galvanized Octagonal Poles

1 Design

The Octagonal poles shall be designed to withstand the maximum wind speed of 169 KM / Hr. as per IS 875. The top loading i.e. area and the weight of fixtures are to be considered to calculate maximum deflection of the pole and the same shall meet the requirement of BS: 5649 Part VI 1982.

2 Pole Shaft

a) The pole shaft shall have octagonal cross section and shall be continuously tapered with single longitudinal welding. There shall not be any circumferential welding. The welding of pole shaft shall be done by submerged Arc Welding (SAW) process.

b) All octagonal pole shafts shall be provided with the rigid flange plate of suitable thickness with provision for fixing 4 foundation bolts. This base plate shall be fillet welded to the pole shaft at two locations i.e. from inside and outside. The welding shall be done as per qualified MMAW process approved by Third Party Inspection agency.

3 Door opening

The octagonal poles shall have door of approximate 500 mm length at the elevation of 500 mm from the Base plate. The door shall be vandal resistance and shall be weatherproof to ensure safety of inside connections. The door shall be flush with the exterior surface and shall have suitable locking arrangement. There shall also be suitable arrangement for the purpose of earthing.

The pole shall be adequately strengthened at the location of the door to compensate for the loss in section.

4 Material

a)	Octagonal Poles	-	HT Steel Conforming to grade S355JO
b)	Base Plate	-	Fe 410 conforming to IS 226 / IS 2062
c)	Foundation Bolts	-	EN.8 grade

5 Welding

The welding shall be carried out confirming to approved procedures duly qualified by third party inspection agency. The welders shall also be qualified for welding the octagonal shafts.

6 Pole sections

The Octagonal Poles shall be in single section (up to 11 mtr). There shall not be any circumferential weld joint.

7 Galvanization

The poles shall be hot dip galvanized as per IS 2629 / IS 2633 / IS 4759 standards with average coating thickness of 70 DIGHI on. The galvanizing shall be done in single dipping.

8 Xing type

The Octagonal Poles shall be bolted on a pre-cast foundation with a set of four foundation bolts for greater rigidity.

9 Top Mountings

The galvanized mounting bracket shall be supplied along with the Octagonal Poles for Installation of the luminaries.

10 Manufacturing

The pole manufacturing & galvanizing unit shall be ISO 9001: 2000 & ISO 14001 certified to ensure consistent quality & environmental protection.

11 Service window

A service window of the size 150 mm x 100 mm shall be provided in the base of the pole to allow access to electrical connections and terminations. It shall be covered with MS plate and proper rubber gaskets shall be provided to prevent any ingress of water etc.

12 Electrical connections

Four-way connectors shall be provided along with Slide lock and 1 no. 6 amps Sp MCB including 2.5 sqmm PVC insulated copper conductor wires from the terminal block to the fixture and 2 nos. 32 mm dia GI sleeves of suitable length shall be provided up to the service window. An earth boss is provided on the control plate along with connectors and interrupters.

1.48.8 Galvanized Octagonal Poles Dimensions

Table 1-30: Galvanized Octagonal pole dimension detail

Height	**Top Dia (A/F)**	**Bottom Dia (A/F)**	**Sheet Thick-ness**	**Base Plate Dimensions (LXBXT)**	**Foundation Bolt**			
					Bolt Size (No. X Dia)	Pitch Circle Dia (PCD)	Bolt Length	Projected Bolt Length
(mtr)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
3	70	130	3	200 x 200 x 12	4 x 16 Dia	200	450	80
4	70	130	3	200 x 200 x 12	4 x 16 Dia	200	450	80
5	70	130	3	200 x 200 x 12	4 x 16 Dia	200	600	80
6	70	130	3	220 x 220 x 12	4 x 20 Dia	205	600	100
7	70	130	3	220 x 220 x 12	4 x 20 Dia	205	700	100
8	70	135	3	225 x 225 x 16	4 x 20 Dia	210	750	100
9	70	155	3	260 x 260 x 16	4 x 24 Dia	250	750	125
10	70	175	3	275 x 275 x 16	4 x 24 Dia	270	750	125
11	90	210	3	300 x 300 x 20	4 x 24 Dia	300	750	125
12	90	240	3	320 x 320 x 20	4 x 24 Dia	325	850	125

1.48.9 Lighting junction boxes

Junction boxes shall be used for looping of lighting cables in the lighting circuit. Junction boxes shall be made of cast aluminium having IP55 degree of protection as per IS: 2147. The junction boxes shall be 4-way, dome cover type, suitable for mounting on surface or wall complete with mounting accessories. Terminals shall be suitable for incoming and outgoing cables with 20% spare terminals.

1.48.10 Smart Pole

These specifications are intended to cover design, manufacture, testing / inspection before dispatch, packing, and transportation to site, erection supervision, testing and commissioning of Smart pole complete with all accessories / fittings and spare parts as specified herein

1 Intelligent Street Pole (Smart Pole)

a) Based on the design of the contractor, Smart Poles with telecom infrastructure will be established which will house the telecom base stations, LED Based Smart Lights, Digital Billboard, Wi-Fi, Environmental sensor, Surveillance camera and other related equipment. This shall be carried out by the Contractor only at junction locations at each side of traffic after due consultations and approvals with the competent authorities.

b) Contractor shall submit various possible intelligent street poles designs (Physical Design), 3D/AutoCAD design, to the Authority(ies) for seeking Sign Off. All the proposed designs should be in total conformance with the prevalent best practices of engineering.

c) Contractor shall obtain pole design sign off from the structural engineer / nominated agency appointed by the Authority(ies)

d) The smart city Phase A activation area shall have minimum number of intelligent street poles as detailed elsewhere in the tender. However, it shall be contractor’s obligation to provide a higher number in case needed for proper implementation of the smart city concept.

e) The height of the pole shall be driven by the requirement derived from lighting calculations to obtain the correct Luminosity levels.

f) Material of the pole shall be GI

2 LED Based Smart Lights (One/Two on each smart pole as per requirement)

Electric streetlights are essential elements of a municipal environment and services. They affect resident sense of safety while influencing a city's ability to create an inviting environment for business and tourism. Unfortunately, outdoor lights are also a major energy draw. Therefore, following are desired in designing, implementation and O&M of LED based Smart Lights on Smart Pole:

a) Low energy consumption, cost, and its maintenance

b) Enhance situational awareness, real-time collaboration, and decision making across city

c) Add intelligent IT innovations to civic utilities, public safety without adding significantly more physical infrastructure

d) Real-time data communications with low latency (or minimal delay), to improve operational efficiency

e) Ensure efficient operation and maintenance of street lighting services using the smart city platform

3 The scope of work includes but is not limited to.

a) The Contractor needs to install LED based Smart Lights on the Intelligent Poles as per recommended level of illumination as specified in tender specification.

b) LED fixtures should be controlled from the Integrated Command and Control Center with the aid of a centralized software by another package contractor. The luminaires shall have the facility of group control feature which will be approved by Authority(ies) basis the nature of road, pre-requisites of a locality or any directives issued by any government department etc.

c) Supply, installation, testing and commissioning, O&M of all supplied and installed equipment system to meet the requirement as defined in specifications.

d) All the machineries and equipment required for implementation of the project is to be arranged by the Contractor, Authority has to provide only authorization and necessary clearance and permission if required.

e) The quality of the luminaries/ Lux level will be maintained by Contractor during the project life. The Contractor will have full responsibility of warranty of LED's/fixture for the entire concession period and warranty will start from the date of project go-live.

f) Design, Installation, testing and O&M of Central Management Software for remotely monitoring and Controlling of LED luminaires from the Integrated Command and Control Center of the Authority(ies).

g) Implementation of National Lighting Code (NLC) illumination parameters towards safety of motorists & pedestrians. Contractor needs to highlight the areas with suitable justification where the NLC parameters could not be followed due to deficiency in current infra.

1.48.11 High Mast

1 Structure:

The High mast shall be of continuously tapered, polygonal cross section, presenting a good and pleasing appearance and shall be based on proven In-Tension design conforming to the standards referred to above, to give an assured performance, and reliable service. The structure shall be suitable for wind loadings as per IS 875 Part-3.

2 Construction:

The mast shall be manufactured using special steel plates, conforming to BS-EN10-025 and shall be delivered in multiple sections of effective length 10 meters. Thus a 30/25 m mast shall be delivered in three sections and 16 M / 20 mast in 2 sections to site. Each section shall be fabricated out of single plate duly folded and welded. There shall be only one longitudinal seam weld per section. Sections with more than one weld, circumferential or longitudinal, shall not be accepted. At site the sections shall be joined together by slip-stressed-fit method. No site welding or bolted joint shall be done on the mast. The minimum overlap distance shall be 1.5 times the diameter at penetration. The minimum top diameter shall be 150 mm. Bottom diameter and plate thickness shall be as per the structural requirements. Detailed design calculation of the mast shall be submitted for verification.

The mast shall be provided with fully penetrated flange, which shall be free from any lamination or incursion. The welded connection of the base flange shall be fully developed to the strength of the entire section. The base flange shall be provided with supplementary gussets between the bolt-holes to ensure elimination of helical stress concentration. For the environmental protection of the mast, the entire fabricated mast shall be hot dip galvanized, internally and externally, having a uniform average thickness of 85 microns for plates with more than 5 mm thickness and 70 microns for 5 mm or less. Galvanizing shall be done in single dipping method for better adhesion and life.

3 Door Opening:

An adequate door opening shall be provided at the base of the mast and the opening shall be such that it permits clear access to equipment like winches, cables, plug and socket, etc. and also facilitate easy removal of the winch. The door opening shall be complete with a close fitting, vandal resistant, weatherproof door, provided with a heavy-duty double internal lock with special paddle key. The door opening shall be carefully designed and reinforced with welded steel section, so that the mast section at the base shall be unaffected and undue buckling of the cut portion is prevented. Size of door opening shall not be more than 1200 x 250 mm to avoid buckling of the mast section under heavy wind conditions.

4 Dynamic Loading for the Mast:

The mast structure shall be suitable to sustain an assumed maximum reaction arising from a wind speed as per IS 875 (three second gust) and shall be measured at a height of 10 metres above ground level. The design life of the mast shall be at least 25 years. The force co-efficient taken for design of the polygonal structure is to be established from the wind tunnel test data.

5 Lantern Carriage - Fabrication:

A fabricated Lantern Carriage shall be provided for fixing and holding the flood light fittings and control gearboxes. The Lantern Carriage shall be of special design and shall be of steel tube construction, the tubes acting as conduits for wires, with holes fully protected by grommets. The Lantern Carriage shall be so designed and fabricated to hold the required number of flood light fittings and the control gearboxes, and also have a perfect self-balance. The Lantern Carriage shall be fabricated in two halves and joined by bolted flanges with stainless steel bolts and nylon type stainless steel nuts to enable easy installation or removal from the erected mast. The inner lining of the carriage shall be provided with protective PVC arrangement, so that no damage is caused to the surface of the mast during the raising and lowering operation of the carriage. The entire Lantern Carriage shall be hot dip galvanized after fabrication.

6 Junction Box:

Weatherproof junction box, made of SS 304 with single sheet construction of 1.5 mm brushed grain 240 shall be provided on the Carriage Assembly as required, from which the inter-connections to the designed number of the flood light luminaires and associated control gears fixed on the carriage, shall be made.

7 Raising and lowering mechanism:

For the installation and maintenance of the luminaires and lamps, it will be necessary to lower and raise the Lantern Carriage Assembly. To enable this, a suitable Winch Arrangement shall be provided, with the winch fixed at the base of the mast and the specially designed head frame assembly at the top.

8 Winch:

The winch shall be of completely self-sustaining type, without the need for brake shoe, springs or clutches. Each driving spindle of the winch shall be positively locked when not in use, gravity activated PAWLS. Individual drum also should be operated for fine adjustment of lantern carriage. The capacity, operating speed, safe working load, recommended lubrication and serial number of the winch shall be clearly marked on each winch. The gear ratio of the winch shall be 53: 1. However, the minimum-working load shall be not less than 750 kg. The winch shall be self-lubricating type by means of an oil bath and the oil shall be readily available grades of reputed producers. The winch drums shall be grooved to ensure perfect seat for stable and tidy rope lay, with no chances of rope slippage. The rope termination in the winch shall be such that distortion or twisting is eliminated and at least 5 to 6 turns of rope remains on the drum even when the lantern carriage is fully lowered and rested on the rest pads. It should be possible to operate the winch manually by a suitable handle or by an integral power tool. It shall be possible to remove the double drum after dismantling, through the door opening provided at the base of the mast. A test certificate shall be furnished by the Contractor from the original equipment manufacturer, for each winch in support of the maximum load operated by the winch. The winch shall be type tested through reputed institutions like IIT as consultants and the type test report shall be submitted along with offer. A test certificate is to be submitted along with supplies.

9 Head Frame:

The head frame, which is to be designed, as a capping unit of the mast, shall be of welded steel construction, galvanized both internally and externally after assembly. The top pulley shall be of appropriate diameter, large enough to accommodate the stainless-steel wire ropes and the multi-core electric cable. The pulley block shall be made of non-corrodible material and shall be of die cast Aluminium Alloy (LM-6). Pulley made of synthetic materials such as Plastic or PVC are not acceptable. Self-lubricating bearings and stainless-steel shaft shall be provided to facilitate smooth and maintenance free operation for a long period. The pulley assembly shall be fully protected by a canopy galvanized internally and externally. Close fitting guides and sleeves shall be provided to ensure that the ropes and cables do not dislodge from their respective positions in the grooves. The head frame shall be provided with guides and stops with PVC buffer for docking the lantern carriage.

10 Stainless Steel Wire Ropes:

The suspension system shall essentially be without any intermediate joint and shall consist of only non-corrodible stainless steel of AISI 316 grade. The stainless-steel wire ropes shall be of 7/19 construction, the central core being of the same material. The overall diameter of the rope shall not be less than 6 mm. The end constructions of ropes to the winch drum shall be fitted with talurit. The thimbles shall be secured on ropes by compression splices. Two continuous lengths of stainless-steel wire ropes shall be used in the system and no intermediate joints are acceptable in view of the required safety. No intermediate joints/terminations, either bolted or else, shall be provided on the wire ropes between winch and lantern carriage.

11 Electrical System, Cable, and Cable Connections:

Bottom electrical accessories of the mast shall be flaming proof. A suitable flameproof plug socket unit shall be provided at the bottom compartment. This unit shall have facilities for terminating incoming cable (up to 4 core 16 sq mm Al Armoured). Outgoing of this unit shall be trailing cable for the mast through a plug. The electrical connections from the bottom to the top shall be made by special trailing cable. The cable shall be EPR insulated, and PCP sheathed to get flexibility and endurance. Size of the cable shall be minimum 5 core 2.5 sq mm copper. The cable shall be of reputed make. At the top there shall be weatherproof junction box to terminate the trailing cable. Connections from the top junction box to the individual luminaires shall be made by using 3 core 1.5 sq. mm flexible PVC cables of reputed make. Also, suitable provision shall be made at the base compartment of the mast to facilitate the operation of internally mounted, electrically operated flame proof power tool for raising and lowering of the lantern carriage assembly.

12 Power Tool for the Winch:

A suitable, high-powered, electrically driven, internally mounted power tool, with manual override shall be supplied for the raising and lowering of the lantern carriage for maintenance purposes. The speed of the power tool shall be to suit the system. The power tool shall be single speed, provided with a motor of the required rating. The power tool shall be supplied complete with suitable control. The capacity and speed of the electric motor used in the power tool shall be suitable for the lifting of the design load installed on the lantern carriage. The power tool mounting shall be so designed that it will be not only self-supporting but also aligns the power tool perfectly with respect to the winch spindle during the operations. Also, a handle for the manual operation of the winches in case of problems with the electrically operated tool shall be provided and shall incorporate a torque-limiting device. The power tool operation shall always be through a separate torque-limiting device to protect the wire ropes from over stretching. It shall be mechanical with suitable load adjusting device. The torque limitor shall trip the load when it exceeds the adjusted limits. There shall be suitable provision for warning the operator once the load is tripped off. The torque limitor is a requirement as per the relevant standards in view of the overall safety of the system. Each mast shall have its own power tool motor.

13 Lightning Finial:

One number heavy duty hot dip galvanized lighting finial shall be provided for each mast. The lightning finial shall be minimum 1.2 M in length and shall be provided at the centre of the head frame. It shall be bolted solidly to the head frame to get a direct conducting path to the earth through the mast. The lightning finial shall not be provided on the lantern carriage under any circumstances in view of safety of the system

14 Aviation Obstruction Lights:

Suitable Aviation Obstruction Lights (minimum 2 Nos.) of reliable design and reputed manufacturer shall be provided on top of each mast.

15 Earthing Terminals:

2 Nos. earth terminal using 12 mm diameter stainless steel bolts shall be provided at a convenient location on the base of the Mast, for lightning and electrical earthing of the mast. Each mast shall be earthed at two points using minimum 25x6 mm GI strip with two independent GI pipe earth electrodes of 40mm dia, 2.5 mtr long.

16 Feeder Pillar:

Each mast shall be provided with a feeder pillar fabricated out of min 1.5 mm CRCA sheet for non load bearing members and 2 mm for load bearing members and finished with Nanoceramic coating, electrophoretic dip coating followed by powder coating with C5H painting if required

The feeder pillar shall comprise of incoming TPN MCB, Copper wiring, outgoing terminals, and contactors for reversing the motor.

17 Tests

The supplier, before handing over the installation to the Engineer-in-charge, shall carry out tests on all fittings and cables as per IS Specifications. the test shall include:

a) Megger test

b) Continuity test.

c) Phase sequence and polarity test.

18 LED Street Light Luminaire

a) Supply of LED streetlight luminaries complete with pressure die cast/extruded aluminium housing and adhering to the following specifications and lighting design requirements will be as per actual applications-

b) Efficiency of driver electronics shall be more than 90%.

c) The LED should be driven at the suitable current and within the permissible limits specified by the LED manufacturer.

d) Power factor of the electronic driver should be at least >0.95 with THD <10%.

e) The LED luminaries shall produce constant lux level in the voltage range of 100V to 280V. Voltage variations/ fluctuations in the specified voltage range shall not impinge upon the lux level it produces.

f) The life span of the LED source including its Driver shall be greater than 50000 hours.

g) The Driver input power supply must be protected with an IP 65 rated Type 2+3 SPD having Up 320V, In 10KA, Imax 20KA and Uoc 20KV with indication and built-in thermal disconnection.

h) The luminaries shall conform to IEC 60598 or equivalent standard. The driver should comply with IEC 61347-2-13, IEC 61547, CISPR-15; and 61000-3-2.

i) The luminaire shall be suitable for LED and for mounting height up to 9mtrs from ground level.

19 Electronic Components

The electronic components used shall be as follows-

a) IC (integrated circuit) used shall be of industrial grade.

b) The resistors shall be preferably made of metal film of adequate rating.

c) The conformal coating used on PCBs should be cleared and transparent and should not affect color code of electronic components.

d) The heavy components shall be properly fixed. The solder connection should be with good finish.

1.48.12 Construction

a) The casing of the lighting luminaries shall be made of pressure die cast aluminium coated with epoxy polyester powder coat single, self-contained device not requiring any on-site assembly for installation onto an existing lighting luminary integral with power supply unit. The driver unit must be accessible and if need be replaceable easily and with minimum use of tools.

b) The casing made of non-corrosive aluminium having high conductivity shall have external surface designed in a manner so as to act as an efficient heat sink to extract heat generated at pn-junction of a LED. Efforts shall be made to keep the overall outer dimensions as minimum as possible without compromising on the performance of the LEDs or luminary.

c) The assembly and manufacturing process for the LED source assembly in modules/ arrays shall be designed to assure all internal components are adequately supported to withstand sudden impacts and mechanical shock and vibration from high winds and other sources.

d) No part shall be constructed of polycarbonate unless it is UV stabilized

e) Material used for the lens of LED source shall be of toughened glass, heat resistant and shall not undergo discoloration during lifetime of the LED source. It shall conform to ASTM specifications for the materials. Any discoloration observed in the lens shall be considered a failure under warranty clause.

f) All luminaires shall be provided with acrylic / polycarbonate / glass diffusers and/or aluminized reflectors and/or lenses to provide proper road lighting distribution.

g) Toughened and/or tempered glass of sufficient strength may be provided under the LED chamber to protect the LEDs and luminaires.

h) The LED lens shall be UV stabilized and shall be capable of withstanding ultraviolet (direct sunlight) exposure for a minimum period of 60 months without exhibiting evidence of deterioration.

i) The luminaries shall be capable of operating normally in ambient temperatures from -20°C to 50°C maintaining junction temperature below 100°C and heat sink temperature below 60°C, ensuring efficient thermal management of the luminaire.

j) The fixture shall be designed in such a manner that it is easy to handle and install, is not too large and unwieldy, is of robust construction, light weight and conforms to minimum IP65 class of protection for outdoor use against dust and moisture intrusion.

k) The luminary shall be provided with a built-in external heat sink as well as an aluminium MCPCB printed circuit board, designed in such 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.

1.48.13 SCADA Interface for :-

Following SCADA interfaces shall be inclusive beside all other SCADA scope mentioned in SCADA section in this volume, I&C sections for street Lighting and PLC systems.

1.49 Central Monitoring and Control Room (For Lighting)

This project involves implementing a comprehensive SCADA system across all Street Light Control with integration into a centralized location such as MRSS/ZSS/CSS or area DBs and its further interface with third party software at ICCC for monitoring. The system will feature redundant SCADA for each Scada System and a web-based centralized SCADA for unified monitoring, control, data Logging and reporting.

1. **Street Lighting SCADA Systems (Operation and Monitoring) –** Redundance Server and Software SCADA system capable of

a) Interfacing with power relays and energy meters.

b) Monitoring and controlling of Street Light Control Panels.

c) Graphics implementation.

d) Displaying real-time data, alarms, and historical trends.

1. **Programming, Configuration, and Testing of PLCs/Controllers.**
Programming of Street Light Scada for:

a) Relays, Energy Meters, Street Lights, etc.

b) Data acquisition from energy meters and relays.

c) Implementation of IEC 60851/61850 protocols.

d) Functional testing to ensure seamless data communication and control.

SCADA System Development.
Substation and Main Station SCADA:

a) Single-line diagrams of Illumination, lighting panels/ Transformers, Relays, Energy Meters, Street Lights,

b) Real-time data visualization.

c) Graphics Implementations.

d) Alarm/event handling and historical trends.

2. **Command Control Center SCADA (ICCC) -** Web-based interface design with features:

a) Dashboard for comprehensive monitoring of all luminaires.

b) Consolidated alarms, events, and reports.

c) User role management for secure access.

2.1 Alarms and Notifications

Alarm prioritization and notifications for:

a) Faults Alarms

b) Email alerts for critical events.

c) Historical Data and Reporting

2.2 Local and centralized data logging for:

a) Energy consumption, fault analysis, and operational efficiency.

b) IEC 60851-compliant reporting with customizable formats.

3. **Communication protocol for third party data:**

a) Lighting panels to Main Scada System on Modbus TCP IP.

b) Power relays and Energy meters to ZSS/MRSS/LDB Scada System on Modbus TCP IP.

c) Street Light Control Panels to main Scada System on Modbus TCP IP.

4. **Scada for Illumination Systems –** Redundance Server and Software SCADA systems capable of

a) Monitoring and controlling LDBs, Lighting Transformers.

b) Interfacing with power relays and energy meters.

c) Graphics implementation.

d) Displaying real-time data, alarms, and historical trends.

Programming, Configuration, and Testing Controllers- Programming of Lighting Scada for:

a) Monitoring and controlling of LDB, Transformers, Relays, Energy Meters.

b) Data acquisition from energy meters and relays.

c) Implementation of IEC 60851/61850 protocols.

d) Functional testing to ensure seamless data communication and control.

5. STREET LIGHT AUTOMATION SPECIFICATION

The proposed system features advanced street light controllers with Ethernet output, dual RS485 ports, a single RS232 port, 8 digital inputs (DI), and 8 relay outputs, designed to deliver seamless integration and robust performance. Each controller connects to energy meters via RS485, enabling real-time monitoring of voltage, current, power factor, and energy consumption. The controllers are integrated into a centralized software platform through a reliable fiber optic network, ensuring efficient data aggregation and visualization from all connected streetlights and energy meters. This setup not only streamlines energy management but also enhances operational control, providing a scalable and future-ready solution.

Street Lights SCADA IMPLEMENTATION

The proposed street light automation system utilizes a robust fiber optic network for seamless connectivity between all street light controllers and the centralized monitoring location. Each street light controller is equipped with an Ethernet port, which is connected to a fiber media converter for communication over the fiber optic infrastructure. At the central location, a fiber optic switch aggregates data from all controllers. The switch connects to the centralized software server, enabling real-time monitoring and control.

SCADA software designed base on client and server systems. By installing you can monitor and controlling of the entire unit which is connected with this software. PC/WEB based SCADA which controlled on line / off line street light operation, parameter updating, maintenance management and emergency on / off street light with fiber connectivity.

SCADA software is browser-based software which gives complete command of your remote energy saver.

As it's compatible with standard browser, it gives you portability across the devices. So now any of your smart phone or tablet becomes your remote monitoring and controlling station.

Web based Software provides complete history of logged data with extensive charts and reports with all different energy meter parameters.

In SCADA, multi featured interface for managing street lights. Web Interface is based on well proven technology.

Due to its top security features only, authorized user can use the services. SCADA Software can be maintained remotely. New control units, users, groups, report schedule etc. can be added and configured remotely. Web Interface gives instant status of the street lights on the dynamic map. The problems like over/under voltage, over current, short circuit etc automatically detected.

Features

SCADA Software replaces visual inspections of individual street lighting with sitting at pc with wireless connectivity. Also, by fault alarm and monitoring of data user can judge the fault status and severity of fault.

Remote switching through Web Base Software to override local controller from SCADA.

User can demand any time live status of feeder pillar for current electrical and real time parameters from SCADA. Emergency Stop / Manual ON / Manual OFF / Test Mode of feeder pillar from SCADA.

User can monitor and change all settable parameter setting and clock time setting From SCADA Control.

Generate electrical profile of any individual feeder pillar form SCADA.

SCADA received the self-generated data massage from individual

Feeder Pillar like, ON time, Off time, Power Down time, Auto mode / Manual Mode, Volt Fault, Over Current Fault, Short Circuit Fault, Neutral Fault, RTC Fault, ADC Fault, Memory Fault, Low Ampere Fault, Door Open, Relay Fault, Calibration Data and acknowledgement of massage demand by SCADA of Parameter writing, E Stop, Test Mode, E Profile, All this massage contain All electrical parameter with real -time clock date and time.

The proposed street light automation system incorporates a redundant SCADA architecture to

ensure high availability and uninterrupted operation. This redundancy setup involves deploying two

SCADA servers operating in a primary-secondary configuration, where the secondary server

automatically takes over in case of any failure in the primary server.

The redundant SCADA system continuously synchronizes data between both servers, including real

no loss of critical information, providing seamless system functionality even during maintenance or unexpected downtime.

Key benefits of the redundant SCADA system should include:

a) System Reliability: Guarantees continuous operation of the street light automation system without interruptions.

b) Data Integrity: Ensures all energy, runtime, stop time, and fault data are consistently logged and available for reporting.

c) Operational Security: Prevents single points of failure, minimizing the risk of system outages.

This robust architecture underpins a resilient and efficient streetlight management system, ideal for critical infrastructure applications

6. OFC Communication Network

Redundant communication system for Each Street Light Scada.

a) 24 core Single Mode OFC cable shall be used for the network connectivity for Street light SCADA, Water SCADA, Pump Station, Power SCADA, etc.

b) Armond cable having three different tubes of 8 core fiber and MITL logo shall be printed of OFC cable.

c) Three different tubes shall be used for different network like Water SCADA, Streetlight SCADA and Power SCADA.

d) All substation shall be connected in ring topologies.

e) All end devices switches shall be connected in ring topology and dual homing.

f) Industrial grade managed switch with SPF module.

g) Fully loaded LIU's, patch cords with accessories

h) Outdoor Racks with patch panels.

1 Network Management software with server.

a) All end device node shall be configured in the NMS software

b) Failure notification shall be triggered

c) Contractor shall provide the NMS report at the time of O&M Payment

1.50 Technical Specification for Earthing

This specification covers the technical and associated requirements for the entire earthing system substations, required to protect persons and equipment and to allow safe service and maintenance of the installations. The earthing system includes the underground grid, ground rods and connections. The earthing system shall be designed to minimise the dangers from step, touch and transferred potentials which can occur under maximum fault conditions. The Contractor shall design, furnish and install the substation earthing system in accordance with the provision on latest IEEE Std. 80, Guide for Safety in Substation Earthing, IS: 3043, Code of Practice for Earthing and the provision of this specification. The contractor shall submit calculations in support of his design.

In addition to the above codes and standards, the Contractor shall comply with applicable national and local laws, codes, regulations, statutes, and ordinances.

The Contractor shall bear full responsibility that the earthing system materials have been designed and fabricated in accordance with all codes and standards and that they perform under the conditions and to the standards specified herein.

The Contractor shall carry out earth resistivity measurement for the substation site. Based on the result of this measurement and the system parameter, the appropriate design and the calculation will be determined whether impermissible touch and step voltages occur at any place of the station (including outside area) which may be endangered. These calculations will decide on the provisions for earthing to be made with the relevant part of the civil works related to foundations. It shall be agreed between Engineer and Contractor, about special arrangements, if calculations prove that touch and step voltages are higher than permitted and the Contractor proves that he modified the earthing grid to its optimum. Only calculations built up on computer generated design programmes shall be accepted. A special software for providing detailed analysis of the actual step and touch voltages likely to be generated has to be used.

The HV and LV systems are solidly earthed at the neutral point of the power transformer. The size of earthing conductors to be connected with the earthing system shall be designed for an earth fault level of 40 kA (1 sec). The material for earthing in particular for jointing shall be selected to prevent corrosion at the connection points as well as at the earthing material itself, both underground and exposed to air. If necessary, cathodic protection of an approved design shall be applied. In order to minimise the effect of seasonal variations of earth resistance, the earthing system shall be designed for the worst conditions.

1.50.1 Description of Services

The Contractor shall provide a complete earthing system consisting of:

The main outdoor subsoil earthing system, with individual loops around each building, foundation, structure, etc., of the site.

Sub-earthing systems for buildings, foundations, structures, tanks, etc., being connected to the subsoil earthing system as required

All electrical equipment such as motors, transformers, substations, foundations, switchboards, control boards, relay and auxiliary relay boards, all other subsidiary electrical equipment as well as all metal parts of civil construction or the mechanical equipment such as transformer rails, pumps, pipes, steel structure, tanks, cable trays, etc. shall be connected to the earthing system.

All materials and parts which are not specifically mentioned herein but are necessary for the safety of operating personnel and safe operation of the substation shall be furnished and determined by the Contractor at no increase in cost to the Owner.

1.51 Design Requirements

1.51.1 General

The ground grid shall be composed of a system of galvanized conductors buried approximately 500 mm below finished ground level, excluding crushed rock surfacing. The grid system shall cover the entire fenced substation area and shall be extended to the outer of the substation fence. A perimeter conductor shall run around the substation in a distance of 0.5m to the fence and shall be connected to the inner earthing grid and to the fence in regular intervals. Where necessary to reduce the overall earth resistance, earth electrodes shall be provided and connected to the perimeter of the main earth grid. A minimum of four (4) of the specified ground rods must be installed (one at each corner of the ground grid). The Contractor shall determine the spacing of ground grid conductors and the total number and location of ground rods and their lengths.

Earthing conductors buried in the soil shall be of galvanized steel rounds, coated if and as necessary. Earthing conductors embedded in concrete shall be of galvanized steel. Adequate corrosion protection shall be provided when conductors leave the concrete, respectively the soil.

The design of the earthing system and the materials to be used shall comply with the requirements for the specified cathodic corrosion protection.

Earthing conductors laid on cable trays or similar shall be galvanized steel.

All interconnections of the earthing grid to equipment and the connections be-tween the earthing grid and the earthing rods shall be made by the termite welding process. Only those connections located in earthing pits and occasion-ally intended to be opened for testing purposes shall be of the bolted type.

When a substation is located adjacent to the existing earthing system, the ground systems of the existing or new facilities shall be connected together by at least three galvanized steel strips appropriately sized for mechanical strength and the specified fault current with minimum conductor size to be 125 mm2.

Drawings and calculations shall be submitted for approval giving sufficient in-formation on the earthing, lightning protection, the earthing of structure mounted equipment, as well as on methods of measuring the earth resistance, respectively the earth voltage, the touch and the step voltage.

If the actually measured resistance of the Contractor-designed and installed ground grid is higher than one ohm or as specified, the Contractor shall install, at no extra cost to the Owner, additional earthing rods, mats, earthing electrodes, etc., until the field-measured resistance is equal to or less than the specified value.

Joints which are indicated as test points shall be bolted or clamped. Joints in tape, other than at test points, shall be made by the welding process. All welding joints shall be with bitumen coating with non-rusting paints. Overlap of conductors shall be not less than 100mm.

Joints and connections shall be protected by a coating which will form a seal and exclude moisture in all weather conditions. At connections to earth electrodes the coating shall cover all exposed conductors. Protective coatings shall be of a waterproof, inert, tenacious material.

Bolts, screws, nuts, washers, and rivets shall be stainless steel of superior quality.

1.51.2 Equipment and Materials Requirements

The equipment and materials shall be suitable for outdoor installation and use at specified service condition without corrosion, deterioration, or degradation of performance characteristics.

1.51.3 Earthing Conductors

Earthing conductor shall be copper conductor of soft drawn concentric stranding bare copper conductor.

Ground leads running down from the lightning rod or air terminal rods shall be hard drawn galvanised steel and shall be provided with the required clamp supports mounted on the steel structure at approximately 1.5 m intervals.

The cross sections of the various earth conductors shall be determined in accordance with IEEE standard / IS: 3043, however, the minimum conductor cross sections shall be as follows:

50 x 6 mm	EHV, HV and LV switchgear
25 x 6 mm	Motor
25 x 6 mm	Metal raceways and cable trays
25 x 6 mm	Intermediate terminal boxes, cabinets, panels
25 x 6 mm	Other metal parts as may be required

1.51.4 Ground Rods

The ground rod shall be copper-covered steel of circular cross section, with a nominal diameter of 19 mm and not less than 3 meters long in section of 1.5 meters. If more than one earthing rod are necessary, they shall not be less than 3 m apart.

Each ground rod shall have a conical swaged point at one end and shall have a continuous smooth copper covering of at least 0.254 mm thickness molten-welded or copper bonded (electro-deposit) to a steel core. The copper clad or pressed type will not be accepted.

Where earth plates are indicated, they shall be 600mm x 600mm minimum, of solid or lattice copper not less than 3mm thick.

Electrodes shall be installed in undisturbed ground. The distance between any two electrodes shall be not less than the sum of the lengths of the two electrodes.

Backfill immediately surrounding plate electrodes shall have a low specific resistivity and good water retention properties and shall be well compacted.

1.51.5 Inspection Pits

Unless otherwise indicated or required, connection between an earth conductor and its associated earth electrode system shall be in an enclosure.

The enclosure shall have a removable top cover, which shall be flush with finished ground level. The enclosure shall be a purpose made inspection pit made of concrete. The earth electrode connection shall be just below the lid of the inspection pit with adequate access for testing purposes. The enclosure shall be clearly labelled to indicate the electrodes function and, where appropriate, its identification number.

1.52 Earthing Hardware

1.52.1 Steel Structure Earthing

Every steel structure that carries insulators or apparatuses shall be connected to the earthing grid. To ensure contact even if a connection fails or a conductor is cut off, every structure must be connected via two different risers to two different parts of the earthing grid.

Steel structures with more than one leg should have two legs connected to the grid, with one connection to each leg. The legs with the greatest spacing between shall be chosen for the earth connection.

Circuit breaker framework is not considered as proper connections between steel structures. If there are no connections between the legs which are able to carry the current, all legs must be connected to the grid with their own risers.

Operating mechanisms and motor drives placed on separate stands shall be connected as above.

1.52.2 Transformer Earthing

The transformer tank shall be connected to earth following the same principles as for steel structures.

The neutral point of transformers shall be connected to the earthing grid via an isolated link or conductor. The connection to the two earthing rods, which are also connected to earthing grid, shall be made by two independent copper strips from the neutral.

1.52.3 Earthing of Switchgear

Earthing switches are to be connected via a direct earthing connection and not via the steel structure. Connections between any type of earthing device, e.g. earthing switch, and risers from the earthing grid shall be made through a copper wire connected between the earth contact of the earthing device and a riser. The neutral of the primary winding of Voltage Transformer, shall be grounded via a separate earthing connection to earthing rod and not via the steel structure.

Each lighting arrester shall be grounded separately with a full rated earthing connection and not via the steel structure. In addition, an earthing rod shall be driven into the ground at each earthing point of a lighting arrester as close as possible to the lighting arrester and connected to it.

1.52.4 Earthing inside Buildings

For potential equalising of the building an earthing grid of 8 mm reinforcement bars shall be cast into the surface concrete of all floors of all switchgear room or basements with power cables installed. The connection points shall be welded. The mesh size shall not be greater than 3 x 3 m. Suitable connection points shall be brought out of the concrete to allow connection to the main earthing and to all parts of equipment and building to be earthed. The part of these connecting points which protrudes from the concrete shall be tinned. The earthing grids of the different levels shall be connected at 8 to 10 m. on the periphery distributed locations.

The size of the main earthing shall be defined by earthing calculations. The design value for the main earthing grid shall be 40 kA (1 s) rating and with consideration of CADWELDED joints.

To ensure that reinforcement grid is made electrical continuous, a sufficient number of connection points shall be brought out of the concrete. Together with the detailed civil engineering drawings, the earthing design is to be checked before releasing for construction.

The connections to these parts should be of tinned copper of adequate cross section of at least 70 mm^2. Further similar connection points shall be installed at a number of places for the connection of portable earthing equipment when working in the station. All iron parts of the building and the reinforcement shall be connected to this common earthing installation.

Generally, each electrical device must be equipped with an earthing screw of sufficient diameter for connection to the earthing system. The same applies to all metallic parts such as panels, doors, rails, fences, transformers, etc. are effectively connected by earth conductors.

High voltage equipment and each GIS or metal enclosed switchgear bay shall be equipped with at least two terminal bolt M 16 in diameter or suitable earthing pads of adequate size to accommodate at least two bolts for proper connection to the earthing system.

For connection to all kind of control, protection, LV, panels etc. an earthing grid shall be laid in all cable trenches of at least 50 x 5 mm tinned copper bar.

Control panels and desks, switchboards, etc. consisting of several individual sections or compartments shall each be connected to this tinned copper earth bar unless all panels are solidly welded together, or other approved means are applied ensuring solid earthing connections. In such a case, provisions for earthing must be made at one end at least.

1.52.5 Earthing outside Buildings

As a minimum, one grading ring of galvanized steel strip shall be laid around each building at a distance of 1 m (each) and at a depth of 0.6 m.

The connections to the building earthing installation shall be made within the building. An earthing grid of sufficient size, defined by earthing calculations and consisting of galvanised steel conductor with a maximum mesh size of 3 x 3 m shall also be installed in the transformer bays.

All individual earthing grids shall be interconnected at spacing by not more than 5 meters. Buried in ground or supported on building structures, cable trenches, walls, etc. by means of brass clamps with spacing of not more than 1.25 m.

Steel fences within and around the substation area shall be connected to the earthing system at least at two different points and at maximum 10 meters intervals. All metal parts have to be connected through by welding or suitable earthing conductors.

1.52.6 Other Earthing Arrangements

Connection boxes for low voltage or control cables shall be connected via one 50 mm2 wire (35 mm2 copper if the terminal of the box does not allow more), irrespective of whether the box is mounted on an otherwise earthed steel structure or not.

Poles for lighting and other types of metal structures within the substation area, not mentioned hitherto, shall be connected to the earthing grid one connection for each item.

1.52.7 Earthing Equipment

To meet the safety regulations before any maintenance or repair works are started on the HV/ LV power equipment, the disconnected "live" parts of the equipment shall be grounded by means of mobile earthing sets. The portable or mobile earthing sets (Substation Earthing Sets) shall be supplied by the Contractor. One earthing set shall be supplied per substation and voltage level.

1.53 Tests

1.53.1 General

The Contractor shall carry out at his own expense all tests necessary to ensure the satisfactory design and manufacture of all earthing equipment and materials in accordance with Indian / IEC Standard.

1.53.2 Design Tests

Conductors, hardware's, and materials shall be subjected to the design (or type) tests in accordance with applicable Indian or equivalent IEC standards. Even though the Engineer witnesses the required tests, and the earthing, hardware's and materials meet the acceptance criteria, the Contractor shall not be relieved of the responsibility of providing conductors, hardware's and materials conforming to all the requirements of the specification.

1.53.3 Quality Conformance and Routine Test

1 Earthing Conductors

The tests shall be performed in accordance with IEC 60621-2 and shall include, but not limited to the following:

Tensile strength tests

Elongation tests

Conductor resistivity tests

Dimension measurement

Surface finish inspection

Weight of conductor

2 Miscellaneous Hardware

The test shall be performed in accordance with IEC 60621-2 and the manufacturer standard. The routine tests shall be performed by selecting the samples from each lot of equipment. The number of samples required for the tests shall be all for 1-3 sets; 3 for 4-30 sets; and 10% for over 30 sets.

General inspection

Measurement of dimensions

Tensile tests No. of samples required: 1 for 20-50 sets.

2 for 51-100 sets; and

4 for over 100 sets

Galvanising tests

3 Earthing Materials

Quality conformance tests are required to verify the quality of materials and workmanship. They are to be made on fittings taken on random from the various lots offered for acceptance.

1.53.4 Routine Tests

These tests are intended to eliminate defective materials and fittings. They are to be made on all materials and fittings of the type to which they are applicable, per applicable standards and / or per Contractor's quality assurance methods if accepted by the Employers Engineer.

1.53.5 Field Tests

Field tests and acceptance tests, if any shall be performed by the contractor as per IS: 3043 / IEC /IEEE-80 standard. The Contractor shall provide instructions and acceptance criteria including the calculated value of the resistance of the installed earthing grid for field testing and measurement prior to energising the substation / equipment.

Measurement of the earth voltage by the voltmeter/ ammeter method, test current 100 - 300 A or an equivalent approved method.

Measurement of the step and touch voltage.

1.53.6 Test Report

Five (5) copies of test reports of all standard tests as per IS: 3043 / IEEE-80, performed subsequent to the date of award. All routine tests shall be certified by the inspector and submitted to the Employers Engineer within fifteen (15) days after test.

The Contractor shall bear the costs of furnishing these records and reports.

1.54 Technical Specification For Electrical SCADA System

1.54.1 SCADA System

For DPIA ParceL-B Phase-1 activation area, a dedicated Electrical SCADA system shall be provided for MRSS (under MSETCL Scope) and 2 numbers of. Switching Stations and 10 numbers of Distribution substations. . The EPC contractor must employ the specialist SCADA system integrator with similar types of installations. SCADA system for MRSS and ZSS is in the scope of others while SCADA for Switching and distribution sub stations and its interface provision (for monitoring only) with SCADA for MRSS, ZSS, ICCC is in the scope of bidder.

Below specification are common technical specification for Electrical SCADA system.

SCADA system shall comprise following equipment

Data concentrator panel

Communication Module

Ethernet switches and LIU cards

Personal computers

GPS unit (for real time monitoring of the relays and meters)

UPS

Battery and Battery charger

All the power transformers, GIS switchgears, LT Panel, AMF panels metering equipment and protection relays shall be compatible to SCADA.

1.54.2 Data Concentrator Panel

To maintain the redundancy and to increase the reliability of power network, 100% redundant Data concentrator panel shall be envisaged for 400kV/220kV33kV MRSS (MSETCL Scope) and 33kV Switching Stations & 33/11kV Distribution Substations. Each Data concentrator panel shall have required number of IO cards, Ethernet cards for connection substation equipment, meters, protection relays, RMU unit MMI(Man Machine Interface) and substation PC. The Data concentrator panel shall be floor standing type and shall have all necessary arrangement to interface with various devices. Redundancy required at Processor level too.

The MMI system shall also be capable for accepting the metering input on RS 485 Modbus protocol. Data concentrator panel should be powered from the substation battery chargers. The DC convertor should be the part of the data concentrator.

1.54.3 Remote IO Panels

All the metering and protection relays at remote locations shall be interfaced with substation SCADA through Remote IO panels. These panels shall be strategically located near the load centre RMUs/CSS. Each IO panel shall have sufficient IO cards to accommodate all IO's coming from RMU's/CSS and other field devices. RIO panel shall also be housing necessary Ethernet switches and LIU cards to communicate with substation SCADA. The substation SCADA system shall have independent Data concentrator panel which shall have sufficient IO cards to accommodate all the IO's of substation equipment. It is envisaged that 25% spare IO cards shall be provided in each IO panel to take care of future requirement.

Below minimum inputs/outputs shall be taken in SCADA system -

Power Transformers- OTI Alarm, WTI Alarm, Buchhohlz Alarm, MOG alarm, OTI Trip, WTI Trp, Buchholz Trip, PRV alarm, PRV trip, Ventilation Fan failure, Tap changers voltage settings (from RTCC Panel)

Auxiliary Transformers- Oil & Winding Temp. High

EHV & HV GIS and LV switchgear - Breaker ON/OFF Command, Indication/Alarm like Breaker ON/OFF, TRIP, Trip Circuit Healthy, Breaker position i.e. Test, Service and Maintenance mode, isolator Open/Closed, Earth Switch Open/Closed and all Meter and Protective relay parameters.

Ring Main Units (RMUs) and Compact Substations- Breaker ON, OFF & Trip status, LBS ON/OFF Command, CB ON/OFF command, Load break Switch ON indication, Earth switch ON for LBS, Earth switch ON for CB, SF6 gas pressure, Battery fail, FRTU local/Remote and all Meter and Protective relay parameters.

All Numerical Relays- All protection parameters and relay status from EHT, HT, LV Switchgears and AMF panel.

All meters- All metering parameters from EHT, HT, LV Switchboard, AMF panel, lighting Feeder pillar, HM feeder pillar and Power feeder pillars and from MFM located at each plot boundary.

Utility plants like STP, CETP, WTP, Pumphouse etc. – Start/Stop command, ON/OFF incitation, Trip Indication, Common fault alarm, Trip feedback for each Motor feeder.

Variable Speed Drive- Start/Stop command, ON/OFF indication, Trip indication, Common fault alarm, Trip feedback and all Meter and Protective relay parameters.

Beside above input/outputs, it is envisaged that 25% spare IO cards shall be provided in each IO panel to take care of future requirement.

1.54.4 Communication

To ensure 100% redundancy, All protection relays and MFM of Electrical equipments shall be connected to SCADA system Ethernet switches through Fibre Optic cables in Ring Network. All protection Numeric Relays shall have fiber optic ports and shall communicate to Ethernet switch on star topology and shall be connected to star coupler using fiber optic cables. Communication from relays to Ethernet switch shall be through redundant communication port. Communication from GIS switchboard Ethernet switch to data concentrator panel shall be simultaneous on redundant ports. RS 485 to FO converters wherever required shall be part of offered relay/other hardware.

All RMUs/CSS shall be made to communicate with substation SCADA system on Fibre Optic cable in Ring system. For this purpose, remote IO Panel shall be provided near the RMU/CSS units and each RIO panel shall communicate with SCADA system on Fibre Optic network.

The communication protocol shall be selected to transfer all information including time stamp data from relay to data concentrator/substation MMI. The relay communication shall be on latest IEC61850 protocol.

The maximum number of relays in one LAN shall be decided so as to achieve maximum scan time as 600 ms. The above scan time does not include screen refresh rate at MMI.

To maintain the reliability of Power system and to have better communication between substations the SCADA system in each substation shall be connected together. To achieve this purpose, each Data concentrator panel shall be connector together in Fibre Optic network.

In order to have 100% redundancy in the communication system all five substations shall be connected together in Fibre Optic Ring system. The successful bidder shall incorporate all necessary requirements to achieve 100% redundancy in the SCADA communication system.

The bidder should submit necessary certification for compliance of IEC61850 protocol. In case of proprietary protocol, the protocol converter shall be supplied as part of contract. Protocol converter, if provided, should not affect the speed of communication.

1.54.5 System Diagnostic

The system should have communication diagnostic feature of each substation level component. Proper communication of devices should be identified by communication status. Device, which does not communicate properly, should be clearly highlighted on operator's screen.

1.54.6 User Authorization

The system to be configured to object authorization so that each user defined in the system can be given access-rights for various features e.g.

System managing.

Engineering.

Normal operation (Open/Close of Breakers).

View only.

1.54.7 Digital Communicable Meter

All Digital communicable meter from 220kV GIS,132kV, 33kV GIS, 11kV GIS, 415V Aux Switchboard, CSS, Lighting feeder pillar, Power feeder pillar, HM feeder pillar, AMF panel and MFM to be located at each plot shall be with RS 485/FO port suitable for SCADA as well as local metering. All these meters shall be connected to respective substation SCADA on fibre optic cable network. The successful bidder shall provide necessary devices to connect all meters to substation SCADA on fibre optic network.

1.54.8 Engineering

For ease of engineering, the engineering tool designed for the SCADA system should be based on latest international guideline protocol IEC61850 modelling.

1.54.9 Time Synchronization

For the real time monitoring of Power system equipment, Time clock synchronization feature shall be provided. The real time clocks of all numerical relay shall be synchronized with data concentrator/HMI time clock. GPS unit shall provide in each substation and shall be synchronized with other substation GPS by using GPS receiver at substation. The resolution of time synchronization shall be + 1 millisecond or better throughout the entire system.

1.54.10 System Description

The SCADA network to include all the hardware and software required to make system work as detailed in this specification. All the I/O's, RTU's, all as mentioned in the Control System architecture is to be integrated with all the required Hardware/Software. It is the SCADA manufacturer/supplier's responsibility as a whole to provide the complete system including the Ethernet Fiber optic communication network supplied, installed, tested & commissioned all as required and to the complete satisfaction of the Authority.

The total SCADA system with RTU's shall be supplied by a single manufacturer. (NTS: Modify this paragraph to reference the control descriptions.)

The operator station shall be a Server / Client architecture for each substation with total redundancy. The quantities and arrangement shall be as per the manufacturers design. There shall be minimum three Operator workstations and minimum one Engineering Workstation. These stations shall have monitors of minimum 21-inch size, high resolution color graphic type. The operator stations shall be operating on Windows platform field proven with Manufacturer's SCADA.

The SCADA must be infinitely expandable. The system software shall not limit the system expandability. The only limit on the number of I/O that can be supported by the system shall be the physical quantity of hardware supplied. The consoles for the Workstations shall have space provisions for adding future systems. There shall be minimum 30% spare I/O capacity in the Hardware and software of the system supplied. 20% of the capacity shall be in the form of I/O Modules with cable connectors up to modules & terminations done up to terminal strip. 10% of the capacity shall be in the form of empty space in the rack slots for modules but cable connectors left up to module space & completely wired up to terminal strip. This consideration must be taken care in processor designing also.

Termination units or terminal strips shall be provided for the termination of field wiring within each field enclosure of the plant department. Termination of field wiring directly to I/O edge card termination of I/O module is not acceptable. The field wirings can be connected / disconnected without disturbing or removing the respective I/O module.

All the I/O modules shall be of plug & play type and shall be recognized by the controller automatically once they are plugged in to the system. All I/O module related configuration shall be done through software and no hard selection like dip switches / jumpers / POT are allowed. The addition of I/O in the network / configuration of I/O shall be carried out while the processor is in online. I/O modules shall have flash memory for firmware upgrades through network. Replacement of a same type of I/O module but with a different revision level shall not require a reconfiguration of the system. The response of individual channel of I/O shall be configurable independently for its state / behaviour during a fault. (NTS: Define the System Supplier, Manufacturer, Contractor, and Owner for the Project.)

All the marshalling cabinets for the I/O wiring as required in the System architecture shall be provided by the SCADA manufacturer.

All Hardware, Software (including Operating System, SCADA, networking, applications, Web view functionality, etc.) supplied shall be new, state of the art and current at the time of installation with latest versions and revisions in firmware and software

It will be contractors' responsibility to provide all parameters over type of interfaces to be decided by ICT Consultant after coming on board. All the required interfaces (including interface arrangements to be decided such as enterprise bus) will be fully configured by contractor in its scope of work on both sending and receiving ends for all or part of the parameters as per the requirements to be laid by ICT Consultant for integrating with city ICT infrastructure for control, display, monitoring, reporting etc.

All the field devices should be SMART and to be supplied with internal switching and protection devices as per Indian and other International standards as applicable.

All the costs with respect to the hardware, software, interfacing, Ethernet Fiber optic networking shall be included in the Contractor's scope.

1.54.11 SCADA System additional Interfaces

Central Monitoring and Control Room (at MRSS)

This functional scope involves implementing a comprehensive SCADA system across all Substations being installed by Contractor with integration into a centralized location viz MRSS, ZSS, ICCC (in others' scope, but interfacing remains in Bidder's scope). Wherever applicable, both receiving and transmitting ends are to be connected with OFC by Bidder. The system will feature redundant SCADA for each SCADA System and a web-based centralized SCADA for unified monitoring, control, data Logging and reporting.

a) Main Station SCADA Systems (Operation and Monitoring) – Redundance Server and Software SCADA system capable of

   i. Monitoring and controlling RMU panels.
   ii. Monitoring of Transformers.
   iii. Interfacing with power relays and energy meters.
   iv. Interfacing for Monitoring and controlling of Street Light Control Panels.
   v. Graphics implementation.
   vi. Displaying real-time data, alarms, and historical trends.

b) Programming, Configuration, and Testing of PLCs/Controllers.

   Programming of Power Scada, Street Light Scada for:
   i. Monitoring and controlling RMU panels, Relays, Energy Meters, etc.
   ii. Data acquisition from energy meters and relays.
   iii. Implementation of IEC 60851/61850 protocols.
   iv. Functional testing to ensure seamless data communication and control.

c) SCADA System Development.

   All Substation and interface with Main Station SCADA:
   i. Single-line diagrams for RMU panels, Transformers, Relays, Energy Meters,
   ii. Real-time data visualization.
   iii. Graphics Implementations.
   iv. Alarm/event handling and historical trends.

d) Interface with Command Control Center SCADA (ICCC) - Web-based interface design with features:

   i. Dashboard for comprehensive monitoring of all stations.
   ii. Consolidated alarms, events, and reports.
   iii. User role management for secure access.

e) Alarms and Notifications

   Alarm prioritization and notifications for:

i. Faults Alarms
ii. Email alerts for critical events.
iii. Historical Data and Reporting

f) Local and centralized data logging for:

i. Energy consumption, fault analysis, and operational efficiency.
ii. IEC 60851-compliant reporting with customizable formats.

g) Communication protocol for third party data:

i. RMU panels to Main Scada System on Modbus TCP IP.
ii. Power relays and Energy meters to main Scada System on Modbus TCP IP.
iii. Street Light Control Panels to main Scada System on Modbus TCP IP.

h) Power Scada for Sub Stations SCADA Systems – Redundance Server and Software SCADA systems capable of

i. Monitoring and controlling RMU panels, Transformers.
ii. Interfacing with power relays and energy meters.
iii. Graphics implementation.
iv. Displaying real-time data, alarms, and historical trends.

i) Programming, Configuration, and Testing Controllers- Programming of Power Scada for:

i. Monitoring and controlling RMU panels, Transformers, Relays, Energy Meters.
ii. Data acquisition from energy meters and relays.
iii. Implementation of IEC 60851/61850 protocols.
iv. Functional testing to ensure seamless data communication and control.

j) SCADA System Development Substation and Main Station SCADA:

i. Single-line diagrams for RMU panels, Transformers, Relays, Energy Meters.
ii. Real-time data visualization.
iii. Graphics Implementations.
iv. Alarm/event handling and historical trends

k) Programming, Configuration, and Testing Controllers Programming of Scada for:

i. Monitoring and controlling Sub Stations.
ii. Data acquisition from energy meters and relays.
iii. Implementation of IEC 60851/61850 protocols.
iv. Functional testing to ensure seamless data communication and control.

l) SCADA System Development

Substation and Main Station SCADA Development of screens for:

i. Real-time data visualization.
ii. Graphics Implementations.
iii. Alarm/event handling and historical trends.

m) OFC Communication Network

Redundant communication system for Each Sub Stations and main Sub Station for Power Scada, Street Light Scada.

i. 24 core Single Mode OFC cable shall be used for the network connectivity for Street light SCADA, Wat, Power SCADA, etc.
ii. Armond cable having three different tubes of 8 core fiber and MITL logo shall be printed of OFC cable.
iii. Three different tubes shall be used for different network like Power SCADA.
iv. All substation shall be connected in ring topologies.
v. All end devices switches shall be connected in ring topology and dual homing.
vi. Industrial grade managed switch with SPF module.
vii. Fully loaded LIU's, patch cords with accessories
viii. Outdoor Racks with patch panels.

n) Network Management software with server.

i. All end device node shall be configured in the NMS software
ii. Failure notification shall be triggered
iii. Contractor shall provide the NMS report at the time of O&M Payment

1.54.12 Man, Machine Interface (MMI)

The system should be interfaced with communicable protection & metering devices and other equipment's in the substation in such a way that operator can easily access the essential information regarding the network and control the same so as to ensure availability of electric network at its maximum efficiency giving highest utilization of the installed primary equipment's.

MMI Software configuration to be carried out to display the following data at the MMI and shall primarily but not limited to provide the following functions: -

Dynamic Single line diagram with bus bar colouring & with status of all process objects like breaker, isolators etc.

Alarm and Events with time stamping.

Online measurements and scaling of measurement.

Relay parameterisation.

Disturbance record uploads.

Object control.

Classification and display of events in alarm class e.g. persisting and fleeting alarms.

Time synchronization.

Each uploaded event/alarm list should contain:

The event data and time.

The name of the event object with a descriptive

The name of the feeder from which the event has generated.

The state of value of the object.

Possibility of filtering alarms according to feeder criteria. The information fields above shall be structured in columns for maximum readability.

1.55 Factory Acceptance Test

1. Type Tests

All equipment shall have valid type test certificates for similar models. Fresh Type tests for the equipment are not needed, provided the manufacturer can submit certificates that the equipment complies with all type tests as prescribed by the respective IEC standards.

1.55.1 Routine Tests

All routine tests as per international standards shall be carried out on all the items of the SCADA system.

1.55.2 Site Testing and Commissioning (By EPC Contractor/SCADA System Vendor)

1 General

This section defines the minimum requirements of pre-commissioning tests and commissioning tests that are to be carried out for the SCADA system equipment. The tests shall be conducted from the Substation SCADA after complete installation.

Functional checks for all alarm and indication points

Functional checks for all the communication alarms by simulation/switching off the equipment.

Functional checks for control outputs by simulation

Tests to be conducted by manufacturer of SCADA systems:

Functional checks of all transducers if signals from them are available. Otherwise, a test instrument for injection of mA signals shall be used.

Functional checks for all alarm and indication points and energy pulses at the Substation SCADA by field simulation.

Functional checks for all control outputs from the Substation SCADA by physically operating the equipment or a test relay.

Any other tests recommended by manufacturer.

1.56 Technical Specification for Uninterruptible Power Supply System for SCADA

The UPS (Uninterrupted Power Supply) shall be floor mounted; self-contained and metal clad and shall be suitable for supplying a nonlinear load. It shall be possible to open the enclosure front door when the unit is in use without exposing any live contact touch.

The UPS shall be online type incorporating minimum six plus rectifier and pulse width modulating inverter technology with microprocessor control. It shall incorporate a static bypass switch that shall operate in event of UPS failure, overload, or manual initiation in order to transfer the output supply to mains without disturbance to the output supply.

The UPS shall incorporate DC under voltage trip circuit to electromechanically trip the UPS output in order to protect the batteries. The noise level of the unit shall not exceed 85 dB (A) at 1.86 m from the UPS cabinet. The output of the invertor shall be a sine wave having less than 2% THD for liner loads and less than 4% for 50% nonlinear loads. It shall be suitable for load power factors 0.7 lag to 0.9 lead.

The unit shall have a dynamic response such that 100% step load causes and output voltage transient of less than +/- 4% with a recovery of less than 5ms. The load crest factor shall not be less than 3:1.

Indicators shall be provided for the following

a) UPS Status.

b) PS alarm conditions.

c) The UPS shall provide output for the following purpose.

d) Warning (Viz., low battery voltage).

The batteries shall be housed, within a separate matching battery cubicle suitable for location adjacent to the UPS. The batteries shall be of the rechargeable, sealed maintenance free lead acid type. The battery supply to the UPS shall be via a fused load break switch dis-connecter circuit breaker. The battery recharge time to 90% of full charge shall be approximately ten times the discharge time at full load. Terminals shall be shrouded to prevent accidental contact. The Uninterruptible Power Supply (UPS) system with SMF Lead Acid Battery shall conform to the minimum following specifications:

i. Input

ii. Input Voltage: 230 V. +/- Frequency: 50 Hz +/- 5%.

iii. Nominal DC input: Bidder to design and submit calculations (Battery).

iv. Output

v. Output: 230 V AC, applicable KVA with 25% margin as per load

vi. calculation.

vii. Regulation Mode: +/- 1%.

viii. Load power factor: 0.8 to unity.

ix. Duty: Continuous.

x. Ripple on DC: < 2%.

xi. General

xii. Principal of operation: Shall be solid state, pulse with Modulation (PWM).

xiii. Cable entry: Bottom cooling method: Forced air.

xiv. Type of Battery: Sealed Maintenance Free.

1.57 Technical Specification for Segregated Phase Busduct

The bus ducts shall be used to provide interconnection between 10MVA, 33kV/11kV power transformer and 11kV GIS. The transformer LV Terminal box and Incomer of 11kV GIS shall include provisions for Phase segregated bus duct.

The rated short-circuit withstand current of the bus duct system shall be greater than the total maximum momentary asymmetrical short circuit current by a minimum margin of 10%, without electrical, thermal or mechanical damage or permanent deformation.

The rated short-time current of the bus conductor shall be greater than the maximum symmetrical short circuit current that can flow by a minimum margin of 10% over three seconds, without the temperature of the bus conductor exceeding 250 Deg C.

The design of bus-ducts shall not impede access to any equipment for maintenance.

The design of the bus ducts shall consider the relative movement between the conductor and the outer enclosure to ensure relative movements are accommodated without stresses being applied to supporting insulators.

1.57.1 Bus Enclosure

1 Types of Bus Enclosure

The bus enclosure shall be of continuous bonded type.

2 Selection of Enclosure

Selection of enclosure shall be suitable for the `natural air cooled' type busducts.

3 Material

The bus enclosure shall be made of a non-magnetic material such as aluminium alloy.

4 Shape

The section of the bus duct enclosure shall be circular for isolated phase bus duct and rectangular for segregated phase bus duct.

5 Mechanical Strength

The design of the bus duct enclosure shall be such that it will withstand the internal or external pressures resulting from the following:

Normal operating conditions

Momentary short circuit currents (peak)

Rigours of adverse weather conditions, and

Combination of the above.

The housings shall be of sturdy construction to have inherent strength to withstand the above forces, and the bus ducts shall be designed accordingly.

6 Construction

The entire bus duct shall be designed for outdoor installation, with a dust, vermin and weather-proof construction. The degree of protection shall be better than or equal to IP-55.

7 Temperature Rise

Under all normal operating conditions, the hot spot temperature of the enclosure shall not exceed 80ºC.

8 Joints

Enclosure joints shall be factory-welded to the maximum extent possible within shipping limitations.

Where bolted joints are required, these shall be flanged joints. Protective coatings shall be applied to all surfaces where dissimilar metals are in contact to prevent corrosion and ensure good contact. Nuts, bolts, and washers shall be of non-corrosive material and shall be non-magnetic.

9 Flexible Joints

Flexible joints (flexible braided copper conductors) shall be provided on the bus enclosure at the following points:

Termination compartment of the Power Transformer

Incomer of 11kV GIS.

Additional flexible joints shall also be provided wherever deemed necessary by the Vendor.

The flexible joints shall take care of expansion and contraction due to temperature variations, transfer of vibrations from the generator pedestal and fault conditions. The flexible joints shall be able to carry the longitudinal enclosure current and the rated momentary short-circuit current, otherwise bonding is required.

10 Condensation Prevention and Removal

Facilities shall be provided to ensure that under all operating conditions and site conditions, condensation of moisture does not occur inside the bus enclosure.

11 Bonding

Bonding shall be provided across flexible joints and between phases as applicable for a continuous bonded type of bus duct if made of insulating material and shall be capable of carrying the longitudinal enclosure current and the rated momentary short-circuit current.

12 Terminal Enclosures and Flanges

Terminal enclosures with flanged ends shall be provided at the transformer and 11kV GIS. Drilling dimensions shall suit the flanges on the equipment to which the duct connects. The terminal enclosures shall be of non-magnetic material. The flanges shall be provided with gaskets, nuts, bolts etc.

13 Drain Plugs and Vents

Filter type drain plugs shall be installed at low points along the run of the bus ducts to drain out automatically any moisture condensing within the bus enclosure.

The drain plugs shall be fitted with porous filter elements which will permit the escape of the moisture but prevent the ingress of dust. The filter elements shall be easily removable for cleaning purposes.

14 Gaskets

The gasket material and thickness shall be so selected as to satisfy the operating conditions imposed by temperature, weathering durability etc. Care shall be exercised to ensure that covers fit easily, that the required compression of the gaskets can be obtained without damage or bending of the inspection covers. Over compression of the gaskets shall be avoided.

The material of the gasket shall preferably be PU Foam closed-cell sponge rubber or equivalent.

Flange gaskets shall be provided at the terminal enclosures of generators, the step-up transformers, generator circuit breaker, medium voltage unit auxiliary transformers and the neutral earthing cubicle.

15 Miscellaneous Hardware

The bus duct shall not have any through bolts. All nuts, bolts and spring washers shall be mild steel hot dipped galvanized or manufactured from non-corrosive materials. Clamps, splice plates etc. shall be provided wherever necessary.

16 Earthing

Earthing arrangements shall be as applicable for continuous bonded type of bus duct with facilities to provide a connection to the station earthing bus.

17 Wall Penetrations

Wall penetration shall be designed to provide a weather tight seal, take into account: -

enclose temperature may be as high as 80 deg C,

longitudinal movement due to thermal expansion and contraction

constructed of non-magnetic material

provide protection against UV attack.

1.57.2 Bus Conductor

1 Supports

The bus conductor shall be supported on post insulators. Sliding surfaces shall allow relative axial movement between the bus conductor and the enclosure.

2 Material

Except as noted the material of the conductor shall be electrical grade aluminium alloy or copper.

3 Rating

The bus conductor shall be rated to continuously carry at any ambient air temperature up to a maximum of 50˚C. The bus conductor shall be able to deliver the rated output at an applied voltage of ±10% nominal voltage. The current rating indicated on the SLDs are indicative only.

Vendor to calculate the rating of busducts based on the actual equipment data and submit the sizing calculations for approval. Bus ducts rated as per approved calculations shall be supplied for the project. The bus conductor shall be designed to carry the rated current under site operating conditions.

4 Shape

The bus duct conductor shape shall be the Manufacturer's standard.

5 Mechanical Strength

The bus conductors, insulators and insulated supports shall withstand without permanent deformation, deterioration of conductor material and reduction in the BIL value of the bus duct, the stresses consistent with the momentary short circuit current.

6 Losses

The losses in the conductor shall be limited to such a value that the temperature rise of the conductor does not exceed the specified values.

7 Joints

The bus conductor joints shall be factory-welded to the maximum extent possible within shipping limitations.

Flexible expansion joints shall be provided in the bus runs to accommodate relative movement due to temperature changes, operational movement, vibration and at equipment terminals to facilitate connections. One side of these joints shall be factory-welded.

Bolted joints shall be designed to maximize surface to surface contact between contact surfaces and to minimize loss of clamping pressure over the lifetime of the joint due to creep deformation.

When copper to copper or aluminium to aluminium bolted joints are required all contact surfaces, including bolt holes, shall be silver-plated. Connector bodies or fish plates used in the bolted joint shall be made of the same material as the bus conductor.

When copper to aluminium bolted joints is made all contact surfaces, including bolt holes, shall be silver plated. Connector bodies or fish plates shall be made of aluminium and should be as much as possible larger in comparison with the copper conductor to reduce the electrolytic current density over the exposed face of the aluminium connector.

The bolted joint design should be such that clamping bolts and areas of high stress which provide structural strength are not in the regions subject to galvanic attack.

The copper conductor shall not be placed above the aluminium conductor to minimise to prevent the possibility of copper salts washing over the aluminium.

Nuts, bolts, and washers for bus joints shall be of non-corrosive material and shall be non-magnetic.

If stainless steel bolts be used, Belleville washers, or equivalent, shall be used in place of flat washers to compensate for the differences in expansion of between stainless steel, aluminium, and copper.

If applicable to the joint design, electrical jointing compound shall be applied to the contact surfaces to prevent corrosion and ensure good electrical contact.

Each type of joint shall be tested for temperature rise to prove the adequacy of the design. The maximum temperature rise at the joints shall be less than the specified temperature rise for the bus conductor.

8 Clamps and Hardware

The busbar clamps and insulators shall be designed to withstand the forces due to momentary short circuit current. They shall permit free longitudinal movement of the busbars to the limits required under all normal and abnormal operating conditions. The material of the clamps shall be aluminium alloy. Suitable aluminium spacers shall be provided wherever necessary.

Suitable splice plates and bimetallic connectors shall be provided wherever necessary.

9 Bolted Disconnecting Links

Bolted disconnecting links with rating same as that of the main busbars shall be provided in the run of the bus duct to facilitate disconnection of the busbars during testing and maintenance. The separation between the busbar sections with the bolted links removed shall be sufficient to withstand the rated voltage of the bus duct.

1.57.3 Cooling

1 General

The bus ducts shall be `naturally air cooled'.

1.57.4 Bus Support Insulators

Within the bus ducts, the bus shall be mounted and supported on insulators. The insulators shall be mounted on resilient pads provided in the bus enclosure.

1 Material

The insulators shall be made of porcelain/resin cast or equivalent and shall be tested for partial discharge.

2 Mechanical Strength

The insulators shall possess sufficient mechanical strength to withstand the forces due to momentary short circuit currents. The spacing of the bus insulators shall be decided giving due factor of safety.

3 Electrical Strength

As a consequence of current loading and variations in temperatures in the bus enclosure, condensation of moisture may take place on the surface of the insulators. The insulators shall have a high creepage distance and a withstand voltage rating sufficient to provide specified insulation under highly humid conditions.

1.57.5 Seal-Off Bushings

1 Seal-off Bushings

The bus ducts shall be equipped wherever necessary with baffle or sell-off bushings to prevent interchange of air at different temperatures as well as infiltration of dust.

The sell-off bushings shall be flanged type.

2 Material

The insulator for seal-off bushings shall be of epoxy or porcelain. The bushings shall be designed for thermal expansion and contraction due to temperature differential specified for outdoor or indoor use.

3 Mechanical Strength

The insulators shall withstand the maximum short circuit forces under fault conditions. The insulator material shall not deteriorate under normal operating temperatures or due to temperature rise under fault conditions.

4 Electrical Strength

The electrical properties of the insulator shall conform to this Specification.

1.57.6 Bus Duct Supports

1 Material

The supporting structures for the bus duct shall be supplied by Vendor. The structures shall be fabricated from standard steel sections and shall be hot dip galvanised after fabrication. The structures shall be located in such a way as to provide easy access at the connecting points.

2 Mechanical Strength

The supporting structures shall be designed to withstand the dead weight of the bus duct, the short circuit forces under maximum fault conditions, and also the wind load and forces due to acceleration.

3 Losses

Losses in structural steel caused by:

Circulating currents in closed loops in metallic members, and

hysteresis and eddy currents in magnetic material members,

Shall be minimised by providing:

physical gaps or insulation in the members, and,

low resistance short circuiting bands made of welded aluminium flats on the transverse beams under each phase enclosure.

4 Accessories and Hardware

The supporting structures in the Vendor's scope of supply shall include supporting members, brackets, hangers, longitudinal and transverse beams, channels, nuts, bolts, insulating pads, insulating washers and all other hardware which are necessary for the erection and support of the entire bus duct installation. All the accessories and hardware of ferrous material shall be hot dip galvanized.

5 Method of Support

Supporting structures and their foundations shall not impede clear access to any equipment.

The supporting structures shall allow axial movement of the bus duct enclosures due to the thermal expansion and contraction that will occur over the entire range of operating temperatures.

Sliding supports shall be suitably designed to prevent then being damaged or distorted due to the sliding forces acting upon them due to axial movement of the bus duct enclosures. In addition, the supporting structures themselves shall be sufficiently rigid enough to withstand the axial sliding forces without causing undue deflection of the supports.

6 Earthing

Each supporting structure shall be securely connected at two points to the station earthing bus. All necessary hardware, such as clamps, connectors, etc. required for this purpose shall be provided and installed by the Vendor.

7 Civil

Design of support structures shall consider the layer of waterproof membrane/insulation/concrete paving on the roof of the Unit Electrical Building. To ensure the roof membrane forms a watertight seal, and to prevent possible corrosion of the bus duct supports located on the roof of the Unit Electrical Building, shall be fixed to concrete plinths raised 50mm above this layer. The plinths shall be adequately anchored to the roof slab.

1.57.7 Markings

All components of the bus ducts along with the supporting structure shall be distinctly marked for erection in accordance with the erection drawings to be prepared and furnished by the Vendor. These marks shall be made in a manner as not to be obliterated and erased in transit or to damage the galvanizing of the supporting structure.

In all locations where personnel will have access to the bus duct enclosure, warning sign shall be fixed or painted onto the enclosure warning of hot surfaces.

1.57.8 Miscellaneous

Studs, nuts, bolts and tapped holes shall conform to the relevant standards. Only hexagonal nuts shall be used. All bolts holes shall be spot faced for nuts.

Castings and forgings shall conform to respective material specifications and shall be free from flaws. They shall be machined true as per good workshop practice. Welding shall be performed in accordance with relevant recognized standards.

All threaded pipe connections and fittings, pipe flanges and tube fittings shall comply with relevant standards.

Cross over bridges shall be provided for personnel to cross over the bus duct enclosure on each side of the generator circuit breaker.

1.57.9 Design requirements of Bus Duct

The Vendor shall submit design calculations to demonstrate the following:

Sizing of the bus conductors thermal capability to withstand the rated continuous current and three seconds short time current.

Sizing of the busbar enclosures thermal capability to withstand conditions as required above.

Spacing of the insulators with respect to mechanical strength to withstand forces due to momentary short circuit current.

Heat loss and temperature rise calculations for conductors and enclosures.

Strength and deflection of supporting structures as specified.

All formulae and other information from which the heat losses are derived shall be listed together with authoritative source from which they were obtained.

1.58 Technical Specification for Non-Phase Isolated LV Busduct

This specification covers design, manufacture, testing and supply at site of 415V, 50Hz, 50 kA / 1 Sec, non-segregated phase busduct of continuous rating of 2500A, 2000A & 1250A with interleaved aluminium busbars and aluminium alloy enclosure and aluminium busbars and MS enclosure along with accessories.

All necessary accessories required should form part of supply and no additional rate for the same shall be considered. The busduct assembly shall be dust, vermin and corrosion proof construction totally enclosed, compartmentalized cubicle design with removable top and bottom covers.

The busduct shall be suitable for the following operating system.

Rated Voltage	: 415V ±10%, 3 Ph, 4 Wire, as specified or 3 Ph, 3 Wire, as specified
Rated Frequency	: 50 Hz ±5%
Fault Level	: 50 kA for 1 Sec.c
Enclosure	: IP 54 (indoor); IP 55 (outdoor)

1.58.1 Specific Requirements

The design, manufacture and testing of the busduct and its accessories covered by this specification shall comply with the latest issue of the standards as listed in ‘Codes and Standards’.

It shall be the responsibility of the SUPPLIER to make necessary modifications / changes (if pointed out by the Electrical Inspector), on the duct system without additional cost to the PURCHASER.

The Busduct shall be designed for the above current ratings and for a maximum temperature rise of 40 Deg. Cover an ambient temperature of 45 Deg. C, but with total cross section of not less than the sizes as indicated below:

a) 1250 A: 5 sq. inch per phase and 2.5 sq. inch for neutral.

b) 2000 A: 6 sq. inch per phase and 3 sq. inch for neutral.

c) 2500 A: 7.5 sq. inch per phase and 4 sq. inch for neutral.

The bus bars in ‘interleaved’ fashion for 2000A and above and shall be in ‘RYBN’ configuration. The busbars shall be of hard drawn high conductivity electrolytic grade aluminium alloy of 63401-WP as per IS 5082. The busbars shall be of rectangular cross section. The busbars shall be of uniform cross section along its entire length. No tapering of the busbar cross section is allowed.

The busduct enclosure for 2000A and above shall be of Aluminium alloy sheets of minimum thickness of 3 mm conforming to 19000 grade, H2 condition as per IS:6051, bolted on to an angle iron /structural steel framework. Busduct of rating up to 1600A shall be with MS enclosure of minimum 2mm thick CRCA sheets. The busduct shall be painted after suitable pre-treatment of all structural steel and plates with anti-corrosive epoxy base primer paint and two coats of anti-corrosive epoxy base paint, externally to shade RAL 7035 for indoor busducts and Admiralty Grey to shade 632 as per IS:5 for outdoor busducts. The enclosure shall conform to IP55 for outdoor and IP54 for indoor. Inner surface of the busduct shall be coated with black matt finish.

The bare busbars shall be provided with a coat of matt finish. The joints in the busbars shall be of the bolted type and it shall be ensured that the following precautions are observed:

d) The contact pressure must be ample, and this shall be maintained during the time the panel is in service.

e) The surfaces of the conductors must be clean.

f) With flat conductors, the overlap should be equal to or greater than the width of the bars or ten times the bar thickness whichever is greater.

g) The joints shall be treated by the application of joint compound to render the joint moisture-proof.

h) For the joints cadmium plated high tension MS bolts having expansion characteristics due to temperature change similar to the conductor may be used with steel nuts.

i) The efficiency of the joints shall be preserved by smearing the surfaces with oxide inhibiting grease just prior to making the joint. Minimum phase and earth clearances required shall be maintained at joints. The joints shall be thoroughly shrouded.

j) The busbar arrangements shall generally conform to IS:5578 and IS:11353. The bus duct shall be also supplied with two numbers of earth buses running throughout length of the busduct made of Aluminium strips of min. 75x10 mm.

k) The spacing between two aluminium flats of same phase shall be the thickness of one conductor.

The busbars shall have a short circuit withstanding capacity of 50 kArms for 1 sec. and a dyna DIGHI withstand capacity of 105 kA peak. The busbars shall be phase identified by colour, at intervals. Colour code shall be RED, YELLOW and BLUE for phase buses and BLACK for the neutral.

Busbars shall be supported on tough, non-hygroscopic, resin bonded self-extinguishing fire-retardant insulators preferably of SMC / DMC with ribbed construction to prevent tracking due to dust paths. Busbars and supports shall withstand the maximum stresses that are likely to be induced by the short circuit currents specified.

The busbar support shall be at an interval of not more than 500 mm. The busduct shall be supplied with copper flexible expansion joints at transformer end and aluminium expansion joints at switchgear ends. The supports and expansion arrangement shall be so chosen to avoid undue stress to the busbars, supports and end connections. Expansion joints with rubber bellows shall be envisaged wherever the length exceeds 4M.

Dust preventing gaskets ofPU Foam shall be used for enclosures to ensure water and dust tightness. The construction shall have removable covers at top and bottom side of the busduct.

Space heaters one each at termination ends and every 6M straight length with thermostats, controlled by MCBs, shall be provided to prevent moisture condensation, and maintain cubicle temperature 5 Deg. C above the ambient.

The clearance between the individual bare phase power busbars and between the phase and earth busbars in air shall be not less than 25 mm and 16 mm respectively.

Drain points shall be provided at the bottom of the busduct, at suitable locations. The busduct shall be provided with silica gel breathers, in all sections.

Wall frame assembly shall be provided at the wall crossings.

The bus duct should match with the flanges of the transformer and Switchgear Panels.

The manufacturer shall co-ordinate with the panel supplier to avoid ‘phase cross over’ chambers, in the busduct.

1.58.2 Tests

The busduct assembly shall be subjected to the following routine tests:

Visual inspection and dimensional checks

Insulation resistance test

Power frequency withstand voltage test at 2.5 kV.

The following type tests as per the latest revision of IS:8623 shall be carried out in the presence of the PURCHASER / CONSULTANT’S representative, if those tests have not been carried out for similar rating by the manufacturer within the past three (3) years:

Temperature rise test for the maximum rating called for in the price schedule

Short circuit test

Degree of protection

Test Certificates shall be submitted for the PURCHASER /CONSULTANT's approval before dispatch of the equipment.

1.58.3 Drawings and Manual

The drawings and manual shall be submitted as per the ‘List of Drawings / Documents to be submitted’.

1.59 Technical Specification for Battery And Battery Charger

This specification covers Design, Manufacture, Testing at works and supply of the complete battery chargers for three phases.

1.59.1 Applicable standards

The design, manufacture and performance of the equipment shall comply with all currently applicable standards, regulations, and safety codes. Nothing in this Specification shall be construed to relieve the Bidder of their responsibility.

Unless otherwise specified, the battery charger shall conform to the latest applicable Indian / IEC standards and in particulars to the following standards.

IS-3895 -Specification for rectifier equipment in general

IS-2208 -Specification for HRC fuses.

IS-1248 -Specification for Indicating Instruments.

IS-2147 -Degree of protection for cubicles

IS-375- -Specification for wiring

IS-4540 -Mono crystalline semiconductor rectifier Assemblies and equipment

IS-6619 -Safety code for semiconductor rectifier equipment.

IS-2026 -Transformers

IS-2959 -A.C contactor for voltages not exceeding 1000V

IS-6005 -Code of practice for phosphating of Iron and Steel.

IS-5921 -Printed circuit boards.

IS-249 -Printed circuit boards

The bidder shall clearly state the Standards to which the equipment offered by him conforms.

1.59.2 Construction

It will be indoor, freestanding, floor mounting and naturally air-cooled type, designed for continuous operation in the ambient temperature of 50˚C. Good ventilation shall be made through side louvers.

Each charging equipment offered shall be housed in a sheet steel cubicle reinforced by angle iron frame and shall be mechanically strong. The cubicle shall be dust and vermin proof. The rear and front door cover of the cubicle shall be hinged and shall have locking arrangement. sheet steel cubicle of 16 fold profile frame with thickness of 2mm for load bearing member and 1.5 mm for other sides

All the accessories and equipment shall be of adequate rating to suit the above requirements.

Gland plate: Gland plate of 3 mm thickness for incoming / outgoing cables shall be provided. Earthing with two separate earthing terminals shall also be provided.

All the door mounted equipments as well as equipments mounted inside the cabinet shall be provided with individual riveted /life lasting adhered labels with equipment description engraved.

Gland plate: Gland plate for incoming / outgoing cables shall be provided.

Arrangement for two separate earthing shall be provided.

Electrical indicating instruments shall be mounted flush-on panel with only flange projecting. The dial shall be white with black numbers and lettering.

The electronic control circuitry should have built in facture of soft start, so that whenever the charger is switched on, the output voltage should increase gradually.

1.59.3 Finish

Each cubicle will undergo a through process of de-rusting, cleaning, application of nanoceramic coating followed by electrophoretic dip coat and powder coat to RAL 7035. Paint thickness shall be 60 to 100 microns.

1.59.4 Wiring

All chargers will be complete with internal wiring and input and output terminals. The components shall be liberally rated. Standard colour code practice shall be followed, with the use of ferrule for numbering and identification of wires. 1.1 KV grade FR & C1 type copper conductor of suitable size shall be used. All hardware such as screws nuts, studs, washers shall be of brass and no ferrous parts shall be used in electrical circuitry control / power.

1.59.5 Ratings

Adequate rated 110V Battery charger with Ni Cd batteries for 8-hour autonomy shall be supplied by contractor. Appropriate sizing calculation should be submitted for approval.

1.59.6 Duty

The composite charger shall consist of two separate chargers, viz. the float charger and the boost charger. The charger shall be required to cater the following requirements.

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.

Normally the float charger shall operate in parallel with the 110 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 110 V to 126 V 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.

The float charger shall supply the DC output voltage with + / - 1% stability of adjusted value for AC voltage fluctuations for DC load variation from zero to 100% load.

During emergency, when the AC supply fails, the battery shall meet the DC load of the sub-station and in doing so, will get discharged gradually. The battery will need boost charging, for which, a separate charger, called the boost charger shall be required.

Boost charger shall have adequate rating to quick charge the battery fully within 5 hrs (Ni-Cd) after an emergency during which the complete DC load is met by the battery.

While boost charging the battery, the charger may also be called upon to supply the DC load of the substation in case of float charges failure. The required dropper diodes shall be provided to restrict load bus bar voltage not exceeding 126 volts DC

Boost charger shall incorporate static components, comprising of silicon-controlled rectifiers with necessary protection. Boost charger, apart from its normal constant current operation shall be also capable of constant voltage operation which shall enable it to operate as a float charger delivering stabilized DC output voltage within +/-1% from no load to full load in case of float charger failure. Suitable electrical circuitry shall be provided for this purpose. In the constant current mode, it shall have a current stability of +2% of the set value. The constant current setting shall have step less range from 10% to 100% of full rated current. Further, the boost charger shall have a provision of manual mode of operation, over and above auto-mode of operation. Required circuitry arrangement with auto/manual selector switch etc. shall also be provided for the purpose.

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 D.C. contactor may be incorporated which shall get energized through N/C contact of the contractor on A.C. side of the boost charger. In case of failure of A.C. supply, this contractor shall connect the entire battery supply to the load through one of its N/O contacts automatically without any interruption of D.C. supply even of a momentary nature. Under no circumstances the voltage across lower taped terminals shall exceed (+) 10% or fall below (-) 15% of the rated voltage.

1.59.7 Load Limiting

The charger shall be provided with load limiting feature for protection against overload. The load limiting curves shall be submitted with the offer. The SCRs / Thyristors shall be protected against voltage surges by providing voltage suppressor devices and/or other latest method of protection.

1.59.8 Incoming Power Supply

Incoming AC supply of 415 volts 50 Hz three phase, four wire for float & boost charger shall be available.

1.59.9 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 5% on resistive load. The DC output shall be free from switching surges, transients, etc.

1.59.10 Specific Provisions

The composite charging equipment shall have a separate float charger and a boost charger. Each charger shall consist of the following components and components shall be of the best quality and bill of materials along with rating of the same shall be submitted invariably with the offer.

1.59.11 Float Charger (Three Phases)

Float charger shall be provided with followings:

Three phase AC input ON / OFF main switch

AC input HRC fuses

Fuse fail and phase sequence reversal detector (Solid state type) for AC input.

LED type Indicator for AC supply „ON" indication (after main AC fuse).

Two winding copper wounds naturally air cooled three phase transformers of adequate rating with -15% to +10 % tapping (5% step) on primary side with necessary secondary tapes for achieving required control DC output voltage.

Full wave-controlled Rectifier Bridge comprising of silicon diodes and silicon-controlled rectifiers (SCR) with R/C surge suppressor network and suitable heat sink along with freewheeling diodes and semi-conductor fuse protection.

Fuse fail detector (Solid state type) for semi-conductor fuses

Ammeter of (with external shunt) for measuring DC output current of float charger

Auto / manual mode selector switch.

Potentiometer for controlling DC output voltage in auto and manual modes.

Suitable filter circuit comprising filter choke, filter condenser with HRC fuse protection and bleeder resistor. Bleeder resistor shall be automatically isolated from the circuit, when float charger current reaches to a value which is sufficient to keep the SCRs ON and it comes back into circuit when float charger current decreases to a value just above the hold ON current of the SCR.

Blocking diode with suitable heat sink.

DC output ON / OFF switch.

DC output fuses (HRC type).

DC „ON" LED type indicating lamp

Dropper diode selector switch with minimum three positions.

Diodes for dropper diode scheme (minimum 20 nos.).

Dropper Diode Bypass scheme in case of AC supply fail

Any item not specifically mentioned but required for efficient working of the equipment.

1.59.12 Boost Charger (Three Phase)

Boost charger shall be provided with followings

Three phase AC input ON / OFF main switch

AC input HRC fuse of required capacity

Fuse fail and ***phase sequence reversal*** detector (Solid state type) for ***AC input***.

LED type Indicator for AC supply „ON" indication indicating lamp for AC supply „ON" indication (after main AC fuse).

Two winding copper wounds naturally air cooled ***three*** phase transformers ***of adequate rating*** with -15% to +10 % ***tapping (5% step)*** on primary side with necessary secondary tapes for achieving required control DC output voltage.

Full wave-controlled Rectifier Bridge comprising of silicon diodes and silicon-controlled rectifiers (SCR) with R/C surge suppressor network and suitable heat sink along with freewheeling diodes and semiconductor fuse protection.

Fuse fail detector (Solid state type) for semi-conductor fuses

Ammeter of (with external shunt) for measuring DC output current of float charger

i. Auto / manual mode selector switch. Constant current constant voltage mode selector switch.

ii. Potentiometer for adjustment of constant current in boost mode.

iii. Potentiometer for controlling DC output voltage in float mode (auto and manual modes).

iv. Suitable filter circuit comprising filter choke, filter condenser with HRC fuse protection and bleeder resistor.

Bleeder resistor shall be automatically isolated from the circuit when float charger current reaches to a value which is sufficient to keep the SCRs ON and it comes back into circuit when float charger current decreases to a value just above the hold ON current of the SCR.

Thermal relay for overload protection.

Blocking diode with suitable heat sink.

Double pole DC output ON / OFF switch.

DC output fuses (HRC).

DC „ON" LED type indicating lamp with series resistor.

Dropper diode scheme ON / OFF switch.

Dropper diode selector switch with minimum four positions.

Diodes for dropper diode scheme (minimum 28 nos.).

Any item not specifically mentioned, but which is needed basically for efficient working of the equipment.

1.59.13 Common Components (Three Phase Charger)

DC Voltmeter, double pole 4 position rotary type to measure DC voltage across float section, boost section, load and battery with HRC fuse protection.

AC voltmeter to measure the AC input voltage with suitable fuse link and selector switch arrangement.

i. Range 0 - 300V for Single phase charger.

ii. Range 0 - 500V for Three phase charger.

DC charge / discharge ammeter with suitable external shunt to read discharge / charge current of the battery.

Ammeter (range 100 – 0 – 100 mA) showing the earth leakage current of the charger & out going circuit (load side).

DIN Rail Mountable Touch-proof UL approved PTC Type Space heater with UL approved Hygro- thermostat ON / OFF based switch and required fuses/MCB.

The charger shall be provided with horizontal CFL Suitable 9 W, 1200 Lumens, UL approved industrial grade LED Light with Built-in PIR without the need for door operated switch with Electrical Life of Minimum 60000 Hrs.

Detachable cable gland plates min. 2 Nos. for cable entry from bottom and size suitable for required cables.

DC contactor interlocked with boost charger AC contactor.

Silicon blocker diode with suitable heat sink to be connected to a suitable tapping of battery to maintain DC continuity during power failure while batteries are on boost charge.

Multipin socket with switch and fuse.

Foundation bolts as per requirements.

All switches shall be rotary type.

Lifting lugs

1.59.14 SCADA Compatibility

The Battery Charger shall be fully SCADA compatible. It shall have sufficient Nos of potential free contacts & transducers (4-20mA output) for digital and analogue signals respectively. It shall also be possible to control various functionality of Battery Charger from SCADA system through hard wire connection.

Typical I/O requirement is tabulated here under. The exact number and description shall be as per detailed engineering.

Parameters	Digital Inputs	Control Outputs	Analog Inputs (4-20ma)
AC mains fail	√		
Load Bus Over Voltage	√		
Load Bus Under Voltage	√		

Float Charger fail	√		
Earth Leakage	√		
Float Charger On	√	√	
Float Charger Off	√	√	
Float Charger on Auto mode	√		
Float Charger on Manual mode	√		
Boost Charger On	√	√	
Boost Charger Off	√	√	
Boost Charger on CV mode	√	√	
Boost Charger on CC mode	√	√	
Charger on local mode	√		
Charger on Remote mode	√		
Battery Voltage			√
Boost Voltage			√
Float Voltage			√
Load Voltage			√
Battery Current			√
Boost Current			√
Float Current			√
Load Current			√
Battery Room Temperature			√

1.59.15 Protection and Annunciation

Following alarms with alarm indicating lamps and alarm accept push button and lamp test push button shall be included in the scope of supply.

Load under voltage

DC Earth leakage

Float chargers fail

Main AC supply fail

DC over voltage relay for battery protection.

HV phase fail/phase sequence reversal protection

Boost charger failure

Semiconductor Fuse Fail - Float

Semiconductor Fuse Fail – Boost

AC Input Fuse fail – Float

AC Input Fuse fail – Boost

Looking to the detailed description of duty requirements of the charger and the battery, the manufacturer shall design a circuit which shall be capable of providing complete protection to various components of the unit and automatic i.e. with automatic voltage regulator in the float circuit operation of the unit without interruption.

Necessary product information booklet, drawings, circuit diagrams, operation & maintenance manual, all the type test reports as per applicable standards, supply & performance certificate etc. shall be submitted along with the offer.

1.59.16 Tests

1 Type Tests

The following type test reports as per applicable standard for Battery chargers shall be submitted with technical bid. Rectifier transformers shall conform to all type tests specified in IS: 4540 and short circuit test as per IS: 2026. The type test reports shall not be older than seven years from the expiry of the validity of the offer. Tests shall be carried out as per procedures specified in Annexure-I.

Voltage regulation test

Load limiter characteristics test

Measurement of Efficiency

High voltage test

Temperature rise test

Short circuit test at no load and full load at rated voltage for sustained short circuit.

Degree of protection test – *IP 42*

Measurement of ripple by Oscilloscope

Temperature compensation feature demonstration

Type test reports of Rectifier Transformers - all tests as specified in IS: 4540 and short circuit test as per IS: 2026

2 Acceptance / Routine Tests

The following test shall be carried out by the manufacturer on each battery charger.

Visual inspection and dimensions.

Checking of wiring & continuity of circuits

Insulation resistance.

HV test

Ripple content measurement

No load tests

Load test

Efficiency tests

Operational tests for protection, alarm, indication.

Auto/Manual operation test.

3 Packing and Marking

The equipment shall be dispatched securely packed in wooden crates suitable for handling during transit by rail / road, so as to avoid any loss or damage during transit. Three sets of each of the detailed dimensional drawings, commissioning and operating instructions manual, literature, write up and test certificates of bought items shall be supplied with each of the battery charger.

1.60 Technical Specification for DWC HDPE Pipe

This document specifies the requirement and testing for Double Walled Corrugated (DWC) HDPE Ducts buried underground including ducts & duct fittings for protection wherever required for all types of Electrical Cables.

1.60.1 Standards

This specification requires reference to the following specifications.

IS: 14930 Part-1	General requirements of Conduit system for Electrical and Communication installation
IS:14930 Pt.-II	Requirements of Conduit system for Electrical and Communication installation
IS:2530	Method for test for Polyethylene moulding materials and polyethylene compounds.
IS:7328	HDPE materials for moulding and extrusion
IS:12063	Classification of degrees of protection provided by enclosures of electrical equipment
IS:11000 (Pt-2/Sec1)	Glow-Wire Test and Guidance, Test Methods for Fire Hazard Testing
ASTM D 1693	Test method for environmental stress – cracking of ethylene plastics
ASTM D 638	Standard test method for tensile properties of plastic
ASTM D 790	Test method for flexural properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
ASTM D 2240	Standard Test method for Rubber property
ASTM D 648	Standard Test method for deflection temperature of plastic under flexure load in the Edgewise Position

1.60.2 General Requirements

The DWC Duct shall consist of two layers, the outer layer will be corrugated, and the inner layer shall be plain and smooth.

DWC Duct and conduit fittings within the scope of this specification shall be so designed and constructed that in normal use their performance is reliable and without danger to the user or surroundings.

When assembled in accordance with manufacturer's instruction as part of a conduit system, they shall provide mechanical protection to Electrical/power Cables contained therein.

Within the conduit system there shall be no sharp edge, burrs or surface projections which are likely to damage insulated conductors or cables or inflict impurity to the installer or user.

The protective properties of the joint between conduit and conduit fittings shall be not less than that declared for the conduit system.

The DWC Duct and fittings shall withstand the stresses likely to occur during transport, storage, recommended installation practice and application.

The DWC duct shall be supplied in continuous length in coil form or straight length, suitable for shipping and handling purpose.

For conduit systems that are assembled by means other than threads, the manufacturer shall indicate whether the system can be disassembled and if, so, how this can be achieved.

1.60.3 Requirements of Raw Materials used for the DWC HDPE Duct

The base HDPE resin used for the outer and inner layer of the DWC HDPE Duct shall conform to any designation of IS:7328 or to any equivalent standard meeting the requirements given in below table, when tested as per the standards given therein. However, the manufacturers shall furnish the designation for the HDPE resin as per IS: 7328 as applicable

Table 1-31: Raw Material Requirements for HDPE Pipes

S.No	Parameter	Specified Limit	Test Method
1.	Density	0.940 to 0.958 g/cc at 27ºC	IS:2530 or IS:7328
2.	Melt Flow Index	0.2 to 1.1 g/10 min at 190ºC, 5 kg load	IS:2530
3.	Tensile Strength at Yield	20 N/mm2 Minimum	ASTM D 638-IV
4.	Elongation at Break	600 % Minimum	ASTM D 638-IV
5.	Hardness Shore D	Between 60 and 65 units	ASTM D 2240
6.	Environmental Stress Crack Resistance	No cracking after 96 hrs.	ASTM D 1693
7.	Flexural modulus at 1 % strain	690 N/mm Minimum	ASTM D 790
8.	Heat Deflection Temperature at 45 g/mm2	65 Deg C Minimum	ASTM D 648
9.	OIT (in Aluminum Pan)	30 minutes minimum	As per Annexure-E

The anti-oxidants used shall be physiologically harmless.

None of the additives shall be used separately or together in quantities as to impair long term physical and chemical properties of the duct.

Single pass rework material of the same composition produced from the manufacturer's own production may be used and it shall not exceed 10% in any case.

The raw material used for extrusion shall be dried to bring the moisture content to less than 0.1%.

Suitable UV stabilizers shall be used only for manufacture of the non-, black-coloured HDPE duct to protect against UV degradation, when stored in open. The purchaser may ask for UV content test. The test result for UV Content test by FTIR method from any recognized laboratory shall be accepted and the Hindered Amine Light Stabiliser shall be minimum 0.15 %. UV Content test need not to be conducted in case of UV Stabilized raw material is used.

1.60.4 Requirement of DWC HDPE Ducts

Visual Requirement: The ducts shall be checked visually for ensuring good workmanship that the ducts shall be free from holes, breaks and other defects. The ends shall be cleanly cut and shall be square with axis of the ducts.

Colour: The colour of the duct viz. Black, Red, Green, Blue, Orange, Violet, Grey, Brown and Yellow. The purchaser shall specify the colour of the duct at the time of ordering.

Dimensions: The dimensions of the DWC HDPE Ducts shall be as per below table.

Table 1-32: DWC HDPE Pipes Dimensions

Nominal Size (mm)	Outside Diameter(mm)	Outside Diameter Tolerance (mm)	Minimum Inside Diameter (mm)
40	40	+ 0.8	30
50	50	+ 1.0	38
63	63	+ 1.2	50
75	75	+ 1.4	62
90	90	+ 1.7	74
110	110	+ 2.0	94
120	120	+ 2.2	102
125	125	+ 2.3	105
145	145	+ 2.7	122
160	160	+ 2.9	134
180	180	+ 3.3	151
200	200	+ 3.6	174
225	225	+ 4.1	195
250	250	+ 4.5	216
315	315	+ 5.7	268

Standards Length: Duct up to 50 mm OD nominal size shall be supplied in standard length of 100 mtr. ± 1% or 6 mtr ± 1 % and all other sizes will be supplied in standard length of 6 mtr. ± 1%

Compression Strength: The conduit system shall have adequate mechanical strength. Conduits when bent or compressed either during, or after, installation according to manufacturer's instructions, shall not crack and shall not be deformed to such an extent that introduction of the insulated conductors or cables becomes difficult or that the installed insulated conductors, or cables are likely to be damaged while being drawn in. Compliance may be checked with the application of force which shall be at least 450 N, when reaching the deflection of 5%.

Impact Strength: The conduit system shall have adequate mechanical strength. Conduits when exposed to impact either during, or after, installation according to manufacturer's instructions, shall not crack and shall not be deformed to such an extent that introduction of the insulated conductors or cables becomes difficult or that the installed insulated conductors, or cables are likely to be damaged while being drawn in. Compliance may be checked by ensuring there shall be no crack allowing the ingress of light or water between the inside and outside after the test.

Bending Strength: The conduit system shall have adequate mechanical strength. Conduits when bend either during, or after, installation according to manufacturer's instructions, shall not crack and shall not be deformed to such an extent that introduction of the insulated conductors or cables becomes difficult or that the installed insulated conductors, or cables are likely to be damaged while being drawn in. During the test sample shall not flatten Compliance shall be checked by passing a ball having a diameter equal to 95% minimum inner diameter of the sample declared by the manufacturer, through the sample whilst it is bent around the test apparatus.

Oxidation Induction Test (OIT): The OIT in a qualitative assessment of the level (or degree) of stabilization of material. The induction time in oxygen when tested with an Aluminium pan shall not be less than 30 minutes.

Resistance To Flame Propagation: Non flame propagating ducts shall have adequate resistance to flame propagation. Samples of DWC HDPE Ducts shall be checked by applying a 1KW flame.

Carbon Black Content: In case of black coloured duct Carbon Black Content by weight should be between 2 % and 3 %. Test shall be conducted in accordance with the IS: 2530

Anti Rodent Properties: Safety of ducts from the direct attack of subterranean organism anti rodent material is of utmost importance. These ducts shall be evaluated for their safety against rodents before laying them in the fields.

Resistance to External Influences on DWC HDPE Duct Accessories: The DWC duct accessories shall be tested for external influences as per IS-12063 for ingress of dust & ingress of water. DWC Duct systems when assembled in accordance with the manufacturer's instructions shall have adequate resistance to external influences according to the classification declared by the manufacturer with a requirement of IP 67.

Marking Identification: The conduit shall be prominently marked at regular intervals along their length of preferably 1m but not longer than 3m using indelible ink with following.

Manufacturers name

Specification No.

Name of the duct with size

Lot No. of the Product

Date of manufacture

Product Length

Purchaser's Name/ symbol

1.60.5 DWC Duct Accessories.

The following accessories are required for jointing the ducts and shall be supplied along with the ducts against specific orders. The manufacturers shall provide complete procedure and method for installation of the accessories. The required quantities of accessories are to be mentioned by the purchasing authority in the purchase order.

a) Plastic Coupler:

The coupler shall be of Push-fit type with O-ring. It is used for jointing two or more ducts. The design of this shall be simple, easy to install and shall provide airtight and watertight joint between the two ducts. The coupler shall insure that the two ducts are butted smoothly without any step formation in the inner surface. The coupler may be straight, bands, T-joints type as per requirements of purchaser.

b) End Cap:

This cap made of suitable plastic material shall be fitted on both ends of duct, coil after manufacturing the duct. This shall avoid entry of dust, mud, and rainwater into the duct during the transit & storage.

The dimensions of accessories shall be suitable for joining the ducts of dimension

1.60.6 Type Tests

Complete DWC Duct systems for each offered size of the duct on fresh samples shall be subjected to following tests minimum after 240 hrs of manufacture.

a) Visual Requirement

b) Color

c) Dimension

d) Standards length

e) Compression Strength

f) Impact Strength

g) Bending Strength

h) Oxidation Induction Test

i) Resistance to Flame Propagation

j) Carbon Black Content

k) Anti rodent

l) Resistance to External Influences on DWC HDPE Duct accessories

The Oxidation Induction Test, Resistance to Flame Propagating Test, Carbon Black Content Test, Anti Rodent Test on the DWC duct and Resistance to External Influences on DWC HDPE Duct accessories shall be conducted at the manufacturer’s laboratory by inspecting authority or at any recognized laboratory.

The raw material tests of the DWC duct shall be conducted for each grade of raw material Test may be conducted at the manufacturer’s laboratory by inspecting authority or at any recognized laboratory.

Unless otherwise specified each test shall be made on three new samples.

1.60.7 Acceptance Tests

The following test shall be carried after 240 hrs of manufacture on samples selected from the lot as per sampling plan.

a) Visual Requirement

b) Color

c) Dimension

d) Standards length

e) Compression Strength

f) Impact Strength

g) Bending Strength

h) Oxidation Induction Test

i) Resistance to Flame Propagation

The Resistance to Flame Propagating Test on DWC HDPE Duct may be conducted at the manufacturer's laboratory by inspecting authority or at any recognized laboratory.

Unless otherwise specified each test shall be made on three new samples.

1.60.8 Routine Tests

The following tests be carried out by the manufacturer after 240 hrs of manufacture: -

a) Visual Requirement

b) Color

c) Dimension

d) Standards length

e) Compression Strength

f) Impact Strength

g) Bending Strength

h) Resistance to Flame Propagation

The Resistance to Flame Propagating Test on DWC HDPE Duct shall be conducted at the manufacturer's laboratory by inspecting authority or at any recognized laboratory.

The Density and Melt Flow Index tests on raw material of the DWC duct for each grade of raw material shall be conducted.

1.60.9 Inspection

All the gauges/ test & measuring instruments shall be under calibration control at the time of inspection and proof to this office shall be produced.

Inspection and testing shall be carried out by the inspecting authority nominated by the purchaser to ensure that all the requirements of this specification are complied with for the acceptance of the materials offered by the supplier for inspection.

The purchaser or his nominee shall have free access to the works of the manufacturer and to be present at all reasonable times and shall be given facilities by the manufacturer to inspect the manufacturing of the duct at any stage of manufacture. He shall have the right to reject whole or part of any work or material that does not conform to the terms of this specification or any equivalent specification or requirement applicable and may order the same to be removed / replaced or altered at the expense of the manufacturer. All reasonable/complete facilities considered necessary by the inspecting authorities for the inspection of the ducts shall be supplied by the manufacturer free of cost.

The manufacturer shall supply the duct samples and samples of the raw materials free of charge as required by the inspecting authority and shall at his own cost prepare and furnish the necessary test pieces and appliances for such testing as may be carried out at his own premises in accordance with this specification. Failing the existence of facilities at his own premises for the prescribed tests, the manufacturer shall bear the cost of carrying out the tests in an approved laboratory, workshop, or test house.

1.60.10 Information to be supplied by the Purchaser

Normally the duct will be supplied as per the standard dimensions and length as mentioned in this document. However, purchaser may specify his own dimensions/lengths/packing requirements etc. In such cases necessary tolerance shall also be specified by the purchaser.

Adequate quantity & type of duct accessories shall be supplied along with each lot. Purchasers may specify additional requirement.

Inspecting agency for acceptance of material.

Colour of the Duct.

1.60.11 Packing and condition of delivery

The pipe may be supplied in loose sticks.

All materials furnished and all work performed shall be inspected and tested. Deliverables shall not be shipped until all required inspections and tests have been completed, and all deficiencies have been corrected to comply with this Specification and approved for shipment by the Employer.

Except where otherwise specified, the Contractor shall furnish all manpower and materials for tests, including testing facilities, power and instrumentation, and replacement of damaged parts. The costs shall be borne by the Contractor and shall be deemed to be included in the contract price.

The entire cost of testing for factory & site acceptance, routine tests, production tests and other test during manufacture & site activities specified herein including the expenses of Inspector/Employer’s representative shall be treated as included in the quoted unit price of materials.

Acceptance or waiver of tests will not relieve the Contractor from the responsibility to furnish material in accordance with the specifications.

All tests shall be witnessed by the Employer and/or its authorized representative (hereinafter referred to as the Employer) unless the Employer authorizes testing to proceed without witness. The Employer representative shall sign the test form indicating approval of successful tests.

Should any inspections or tests indicate that specific item does not meet Specification requirements, the appropriate items shall be replaced, upgraded, or added by the Contractor as necessary to correct the noted deficiencies at no cost to the Employer. After correction of a deficiency, all necessary retests shall be performed to verify the effectiveness of the corrective action.

The Employer reserves the right to require the Contractor to perform, at the Employer's expense, any other reasonable test(s) at the Contractor's premises, on site, or elsewhere in addition to the specified type. Acceptance, Routine or Manufacturing tests to assure the Employer of specification compliance.

The Employer also reserves the right to require any retesting of previously approved tests at the Employer's expenses. However, if the retest(s) reveal non-compliance to the specification, the Contractor shall bear the expenses for the retesting and remedial action at no cost to the employer.

1.60.12 Factory Acceptance Test

Factory acceptance tests shall be conducted on randomly selected final assemblies of all equipment to be supplied. Visual inspection shall be carried out on 100% basis for all the equipment/items offered. Factory acceptance testing shall be carried out on HDPE and accessories.

Material shall not be dispatched to the Employer until required factory tests are completed satisfactory all variances are resolved, full test documentation has been delivered to the Employer, and the Employer has issued Material Inspection & Clearance Certificate (DIGHIC). Successful completion of the factory tests and the Employer approval to dispatch shall in no way constitute final acceptance of the system or any portion thereof. These tests shall be carried out in the presence of the Employer's authorized representatives.

Factory acceptance tests shall not proceed without the prior delivery to and approval of all test documentation by the Employer.

The factory acceptance test shall demonstrate the technical characteristics of the equipment in relation to these specifications and approved drawings and documents. The factory acceptance test for items shall be proposed by the Contractor in accordance with technical specifications and Contractor's (including Sub-Contractor's/supplier's) standard FAT testing program. For Test equipment, FAT tests shall include supply of proper calibration certificates, demonstration of satisfactory performance, evidence of correct equipment configuration and manufacturer's final inspection certificate/report.

1.60.13 Sampling

All the length of same nominal size, similar construction and class manufactured from the same material under essentially similar conditions of production shall be grouped together to constitute a lot.

For judging the conformity of a lot to the requirements of the acceptance tests, sampling shall be done for each lot separately. For this purpose, the number of lengths to be selected at random from the lot shall be in accordance with below table.

Table 1-33: Scale of Sampling

Lot Size	For dimensional requirements		Other Acceptance test
	Sample size	Permissible Number of defectives	
Up to 300	13	0	2
301 to 500	20	0	3
501 to 1000	32	1	4
1001 to 3000	50	2	5
3001 and above	80	3	7

Theses lengths will be selected at random from the lot for taking samples. From each of these lengths, sample of duct shall be taken. The length of the sample shall be sufficient so as to provide test pieces of required lengths as laid down in various test clauses.

1.60.14 Site Acceptance Tests

Randoms checks somewhere in the middle of the pipe, by cutting the duct, will be made at site to ensure that ducts supplied are of correct dimension and thickness and there is no compromise on thickness in intermediate length, for saving in materials cost.

100% Duct pipe being supplied would be measured length to cross check the length of the duct pipe.

To keep a check on the use of filler material, ash contents would be determined on randomly selected samples as per ASTM D 1603 method and the value of ash content, thus determined, shall not exceed 0.3% (outer coloured layer).

UV Stabilise Content: UV Stabiliser content of finished duct shall not be less than 0.15%

Third party inspection on above, in addition to inspection at factory, would be carried out by independent agencies. on randomly picked up samples from field for testing of relevant parameters, thereby ensuring right quality of ducts. Failure of samples to pass any of the prescribed tests/parameters would result in immediate invoking of PBG/Blacklisting of the Vendor.

1.61 Technical specifications for RCC cable trench with Cable tray's

1.61.1 Scope of Work:

The scope is to provide the complete RCC Trench for Electrical system, complete in all respects and covers design, engineering & procurement and to undertake subsequent DLP and O&M as detailed in the General Specifications sections. Any works required to provide a complete and fully functional and safe system shall be deemed to be included whether mentioned here or not. The scope of works shall broadly consist of the following items.

RCC Trench & Civil works for 11kV, 1.1kV and OFC complete in all resoects, Cables will be laid in tier formation through the cable trenches which is not scoped in this tender

The Contractor shall design and construct the complete works of RCC trench necessary at site required to complete the electrical system.

All general civil specifications are mentioned in separate chapter.

1.61.2 Consideration

0DR-C-1000 to DI1501-RHD-PE-PS-DR-C-1083

1.61.3 Road Crossing

From the feeder pillar onward, the service cable shall also be laid in flexible adapter (duct) and extension from nearest RCC able trench to the meter board individual plot.

Wherever the Cables are crossing the road from RCC cable trench and cables shall be laid through HDPE Conduits. Pulpit/Manhole shall be provided either side of the road crossing cables through HDPE conduit.

Cables crossing the bridges the cable shall be laid through suitable size of pipes as per instructions of the Engineer

1.61.4 Dewatering

Sump pit will be provided at suitable interval in cable trench for dewatering purpose. Suitable slope towards sump pit to be maintained in cable trench to avoid water logging within cable trench. Sump pit water to be drain out through portable water pumps. The pumped-out water from the trench shall be disposed of in existing storm water arrangement nearby.

1.62 Technical Specification for Pushbutton stations

1.62.1 Scope

The specification covers the requirement of design, manufacturing, testing, packing and supply of industrial type Push button stations and accessories suitable for Installation in safe outdoor areas.

1.62.2 Codes and Standards

The equipment shall comply with the requirements of latest revision of the following standards issued by BIS (Bureau of Indian standards) unless otherwise specified.

a) IS-5 - Colors of ready mixed paints and enamels

b) IS 1248 (part 1&2) - Direct acting indicating analogue measuring instruments and their accessories

c) IS 13947 (part1&5) - LV switchgear and control gear

1.62.3 General Requirements

The offered equipment shall be brand new with state-of-the-art technology and proven filed track record. No prototype equipment shall be offered.

Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment for at least 10 years from the date of supply.

1.62.4 Site conditions

The equipment shall be suitable for installation and satisfactory operation in tropical, humid and corrosive atmosphere as material handling plant unless otherwise specified design ambient temperature of 50 deg C shall be considered.

1.62.5 Technical requirements

1 Construction

The Enclosure of the control station shall be made SS 316 L single sheet construction brushed grain 240 with Pu foam gasket, dust and vermin proof, wall/structure mounting.

The control stations shall be suitable for use in outdoor open locations and shall have IP65 degree of protection. They shall preferably be provided with integral canopy.

Control station shall be suitable for 240V AC control supply

The control station shall be provided without Foam gaskets

If the enclosures requires painting (both internal and external) Nanoceramic coating, electrophoretic dip coating followed by powder coating with C5H painting wherever if required

All accessories like nuts, bolts, washer etc. shall be made of stainless-steel SS-304

The control station shall be provided with two earthing studs with lugs on the external surface of the enclosures suitable for termination of 8SWG GI wire.

The control stations shall be provided with undrilled gland plate. However double compression nickel-plated brass cable gland shall be supplied loose to suit the specified cable sizes.

The control stations shall have external fixing lugs for mounting on wall or column. The holes provided on these lugs shall be of oblong type.

A name plate indicating TAG NO. shall be provided one ach control station. The nameplates shall be engraved on 3 plies white, black la DIGHI old sheets using square cutters. Black engraved Perspex sheet nameplate shall also be acceptable. Nameplates shall be fixed by screws and shall not be pasted.

2 Component Specification

Push buttons for START & STOP shall be of GREED and RED color respectively. Unless otherwise specified each push button shall have one normally open (BO) and one normally Close (NC) contract. The START/STOP push button shall have flush mounted type.

Emergency stops push button to be stay put type with mushroom head press to lock and twist to unlock type. Emergency stops push button hard wired to MCC/HT switchgear.

All control switches shall be provided key-operated selector switch, two position maintained. Unless otherwise specified, all selector switches shall have minimum two poles for each position. Each position of switch shall be indelibly marked on the control station selector switches shall have spare contacts.

All ammeters shall be of moving iron type having an accuracy class of 3 and suitable for 1 ampere CT secondary. Unless otherwise specified, minimum size of ammeter shall either be 72mmx72mm or maximum 92mmx92mm, 80% of the scale length shall be cover 100% of the CT primary current uniformly and the balance 20% of the scale shall cover 100-600%of the CT primary. A red marked corresponding to the full load current of the motor shall be provided on the ammeter dial. The ammeter front glass shall be toughened.

All ammeters shall be digital type (for above 30kW motor). Motor starters shall be provided with suitable dual (4-20mA) output transducers connected to the secondary of the current transformer in respective panels/modules for push button station ammeters.

All push button and control switch contracts shall be rated for min 5 Amps at 240V AC.

Indicating lamps wherever provided, shall be clustered LED type mounted inside an enclosure of minimum diameter of 15mm

3 Terminal & Wiring

The control stations shall be provided with required number of terminals with 20% spare terminals. More than 2 wires per terminal shall not be permitted. If required, additional terminal with shorting link may be used. Each terminal for external cable connection shall be suitable for termination of 2.5 Sq.mm solid copper conductor. In case lugs are required for cable termination, tinned copper type lugs shall be provided.

All internal wiring shall employ 2.5 sq.mm 660V grade, PVC insulated copper conductor wires.

4 LCS shall be provided with minimum following devices

Local/Remote selector switch, STOP, EMERGENCY STOP and START pushbuttons, LED lamps (local permissive, status etc.), Digital Ammeter (Above 30kW or VFD controlled LT motors).

1.62.6 Inspection, testing and Acceptance

During fabrication, the equipment shall be subjected to inspection by end customer or by customer consultant or by an agency authorized by the customer (Third party), if specified/agreed in inspection test plan. Manufacturer shall furnish all necessary information concerning the supply to inspector All routing/acceptance test shall be carried out at manufacturer’s work under his care and expense.

Test certificate of bought out components shall be shown to the inspection agency on demand during inspection.

All equipment’s shall be subjected to various acceptance test as per standard but not limited to the following:

a) General visual inspection

b) Dimensional inspection

c) Verification of mechanical and Electrical operations

d) Dielectric test

e) Any other routine and acceptance test as per applicable standards.

1.62.7 Drawings/Documents to be furnished for approval.

General arrangement and dimensional drawing of equipment including weight, fixing details

Complete technical data sheet of the equipment

Wiring diagram of equipment

Painting and constructional details

Quality control plan

1.63 Solar Tree

In open/green space, solar tree can be provided based on feasibility of location. A solar tree is a structure where solar modules are planted on a single pillar, which looks like a tree trunk. It serves the dual purpose of being an artwork and an energy generator. The solar tree is capable of incorporating IOT-based features, i.e. round-the-clock CCTV surveillance in agricultural fields, real-time humidity, wind speed, rainfall prediction and soil analytics sensors.

Recently solar tree has been installed at the CSIR-CMERI Residential Colony, Durgapur. Each solar tree will cost ₹750,000. In all, there are 35 solar photovoltaic (PV) modules in each tree with a capacity of 330 W each. Total capacity of one solar tree is approximately 11.5 kWp. Description of Solar tree has been mentioned in this report to promote the installation of same by individual developer/plot owners in future. This requirement will be made mandatory for plot owners through the Development Control Regulation.

1.64 Design Life

S.No.	Items	Design Period in years	Code Reference (all latest versions to be used)
A	Road layers		
1	Bituminous layers	10	IRC 37: 2018
2	Base, Sub-base and Embankments	20	IRC 37: 2018
B	Drainage Structures		
1	Cross Drainage Works - HP drains	100	IRC 84: 2014
2	Cross Drainage Works - Box drains	100	IRC 84: 2014
3	RCC Side Drains	30	CPHEEO Manual
C	Misc. Items		
1	High mast - GS	25	CPWD Manual
2	Light poles - GS	25	CPWD Manual
3	Underground cabling	20	CPWD Manual
D	Pumping and Pipes		
1	Electric motors - single phase	15	CPHEEO Manual
2	Electric motors - Three phase	15	CPHEEO Manual
3	Electric Pump	15	CPHEEO Manual

S.No.	Items	Design Period in years	Code Reference (all latest versions to be used)
4	Diesel Pump	10	CPWD Manual
5	Diesel Generator	12	CPWD Manual
6	Sewage Pump	15	CPHEEO Manual
E	Substation		
1	Transformers	25	CPWD Manual
2	Switchgear LT/HT	20	CPWD Manual
3	Voltage Stabilizer	10	CPWD Manual
F	Civil Structures		
1	Storage by dams	50	CPHEEO Manual
2	Pumping station - Pump house- Civil Structure	30	CPHEEO Manual
3	Sewage Treatment Plant		
a)	Civil Structures	30	CPHEEO Manual
b)	Electrical & Mechanical Components	15	CPHEEO Manual
4	Water treatment units	15	CPHEEO Manual
5	Pipes and distribution systems	30	CPHEEO Manual
6	Reservoirs - Overhead and ground level	30	CPHEEO Manual

1.65 List of Proposed/Preferred Makes for Electrical Equipment's

Make of Electrical equipments should be compliance with MSETCL/MSEDCL List of proposed/preferred vendors as listed in the Approved Vendor List. Contractors shall refer latest MSETCL/MSEDCL official circular on the List of proposed/preferred vendors, as applicable.

1.65.1 Vendor approval criterion

Vendor approval shall be based on the records/credentials furnished by the vendors. Following are approval criterion shall be adapted.

CPRI/CBPC/ERTL/ISA/ERDA or equivalent State/Central Government Agencies approvals, not earlier than last Five years.

Approval of the Works from the State Licensing Authority.

Nomenclature/Capacity Range of the Product to be mentioned clearly.

Valid Calibration Certificates of the Instruments being used for the measurement of respective parameters during internal testing.

Factory Internal Test and Quality Procedures.

Copies of PO bagged from Government/Private agencies, not later than, in last Five years.

Copies of Test Reports/Factory Acceptance tests duly signed by End Users/Clients

Satisfactory Performance Certificate, after the Product has been commissioned.

Authorization Letter to supply & commission, wherever applicable, from original Equipment Manufacturer (OEM).

Preference to Vendors may be considered for Approval, if already approved from MSETCL/MSEDCL/NICDC/MITL with above requisites, also available.

All documents to be self-attested and sealed by the Supplier, duly compiled with the Index Folder.

1.66 List of Drawings- Electrical

As per Volume 3.