VADODARA SMART CITY DEVELOPMENT LTD.

VOLUME – II – PART - 2

TECHNICAL SPECIFICATION OF ELECTRICAL WORKS

TENDER FOR

"Design, engineering, procurement, supply, erection, testing, commissioning and demonstration of performance guarantees for sewage pumping sets along with associated electrical equipment, manifold with C.I. piping system, required civil works, for Sewage Pumping Stations for Vadodara City -Part-1"

DECEMBER -2019

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1. SCOPE OF WORK:

1.1. The scope of services covers the design, detailed engineering, preparation of construction drawing, manufacture, acceptance testing at manufacturer's works or at any accredited agency, supply, packing, forwarding and delivery from manufacturer's works/ place of storage to erection site including transit insurance, unloading, storage at site, moving from place of storage to place of installation, assembly, Cleaning/ lubricating, Touch up painting, erection, testing, commissioning & performance demonstration and handing over along with all necessary spares of original ratings & specifications on Design, Build and O&M as per tender (including a year of defect liability period). Inland and overseas transit insurance, transport, testing at site shall be Contractor's scope. Tender BOQ and drawings, if provided, are for reference purpose only which is the minimum requirements; Contractor shall ensure that design & equipment ratings shall be as per specification requirements.

1.2. The Contractor shall prepare design calculations based on parameters/ design criteria indicated in the specifications. The Contractor shall prepare detailed engineering and construction purpose drawings to make his/ her own estimate of ratings & quantities (minimum requirements as per price schedule, technical data sheets & other relevant details) for entire electrical including all items, systems such as equipments, power & control cables/ cabling system, lighting system, earthing, lightning protection, main & auxiliary power distribution, instruments, civil works required for completion of Works.

1.3. Contractor shall take due care of the site Seismic conditions while design of all equipments/ components used in entire electrical & instrumentation systems covered in this specification. Contractor shall furnish list of additional design parameters considered in design to fulfill above requirement.

1.4. Design and detailed engineering of the materials procured by Contractor is included in scope. Contractor shall submit each document/ calculations of system which is included in scope to Purchaser/ Consultant for final review/ approval. All design documents/ calculations prepared by Contractor shall be with ISO documentation i.e. with duly singed by qualified authorities and stamped. Design documents/ calculations prepared by sub-Contractors shall be approved by Contractor and stamped copy of approval along with no-deviation sheet from sub-contractor shall be submitted by the Contractor to Purchaser/ Purchaser's representative for final review/ approval. In case of revision on any calculation/ Drawing/ Document, revised drawing shall be submitted with proper compliance report.

1.5. Expert or manufacturer supervision for sub-contractor supplied material shall be provided by Contractor and included in offer.

1.6. Contractor shall be solely responsible for any shortages or damages in transit for his supply scope, handling and/ or in storage of any materials and erection of the equipment, supply of erection tools at site. Contractor shall ensure that it will not affect any activity or project schedule. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.

1.7. Contractor shall identify activities and mile stones of the work forecasted for next month with optimistic and pessimistic dates of work completion. Contractor shall prepare program evaluation and review techniques to identify critical path of project and activity sequences. The project schedule shall be prepared and updated fortnightly in MS Project.

1.8. Nothing in this specification shall be constructed to relieve the Contractor of his/ her responsibilities towards following best engineering practices established in the country.

1.9. Obtaining approval including load sanction/ release from Gujarat Energy Transmission Corporation (GETCO)/ Madhya Gujarat Vij Company Ltd. (MGVCL)/Gujarat Electricity Board (GEB), No Objection Certificates from GETCO/ MGVCL /GEB, Electrical Inspector (CEIG), relevant Government Agencies, Statutory Authorities, as applicable is included in Contractor's scope.

1.10. All necessary legal fees required for various applications to GETCO/ MGVCL /GEB/ Electrical Inspector (CEIG), relevant Government Agencies, Statutory Authorities shall be paid by the Purchaser upon production of valid receipts. The GETCO/ MGVCL /GEB deposit required to be paid for Load Release shall also be borne by the Purchaser.

1.11. The Contractor's scope shall also include measurement of soil resistivity at site by Wenner's four electrode method as per IS: 3043 – 1987 (Reaffirmed in 2006) at minimum four locations at site (for individual pumping station). The earthing system shall be designed for the actual mean soil resistivity value obtained.

1.12. Even if all components of a system included in this specification are not explicitly identified and/ or listed herein, these shall be supplied under this contract to ensure completeness of the system and facilitate proper operation and easy maintenance of the plant. Any and all other works not indicated above but necessary/ required to complete the job in all aspects, are included in the Contractor's scope.

1.13. The Contractor shall include start up spares, essential spares, recommended spares and a set of special tools necessary for operation, routine maintenance of equipment supplied for a period of five years.

1.14. Contractor should visit site and get himself/ herself ascertained regarding the scope of work for the complete Electrical works before submission of quote/ offer. Contractor shall verify from the client all accessories required for normal and satisfactory operation (as deemed by the Purchaser) of the equipment, in case of any confusion, before submission of bid and shall be considered as a part of the Contractor's basic scope of supply and/ or work and no claims whatsoever, for extra payment on these grounds, will be accepted later.

1.15. Contractor's scope shall include design, engineering, manufacture, supply, testing, commissioning and handover of following electrical equipment/ systems as per tender specifications, BOQ & other relevant details. Voltage and fault level for supply shall need to be confirmed with GETCO/ MGVCL/GEB by Contractor before the commencement of design.

1.16. Tariff metering equipment & electric supply connection shall be provided by GETCO/ MGVCL /GEB for which necessary liaison shall be done by Contractor.

1.17. Two/ four pole structure (along with necessary earthing, fence and gate) for receiving incoming supply with GOD (including operating handle and lock), Lightning Arrestors and Drop Out Fuses (wherever applicable for transformer(s) being fed directly from Two/ Four pole structure) for the incoming power supply obtained through overhead transmission line/ cable.

1.18. Incoming point of supply breaker panel/ Ring Main Units (if installed capacity of transformer exceeds 400 kVA/ as per statutory requirement) outdoor type.

1.19. Oil type, ONAN, Dyn11, Distribution Transformers with OCTC/ OLTC + RTCC, AVR, Marshalling box.

1.20. Existing transformer at Ajwa Road Pumping station, Bakrawadi APS and Wagodia pumping stations shall be reused. Checking for healthiness and revamping of the same is in contractor's scope. In case the transformer (partially or totally) is found to be unhealthy for reuse the same shall be discussed with client.

1.21. LV metal enclosed switchgears including Power and Motor Control Centre (PMCC) including starter feeders, equipments (as per technical specification requirements and approved SLD during detailed engineering), PDBs, Sub DBs, Lighting DBs, Receptacles for utilities. Local Start/ Stop push button stations shall be provided near those motors which are not controlled from a local console/ panel.

1.22. For pumping stations with maximum demand less than 100 kVA, fixed type capacitor shall be provided for motor feeders to improve the power factor up to 0.99.

1.23. For pumping stations with maximum demand more than and equal to 100 kVA APFC panel with LV capacitor banks consisting of automatic power factor correction (APFC) relay to improve the power factor up to 0.99.

1.24. Cabling system shall consists of 11 kV grade (UE) and 1.1 kV grade (E), XLPE/ PVC insulated, multi-stranded Al/ Cu, GI round wire/ flat strip armored power cables.

1.25. Proper installation of cable carrier system, including ladder type cable tray for power cable and perforated cable tray for control cable angles/ channels etc. is in contractor's scope

1.26. Earthing for HV/ LV equipments and lightning protection system for all buildings in the Sewage Pumping works locations. The general design shall be on the basis of IS,IEC and CEA regulations and standards (their latest amendments) in line with design criteria & specification requirements.

1.27. Lighting system for all indoor & outdoor areas of Sewage Pumping Station . The lighting system will be controlled by lighting panels installed in respective plant/ station areas, which will be fed from PCC/MCC/PLDB.

1.28. Submission of drawings & documentation as specified under ''General Technical & Particular Requirement'' section for Electrical equipment/ systems.

1.29. Contractor's scope shall also include all civil works and structural works required for installation of all electrical equipment/ systems such as equipment foundations, indoor & outdoor trenches, equipment support structures, two pole structures, control rooms, all excavation works including those for earthing, cabling etc, de-tanking area, soak pits, burnt oil pits, chamber etc.

1.30. Contractor's scope shall also include supply, installation testing and commissioning of fire safety equipment which includes providing printed Instruction Chart both in English and Gujarati and duly framed with front glasses for treatment of person suffering from electric shock, First Aid Box with all the standard contents, fire bucket with 9 Litre Capacity, Fire Bucket Stand, fire extinguisher (CO2 Type), 11kV Rubber Hand Gloves and 6.00 mm thick Rubber Mat for LV of required length and breath.

1.31. It is not the intent to completely specify all details of design and construction herein. Nevertheless, the Electrical system shall conform to high standard of engineering, design and workmanship in all respects and shall be capable of performing satisfactorily in continuous commercial operation under the specified environmental conditions.

1.32. Purchaser reserves the right to issue addendum to the technical specification to indicate modification/ changes in the requirements, if so required at a later date.

1.33. Any additional claim done by the contractor shall be in accordance with GWSSB SOR/ Approved rate of VMC.

1.34. Battery Limit of the contractor shall start from the DP structure owned by VMC. Any augmentation in the incoming side owned by MGVCL, due to increase of electrical demand shall be solely owned by VMC. Any supporting documents like test reports, inspection report etc, restricted to the battery limit, required for the augmentation work shall be provided by the contractor.

1.35. Dismantling and transporting them to area designated by VMC/ VSCDL (within the city limit) of existing transformer, panels and other equipment which are not reused is in the scope of contractor.

1.36. Individual Pump House Scope:

1.36.1. GIDC APS (New)

1.36.1.1. Preparation of detailed electrical design/calculation/ drawings.

1.36.1.2. Dismantling of existing transformer and installation of new 11/ 0.433 kV transformer.

1.36.1.3. Supply, installation, testing and commissioning of LV Distribution Board (LVDB/ PCC)

1.36.1.4. Supply, installation, testing and commissioning of Power and Lighting Distribution Board (PLDB)

1.36.1.5. S.I.T.C. Of Approved make industrial type 32 A TPN (3P+N+E) Wall mounted socket with isolating switch conforming to IP-67.

1.36.1.6. Supply, laying, testing & commissioning 1.1 kV grade, XLPE insulated, stranded Aluminium conductor, galvanized steel flat strip / round wire armoured, extruded PVC type ST2 sheathed, heavy duty cable along with termination, straight through joints and glands

1.36.1.7. Supply, Installation, fabrication, testing & commissioning of cable carrier system.

1.36.1.8. Design, supply, erection, testing and commissioning of suitable general lighting arrangement for pump house, electrical room & switchyard area including required lighting fixtures, fittings, point wiring, distribution box, street lighting poles with junction box, exhaust fan etc. with complete job.

1.36.1.9. Supplying, installation, testing & commissioning of earthing system along with earth pit, earthing grid, air termination, down conductor with test link, complete in all respect.

1.36.1.10. Supplying, installation, testing & commissioning of fire safety equipment.

1.36.2. GIDC APS (Old)

1.36.2.1. Preparation of detailed electrical design/calculation/ drawings.

1.36.2.2. Dismantling of existing transformer from Kalali-II APS, transporting it to GIDC APS and reinstalling it at site after and installation of new 11/ 0.433 kV transformer.

1.36.2.3. Supply, installation, testing and commissioning of LV Distribution Board (LVDB/ PCC)

1.36.2.4. Supply, installation, testing and commissioning of Power and Lighting Distribution Board (PLDB)

1.36.2.5. S.I.T.C. Of Approved make industrial type 32 A TPN (3P+N+E) Wall mounted with isolating switch conforming to IP-67.

1.36.2.6. Supply, laying, testing & commissioning 1.1 kV grade, XLPE insulated, stranded Aluminium conductor, galvanized steel flat strip / round wire armoured, extruded PVC type ST2 sheathed, heavy duty cable along with termination, straight through joints and glands

1.36.2.7. Supply, Installation, fabrication, testing & commissioning of cable carrier system.

1.36.2.8. Design, supply, erection, testing and commissioning of suitable general lighting arrangement for pump house, electrical room & switchyard area including required lighting fixtures, fittings, point wiring, distribution box, street lighting poles with junction box, exhaust fan etc. with complete job.

1.36.2.9. Supplying, installation, testing & commissioning of earthing system along with earth pit, earthing grid, air termination, down conductor with test link, complete in all respect.

1.36.2.10. Supplying, installation, testing & commissioning of fire safety equipment.

1.36.3. Narahari APS

1.36.3.1. Preparation of detailed electrical design/calculation/ drawings.

1.36.3.2. Dismantling of existing transformer and installation of new 11/ 0.433 kV transformer.

1.36.3.3. Supply, installation, testing and commissioning of LV Distribution Board (LVDB/ PCC)

1.36.3.4. Supply, installation, testing and commissioning of Power and Lighting Distribution Board (PLDB)

1.36.3.5. S.I.T.C. Of Approved make industrial type 32 A TPN (3P+N+E) Wall mounted socket with isolating switch conforming to IP-67.

1.36.3.6. Supply, laying, testing & commissioning 1.1 kV grade, XLPE insulated, stranded Aluminium conductor, galvanized steel flat strip / round wire armoured, extruded PVC type ST2 sheathed, heavy duty cable along with termination, straight through joints and glands

1.36.3.7. Supply, Installation, fabrication, testing & commissioning of cable carrier system.

1.36.3.8. Design, supply, erection, testing and commissioning of suitable general lighting arrangement for pump house, electrical room & switchyard area including required lighting fixtures, fittings, point wiring, distribution box, street lighting poles with junction box, exhaust fan etc. with complete job.

1.36.3.9. Supplying, installation, testing & commissioning of earthing system along with earth pit, earthing grid, air termination, down conductor with test link, complete in all respect.

1.36.3.10. Supplying, installation, testing & commissioning of fire safety equipment.

1.36.4. Nizampura APS

1.36.4.1. Preparation of detailed electrical design/calculation/ drawings.

1.36.4.2. Dismantling of existing transformer and installation of new 11/ 0.433 kV transformer.

1.36.4.3. Supply, installation, testing and commissioning of LV Distribution Board (LVDB/ PCC)

1.36.4.4. Supply, installation, testing and commissioning of Power and Lighting Distribution Board (PLDB)

1.36.4.5. S.I.T.C. Of Approved make industrial type 32 A TPN (3P+N+E) Wall mounted socket with isolating switch conforming to IP-67.

1.36.4.6. Supply, laying, testing & commissioning 1.1 kV grade, XLPE insulated, stranded Aluminium conductor, galvanized steel flat strip / round wire armoured, extruded PVC type ST2 sheathed, heavy duty cable along with termination, straight through joints and glands

1.36.4.7. Supply, Installation, fabrication, testing & commissioning of cable carrier system.

1.36.4.8. Design, supply, erection, testing and commissioning of suitable general lighting arrangement for pump house, electrical room & switchyard area including required lighting fixtures, fittings, point wiring, distribution box, street lighting poles with junction box, exhaust fan etc. with complete job.

1.36.4.9. Supplying, installation, testing & commissioning of earthing system along with earth pit, earthing grid, air termination, down conductor with test link, complete in all respect.

1.36.4.10. Supplying, installation, testing & commissioning of fire safety equipment.

1.36.5. Gayetrinagar APS

1.36.5.1. Preparation of detailed electrical design/calculation/ drawings.

1.36.5.2. Dismantling of existing transformer from New Gotri APS, transporting it to GIDC APS and reinstalling it at site after and installation of new 11/ 0.433 kV transformer.

1.36.5.3. Supply, installation, testing and commissioning of LV Distribution Board (LVDB/ PCC)

1.36.5.4. Existing LT panel shall be reused after maintenance along with new one. The incoming supply for the existing panel shall be tapped from the new LT panel.

1.36.5.5. Supply, installation, testing and commissioning of Power and Lighting Distribution Board (PLDB)

1.36.5.6. S.I.T.C. Of Approved make industrial type 32 A TPN (3P+N+E) Wall mounted with isolating switch conforming to IP-67.

1.36.5.7. Supply, laying, testing & commissioning 1.1 kV grade, XLPE insulated, stranded Aluminium conductor, galvanized steel flat strip / round wire armoured, extruded PVC type ST2 sheathed, heavy duty cable along with termination, straight through joints and glands

1.36.5.8. Supply, Installation, fabrication, testing & commissioning of cable carrier system.

1.36.5.9. Design, supply, erection, testing and commissioning of suitable general lighting arrangement for pump house, electrical room & switchyard area including required lighting fixtures, fittings, point wiring, distribution box, street lighting poles with junction box, exhaust fan etc. with complete job.

1.36.5.10. Supplying, installation, testing & commissioning of earthing system along with earth pit, earthing grid, air termination, down conductor with test link, complete in all respect.

1.36.5.11. Supplying, installation, testing & commissioning of fire safety equipment.

1.36.6. New Gotri APS

1.36.6.1. Preparation of detailed electrical design/calculation/ drawings.

1.36.6.2. Dismantling of existing transformer from Kalali-II APS, transporting it to GIDC APS and reinstalling it at site after and installation of new 11/ 0.433 kV transformer.

1.36.6.3. Supply, installation, testing and commissioning of LV Distribution Board (LVDB/ PCC)

1.36.6.4. Supply, installation, testing and commissioning of Power and Lighting Distribution Board (PLDB)

1.36.6.5. S.I.T.C. Of Approved make industrial type 32 A TPN (3P+N+E) Wall mounted with isolating switch conforming to IP-67.

1.36.6.6. Supply, laying, testing & commissioning 1.1 kV grade, XLPE insulated, stranded Aluminium conductor, galvanized steel flat strip / round wire armoured, extruded PVC type ST2 sheathed, heavy duty cable along with termination, straight through joints and glands

1.36.6.7. Supply, Installation, fabrication, testing & commissioning of cable carrier system.

1.36.6.8. Design, supply, erection, testing and commissioning of suitable general lighting arrangement for pump house, electrical room & switchyard area including required lighting fixtures, fittings, point wiring, distribution box, street lighting poles with junction box, exhaust fan etc. with complete job.

1.36.6.9. Supplying, installation, testing & commissioning of earthing system along with earth pit, earthing grid, air termination, down conductor with test link, complete in all respect.

1.36.6.10. Supplying, installation, testing & commissioning of fire safety equipment.

1.36.7. Tandalja APS

1.36.7.1. Preparation of detailed electrical design/calculation/ drawings.

1.36.7.2. Dismantling of existing transformer from New Gotri APS, transporting it to GIDC APS and reinstalling it at site after and installation of new 11/ 0.433 kV transformer.

1.36.7.3. Supply, installation, testing and commissioning of LV Distribution Board (LVDB/ PCC)

1.36.7.4. Supply, installation, testing and commissioning of Power and Lighting Distribution Board (PLDB)

1.36.7.5. S.I.T.C. Of Approved make industrial type 32 A TPN (3P+N+E) Wall mounted with isolating switch conforming to IP-67.

1.36.7.6. Supply, laying, testing & commissioning 1.1 kV grade, XLPE insulated, stranded Aluminium conductor, galvanized steel flat strip / round wire armoured, extruded PVC type ST2 sheathed, heavy duty cable along with termination, straight through joints and glands

1.36.7.7. Supply, Installation, fabrication, testing & commissioning of cable carrier system.

1.36.7.8. Design, supply, erection, testing and commissioning of suitable general lighting arrangement for pump house, electrical room & switchyard area including required lighting fixtures, fittings, point wiring, distribution box, street lighting poles with junction box, exhaust fan etc. with complete job.

1.36.7.9. Supplying, installation, testing & commissioning of earthing system along with earth pit, earthing grid, air termination, down conductor with test link, complete in all respect.

1.36.7.10. Supplying, installation, testing & commissioning of fire safety equipment.

1.36.8. Kalali-II APS

1.36.8.1. Preparation of detailed electrical design/calculation/ drawings.

1.36.8.2. Dismantling of existing transformer and installation of new 11/ 0.433 kV transformer.

1.36.8.3. Supply, installation, testing and commissioning of LV Distribution Board (LVDB/ PCC)

1.36.8.4. Supply, installation, testing and commissioning of Power and Lighting Distribution Board (PLDB)

1.36.8.5. S.I.T.C. Of Approved make industrial type 32 A TPN (3P+N+E) Wall mounted socket with isolating switch conforming to IP-67.

1.36.8.6. Supply, laying, testing & commissioning 1.1 kV grade, XLPE insulated, stranded Aluminium conductor, galvanized steel flat strip / round wire armoured, extruded PVC type ST2 sheathed, heavy duty cable along with termination, straight through joints and glands

1.36.8.7. Supply, Installation, fabrication, testing & commissioning of cable carrier system.

1.36.8.8. Design, supply, erection, testing and commissioning of suitable general lighting arrangement for pump house, electrical room & switchyard area including required lighting fixtures, fittings, point wiring, distribution box, street lighting poles with junction box, exhaust fan etc. with complete job.

1.36.8.9. Supplying, installation, testing & commissioning of earthing system along with earth pit, earthing grid, air termination, down conductor with test link, complete in all respect.

1.36.8.10. Supplying, installation, testing & commissioning of fire safety equipment.

1.36.9. Yakutpura MPS

1.36.9.1. Preparation of detailed electrical design/calculation/ drawings.

1.36.9.2. Dismantling of existing transformer from Nizampura APS, transporting it to GIDC APS and reinstalling it at site after and installation of new 11/ 0.433 kV transformer.

1.36.9.3. Supply, installation, testing and commissioning of LV Distribution Board (LVDB/ PCC)

1.36.9.4. Supply, installation, testing and commissioning of Power and Lighting Distribution Board (PLDB)

1.36.9.5. S.I.T.C. Of Approved make industrial type 32 A TPN (3P+N+E) Wall mounted with isolating switch conforming to IP-67.

1.36.9.6. Supply, laying, testing & commissioning 1.1 kV grade, XLPE insulated, stranded Aluminium conductor, galvanized steel flat strip / round wire armoured, extruded PVC type ST2 sheathed, heavy duty cable along with termination, straight through joints and glands

1.36.9.7. Supply, Installation, fabrication, testing & commissioning of cable carrier system.

1.36.9.8. Design, supply, erection, testing and commissioning of suitable general lighting arrangement for pump house, electrical room & switchyard area including required lighting fixtures, fittings, point wiring, distribution box, street lighting poles with junction box, exhaust fan etc. with complete job.

1.36.9.9. Supplying, installation, testing & commissioning of earthing system along with earth pit, earthing grid, air termination, down conductor with test link, complete in all respect.

1.36.9.10. Supplying, installation, testing & commissioning of fire safety equipment.

1.36.10. Sardarnagar APS

1.36.10.1. Preparation of detailed electrical design/calculation/ drawings.

1.36.10.2. Dismantling of existing transformer and installation of new 11/ 0.433 kV transformer.

1.36.10.3. Supply, installation, testing and commissioning of LV Distribution Board (LVDB/ PCC)

1.36.10.4. Supply, installation, testing and commissioning of Power and Lighting Distribution Board (PLDB)

1.36.10.5. S.I.T.C. Of Approved make industrial type 32 A TPN (3P+N+E) Wall mounted socket with isolating switch conforming to IP-67.

1.36.10.6. Supply, laying, testing & commissioning 1.1 kV grade, XLPE insulated, stranded Aluminium conductor, galvanized steel flat strip / round wire armoured, extruded PVC type ST2 sheathed, heavy duty cable along with termination, straight through joints and glands

1.36.10.7. Supply, Installation, fabrication, testing & commissioning of cable carrier system.

1.36.10.8. Design, supply, erection, testing and commissioning of suitable general lighting arrangement for pump house, electrical room & switchyard area including required lighting fixtures, fittings, point wiring, distribution box, street lighting poles with junction box, exhaust fan etc. with complete job.

1.36.10.9. Supplying, installation, testing & commissioning of earthing system along with earth pit, earthing grid, air termination, down conductor with test link, complete in all respect.

1.36.10.10. Supplying, installation, testing & commissioning of fire safety equipment.

1.36.11. Kalaghoda APS

1.36.11.1. Preparation of detailed electrical design/calculation/ drawings.

1.36.11.2. Supply, installation, testing and commissioning of LV Distribution Board (LVDB/ PCC)

1.36.11.3. Supply, installation, testing and commissioning of Power and Lighting Distribution Board (PLDB)

1.36.11.4. S.I.T.C. Of Approved make industrial type 32 A TPN (3P+N+E) Wall mounted socket with isolating switch conforming to IP-67.

1.36.11.5. Supply, laying, testing & commissioning 1.1 kV grade, XLPE insulated, stranded Aluminium conductor, galvanized steel flat strip / round wire armoured, extruded PVC type ST2 sheathed, heavy duty cable along with termination, straight through joints and glands

1.36.11.6. Supply, Installation, fabrication, testing & commissioning of cable carrier system.

1.36.11.7. Design, supply, erection, testing and commissioning of suitable general lighting arrangement for pump house, electrical room & switchyard area including required lighting fixtures, fittings, point wiring, distribution box, street lighting poles with junction box, exhaust fan etc. with complete job.

1.36.11.8. Supplying, installation, testing & commissioning of earthing system along with earth pit, earthing grid, air termination, down conductor with test link, complete in all respect.

1.36.11.9. Supplying, installation, testing & commissioning of fire safety equipment.

1.36.12. SSG Hospital APS

1.36.12.1. Preparation of detailed electrical design/calculation/ drawings.

1.36.12.2. Supply, installation, testing and commissioning of LV Distribution Board (LVDB/ PCC)

1.36.12.3. Supply, installation, testing and commissioning of Power and Lighting Distribution Board (PLDB)

1.36.12.4. S.I.T.C. Of Approved make industrial type 32 A TPN (3P+N+E) Wall mounted socket with isolating switch conforming to IP-67.

1.36.12.5. Supply, laying, testing & commissioning 1.1 kV grade, XLPE insulated, stranded Aluminium conductor, galvanized steel flat strip / round wire armoured, extruded PVC type ST2 sheathed, heavy duty cable along with termination, straight through joints and glands

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1.36.13. Sardar Bhuvan APS

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1.36.13.3. Supply, installation, testing and commissioning of Power and Lighting Distribution Board (PLDB)

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1.36.13.5. Supply, laying, testing & commissioning 1.1 kV grade, XLPE insulated, stranded Aluminium conductor, galvanized steel flat strip / round wire armoured, extruded PVC type ST2 sheathed, heavy duty cable along with termination, straight through joints and glands

1.36.13.6. Supply, Installation, fabrication, testing & commissioning of cable carrier system.

1.36.13.7. Design, supply, erection, testing and commissioning of suitable general lighting arrangement for pump house, electrical room & switchyard area including required lighting fixtures, fittings, point wiring, distribution box, street lighting poles with junction box, exhaust fan etc. with complete job.

1.36.13.8. Supplying, installation, testing & commissioning of earthing system along with earth pit, earthing grid, air termination, down conductor with test link, complete in all respect.

Supplying, installation, testing & commissioning of fire safety equipment.

1.36.14. Kalupura APS

1.36.14.1. Preparation of detailed electrical design/calculation/ drawings.

1.36.14.2. Supply, installation, testing and commissioning of LV Distribution Board (LVDB/ PCC)

1.36.14.3. Supply, installation, testing and commissioning of Power and Lighting Distribution Board (PLDB)

1.36.14.4. S.I.T.C. Of Approved make industrial type 32 A TPN (3P+N+E) Wall mounted socket with isolating switch conforming to IP-67.

1.36.14.5. Supply, laying, testing & commissioning 1.1 kV grade, XLPE insulated, stranded Aluminium conductor, galvanized steel flat strip / round wire armoured, extruded PVC type ST2 sheathed, heavy duty cable along with termination, straight through joints and glands

1.36.14.6. Supply, Installation, fabrication, testing & commissioning of cable carrier system.

1.36.14.7. Design, supply, erection, testing and commissioning of suitable general lighting arrangement for pump house, electrical room & switchyard area including required lighting fixtures, fittings, point wiring, distribution box, street lighting poles with junction box, exhaust fan etc. with complete job.

1.36.14.8. Supplying, installation, testing & commissioning of earthing system along with earth pit, earthing grid, air termination, down conductor with test link, complete in all respect.

Supplying, installation, testing & commissioning of fire safety equipment.

1.36.15. VIP APS

1.36.15.1. Preparation of detailed electrical design/calculation/ drawings.

1.36.15.2. Supply, installation, testing and commissioning of LV Distribution Board (LVDB/ PCC)

1.36.15.3. Supply, installation, testing and commissioning of Power and Lighting Distribution Board (PLDB)

1.36.15.4. S.I.T.C. Of Approved make industrial type 32 A TPN (3P+N+E) Wall mounted socket with isolating switch conforming to IP-67.

1.36.15.5. Supply, laying, testing & commissioning 1.1 kV grade, XLPE insulated, stranded Aluminium conductor, galvanized steel flat strip / round wire armoured, extruded PVC type ST2 sheathed, heavy duty cable along with termination, straight through joints and glands

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1.36.15.8. Supplying, installation, testing & commissioning of earthing system along with earth pit, earthing grid, air termination, down conductor with test link, complete in all respect.

Supplying, installation, testing & commissioning of fire safety equipment.

2. PROJECT INFORMATION:

2.1. SITE/ ENVIRONMENTAL CONDITIONS:

2.1.1. Ambient temperature : 50ºC

2.1.2. Relative Humidity : 5 - 95%

2.1.3. Area Classification : Non Hazardous

2.1.4. Seismic Data : As per IS 1893 latest issue

2.2. NOMINAL SYSTEM VOLTAGE:

2.2.1. Incoming supply : 11 KV, 3 ph, 3 wire, 50 Hz AC (to be confirmed with MGVCL/GEB by Contractor)

2.2.2. Plant power distribution supply: 415V, 3 ph, 4 wire, 50 Hz, AC

2.2.3. General lighting & space heating: 240V, 1 ph, 2 wire, 50Hz, AC

2.2.4. Control & protection & emergency lighting: 24 V or 30 V or 110V, 2 wire DC (as applicable) for HT switchgear; 240V AC for LT equipment.

2.2.5. Potential transformer secondary: 110 V, 3 ph, 50 Hz, AC

2.2.6. Voltage variation:

a. 11 kV supply : ± 10%

b. 415 V supply : ± 10%

2.2.7. Frequency variation : ± 5%

2.2.8. Combined voltage and frequency variation : ±10%

2.3. SYSTEM EARTHING:

2.3.1. 11 kV, 3 ph AC system : Neutral solidly earthed

2.3.2. 415 V, 3 ph, AC system : Neutral solidly earthed

2.3.3. 240 V, 1 ph, AC system : Neutral solidly earthed

3. DESIGN CRITERIA FOR ELECTRICAL EQUIPMENT/ SYSTEMS:

3.1. GENERAL:

3.1.1. The design criteria, given below has to be followed by the Contractor for designing/ sizing of electrical equipments covered under Contractor's battery limits; However it is to be noted by the Contractor that, following this design criteria does not relieve the Contractor from adherence to the standards, regulatory requirements & best engineering practices.

3.2. ESTIMATION OF LOAD/ MAX DEMAND: The following considerations are to be followed to arrive at the maximum electrical demand.

3.2.1. Efficiency

3.2.2. The efficiency of pump motors shall be as per the Manufacturer's Data sheets.

3.2.3. Load Factor

a.	Main motors and pumps	:	Mechanical load in kW/ selected motor kW
b.	Auxiliary load (valve actuators, Crane/ Hoist, etc.)	:	0.7
c.	Lighting load	:	1.0
d.	Ventilation System	:	0.9

3.2.4. Diversity Factor

a.	Main motors	:	1.0
b.	Auxiliary load (valve actuators, Crane/ Hoist, etc.)	:	1.0
c.	Lighting load	:	1.0

3.2.5. Power factor of Motors : As per the Manufacture's Data sheets

3.3. TRANSFORMER SIZING/ SELECTION:

3.3.1. Criteria 1:

a. The capacity of the transformers will be calculated based on the total simultaneous maximum demand (calculated based on the load factors and diversity given above, PF, efficiency).

b. Additional 10% contingency shall be considered for deriving transformer sizing.

c. Similarly, after consideration of 10% contingency over maximum demand (MD), sizing of the selected transformer shall be such that maximum transformer loading shall not exceed 90% (of the MD + 10% Contingency) load.

d. Power factor correction to 0.95% shall be considered during sizing calculation.

3.3.2. Criteria 2:

a. The adequacy of transformer sizing shall also be proved on the basis of % Voltage dip observed at the motor terminal. % voltage dip at motor terminal shall not exceed 15% i.e. with the use of appropriate starter & considering largest motor starting & base load (all other loads except the highest rating motor are running); the % voltage dip during starting at motor terminal shall not exceed 15%.

b. The Voltage dip and fault level calculations needs to be calculated based on following actual data collected from nearest Substation and Grid.

   i. The fault level of HV bus from which power supply will be taken to the plant.

   ii. Impedance of HV Overhead Line Conductor/ HV Cable interconnecting the HV bus of Substation and HV switchboards of the Plant

c. For the per unit calculation purpose, minimum starting current for various types of starter applications shall be considered as following:

   i. DOL Starter – 6 times the rated current.

   ii. Star- Delta Starter – 3 times the rated current.

   iii. Auto Transformer Starter (ATS) – 3 times the rated current.

3.3.3. Wherever HT supply (above 100 kVA / as per GERC rules prevailing at that time) is envisaged, 100% stand-by shall be provided for transformers. All the associated equipments/ accessories shall be provided for Stand-by transformer as well. In normal condition, both the transformers shall feed their respective bus sections by keeping bus coupler open & in case of failure of one transformer, the other transformer shall be able to take 100% load with bus coupler in close position.

3.3.4. The Load losses and No-load losses of transformer shall be within the values given in IS 1180-2014 (Energy efficiency Level 1).

3.4. SWITCHGEAR SIZING/ SELECTION:

3.4.1. Switchgear shall be sized/ selected considering the following:

a. Rating suitable for carrying full load current of the equipment.

b. Suitability for Short Circuit Rating for 1 sec duration.

c. Switchgear for motors shall be suitable for motor duty application.

3.4.2. Switchgear for all the motor feeders shall be Type-2 co-ordination.

3.4.3. Motor starter selection shall be done as follows:

a. Direct On Line (DOL) Starter – For motors rated up to 5.5 kW

b. Star- Delta Starter - For motors rated above 5.5 kW to 15 kW

c. Auto Transformer Starter (ATS) - For motors rated above 15 kW

d. In-panel de-ration of minimum 20% or as provided in Manufacturer's catalogue, whichever is higher shall be considered.

3.4.4. Bus Bar Sizing:

a. The Contractor shall furnish calculations after award of contract, establishing the adequacy of the bus bar sizes to meet the continuous and short time current ratings as calculated.

b. The bus-bars shall be sized considering the following criteria:

i. Sleeves made of insulating material on all bus bars.

ii. Design ambient temperature 50ºC.

iii. Final temperature of the bus-bars complying with requirements of IS 8623 & IEC 60947. Reduced temperature rise limit by 5K (for indoor panels) & 10K (for outdoor panels) to that of mentioned in IS 8623 & IEC 60947 shall be considered to satisfy the final temperature.

iv. Bus bars being inside the panel; De- ration for enclosure and ventilation.

v. Bus bar suitability for carrying rated current continuously.

vi. Configuration of bus bars and Proximity effect

vii. Bus bars shall withstand the short time rating of the panel for 1 sec duration.

3.4.5. POWER FACTOR IMPROVEMENT: Fixed type capacitor for individual feeders shall be provide for panels in pumping stations supplied from 0.415 kV line (Maximum demand below 100kVA).

3.4.6. Capacitors shall be of all polypropylene condenser (APP type) with standard capacity of 2,3,5,7, 10,12.5 & 15 KVAR units of P.F. correction for operation on 3 phase 50 c/s, 400 /440V (+ / - 10%) with externally discharging resistance, earthing terminal & built on angle iron of channel iron frame work and provided with terminal cover box. Complete erected on provided iron bracket or on floor duly tested by license.

3.4.7. POWER FACTOR IMPROVEMENT: APFC Panel shall be sized for panels having maximum demand above 100kVA, considering following design criteria:

a. Minimum 8 steps in an APFC relay shall be considered with 2 steps as spare (pf to be improved to 0.99%).

3.4.8. Capacitor shall be All Poly Propylene (APP), double layer type.

3.4.9. Fixed type capacitor bank, with manual & auto switching and components as indicated in reference electrical Single Line Diagram(s) shall be provided in each Mains incomer (LV) panel for transformer no load compensation.

3.4.10. For each bus section of the Main PCC/ MCC panel, separate APFC panel- based on above design criteria to be provided. Other requirements of APFC panel & its components shall be as per requirement provided in this specification.

3.4.11. Total Capacity & Capacitor bank sizes shall be as given in Table below:

Capacity	5 kVAr	10 kVAr	15 kVAr	25 kVAr	50 kVAr	100 kVAr
* kVAr	# Nos.	# Nos.	# Nos.	# Nos.	# Nos.	# Nos.

* = Contractor has to calculate the capacitor rating based on the system power factor (0.85 or actual, whichever is lesser - to be corrected for 0.99. Rating of APFC panel shall be based on 50% of total running load for each bus section & not on the total connected load basis. Number of stages / steps in a particular APFC panel shall be decided by the Contractor such that minimum 8 steps & maximum 16 steps shall be provided in a particular panel.

3.5. CABLE SIZING: The Contractor shall ensure that cable and wires associated with the power distribution and control systems, plant wiring and all other installations throughout the Works are adequately rated for their use.

3.5.1. The following main aspects shall also be considered while deciding the final size of the cables-

a. Supply voltage and frequency

b. All cables shall be selected to carry the corresponding full load current under site conditions.

c. Route length and disposition of cables

d. Maximum allowable temperature rise under normal full load condition based on the material of cable insulation (XLPE/ PVC).

e. Maximum short circuit current duration (fault clearing time) and final temperature of cable during short circuit current flowing through the cable.

f. For Cables emerging from ACB outgoing, fault clearing time shall be considered as 0.16 second (for Tie feeders if any it shall be 0.5 second)

g. For Cables emerging from MCCB outgoing, fault clearing time shall be considered as 0.01 second

h. For the HT incomer cables (metering kiosk to GOD, GOD to HT switchgear/ transformer) minimum fault clearing time shall be considered as 1 sec.

i. For cable from HT panel outgoing to transformer, fault clearing time shall be considered as 0.16 second.

j. Cable from transformer secondary to PCC incomer, fault clearing time shall be 1sec

k. Contractor to note that, the above fault clearing times are minimum to be considered & fault clearing time shall be considered as per actual relay co-ordination study.

l. Appropriate de-rating factors as per cable manufacturer's catalogue and enlisted below shall be considered for sizing the cable:

   i. Ambient Air Temperature (minimum 50ºC).

   ii. Ambient ground temperature (minimum 40ºC to be considered)

   iii. Laid in Air / ducts/ directly in ground etc.

   iv. Depth of cable burial (minimum 750 mm for LT and 900 mm 11kV HT)

   v. Thermal Resistivity of Soil (minimum 150ºC Cm/ W to be considered)

   vi. No. of cables in a group-touching each other or separated by a distance

   vii. No. of cable trays in tier

   viii. Any other de-ration factors as applicable & as per Manufacturer's catalog.

m. Permissible voltage dips at the time of starting the corresponding motor/ load. Contractor to ensure adherence to the Criteria-2 mentioned above.

n. In running condition, cumulative voltage drop (at 100% rated load) shall not exceed 5% (measured at load end) for the LV loads.

o. All the HV cables shall be Earthed grade (as per system requirement), multi-stranded Al conductor, XLPE insulated, inner/ outer extruded PVC sheath ST2, galvanized steel flat strip armoured cables.

p. The cables shall be 1.1 kV grade, multi-stranded Copper/ Al conductor, XLPE insulated, colour coded, inner and outer extruded PVC sheathed, galvanized steel round wire/ flat strip armoured cables.

q. Cables up to & including 4.0 sq.mm shall be Cu multi-stranded conductor with galvanized steel round wire armoured & balance cables shall be Al multi-stranded conductor with galvanized steel round wire/ flat strip armoured.

r. Single core cable shall have non magnetic material armouring.

s. Control cables shall be Cu multi-stranded conductor with galvanized steel round wire/ flat strip armoured. For cables above 7 cores, minimum two spare cores shall be considered.

3.6. ILLUMINATION SYSTEM: Illumination for various indoor & outdoor areas shall be conforming to the requirements mentioned below:

3.6.1. The illumination levels to be considered for the design of lighting system for various areas shall be as following. These are the illumination levels achieved at Work plane. Work plane height shall be considered as 0.76 m from FGL.

Area	Illumination Level (Lux) - Average values
Pump room & Switchgear rooms	300 Lux
Outdoor plant areas	20 Lux
Switchyard & Transformer Area - General - On Equipment	 10 Lux 30 Lux
Roads	15 Lux

3.6.2. Critical lighting shall be designed such that at all junctions, exit passages & strategic locations the Lux level shall be maintained above 10 Lux. Installite fixtures with built in battery backup shall be considered.

3.6.3. Lighting design shall be performed using latest version of DiaLux Software/ Original Equipment Manufacturer (OEM) validated software. The Validation Report along with software and data files shall be acceptable to Purchaser/ Purchaser's representative.

3.6.4. Various design factors shall be considered as following:

a) Maintenance Factor:
i) Outdoor area : 0.6 (0.7 for LED)
ii) Indoor areas : 0.7 (0.8 for LED)

b) Reflectance Factors:
i) Wall : 30%
ii) Ceiling : 10%
iii) Floor : 30%

c) Uniformity (Min. / Avg.) : 50% Minimum for indoor and 30% for outdoor

d) Color Temperature of the lamp shall be:
i. Indoor Areas : 6500K Minimum
ii. Outdoor Areas 5400K Preferably.

3.7. EARTHING & LIGHTNING PROTECTION SYSTEM:

3.7.1. The safety earthing and lightning protection system will be generally on the basis of following codes and standards (including their latest editions).

a. IS 3043 -1987 (Reaffirmed in 2006): Code of practice for Safety Earthing.

b. IEEE 80 - 2000.

c. IS/IEC-62305, 2013: Code of Practice for the protection of buildings and allied structures against lightning.

d. CEA Regulations - 2010: Measures related to safety & electric supply.

3.7.2. The fault levels considered shall be as follows:

System	Fault level in kA
a) 11kV System	As per MGVCL /GEB source fault level, max 26.3kA for 1 sec. Shall be verified by contractor.
b) 415V System	* (23 kA) for 1 sec

(*) Contractor to design on the basis of actual impedance & adequacy calculations for sufficiency of earth conductor size shall be provided.

3.7.3. Following factors shall be considered for sizing the earthing conductor:

a) Design Ambient Temperature : 50°C

b) Allowable temperature rise for steel welded joints : 500°C

c) Fault clearing time : 1 Second

d) Overall earthing resistance : ≤ 1 Ohms

3.7.4. Measurement of soil resistivity shall be done using Wenner's 4 electrode method as described in IS 3043 -1987 (Reaffirmed in 2006) including its latest amendment.

3.7.5. The soil resistivity of the plant area has not yet been measured; the same should be carried out during detailed engineering by successful Contractor. Test reports shall be certified by Govt. Authorised Laboratory/ Institutes/ Agencies.

3.7.6. After soil resistivity measurement; length of conductor, no. of earth electrodes and no. of test pits shall be finalized based on these design criteria & the requirements specified in earthing requirements.

3.8. DRAWINGS/ DOCUMENTS FOR REFERENCE:

3.8.1. The equipment/ switchgear component ratings & requirements shown in the reference electrical Single Line Diagram(s) technical specification are minimum requirements & after award of contract, Contractor has to get approval for the equipment selection, detailed SLD, detailed cable schedule, etc. with the approval for sufficiency calculations.

2. GENERAL TECHNICAL & PARTICULAR REQUIREMENTS FOR ELECTRICAL , EQUIPMENT/ SYSTEMS:

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Sr. No.	Description
2.1	HV Two/ Four Pole Structure arrangement inside plant premises including HV point of supply breaker if required as per statutory norms
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2.4	Local Push Button Stations
2.5	Fixed Type Capacitor
2.6	APFC Panel with Capacitor Bank
2.6	Cabling System
2.7	Earthing & Lightning protection system
2.8	Lighting & Receptacle System
2.9	LT motors for Pumps

2.1. HV TWO/ FOUR POLE STRUCTURE:

The design, material, construction, manufacture and testing of HV two/ four pole structures shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to the latest applicable standards.

Two/ four pole structures shall conform to the latest applicable standards specified as under. In case of conflict between the standards and this specification, this specification shall govern.

Two/ four pole structures shall be erected in switchyard to receive HV power supply from power supply authority.

Each two/ four pole structure shall be inclusive of items listed below.

2.1.1. Structure:

a) A two/ four pole structure shall be of a rolled steel joist of minimum ISMB 150 (150mm x 75mm) for 6 meter pole/ ISMB 175 (175 mm x 90 mm) for 9/ 11meter pole with 400 mm x 400 mm x 8 mm thick base plate welded at bottom end of all the poles of structure.

b) Mild steel cross members of minimum ISMC 100 mm x 50 mm x 6 mm size channels of 3.5 mtr in length, 8 Nos. shall be provided with cross bracing angles of minimum ISA 50 mm x 50 mm x 6 mm size of 4.5 meter in length.

c) Side clamps, stay clamps, cleats etc. shall be fabricated from minimum 50 mm x 6 mm size MS flats as per actual requirements. All bolts, nuts, washers, etc. shall be of minimum 15 mm size.

d) All the members of two/ four pole structure should be galvanized.

e) Excavation of pits even in hard soil shall be done up to a depth of about 1/ 6 the length of pole and refilling the same after erection of structure and concreting work. Compacting the bottom of pits, providing cement concrete to suit at bottom and side of poles up to at-least 150 mm above FGL curing and making it hard as per requirement.

f) Erection of RSJ poles and fixing of all structural members as per requirement shall be in line, level and properly facing the incoming and outgoing lines. Cross members shall be firmly tightened.

g) All members shall be fabricated to suit mounting/ fixing of Gang Operated Disconnectors/ Isolators, Lightning Arrestors, Pin/ Post insulators, cable end termination Kit/ Box etc.

h) All MS parts shall be painted with two coats of red oxide and two coats of aluminum paints.

i) Earthing terminals shall be provided by welding 15 mm size bolts or cleats of 50 mm x 6 mm size MS flat shall be welded in each joist with a hole of 15 mm size and galvanized nuts, bolts, washers shall be provided as earthing terminals.

j) Necessary hardware including stay wire and its accessories as required for completeness shall be supplied and erected.

k) All drawings/ documents such as GA drawing of two/ four pole structure showing all equipment mounted on the structure, technical particulars & Bill of Material etc shall be prepared and submitted to Purchaser/ Purchaser's representative for approval. Obtaining the approval from CEIG/ IMPD (GOG) and getting power released from supply authority are also included in the scope of work.

2.1.2. Gang operated offload disconnectors (GOD) with earth switch:

a) The double break type isolator (GOD) shall be manually operated and suitable for the specified site conditions and shall be able to-

i. Carry rated current without excessive temperature rise.
ii. Withstand the short circuit forces developed during fault.
iii. Carry the inrush current of the transformer.
iv. Interrupt small inductive and capacitive currents.

b) The operating rod shall be extended up to the operating level and shall have a handle with 'lock and key' arrangement. The operating handle shall be at a level of 1.0 meter from finished ground level.

c) The operating handles shall be mounted on the base of supporting structure. Guide bearings shall be provided if necessary at appropriate height above ground level. Necessary accessories viz. brackets, angles, guides, guide bearings for attaching the operating mechanism and operating handles to the structure and part of the isolator, rust proof pins, ball or roller type bearings shall be provided and installed. All bearings shall be protected by means of covers and grease retainers. Bearings pressure shall be kept low to ensure long life and ease of operation.

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

e) All copper parts shall be Silver or Tin plated. All ferrous parts shall be hot dip galvanized to assure long protection against tropicalised weather.

f) The contacts shall be of silver faced copper ensuring sufficient contact pressure. The male and female contacts shall be of self aligning type to ensure trouble free operation during opening and closing of isolator. Mild steel arcing horn capable of breaking the magnetizing current shall be provided. Earth mesh below GOD to be provided

2.1.3. Isolator Interlock:

a) Electrical interlock arrangement shall be provided among double break isolator (GOD) and respective 11 KV indoor type breakers.

b) Interlocking arrangement shall be robust, heavy-duty type and sturdy in construction.

c) Mechanical interlock between isolator & Earth switch shall be provided.

2.1.4. Insulators:

a) Insulator shall be properly glazed with smooth surface without cracks etc. and dielectric property shall be properly co-ordinated with isolator voltage class. Porcelain used for the manufacturer of insulator shall be uniform, brown color, free from blisters, burns and other similar defects. Insulators of the same rating and type shall be interchangeable.

b) Porcelain and metal parts shall be assembled in such a manner that any thermal expansion differential between the metal and porcelain parts throughout the range of the temperature variation shall not loosen the parts or create undue internal stresses which may affect the electrical or mechanical strength and rigidity. Each cap and base shall be of high grade cast steel or malleable steel casting and they shall be machine faced and smoothly galvanized. The cap and base of the insulators shall be interchangeable with each other.

2.1.5. ACSR Conductor:

a) Aluminum conductor steel reinforced shall be hard drawn from 99.5% pure electrolytic aluminum rods. The Contractor shall specify the conductivity.

b) Chemical composition of the material shall comply with the requirements of relevant standards.

c) The surface of conductor shall be clean and dry and free from any excess grease that may be used in its fabrication. The surface strands shall be smooth and free from burrs and other projections which may be a cause for increasing corona losses.

d) The Contractor shall provide necessary treatment for the bus conductor to make it free from corrosion.

e) The steel wire strand of conductor and steel conductor shall be hot dip galvanized. Zinc coating shall be evenly and uniformly for heavily coated wires.

f) The steel core and inner layer of aluminum wires where more than one aluminum layer exist shall be protected with special grease in order to provide additional protection against corrosion due to salinity. The grease shall fill the whole space between wires within circumscribed cylinder at inner aluminum layer or at steel core if the conductor has only one aluminum layer.

g) The grease shall be chemically neutral with respect to aluminum, zinc and steel. It shall withstand weather conditions given elsewhere and temperature of 85 degree centigrade without alternation of its properties.

h) Bare conductor shall be covered in Alkathene pipes of suitable insulation to avoid accidental contact.

2.1.6. Drop Out (DO) Fuse Unit:

a) Drop Out Fuse shall be of approved make suitable for 11 kV supply and shall be mounted on two pole structure complete with 3 fuse elements of required ampere suitable for continuous current rating and shall offer protection against fault level of suitable ampere at 11 kV.

b) The fuse link shall consists of iron channel base to stack insulators per phase, fuse carrier Bakelite tube, heavy duty non-ferrous metal parts and spring loaded phosphor bronze contacts.

c) The insulator shall comply with impulse voltage in accordance with relevant IS.

2.1.7. Station Class Lightening Arrestors:

a) The design, material, construction, manufacture, inspection and testing of lightning arresters shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed.

b) In case of conflict between the standards and this specification, this specification shall govern.

c) The equipment covered in this specification shall conform to the latest edition of the following standards.

IS: 3070 (Part-3)	Lightning arresters for AC system – Specification (Metal Oxide Lightning Arrester without Gaps)

IEC: 60099-4 Metal Oxide surge arresters without gaps for AC system

d) Constructional Features:

i. Lightning arrester shall be station class heavy duty and non- linear resistance type. The elements shall be in hollow cylindrical form, stacked together. Lightning arrestor shall be of class II, having non – linear voltage – current characteristic and having high discharge capability.

ii. The entire arrester unit shall be housed in a porcelain insulating casing of high strength, made from brown glazed wet process porcelain, with metallic cover plates and terminal assemblies. The end castings shall be hermetically sealed and leak tested to protect the unit from moisture or breathing.

iii. Pressure relief diaphragm, vent pipe, etc. shall be provided on the LA for the escape of gases formed. In the event of failure of L.A., the pressure relief directional aperture should be directed away from adjacent apparatus to prevent damage, due to arc transfer.

iv. All hardware such as clamps, screws, bolts, nuts, washers etc. shall be electro galvanized.

e) Insulators:

i. The porcelain insulators used shall be made from wet process, and shall be homogenous, free from lamination, cavities and other flaws, which may impair its mechanical or dielectric strength. They shall be thoroughly vitrified, tough and impervious to moisture.

ii. The glazing of porcelain shall be uniform brown colour, free from blisters, burns, cracks and other defects. The glazing shall cover all the porcelain part of the insulators except that area which serves as support during glazing or are unglazed for the purpose of assembly.

iii. The minimum creepage distance shall be as stipulated in data sheets. The petticoats shall be spaced for natural cleaning action by wind and rain and avoid concentrated hot spots where local stress can precipitate flashover.

iv. All live metallic parts shall be suitably painted. All joints shall be fluid – tight and air tight. The design of insulators shall be such, as to produce uniform compression pressure joints.

v. All insulators of identical rating shall be interchangeable.

vi. Each bushing shall be provided with aluminium/ bimetallic terminal connectors suitable for inter – connection with aluminium tubular Bus bars or ACSR conductor as specified in data sheet.

f) Accessories: Each lightning arrester shall be furnished complete with the accessories as listed below:

i. Anti – contamination and pressure relief diaphragm complete with vent pipe.
ii. Two (2) grounding pads.
iii. Base plate suitable for mounting on G.I. / steel structure or concrete structure.
iv. Line side terminal suitable for specified conductor.
v. Other standard accessories which are not specifically mentioned but are usually provided with lightning arrester of similar type and rating for efficient and trouble free operation.
vi. Name plates fixed on lightning arresters giving full technical details.
vii. The clamps and connectors on arrestor terminals for connection to Purchaser's line conductor and the connection between incoming transmission line and LA will be in the Contractors scope.

g) Drawings/ documents to be furnished for Purchaser's approval:

i. Technical Particulars
ii. GA drawing of LA indicating weight and overall dimensions
iii. GA drawing of insulating base, discharge counter, terminal assembly
iv. Bill of Material
v. Mounting arrangement (base plate details) on the structure
vi. QAP for Lightning Arrester

2.1.8. Chain Link Fencing and Gravel Filling:

a) The work of erecting chain link fencing includes excavation, brick wall construction, erection of angle/ channel supports, providing chain link mesh on angle/ pipe frame barbed wire fencing at the top, concreting of support members, painting the complete structure and white washing the walls. All materials, hard wares, labours etc. are in the scope of contractor.

b) Fencing height shall be minimum 2.0 meter & shall be complying with CEA guide lines requirements.

c) Gate for entry in the fenced compound shall be fabricated from pipes of heavy duty class. Design of gate shall be got approved from the engineer in charge before starting the fabrication work. All necessary hard wares, fittings, stoppers, locking arrangements with brass pad locks of 100 mm size are in the scope of gate works. Gates shall be self supporting type.

2.2. DISTRIBUTION TRANSFORMERS:

2.2.1. Applicable Standards: Transformer shall comply with all currently applicable statutes, 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 specified as under. In case of conflict between the applicable reference standards and this specification, this specification shall govern.

Transformer	:	IS 1180-2014, IS 2026, BS 171, IEC76, CBIP Pub No. 317
Fittings & Accessories	:	IS 3639
Climate proofing	:	IS 3202 BS-CP-1014 IEC 354
Loading of oil immersed	:	IS 6600 BS-CP-1010 IEC 296
Oil	:	IS 335 BS-148 IEC 137
Bushing for > 1000 V, AC	:	IS 2099 BS-223 IEC 144
Bushing for < 1000 V, AC	:	IS 7421 BS-223 IEC 144
Degree of protection	:	IS 13947 IEC 76
Tests	:	IS 2026 BS-171 IEC 76
Tolerance on guaranteed Particulars	:	IS 2026
Buchhloz relay	:	IS 3637
Electrical insulation classified by thermal Stability	:	IS 1271 BS 2727 IEC 85
Auxiliary Transformer	:	IS 1180
Code of practice for selection, Installation & maintenance of transformer	:	IS 10028

2.2.2. This specification is for complete design, manufacture, testing at manufacturer's works, supply, packing, forwarding and delivery from place of storage/ manufacturer's works to erection site including transit insurance, storage at site, shifting from the place of storage to place of installation, installation, testing and commissioning for two winding, three phase, 50 Hz, outdoor type, distribution transformer of * kVA, 11/0.433kV, ONAN cooled, connected in Dyn11 with OCTC/ OLTC on HV winding as per MGVCL/GEB requirements & other accessories as specified.

(*Transformer rating shall be finalized based on the transformer design criteria, specified in this specifications)

% Impedance shall be as per IS 1180-2014/ IS 2026: 1977 – (Part-1).

2.2.3. The values of Load- losses and No-load losses shall be as given in IS 1180-2014.

2.2.4. The Purchaser reserves the right to reject the transformer if the same does not meet the specification requirement as follows:

a) No load loss exceeds the guaranteed value by 20% or more.

b) Load loss exceeds the guaranteed value by 20% or more.

c) Impedance value differs the guaranteed value by +10% or more (zero negative tolerance)

d) Oil or winding temperature rise exceeds the specified value by 5 deg C

e) Transformer fails on impulse test.

f) Transformer fails on power frequency voltage withstand test.

g) Transformer is proved to have been manufactured not in accordance with the agreed specification

2.2.5. The rejected transformers shall be replaced by transformers complying with the requirements of this specification at the Contractor's cost.

2.2.6. If the commissioning of the project is likely to be delayed by the rejection of a transformer, the Purchaser/ Client reserves the right to accept the rejected transformer until the replacement transformer is made available. Transporting the rejected and replacement transformers as well as installation and commissioning of both the transformers shall be at the Contractor's cost

2.2.7. Transformer Protections**:** The following protections shall be provided for a distribution transformer:

Over-current protection – Instant (50/ 51)	Trip (Relay In HT Panel)
Earth fault protection – Instant (50N)	Trip (Relay In HT Panel)
Oil temperature indicator (OTI - 49O)	Alarm + Trip
Magnetic Oil level gauge (MOG)	Alarm
Oil Surge Relay (OSR) [For transformers with OLTC]	Trip – For OLTC

2.2.8. In case of 11kV Cable feeder, an air insulated cable box with air insulated disconnecting chamber shall be provided on 11 kV side of transformer.

2.2.9. For the pole mounted transformers (i.e. transformers ≤ 100 kVA, 11/ 0.433 kV rating), suitable orientation of HV porcelain bushings shall be ensured for direct termination of ACSR conductor from 11 kV Double Pole Structure.

2.2.10. For transformers above 100 kVA rating, elevated foundation/ plinth of suitable height shall be provided.

2.2.11. All the Civil works such as, transformer foundation, Oil Soak Pit, Burnt oil pit as per CEA guidelines & IS 10028 requirements shall be considered in Contractor's scope.

2.2.12. Ambient temperature of 50ºC shall be considered for transformer design. Temperature rise shall be 40ºC for Oil temperature and 45ºC for winding temperature. Hot spot temperature limits shall be complying with IS 2026, IS 6600 & IEC 60076-2:1993 & it shall be limited to 98 Deg. C.

2.2.13. The limits of hot spot temperature mentioned above will have to be satisfied by the manufacturer by carrying out the heat run test at the lowest negative tap. This test shall be carried out by feeding 1.1 times the total losses at 75ºC at highest current tap.

2.2.14. Neutral of LV winding shall be 50% rated.

2.2.15. Suitable dial type instruments/indicator with alarm and trip contacts shall be provided for monitoring of following parameters for the transformer. The settings shall be site adjustable.

Oil Temperature indicator (OTI)	1 No local + 1 No remote
Magnetic oil level gauge (MOG)	1 No local

2.2.16. The bushing CT required in neutral connection for back up earth fault protection shall be provided before bifurcation of neutral.

2.2.17. Accessories listed below shall be provided for the transformer as per IS standards unless noted otherwise.

a) Anti-earthquake clamping device

b) Marshalling Box

c) All interconnection cables, cable accessories for connection between the transformer marshalling box & other devices mounted on the transformer and inter-connection cables for all the associated equipments/ panels including cable termination accessories such as glands, lugs etc.

d) Foundation bolts & hardware, mounting channel & support structures for marshalling boxes, junction boxes etc.

e) All MS components including steel bolts & nuts shall be hot dip galvanized.

f) Automatic self-resetting type pressure relief device with trip contacts wired up to marshalling box.

g) Additional neutral bushing.

h) Conservator with lifting lugs (for transformers 50 KVA and above with rated voltage up to 11 kV, and all rating above 11kV with oil filling hole with cap and a drain plug.) Conservator shall be complete with plug, sample and drain valve and a shut-off valve on the pipe connection between the transformer tank and conservator to permit removal of the conservator

i) Bushing Terminals or cable boxes complete with connectors for the Purchaser's external conductors or cable.

j) Neutral bushing terminal complete with connector for earth conductor.

k) Four plain rollers in place of fixing channels. The rollers shall be bidirectional, with suitable corrosion-free bearings, suitable for 90 degree rotation & lockable in both directions and of the detachable type.

l) Rating and terminal marking plates

m) Two earthing terminals for body earthing

n) Drain cum sampling valve with plug or cover plate.

o) Dehydrating Silica Gel Breather equipped with a silica gel dehydration capsule and oil seal to eliminate constant contact with the atmosphere.

p) Thermometer pocket with mercury in glass bulb thermometer.

q) Radiator with air release plug, lifting lug, drain valve and with shut off valves.

r) Conservator with lifting lugs, oil filling cap & drain plug.

s) Prismatic oil level gauge (on conservator) with minimum level marking.

t) Jacking Lugs (Transformers weighing above 3000 Kg)

u) Filter Valves

v) Explosion vent with diaphragm/ pressure relief valve (for transformers 50 KVA and above). The device shall be rain-proof after operation.

w) Base channels for fixing on a platform or plinth

x) Lifting lugs for top cover & active part.

y) Lifting lugs for lifting complete transformer with oil.

z) Lifting lugs for lifting core & coils.

aa) Pocket for O.T.I

bb) Neutral C.T with terminal box.

cc) Earthing bar with insulator support.

dd) All indicating lamps shall be multichip LED Type.

ee) Dial type thermometer (150 mm Dia.) with two contacts for oil temperature 'high' and 'very high' alarms. Each contact shall be electrically independent and brought out to separate terminals, rated 220 V.D.C; minimum 0.5A.

ff) Magnetic oil level gauge (150 mm dia. 240 degree scale) with low oil level alarm contact for transformers fitted with conservator. Contact rating suitable for 220V D.C., minimum 0.5A.

gg) Gas actuated Buchholz relay, double float type with a valve between the relay and the conservator.

hh) Gas sampling device at an accessible height and an air release cock for Buchholz relay.

ii) Winding temperature indicator, consisting of:

i. Temperature sensing element. Separate PT100 for digital signal shall be provided as temperature sensor
i. Turret mounted CT.
ii. Local Winding temperature indicating instrument (150mm Dia.) with electrically independent contact(potential free contact) brought out to separate terminals for winding temperature 'high' and 'too high' alarms. Contacts shall be suitable for 220V DC, rated minimum 0.5A.

jj) All digital outputs for control / remote annunciation shall be provided with at least two change-over contacts for alarm & two change-over contacts for trip conditions. Auxiliary relays, if required, to provide change-over contacts suitable for Purchaser's equipment are deemed to be included in the Contractor's scope.

kk) Valves: Valves shall be of Gun Metal material & of suitable diameter for their intended purpose. Following valves shall be provided for each oil immersed transformer.

i. One (1) top filter valve with blanking plate.
ii. One (1) bottom filter valve with blanking plate
iii. One (1) bottom sampling valve with blanking plate
iv. Two (2) Shut-Off / Gate Valve for OLTC Part of Conservator (on both sides of Oil Surge relay)
v. Two (2) Shut-Off / Gate Valve for Main Conservator(on both sides of Buchholz relay)
vi. One (1) Drain valve with blanking plate for Conservator
vii. One (1) bottom drain valve with blanking plate for complete Transformer
viii. One (1) top sampling valve with blanking plate
ix. Radiator shut off valves with blanking plates between radiator head & tank.
x. Oil filling valve with blanking plate for Main & OLTC conservator.

2.2.18. General Constructional Features of Transformer: 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, overloads, over-excitation, short-circuits as per specified standards, without distortion or deterioration or the setting up of undue stresses in any part, and also without affecting the strength and suitability of the various parts for the work which they have to perform. The transformer construction shall be suitable for Seismic Data (As per latest edition of IS 1893) or elsewhere in the specification.

a) Tanks:

i. The exterior of tank and other 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 an oil and weather-resistant nature, preferably of distinct colour from the prime and finish coats. The final coat shall be of a flossy, oil and weather resisting non-fading paint of specified shade. The interior of the tank shall be cleaned by shot blasting and painting with two coats of heat resistant and oil insoluble paint.
ii. Steel bolts and nuts exposed to the atmosphere shall be galvanized.
iii. Vacuum & Pressure Tests-Various Vacuum & Pressure Tests for tank, conservator, radiator, pipes etc. shall be as per mentioned in the CBIP Manual on Transformer – Publication no. 317: 2013 & latest edition thereof.
iv. The material used for gaskets shall be cork neoprene or approved equivalent.

b) Core:

i. The magnetic circuit shall be constructed from high grade cold-rolled non-ageing grain oriented silicon steel laminations and shall be of 'core' type.
ii. The insulation structure for the core to bolts and core to clamp plates shall be such as to withstands BIL & Lightning Impulse Voltage
iii. Each lamination shall be coated with insulation which is unaffected by the temperature attained by the transformer during service.
iv. Core laminations shall be annealed and burrs removed after cutting. Cut edges shall be insulated.

c) Windings:

i. Windings shall be of electrolytic grade Copper of 99.9% purity unless specifically approved by the PURCHASER.
ii. Windings shall be of insulated Copper wire or Copper strip.
iii. Windings and insulation shall be so arranged that free circulation of oil is possible between coils, between windings, and between winding and core.
iv. Winding shall be subjected to a shrinking and seasoning process, so that no further shrinkage occurs during service.

v. The completed core and coil assembly shall be dried in vacuum and shall be immediately impregnated with oil after the drying process to ensure elimination of air and moisture within the insulation.

vi. High voltage end-windings shall be suitably braced to withstand short circuit stresses and stresses caused up by surges.

vii. 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 be otherwise affected under the operating conditions.

viii. Varnish application on coil windings may be given only for mechanical protection and not for improvement in dielectric properties. In no case varnish or other adhesive be used which will seal the coil and prevent evacuations of air and moisture and impregnation by oil.

ix. 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.

x. Terminals of all windings, and if stated also of stabilizing windings, shall be Brought out of the tank through bushings for external connections.

xi. Windings shall be of copper and the conductors shall be transposed at sufficient intervals in order to minimize eddy currents and equalize the distribution of currents and temperatures along the windings.

xii. The sequence and orientation of HV/LV side phase and neutral bushings shall be as specified in the latest edition of relevant IS.

xiii. Transformer shall operate without injurious heating at the rated KVA and at any voltage up to ± 10 % of the rated voltage of any tap. Transformer shall be designed for 110 % continuous over-fluxing withstands capability.

d) Internal Earthing: The framework and clamping arrangement of core and coil shall be securely earthed inside the tank by Copper strap connection to the tank.

e) Terminations:

i. Transformers shall be fitted either with bushing insulators or with air insulated cable boxes / air insulated cable box with disconnecting chamber, as per requirement based on transformer HV incomer.

f) The neutral of the star-connected winding shall be brought out to a separate bushing terminal. The neutral bushing shall be provided on the tank side to facilitate lead of the earth conductor down to the ground level. Bushings:

i. Bushings shall be designed and tested to comply with the applicable standards specified in the specifications.

ii. Bushing rated for 400A and above shall have non-ferrous flanges and hardware.

iii. Fittings made of steel or malleable iron shall be galvanized.
iv. Bushings shall be supplied with terminal connector clamp suitable for connecting the bushing terminal to the specified conductor/ cable.

g) Bushing Current Transformers:

i. Whenever applicable, bushing shall be supplied with current transformers.
ii. Secondary leads, including tappings, shall be brought to a weatherproof terminal box near the bushing.
iii. Bushing C.T. nameplate shall be mounted on the tank adjacent to the terminal box.

h) Cable Boxes and Disconnecting Chamber:

i. The cable boxes, wherever required as per the prescribed criteria, shall be complete with cable joint fittings or sealing ends as required, tinned copper lugs to suit specified cable, compound and all other accessories including compression type glands, armour earth clamps and body earth terminal.
ii. For Cable type of terminations, disconnecting chamber shall be provided to enable the transformer to be removed without unsealing the cables or draining oil from the main tank. The disconnecting chamber shall be air insulated and complete with seal-off bushings, removable flexible connectors/ links and removable covers.
iii. Cable boxes shall be designed to accommodate all cable joint fittings or sealing ends as required, including stress/ cones or other approved means for grading voltage stress on the terminal insulation of cables operating at voltages of 22 kV and above.
iv. Phase to phase and phase to ground clearances within the chamber shall be such as to enable either the transformer or cable to be subjected separately to HV tests.

i) Marshalling Box:

i. Whenever fittings such as OTI/ WTI, temperature indicators with auxiliary contacts, Buchholz relay, bushing CTs etc. are provided the marshalling box shall be provided to marshal in it all the contacts/ terminals of electrical devices mounted on the transformer.

ii. It shall be in the Contractor's scope to provide interconnection cabling between the marshalling box and the accessory devices by either PVC insulated, FRLS wires in GI conduits and/ or XLPE insulated, inner & outer extruded PVC, armoured cable and necessary compression type brass cable glands at the marshalling box for the above mentioned cables as well as for terminating the incoming cables from remote panels.

iii. The marshalling box shall be tank mounted (at easily accessible location), outdoor type, IP 55 protected, weather-proof, sheet-steel (2 mm thick) enclosed, with hinged door having padlocking facility and painted as per paint shade approved by the Purchaser. All doors, covers and plates shall be fitted with Neoprene gaskets. Bottom shall be at least 600 mm from floor level and provided with gland plate and cable glands as required. Top surface shall be sloped.

iv. The marshalling box shall be provided with glass window so as to make the WTI and the OTI dials visible from the outside without opening the door.

v. All contacts for alarm, trip and indication circuits shall each be potential free, wired for auxiliary DC supply as specified and brought out to separate terminals at the terminal blocks in the marshalling-box. Terminals shall be rated for 10A. Wiring shall be 1.1 kV grade, with multi-stranded, copper conductors of sizes not smaller than 1.5 sq.mm for control and 2.5 sq. mm for CT circuits. CT terminals shall be provided with shorting facility and earthing.

vi. The marshalling box shall house the winding temperature indicator (WTI, 150 mm dial), the oil temperature indicator (OTI, 150 mm dial), terminal block, 60W anti-condensation heater, 5/15A industrial type five pin socket and a 10W CFL with fixture, suitable for operating on 240 V AC. Contacts of Buchholz relay, WTI, OTI, magnetic level gauge, PRD, OSR shall be wired up to the terminal block.

j) Noise level of transformers shall be as per latest NEMA standard.

k) Oil - Transformers shall be supplied complete with transformer oil. Transformer oil shall be as per IS-335:1993, BS 148 or IEC 296. 10% extra oil shall be supplied with transformer in non returnable drums.

2.2.19. Maintenance Requirements For Transformers & Associated Equipment:

a) The construction of the transformer & location of the accessories like CTs, lower ends of bushings, terminals, tap-changers etc., shall be such as to afford easy access & permit replacement of auxiliaries without removing the tank cover.

b) Instruments & wiring in the local marshalling box (cabinet) shall be completely accessible & sufficient working space shall be made available in the cabinet. Instruments, wiring & accessories in the cabinet shall be accessible from the front & the rear as well.

c) The rating plate of the transformer shall be supplied as per latest version of IS: 2026.

d) Transformer shall be capable of being used with any make of transformer oil complying with IS: 335.

e) As far as practicable, transformer & accessories shall be so designed that no special tools are necessary for installation & maintenance. However, if special tools are required, the Contractor shall supply one complete set of such tools along-with transformer.

2.2.20. Performance Tests:

a) In addition to the routine tests specified in the latest edition of IS: 2026, tests listed out shall be carried out on the transformer and these shall be included in the quoted prices.

b) The tests shall be carried out in the presence of the Purchaser/ Purchaser's representative. The following tests shall be carried out on the assembled transformer during inspection at the manufacturer's works

i. Measurement of resistance of windings at principal and extreme taps.
ii. Ratio at each tap, polarity and phase relationships
iii. Measurement of impedance voltage at principal and extreme taps
iv. Measurement of no load current and no load losses at rated frequency and at both the rated voltage and 110% rated voltage
v. Measurement of efficiency at ½, ¾ and full load
vi. Measurement of insulation resistance
vii. Induced over voltage withstand test
viii. Separate source voltage withstand test
ix. Magnetic balance test
x. Vacuum & Pressure Test for the tank.

c) In addition to the above tests, lightning impulse withstand test shall be carried out on one limb of HV winding of the transformer if impulse test has not been already carried out on transformer of similar or higher capacity in the last five years. Similarly heat run test shall also be carried out if the same has not been already carried out on transformer of similar or higher capacity in the last five years. Type test certificate shall be submitted along with the bid. if such a test has not been already carried out then same has to be carried out & witnessed by third party (such as CPRI) at the Contractor's expense without any cost and time implication to Purchaser.

d) All tests required by the specification including repeated tests and inspection that may be necessary owing to the failure to meet any tests specified, shall be carried out at the Contractor's expense.

e) If the transformer fails to pass the tests specified, the Client shall have the option to reject the unit. Additional tests shall be conducted to locate the failure and after rectification, all tests shall be repeated to prove that the rebuilt transformer meets the specification in all respects, all at the Contractor's expense.

2.2.21. Drawings/ Documents Required: Contractor shall submit the following drawings/ documents for Purchaser's approval:

a) General arrangement drawing of the transformer, showing plan, front elevation and side elevation complete with all accessories and fittings, detailed dimensions, net weights, quantity of oil, crane lift for untanking, size of lifting lugs and eyes, clearances between HV terminals, between LV terminals, between HV and LV terminals, between HV & LV terminals and ground etc

b) Rating, diagram and terminal marking plates, complete with polarity and vector group

c) Foundation drawing with position of foundation bolts and depth. In case of Soak pit/ Burnt oil pit requirements, the same shall also be included.

d) General arrangement of HV cable box with air insulated disconnecting chamber.

e) General arrangement of LV Cable Box or Bus Duct arrangement.

f) General arrangement of marshalling box & wiring diagram.

g) General arrangement of OLTC/ RTCC & wiring diagram

h) GTP for Transformer

2.2.22. Off Circuit Tap Changing Mechanism (OCTC) for Transformer <= 1000 KVA: OCTC shall be with + 5% to –10% taps in steps of 2.5 % on HV winding of transformer; It shall comprise:

a) Operating handle or wheel, accessible from ground level. Tap changer operating switch mounted on the top of the transformer tanks will not be acceptable

b) Tap position indicator.

c) Pad locking arrangement without interfering with visual tap position indicator shall be provided.

d) The tap-changer connections and contacts shall be accessible through an excess hole having a bolted cover with gasket.

2.2.23. On load Tap Changing Mechanism (OLTC) for Transformer ≥ 1000 KVA: OLTC shall be with + 5% to –15% taps in steps of 2.5 % or as per IS 1180 2014, on HV winding of transformer; It shall have following technical features:

a) The OLTC gear shall be designed to complete successfully tap changes for current equal to 120% of current at minimum tap position of the transformer. Also, OLTC over loading capability shall be compatible with that of transformer specified in IS/IEC specification “Guide for loading of oil immersed transformers”. Devices shall be incorporated to prevent tap change when the through current is in excess of the safe current that the tap changer can handle. The OLTC gear shall withstand through fault currents without injury.

b) When a tap change has been commenced it shall be completed independently of the operation of the control relays and switches. Necessary safeguard shall be provided to allow for failure of auxiliary power supply or any other contingency which may result in the tap changer movement not being completed once it is commenced.

c) Oil in compartments which contain the making and breaking contacts of the OLTC shall not mix with the oil in other compartments of the OLTC or with transformer oil. Gases released from these compartments shall be conveyed by a pipe to a separate oil conservator or to a segregated compartment within the main transformer conservator. An oil surge relay shall be installed in the above pipe. The conservator shall be provided with a prismatic oil level gauge.

d) Oil, in compartments of OLTC which do not contain the make and break contacts, shall be maintained under conservator head by valved pipe connections. Any gas leaving these compartments shall pass through the oil surge relay before entering the conservator.

e) Oil filled compartments shall be provided with filling plug, drain valve with plug, air release vent, oil sampling device, inspection window with view glass.

f) OLTC driving mechanism and its associated control equipment shall be mounted in an outdoor, weather proof cabinet conforming to degree of enclosure protection IP55. The finish shall match with that of the transformer on which it is mounted. The cabinet shall include:
   i. Driving motor (415 V, 3 phase, 50 Hz, AC squirrel cage)
   ii. Mechanically & electrically interlocked motor starting contactors with thermal overload relay, isolating switch and MCCBs.
   iii. Duplicate sources of power supply with automatic changeover from the running source to the standby source and vice versa will be provided in transformer marshalling box and one no. outgoing feeder extending to OLTC Driving Motor cabinet, with appropriate provision for receiving the same.
   iv. Control switch: Raise/ off/ lower (spring return to normal type) or independent push buttons.
   v. Emergency ‘OFF’ push button (maintained type).
   vi. Remote/ local selector switch (maintained contact type).
   vii. Mechanical tap position indicator.

viii. Limit switches to prevent motor over-travel in either direction or final mechanical stops.
ix. Appropriate scheme/ device to permit only one tap change at a time on manual operation.
x. Emergency manual operating device (hand crank or hand wheel).
xi. A five digit operation counter.
xii. Space heaters with thermostat and MCB.
xiii. Control transformers with MPCB/ MCBs on primary and secondary sides for each supply.
xiv. Interior lighting fixture with lamp, door switch/ ON-OFF switch and MCB.
xv. Hinged door with gasket with locking arrangement.
xvi. Terminal blocks, internal wiring, earthing terminals and cable glands for power and control cables.
xvii. Necessary relays, contactors, current transformers etc.
xviii. Transducers or any other appropriate device for remote tap position indication.

g) Control Requirements for OLTC: The following electrical control features shall be provided:

i. Positive completion of load current transfer, once a tap change has been initiated, without stopping on any intermediate position, even in case of failure of external power supply.
ii. Only one tap change from each taps change command even if the command is maintained.
iii. Cut-off of electrical control when manual operation is resorted to.
iv. Cut-off of a counter impulse for a reverse tap change until the mechanism comes to rest and resets the circuits for a fresh operation.
v. Cut-off of electrical control when it tends to operate the tap beyond its extreme position.

h) Remote Control Equipment: The OLTC remote control equipment shall be housed in an indoor sheet steel cubicle to be located in a remote control room. It shall conform to degree of enclosure protection IP42 or better and shall comprise the following:

i. Control switches; Raise/ Off/ Lower (spring return to normal type) or independent push buttons.
ii. If automatic operation is specified, auto / manual selector switch (maintained contact type) and other items as listed.
iii. If parallel operation is specified, master / independent / follower selector switch (maintained contact type) with ‘out of step’ annunciation.
iv. Tap position indicator.
v. Facia type alarm annunciators with “accept”, “lamp test” facilities and hooter / buzzer for alarms as listed.
vi. Necessary auxiliary relays.

vii. Lamp indications for:
- Tap change in progress
- Lower limit reached
- Upper limit reached
- Transformer cooler control apparatus (if applicable)

i. Cable glands for power and control cables.
ii. 240 V rated panel space heater with thermostat.
iii. CFL type interior lighting fixture with lamp and door switch.
iv. MCBs.
v. Terminal blocks.
vi. Internal wiring.
vii. Earthing terminal.
viii. Hook up for the remote operation of tap lower and raise operation and contact/ signal for tap position indication to Purchaser's DCS shall be incorporated in the panel.

i) Automatic Control of OLTC: Automatic voltage regulator (AVR) for auto control of OLTC shall include:

i. Voltage setting device
ii. Voltage sensing and voltage regulating devices
iii. Line drop compensator with adjustable R and X elements.
iv. Timer 5-25 seconds for delaying the operation of the tap changer in the first step for every tap change operation.
v. Adjustable dead band for voltage variation.
vi. Additional features as required when parallel operation with other transformers is specified.

j) Alarms: The following alarms shall be provided:

i. A.C. supply failure
ii. Drive motor auto tripped
iii. Other protective purpose considered essential by the Contractor.
iv. Out of step operation when paralleled transformers supposed to operate on the same tap are operating at different taps.
v. Tap change delayed
vi. AVR failure (if AVR is specified)
vii. For the all specified above a "OLTC trouble" group alarm to be provided in DCS which is located in control room.

k) TESTS:

i. Routine Tests: Routine tests as per IS: 8468 shall be performed on all OLTC's & Motor drive mechanisms. Over and above, Pressure and Vacuum tests shall be conducted as per IEC: 60214.

ii. Type Tests : Type tests as per IS: 8468 shall be carried out on OLTC & Motor drive mechanism when called for. The bidder shall indicate in his price schedule extra price, if any, for carrying out these tests. If type tests are not called for, type test reports for tests conducted (not older than 5 years) on a similar or higher rating OLTC & Motor drive mechanism shall be submitted for Purchaser's approval.

l) Additional Requirements, if any: Tap position indicators and OLTC control switch shall be supplied loose if purchaser decides to mount the same in the power transformer control panel.

m) The finish and dimensions of the panel shall be as specified so as to match with the other panels in remote control room.

2.3. MCC / 415V METAL ENCLOSED SWITCH BOARDS:

2.3.1. Applicable Standards: The design, manufacture and performance of equipment shall conform to the latest standards specified below. In case of conflict between standards and this specification, this specification shall govern.

Metal enclosed switchgear- General requirements	IS: 3427
Factory Built Assemblies of SWGR and control gear for Voltages up to and including 1000V AC & 1200VAC	IS: 8623 / BS: 5486 / IEC: 439
Air Break Switches	IS: 13947-P3 / BSEN6049 / IEC: 947-3
Miniature Circuit Breakers	IS: 8828 / BSEN: 60898
Low Voltage Fuses	IS: 13703 / BS: 1362 / IEC: 269-1
Contactors	IS: 13947/ BSEN: 60947 4 / IEC: 947-1
Starters	IS: 13947/ BSEN60947-4/ IEC: 292-1 to 4
Control Switches & Push buttons	IS: 6857 / BSEN: 60947
Current Transformer	IS: 2705 / BS: 7626
Voltage Transformer	IS: 3156 / BS: 7625 / IEC: 44, 186
Indicating instruments	IS: 1248 / BS: 89 / IEC: 51
Marking and Identification of Conductors and Apparatus Terminals	IS: 11353 / BS: 159
A.C. Electricity Meters	IS: 722, 8530 / BS: 5685 / IEC 145,211
Degree of Protection	IS: 13947 / IEC: 947-P1
Selection installation and maintenance of switchgear and control gear	IS: 10118
Code of practice for phosphating iron	IS: 6005 / BS: 3189

and steel	
Specification for copper rods and bars for electrical purposes	IS: 613
Control transformers for switchgear and control gear voltage not exceeding 1000V AC	IS: 12021

2.3.2. Constructional Features: The switchgear shall be metal enclosed, modular type suitable for indoor/ outdoor installation, dust & Vermin proof, self standing floor mounting with a height not exceeding 2300 mm and shall have following features:

a) Panels shall be complying to Form 4A as per IS 8623: 1993, Part I / IEC 439-1

b) Breaker up to 1250A shall be installed in two tiers and above 1250A, it shall be mounted in single tier.

c) Minimum clearance between live part shall be phase to phase 25.4 mm & phase to neutral 20 mm at any location & shall be complying with the BIL for the panel.

d) Switchgear shall be divided into distinct vertical sections each comprising :

   i. A completely enclosed bus bar compartment running horizontally.
   ii. Enclosed vertical bus bars serving all modules in vertical section.
   iii. A separate horizontal enclosure for all auxiliary power and control buses.
   iv. Vertical cable alley of minimum 250 mm wide covering entire height

e) Operating devices shall be incorporated only in the front of switchgear.

f) Each shipping section shall have metal sheets at both ends

g) Cable alley shall be provided with suitable hinged doors

h) All doors shall be with concealed type hinges and captive screws

i) Each vertical section shall be equipped with a space heater controlled by thermostat

j) Each switchgear cubicle shall be provided with interior lighting with 11W CFL luminaries inclusive of lamp with door limit - on/ off switch.

k) A 240 V AC, 5/ 15 A socket shall be provided in the interior of each cubicle with On-Off switch.

l) All identical equipment and corresponding parts be fully interchangeable without any modifications

m) Main and Auxiliary Buses:

i. Switchgear bus bars shall be of uniform cross section throughout the length and made of Electric grade Aluminium (91 E – 63401)
ii. All bus bars shall be covered with heat shrinkable black PVC sleeves. Coloured polyester tapes for phase identification shall be provided at suitable locations.
iii. Bus bar shall be adequately supported to withstand stresses developed due to short circuits.
iv. Bus bar joints shall be provided with contact grease at the joints and shall be complete with tensile steel bolts, washers and nuts
v. The exposed bus live parts in the cable alley shall be totally covered against accidental contact by a shroud (and not by sleeve) to protect the workmen working on the switchgear.
vi. Vertical bus bars shall have Short Circuit rating same as main bus bar and shall be suitable for all connected load of vertical section.
vii. Neutral bus bar size shall be 50% of phase bus bar.
viii. Termination on bus bars at ACB, MCCBs shall be as per IEC60947-2. For terminations on MCCBs, where phase- phase and phase to earth clearance are not possible, Cu spreaders of suitable size shall be used along with the use of separators.
ix. Bus bar supports shall only be SMC irrespective of bus bar size. The span between the two insulators shall be adequate. Joint positions and insulators shall be properly adjusted so that they don't interfere.
x. For the Main PMCC, Contractor shall ensure that incoming feeders from transformer shall be suitably designed for terminating bus duct if required. Contractor shall consider the necessary arrangement (dummy panel, adapter panel, rear extension etc.) if required, for terminating the bus-duct. Phase transposition, if required, will be done in the Main PMCC.
xi. Wherever Cu bus bars are provided, it shall be tinned copper & not bare Cu.

n) All mounting accessories like base channels, cross angles if required, nuts, bolts etc. shall be supplied by the Contractor.

o) All the indoor switchgear panels shall be suitable for IP-54 degree of ingress protection for the enclosure. Outdoor panels shall be with minimum IP-55, degree of protection

p) All panels shall be made up of CRCA sheet steel of following thickness -

i. Load bearing members - 2.5 mm.
ii. Doors and partitions - Doors – 2.0 mm, Partition - 1.5 mm.
iii. Mounting plate – 2.0 mm.
iv. Gland plate – 3.0 mm for both incomer and outgoing. For single core cable these plates shall be non magnetic.

q) All the panel wiring shall be done with PVC FRLS, multi-stranded copper wires

r) Feeder shall have hinged open-able (more than 105˚) type door with panel locks. All bus-bar covers and other panel covers shall be screw fixed.

s) Suitable barriers of FRP material shall be provided between two terminals connected to different voltage supplies.

t) All doors and detachable components shall be earthed with flexible green coloured (with Yellow coloured band) PVC sheathed 2.5/ 4.0 sqmm. multi-stranded Copper cable.

u) The equipment shall be given tropical and fungicidal treatment.

v) Each compartment & component shall be provided with name plates (with white letters on Black background) at front, inside & rear side.

w) Equipment nameplates shall be fixed by screws/ rivets and shall not be pasted.

x) Metallic Shrouding shall be provided for the isolation of main and vertical bus; as well as to avoid accidental contacts with live parts.

y) Drawing pocket shall be provided on the inside of incomer feeder door.

z) Provision for Top/ Bottom cable entry shall be made to suit the site condition.

aa) Lifting hooks/ eyes shall be provided in each shipping section of the equipment and shall be removable type.

bb) All the panels shall be provided with 20% extra power & control terminals.

cc) All unused contacts of the circuit breaker, protection, auxiliary, control relays shall be wired up to the terminal block.

dd) All terminals of different control voltages shall be separate from each other.

ee) Stud type terminals and ring type lugs shall be used for control cables.

ff) All the control/ power wiring shall be dressed neatly & the wire running through troughs shall be provided with covers

gg) Switchgear shall be easily extensible on both sides by the addition of vertical sections after removing the end covers. It shall be provided with a metal sill frame made of structural steel channel section properly drilled for mounting the switchgear along with necessary mounting hardware. Hardware shall be zinc plated or passivated. It shall be provided with labels on the front and rear indicating the switchgear designation.

hh) Any operating handle of switchgear shall not be more than 1800 mm and not lower than 300 mm from base of the panel.

ii) For individual feeder modules arranged in multi tier formation, it is essential that the modules are integral multiples of the unit size to provide for flexibility in changes if any at site. For safety isolation of the vertical bus bars, insulating barrier with cut outs shall be provided to allow the power slab contacts to engage with vertical Bus bars. A vertical cable alley shall be sufficiently wide for motor control modules and for circuit breaker control modules.

jj) A horizontal separate enclosure for all auxiliary power and control buses, as required shall be located so as to enable easy identification, maintenance and segregation from the main power buses. Tap off connections from these buses shall be arranged separately for each vertical section.

kk) All equipment associated with a single circuit shall be housed in a separate module compartment of the vertical section.

ll) For draw out type modules, only the handles of control and selector switches, push buttons, knobs & cut outs for lamps and meters shall be arranged on the front doors of the respective compartments to permit operation without opening the door.

mm) On circuit breaker controlled circuits, protective relays shall be mounted on the front door of the compartment. All other equipment pertaining to a circuit shall be mounted on the withdrawal chassis. All cut outs shall be provided with gaskets for the purpose of dust proofing.

nn) Current transformers shall not be directly mounted on the buses. Current transformer on circuit breaker controlled circuits shall be mounted on the fixed portion of the compartment.

oo) In breaker compartments, external cable connections shall be carried out in separate cable compartments for power and control cables.

pp) After isolation of the power and control connections of a circuit, it shall be possible to safely carry out maintenance in a compartment with the Bus bars and adjacent circuit live.

qq) The withdrawals chassis shall move on suitable guides and on suitably plated steel or stainless steel rollers or balls to facilitate easy withdrawal.

rr) Cable alleys shall be provided with suitable hinged doors. It shall be possible to safely carryout maintenance work on cable connections to any one circuit with the Bus bars and adjustment circuits live. Adequate number of slotted cable support arms shall be provided for cleating the cables.

ss) Rear of single front switchgear shall be provided with removable panels. It shall be possible for one person to remove and fix the removable panel.

tt) All doors shall be provided with concealed type hinges and captive screws.

uu) The draw out contacts shall be only between copper/copper alloy/ aluminum fuses, which are silver or tinplated. The contact design shall be such that there should be no arcing/ deformation under the associated peak short circuit current.

vv) Switchgear shall be designed in such a way that all components equipment and Bus bars operate satisfactorily without exceeding their respective maximum permissible rise in temperature under ambient temperature conditions prevailing within the switchgear cubical, with reference to ambient temperature outside the switchgear cubical.

ww) Provision of ventilating louvers shall be provided with fine-screened brass or GI meshes to prevent entry of vermin and dust.

xx) The various types of modules indicating the control requirements of each type together with the list of component equipment required for each type shall be as follows: -

i. Incoming circuit - Draw Out type air circuit breaker for above 630A/ Fixed type MCCB for 630A & below
ii. Outgoing feeder - ACB/ MCCB/ MPCB
iii. Auxiliary services - Starters, capacitors, Distribution Boards and other auxiliary load

yy) Physical size of compartment for each type of control and current rating shall be so chosen that all the basic and additional equipment can be housed in the compartment. No equipment associated with any particular circuit shall be permitted to be mounted in any other circuit module.

2.3.3. PCC configuration shall be as per SLD with four pole (FP) incomer breaker and TPN outgoing breakers except Lighting panel outgoing which shall be FP.

2.3.4. Separate instrument's compartment for indicators of flow meter (s), energy meter, level & pressure controller (if any) shall be provided as per actual requirement of suitable size.

2.3.5. Control Voltages : Following control voltages shall be used in LV panels

a) All ACBs tripping / Closing shall be suitable for 110/ 240V AC (24/ 110VDC) as applicable. The trip coil and closing coils of ACBs shall operate satisfactorily under the following conditions of supply voltage:

i. Closing coils - 85 % to 110 % of rated voltage
ii. Trip coils - 70 % to 110 % of rated voltage.

b) Indications/ Annunciator for LV Main PCC/ MCC – 110/ 240V AC (24/ 110VDC)

c) Indications for auxiliary DBs - 240V AC

d) Space heater, 5/15A socket, panel illumination lamp etc. - 240V AC derived from AC bus

e) 240V AC, 110V AC and other voltages shall be segregated to avoid mix-up of voltages.

f) Control transformers suitably rated of voltage ratio 415/ 240/ 110 V on the Incomer/ Bus shall be provided. For the control transformers, MCCB or MPCB shall be provided on the 415 V side and MCBs on the 240/ 110V side. The control transformer shall be cast resin type only.

2.3.6. Painting:

a) All sheet steel work shall be paint through 7 tank electrostatic powder coating process in accordance with the required procedure and with the applicable standards. The switchgear enclosure shall be powder coated with shade as per RAL-7032.

b) The final finished thickness of paint film on sheet steel enclosure shall not be less than 80 microns. Finished painted appearance of equipment shall present an aesthetically pleasing appearance, free from dents and uneven surfaces.

2.3.7. Interchangeability:

All identical equipment and corresponding parts including chassis of draw out modules of the same size shall be fully interchangeable without having to carryout modifications. For trouble free interchangeability, the draw out arrangements shall be designed such that normal dimensional variations are taken care of by self-aligning feature of the modules.

2.3.8. Drawings & Documents Required:

Prior to fabrication of the switchgear, the contractor shall submit following for Purchaser Representative's approval - the dimensional drawing and design calculations indicating bus bar size, short circuit rating of all the electrical component used, internal wiring, components mounting details etc. The contractor shall submit manufacturers catalogues of the electrical components installed in the switchgear.

2.3.9. Inspection:

At all reasonable times during production and prior to dispatch of the switchgear to site, the Contractor shall arrange and provide all the facilities at their plant for inspection & testing of switchgear.

2.3.10. Earthing:

a) Al/ GI earth bus bars of adequate size shall be provided for the entire length of the panel. The framework of the enclosure shall be connected to this earth bus. Provisions shall be made for connection form this earth bus to the main earthing bus bar coming from the earth pit on both side of the switchgear.

b) The earth continuity conductor of each incoming and outgoing feeder shall be connected to this earth bus bar. The armour of cables shall be properly connected with earthing clamp and the clamp shall be ultimately bonded with the earth bus bar.

2.3.11. Labels & Name Plate:

a) Engraved PVC labels shall be provided on all incoming and outgoing feeders. Single line circuit diagram showing the arrangements of circuit inside shall be pasted on inside of the panel door and covered with transparent laminated plastic sheet.

b) A nameplate with the switchgear designation in bold letters shall be fixed at top of the central panel. A separate nameplate giving feeder details shall be provided for each feeder module door.

c) Inside the feeder compartments the electrical components, equipments, accessories like switchgear shall be provided with stickers shall suitably identify control gear, lamps, relays etc.

d) Engraved nameplates shall preferably be of 3-ply (Red-White-Red or Black-White-Black) lamicoid sheet however black engraved perplex sheet nameplates shall also be acceptable. Engraving shall be done with square grove cutters.

e) Nameplate shall be fastened by counter sunk screws and not by adhesives.

2.3.12. Danger Notice Plates:

a) The danger notice plate shall be affixed in a permanent manner on operating side of the switchgear.

b) The danger notice plate shall indicate danger notice in Gujarati, Hindi and English.

c) The danger notice plate, in general shall meet to requirements of local inspecting authorities.

d) Caution name plate, “Caution Live Terminal” shall be provided at all the points where the terminals are likely to remain live and isolation is possible only at remote end i.e. incomer to the switchboard.

e) The danger notice plate shall be made from minimum 1.6 mm thick steel sheet and after due pretreatment to the plate, the same shall be painted white with vitreous enamel paint on both front and rear surface of the plate.

f) The letters, figures, the conventional skull and bones shall be positioned on the plate as per recommendations of latest edition of IS 2551-1982.

g) The said letters, the figures and the sign skull and bonds shall be painted in signal Red color as per latest edition of IS 5 - 1978.

h) The danger plate shall have rounded corners. Locations of fixing holes for the plate shall be decided to suit the design of the switchgear enclosure.

2.3.13. Cable Entry:

a) The panel shall have provisions of cable entry from top/ bottom as per site condition. The removable cable gland plate shall be provided to make entry dust and vermin proof.

b) The panel shall have provisions for fixing the multi-core cable glands.

c) The cable glands support plates shall be 3 mm thick.

d) Cable gland shall be double compression screwed type and made of brass.

2.3.14. Mountings:

a) All equipments in front of panel shall be of flush mounting type.

b) All equipment shall be so mounted that the removal and replacement may be accomplished individually without interruption of services of others.

c) All equipment inside the panel shall be so located that their terminals and adjustments are readily accessible for inspection or maintenance.

d) The centerline of switches, push buttons and indicating lamps shall be matched to give a neat and uniform appearance. Likewise the top lines of all meters, relays and recorders etc. shall be matched.

2.3.15. It is important to note that when pumping station is idle and transformer is required to be kept energized under no load/ part (miniscule) load condition, the necessary LT fixed capacitor bank(approx. 5% of transformer rating) shall be provided in PMCC (transformer LV incomer) panel and shall be manually/ automatically switched on to maintain power factor more than 0.95 but less than 0.99 (near unity). All the components for fixed type Capacitor bank (to be mounted in Main LV PMCC) panel shall be as indicated in typical electrical Single Line Diagram attached with the specifications. This is a complete responsibility of the Contractor to maintain the power factor under idle condition of pumping station. Any power factor adjustment charges levied by power utility shall be recovered from the Contractor along with 5 % lump sum administrative charge by Purchaser.

2.3.16. Moulded Case Circuit Breakers (MCCB):

a) The MCCBs shall conform to IEC 947 & the latest applicable standards.

b) All MCCBs shall be of fixed type unless otherwise specified in the specifications elsewhere.

c) MCCBs shall be of four pole/ triple pole with neutral construction arranged for simultaneous four/ three-pole manual closing and opening and for automatic instantaneous tripping on short circuit.

d) All the incomer & bus coupler MCCBs for Main LT PMCC panels shall be FP type with microprocessor based O/L +S/C + inbuilt E/F release & all outgoings MCCBs shall be TPN with thermal magnetic based O/L +S/C + E/F releases.

e) All MCCB's shall be Schneider make Compact NSX/ Siemens -Sentron 3VL OR equivalent from the approved make list.

f) For achieving the Earth Fault protection in thermal magnetic (TM) based MCCBs, external CBCT, Earth Fault relay & shunt trip provision shall be considered as part of complete TM based MCCB.

g) The ON, OFF and TRIP positions of the MCCB shall be clearly indicated by using LED indications.

h) MCCBs shall be with ICS = ICU = 100%

i) MCCB shall be capable of withstanding the thermal stresses caused by overloads and locked rotor currents of values associated with protective relay settings of the motor starting equipment and the mechanical stresses caused by the peak short circuit current of value associated with the switch gear rating.

j) All the MCCBs shall be of current limiting type and shall provide a cut off in 4-8 milli seconds for prospective currents during faults.

k) All the MCCBs shall be provided with rotary operating handle with door interlock.

l) MCCB terminals shall be shrouded and designed to receive cable lugs for cable sizes relevant to circuit ratings.

m) All MCCBs shall be provided with additional 2 NO + 2 NC contacts, exclusively for Purchaser's use.

n) All the switchgear selection for motor feeders shall be Type-2 co-ordinated.

2.3.17. Entire LV system shall be fuse less type & fuses shall be used only for PT/ Control Transformer primary side. MCBs shall be provided on secondary of PT/ Control transformer

2.3.18. Miniature Circuit Breaker (MCB):

a) MCB shall be hand operated, air break, quick make, quick break type.

b) Operating mechanisms shall be mechanically trip-free from the operating knob to prevent the contacts being held closed under overload or short-circuit conditions.

c) Each pole shall be fitted with a bi-metallic element for overload protection and a magnetic element for short-circuit protection. Multiple pole MCBs shall be mechanically linked such that tripping of one pole simultaneously trips all the other poles. The magnetic element tripping current classification shall be of the type suitable for the characteristics of the connected load. Where this is not specified, it shall be Type C.

d) The short circuit rating shall be not less than that of the system to which they are connected.

2.3.19. Direct-On-Line Starters: Direct on line motor starter shall have following components/ features:

a) Direct-on-line starters shall be suitable for Class AC 3 utilization category as per IS: 13947 (Part 4), unless otherwise mentioned in tender.

b) DOL starter shall have MCCB/ MPCB, Overload Relay with SPP, Contactor etc.

c) Type 2 Co-ordination shall be ensured.

2.3.20. Automatic Star-Delta Starters: Automatic star-delta motor starters shall have following components/ features:

a) Three sets of contactors one for the line, one for the star point and one for the delta, and a timer to automatically change the connections from star to delta.

b) Star Delta Starters shall consist of MCCB/ MPCB, Overload Relay with SPP, Contactors, electronic timer etc.

c) Star-delta contactors shall be electrically interlocked to permit starting of the motor in the proper sequence, namely star contactor closing, line contactor closing, timer energized after time delay, timer contact de-energizing the star contactor, and delta contactor closing.

d) Star-delta starters shall be suitable for AC-3 utilization category as per IS: 13947 (Part 4), unless otherwise mentioned in tender.

e) Type 2 Co-ordination shall be ensured.

2.3.21. Reversing Starters: Motor Reversing starter shall have following components/ features:

a) Forward and reverse contactors, electrically interlocked with each other.

b) Reversing starters shall be suitable for Class AC-4 duty as specified in applicable standards, unless otherwise mentioned in tender.

2.3.22. Auto Transformer Starter(ATS): Auto Transformer starter shall have following components/ features:

a) Auto transformer shall be air cooled type having 3 tappings of 50%, 65% and 80%. The same should be wound with Copper wire. The size of the wire should be determined to suit the associated motor rating. The tapping requirement indicated is minimum required & Contractor to ensure proper tapping selection based on motor starting requirement.

b) Stamping of reputed make and winding wire with ‘B’ class insulation should be used. This should also be suitable for minimum 6 starts per hour. Core shall be of CRGO material.

c) Maximum temperature rise should not be more than 115°C. Kordnoffer circuit (Closed Transition type) should be adopted in ATS panel. There shall be an acrylic/ Hylam sheet over & below the transformer. Also to absorb humming rubber sheet shall be provided below auto transformer.

d) Auto transformer shall be vacuum impregnated.

e) Testing of transformers should withstand full load starting current for six starts per hour, as per relevant IS.

f) ATS shall be provided with thermal overheat protector in each coil of transformer from to give protection overheating. Thermal overheat protector rating shall be 900ºC with 10% tolerance.

g) ATS shall consist of MCCB/ MPCB, Overload Relay, and Contactors etc.

2.3.23. Contactors: The power contactors used in switchboard shall have following features:

a) The Contactors shall confirm to IS 13947 & the latest applicable standards

b) The power contactors shall be of, air break, single throw, triple pole, electromagnetic type.

c) The insulation class of contactor's coil should be B or higher.

d) Operating coils of all contactors shall be suitable for operation on 110/240 V, single phase, 50 Hz supply.

e) Contactors shall be provided with at least two pairs of NO and NC auxiliary contacts.

f) Contactors shall not drop out at voltages down to 70 % of coil rated voltage.

g) All the switchgear selection for motor feeders shall be Type-2 co-ordinated.

h) Motor starters shall be complete with auxiliary relays, timers and necessary indications.

2.3.24. Relays:

a) Main protective relays shall be Numerical type. They shall be suitable for semi-flush mounting with only flanges projecting on the front with connections from the rear.

b) All relays shall be enclosed in rectangular shaped, dustproof cases and shall be suitable for flush mounting.

c) All protective relays shall be in draw out cases with built in test facilities.

d) Auxiliary relays and timers shall be rated to operate satisfactorily between 70 % and 110 % of the rated voltage

e) Test block and switches shall be located just below each relay for testing unless otherwise specified. All auxiliary relay and timers shall be supplied in non-draw out cases.

f) All protective relays shall be provided with at least two pair of potential free output contacts, exclusively for Purchaser's use.

g) Relay cases shall have adequate number of terminals for making potential free connections, to the relay coils and spare contacts. Paralleling of contacts if any shall be done at the terminals on the casing of the relay.

h) Each relay shall have provision for easy isolation of trip circuit for the purpose of testing and maintenance.

i) All relays shall withstand a test voltage of 2 KV, 50 Hz RMS voltages for one minute.

j) Auxiliary seal in units provided on the protective relay shall be shunt reinforcement type.

k) 132 kW & above rated motors shall be breaker controlled with motor protection relay Siemens '7SK 80' OR equivalent from approved make list.

2.3.25. Thermal Overload Relays:

a) Starters shall be complete with a three element, positive acting, ambient temperature compensated, time lagged thermal overload relay with adjustable settings. The setting range shall be properly selected in accordance with the rating of the motor.

b) Thermal overload relays shall be hand reset type

c) 'Stop' push button of the starter and hand-reset device shall be separate from each other.

d) Overload relay hand reset push button shall be brought out on the front of the compartment door. Overload relay shall be provided with at least 1 'NO' and 1 'NC' or one changeover contact.

2.3.26. Timers:

Thermal/ Electronics timer for change over in star-delta and ATS panel should be provided.

2.3.27. Switch And Contactor Ratings:

Switch and contactor rating for various motor starter modules shall be selected by the Contractor, based on the specifications. Contractor shall also select appropriate ratings & ranges for thermal overload relays. These details shall be subject to the Purchaser's approval.

2.3.28. Single Phasing Preventers:

a) Single phasing preventer relay shall be provided to protect motors against single phasing.

b) It should operate satisfactory from 320/ 480V. Timing range of delay start 0 - 45 seconds.

c) Toggle switch for Auto SPP by pass should be provided on front of unit.

d) The relay shall not operate for supply voltage unbalance of ± 5%. After sensing single phasing, the relay shall operate with a time delay of 2 to 3 secs.

e) The relay shall not operate for a 3- phase power supply failure. The relay shall be of the hand-reset type with a hand-reset push button. Resetting shall be instantaneous and independent of the adjusted time delay in the tripping of the unit. Visual indication for the operation of the relay shall be provided.

f) The relay shall be suitable for application to protect reversible and non reversible motors.

g) The relay operation shall be independent of the motor KW rating, the loading conditions prior to the occurrence of the single phasing and RPM of the motor.

h) The relay shall be of the fail-safe type and shall operate to trip the motor when the relay internal wiring is accidentally open circuited.

2.3.29. Power & Control Wiring Connections:

a) Terminals for both incoming and outgoing cable connections shall be suitable for 1.1kV grade Al/ Cu conductor XLPE armoured cable and shall be suitable for connections of solder less sockets for the cable size.

b) Main PMCC incomer feeder shall be suitable for bus duct connections using Aluminum Bus bars for transformer ratings greater than 1000kVA.

c) Both control and power wiring shall be suitable for Bus Duct/ Cable termination as per guidelines mentioned in transformer specifications.

d) Both control and power terminals shall be properly shrouded. Power terminals shall be of stud type.

e) 20 % spare terminals shall be provided on each terminal block. Sufficient terminals shall be provided on each terminal block so that not more than one outgoing wire is connected to per terminal.

f) Suitable barriers of enclosures shall preferably separate terminals strips for power and control from each other.

g) Wiring inside the modules for power, control, protection and instruments etc shall be done with use of 1.1 kV grade, multistranded Cu, PVC FRLS wiring.

h) Power wiring inside the starter module shall be rated for full current rating of respective contactor but not less than 4.0 Sq. mm. 2.5 Sq. mm copper wire shall be used for current transformer circuits.

i) Other control wiring shall be done with 1.5 Sq. mm copper conductor wires.

j) Wires for connection to the door shall be flexible. All conductors shall be crimped with solder less sockets at the ends before connections are made to the terminals.

k) There shall be control transformer for control power supply (110/ 240V AC) and separate control bus.

l) Particular care shall be taken to ensure that the layout of wirings is neat and orderly. Identification ferrules shall be filled to all the wirings terminations for ease of identification and to facilitate checking and testing.

m) Washers shall be used for all Copper and Aluminum connections.

n) Final wiring diagram of power and control circuit with ferrules nos. shall be submitted along with the panel as one of the documents against the contract.

2.3.30. Terminals:

a) The outgoing terminals and neutral shall be brought to a cable alley suitably located and accessible from the panel front.

b) The current transformer for instruments metering shall be mounted on the disconnecting type terminal blocks. No direct connection of incoming or outgoing cables to internal components of the distribution board is permitted; only one conductor may be connected in one terminal.

2.3.31. Wire Ways:

a) The horizontal PVC wire way with screwed covers shall be provided at the top to take interconnecting control wiring between different vertical sections.

2.3.32. Indicating Instruments:

a) All analogue indicating meters shall be 144 x 144 mm size taut band with 240º Scale. All indicating meters shall be provided as per enclosed electrical Single Line Diagram.

b) Ammeters for motor feeders shall have suppressed scale up to 6 times beyond full load.

c) Dials shall be parallax free and white with black numbers and letterings & pointer shall be of knife-edge type. Such instruments shall be provided with zero adjustor accessible from the front.

d) Instruments shall have an accuracy class 1.0 or better.

e) Instrument dials shall be white with black numbers and lettering.

f) Ammeter and current coils of wattmeter's and ammeters shall continuously withstand 120 % of rated current and 10 times the rated current for 0.5 second without loss of accuracy.

g) Voltmeters and potential coils of voltmeters shall withstand 120% rated voltage continuously and twice the rated voltage for 0.5 seconds without loss of accuracy.

2.3.33. Metering Instruments:

a) Multifunction meters shall be provided for all the feeders of 250A & above. For balance all feeders, kWh meters shall be provided. Size of the MFM shall be 96 x 96 sq. mm. MFM shall be provided with following metering features:

i. Current, Voltage, Energy (kWh), MD (kW, kVA), PF & Hz etc.
ii. MFM shall be L&T make 'Quasar'/ Siemens OR equivalent.
iii. MFM shall be with accuracy class 1.0 or better & having RS 485 communication port.

b) Watt-hour meters shall be of 3-phase two- element type suitable for measurement of unbalanced loads in three phases, three wire circuits. They shall be suitable for semi flush mounting on vertical panels.

c) Watt hour meters shall be of the induction type and shall be provided with reverse running stops.

d) Watt-hour meters shall be suitable for operation from the secondary of CTs and PTs. They shall be provided with a separate 3 phases, 4 wires type test terminal blocks for testing of meters without disturbing CT and PT secondary connections.

e) Meters shall be provided with potential indicating lamps and shall have reverse running stops.

f) Meters shall have pointer as well as cyclometer type of register. They shall read KWH, KVARH, and PF as the case may be without the use of multiplication factor which, if unavoidable, shall be 10. The number of digits provided shall be adequate to cover 1000 hours of operation.

g) Current coils of meters shall have a continuous overload capacity of 120 % for both accuracy as well as thermal limits. Also the coil shall withstand at least 10 times rated current for 0.5 second without loss of accuracy.

2.3.34. Current Transformers:

a) Current transformers shall be of cast resin type. Insulation Class shall be Class 'E' or better.

b) Current transformer shall have a short time withstand rating equal to the short time withstand rating of the associated switchgear for one second for breaker feeders.

c) Unless otherwise specified, the minimum performance requirement of current transformers is as follows:
   i. Measuring CTs -15VA, accuracy class 1.0 and.
   ii. Protective CTs - 15 VA, accuracy class 5P20.

d) The above mentioned burdens are minimum required & it will be Contractor's responsibility to coordinate the current transformer burden with the requirements of relays, instruments and leads associated with that particular current transformer. Contractor has to provide sufficiency calculations for the same.

e) Current transformer (CT) shall have polarity markings indelibly marked on each transformer and at the lead terminations at the associated terminal block

f) CT shall be able to withstand the thermal and mechanical stresses resulting from the maximum short circuit current

g) Test links shall be provided in both secondary leads of the CTs to easily carry out current and phase angle measurement tests.

h) Identification labels giving type, ratio, output and serial numbers shall be provided.

2.3.35. Voltage Transformers:

a) Voltage transformers shall be of cast resin type. Insulation Class shall be Class 'E' or better.

b) Unless otherwise specified, the minimum performance requirements of Voltage transformers are as follows:
   i. Measuring VTs - 50 VA per phase and accuracy class 1.0
   ii. Protective VTs - 50 VA per phase and accuracy class 3.0.
   iii. Dual purpose VTs - 100 VA and dual accuracy class 1.0/ 3P for metering and protection respectively. VA is per phase.
   iv. The above mentioned burdens are minimum required & Contractor has to provide sufficiency calculations for the same.

c) All secondary windings of voltage transformers including open delta windings shall be rated for 110 V /√3, 110V/ 3 per phase.

d) Voltage transformer shall have a continuous over voltage factor of 1.2 and short time over voltage factor as follows:
   i. 1.5 for 30 seconds in case of effectively earthed system.
   ii. 1.9 for 8 hours in case of non-effectively earthed system.

e) Voltage transformers shall be complete with suitable rated primary, fuses. Primary fuses shall have a rupturing capacity equal to the rupturing capacity rating of the associated switchgear. All the secondary circuits of the PT shall be protected by MCBs.

f) It shall be possible to replace voltage transformers without having to de-energize the main bus bars.

g) The terminals of PT secondary and tertiary windings, which are required to be connected to earth, shall be earthed by an isolating link without a fuse.

h) Identification labels giving type, ratio, output and serial numbers shall be provided.

2.3.36. Push Buttons:

a) Push buttons shall have two normally open and two normally closed contacts unless otherwise specified. The contacts shall be able to make and carry 5A at 110V DC and shall be capable of breaking 1A inductive load at 110V DC. They shall be provided with inscription plates engraved with their functions.

b) Emergency stop' push buttons shall be of Mushroom type, lockable in the pushed position and shall be shrouded to prevent accidental operation. Key shall not be required for the operation of the push button.

c) The Internal wiring and terminal blocks shall meet the relevant requirements.

2.3.37. Auxiliary Transformers:

Any auxiliary voltage required for any of the component inside the switchgear shall be derived from the main supply by providing adequately rated auxiliary transformer mounted inside.

2.3.38. Indicating Lamps: Indicating lamps shall be:

a) Clustered LED type and of low watt consumption.

b) Provided with series resistors.

c) Provided with translucent lamp covers of colors 'Red', 'Green' and Amber' etc. as required.

d) Indicating lamp shall be of the double contact, bayonet cap type rated for operation at either 110 V AC or at the specified AC/ DC system voltage as applicable.

2.3.39. Control & Selector Switches: Control and selector switches shall be:

a) Rotary type with enclosed contacts.

b) Adequately rated for the purpose intended (Minimum acceptable rating is 10A continuous at 230V AC and 1A (inductive break) 220V D.C.

c) Provided with escutcheon plates clearly marked to show the positions.

d) Control switches shall be spring return to normal type & provided with pistol grip type handles.

e) Selector switches shall be maintained contact stay put type. Switches in ammeter circuits shall be of break type contact. Selector switches shall be provided with oval handles.

2.3.40. Space Heaters:

a) Adequately rated anti-condensation space heaters shall be provided, one for each control panel, for each switchboard and for each marshalling kiosk.

b) Space heater shall be of the industrial strip continuous duty type, rated for operation on a 240 V, 1 phase, 50 Hz, AC system.

c) Each space heater shall be provided with a single pole MCB with overload and short circuit release, a neutral link and a control thermostat to cut off the heaters at 350 C.

d) Space heater indicated in the breaker modules represents the space heater for each vertical section of the switchboard. Where breakers are mounted in two-tier formation, then only one space heater with associated MCB and thermostat is adequate for the vertical section

2.3.41. Cubicle Lighting/ Receptacle:

a) Each control cabinet, marshalling box, etc. shall be provided with interior lighting by means of 11 W CFL luminaries with door operated On/ Off switch.

b) A 240 V, 1 phase, AC receptacle (socket) plug point shall be provided in the interior of each panel with a MCB.

2.3.42. Routine and Acceptance Tests to be conducted by the manufacturer at their own risk and cost in presence of Purchaser/ Purchaser's representative during inspection & testing at manufacturer's works:

a) Following Routine tests as per IS: 13947 and IEC: 60947 standards & other specified relevant IS standards shall be performed by the manufacturer and witnessed by Purchaser/ Purchaser's representative on LV Switchgear panel complete with the accessories.

i. Dielectric test on main circuit.
ii. Test on auxiliary and control circuit.

iii. Measurement of insulation resistance of the main circuit.
iv. Design and visual check.
v. Dimensional check and BOM verification.
vi. High Voltage test on power & control circuit.
vii. Functional & mechanical operation test of all components.
viii. Measurement of thickness of sheet steel & paint.
ix. Verification of wiring as per approved schematic.

b) Following Type Tests reports as per IS: 13947 and IEC: 60947 to be submitted for the same rating & type of LV Switchgear panel conducted in past for review of Purchaser at the time of inspection & testing of equipment. Type test reports should be valid and not be older than the 5 years.

i. Dielectric test on main and auxiliary circuit.
ii. Temperature rise test.
iii. Making and Breaking test of switching elements.
iv. Degree of protection test.
v. Short circuit withstand test.
vi. Electromagnetic compatibility test.

c) Certified copies of all type and routine test certificates and Calibration Certificates of measurement instruments which are used during inspection shall be submitted for the Purchaser's review/ approval before dispatch of the switchgear.

2.3.43. Test Certificates:

a) Testing of switchgear shall be carried out at factory or at site as per standard in presence of Purchaser/ Purchaser's representative.

b) The test results shall be recorded on prescribed forms. The certificates for the test carried out at factory or at site shall be submitted in duplicate to the Purchaser/ Purchaser's Representative for approval. Components and equipment that are not fully interchangeable are liable for rejection. Contractor shall replace all such non interchangeable equipment at his cost.

2.3.44. Drawings/ Documents required: After award of contract Contactor has to submit drawings/ documents for Purchaser's approval as mentioned below but not limited to:

a) General arrangement diagram showing dimensions of enclosure, length, widths and depth of enclosure and bill of quantity indicating the rating, make of each components and quantity.

b) Complete assembly drawings of the switchboard/ distribution board/ MCC showing plan, elevation and typical sectional views and location of cable boxes and control cable terminal blocks for external wiring connections, etc.

c) Foundation plan showing the location of channel sills, foundation, anchor bolts and anchors, floor plans and openings.

d) Schematic power and control wiring diagrams with bus bar rating with material, instrument & control transformers, switchgear rating, control interlocks, relays, instruments, space heaters details etc.

2.4. LOCAL PUSH BUTTON STATIONS:

2.4.1. Constructional Features: The constructional features of the local push button stations shall be as follows:

a) Metal enclosed, weatherproof, suitable for mounting on wall or steel structures. The enclosure shall be die cast aluminum or sheet metal of 2 mm thickness.

b) Dust and vermin proof.

c) Provide a degree of protection of not less than IP55.

d) Metal parts shall be given tropicalisation treatment as per standards and painted with one coat of epoxy primer and two coats of light gray epoxy paint.

e) Provided with inscription plates of rear engraved Perspex with white letters on black background. The letter size shall be 6 mm.

f) Provided with two earthing terminals suitable for earthing wire /strip.

g) Provided with removable undrilled gland plate and cable glands for two nos. 5C x 1.5 mm2 Copper conductor, XLPE insulated, armoured cable. The cable entry shall be from the bottom.

h) Earthing shall be provided by 8 SWG GI wire and connected to earthing system.

2.5. FIXED TYPE CAPACITOR

a) The type of capacitors shall be All Polypropylene type double layer conforming to IS 13585 - 1994 & having following specifications:

Supply	3 phase, 3 wire
Rated voltage	415 V
Rated frequency	50 Hz.
Permissible over voltage	1.1 Vn
Permissible over current:	1.5 In
Temperature category:	50º C

b) The capacitor shall be vacuum impregnated with liquid dielectric having high thermal stability.

c) The capacitors shall have Low Dielectric Loss of ≤ 0.5 W / kVAr.

d) * kVAr is net reactive compensation required to maintain 0.99 PF at 415 V Bus, i.e. excluding compensation required for detuned filters.

2.6. APFC PANEL WITH CAPACITOR BANKS:

2.6.1. Capacitor Banks:

a) The type of capacitors shall be All Polypropylene type double layer conforming to IS 13585 - 1994 & having following specifications:

Supply	3 phase, 3 wire
Rated voltage	415 V
Rated frequency	50 Hz.
Permissible over voltage	1.1 Vn
Permissible over current:	1.5 In
Temperature category:	50º C

b) The capacitor shall be vacuum impregnated with liquid dielectric having high thermal stability.

c) The capacitors shall have Low Dielectric Loss of ≤ 0.5 W / kVAr.

d) Each capacitor bank shall be provided with the 7% detuned filter.

e) * kVAr is net reactive compensation required to maintain 0.99 PF at 415 V Bus, i.e. excluding compensation required for detuned filters.

f) Bushing should have high mechanical strength & method of fixing should be proper so that no leakage occurs.

g) Auto/ Manual switch shall be provided in the APFC panel. For manual switching, every capacitor bank feeder shall be provided with ON & OFF push buttons along with the ON & OFF indications.

h) Minimum current rating under site conditions, of circuit breakers, contactors and cables shall be at least 150% of rated capacitor current, to take care of capacitor inrush current.

i) Contactor for switching of capacitor banks shall have AC -6b utilization category according to IEC 60947-4-1 & sized accordingly.

j) All the components shall be suitable for capacitor duty application.

k) The capacitor banks shall be complete with all parts that are necessary or essential for efficient operation. Such parts shall be deemed to be within the scope of supply whether specifically mentioned or not. Capacitor shall be designed to improve the power factor to 0.99 lagging

l) It shall be complete with the required capacitors along with the supporting post insulators, steel rack assembly, Al/ Cu bus bars, Al/ Cu connecting strips, foundation channels, fuses, fuse clips, etc. The steel rack assembly shall be hot dip galvanized.

m) The capacitor bank may comprise of suitable number of single phase units in series parallel combination. However, the number of parallel units in each of the series racks 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 assembly of the banks shall be such that it provides sufficient ventilation for each unit.

n) Each capacitor case and the cubicle shall be earthed to a separate earth bus.

o) Capacitor shall conform to IS 2834 -1986.

p) The units shall be capable of continuously withstanding satisfactorily any overvoltage up to a maximum of 10 % above the rated voltage, excluding transients.

q) 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 upon disconnection, in accordance with the provisions of the latest edition of IS:2834.

2.6.2. Control Cubicles:

a) Capacitor and capacitor control shall be housed in a metal enclosed cubicle. Capacitor shall be housed in the lower compartment and capacitor control unit at the top compartment, the two compartments being segregated. Control cabinets shall be free standing floor mounted type and shall meet the requirements of Metering, Protection & related provisions for APFC panel as tabulated below:

Panel Name	Breaker Type	Protection	Metering	Indications	Other
APFC Panel					
Incomer	ACB (TPN, MDO) OR MCCB (TPN,	TM based O/L, S/C release , APFC Relay,	Analogue A, V	R Y B, On, Off, Trip	ETPB, A/M SS, Annunciator

	Fixed Type)	E/F Relay with CBCT & Shunt Trip			
Outgoing	MCCB (TP, Fixed Type)	TM based O/L, S/C release	A, AS	On, Off, Trip	Start, Stop Push Buttons

b) APFC panel shall have Al bus bars sized for appropriate SC rating for 1 sec & to carry continuous rated current.

c) All CTs/ PTs shall be cast resin type.

d) All the MCCB's shall be current limiting type. Necessary auxiliary contact block required is included in Contractor's scope.

e) One contact of power factor correction relay shall be provided for annunciation "POWER FACTOR LOW". The relay shall switch-on/ off capacitor banks for loads from 5% to 100%. The annunciation window shall be with test, accept and reset push button & hooter.

f) Capacitor switching and automatic power factor correction panel shall be designed in such a way that power factor of 0.98 lagging shall always be maintained. Timings to cut in capacitors shall be provided in such a manner to facilitate capacitor discharging before next switching and shall also avoid hunting due to temporary fluctuations of load. The timer shall be provided in both auto and manual mode.

g) The Automatic power factor correction panel and capacitor panel are integral type, prewired including power connections. Due consideration shall be given for adding/removal of capacitor or other components and maintenance considerations. Contractor shall submit GA drawings of capacitor and capacitor control panel, with description of power factor control panel with its components.

h) For control circuit 415/ 240/ 110V control transformer shall be considered. VA burden to be decided by the Contractor.

i) Minimum clearance between live parts shall be phase to phase 25.4 mm & phase to neutral 20 mm.

j) Bus bars shall be sleeved with coloured heat shrinkable sleeves. All the Bus bar supports shall be SMC type only.

k) Degree of protection shall be IP-42 for the enclosure, epoxy painted, powder coated with colour shade RAL-7032 for exterior & interior with minimum thickness 80 micron.

l) All necessary auxiliary contactors are included in scope.

m) Contractor shall note that verification of double layer construction shall be done on any one of the capacitor bank during inspection by opening the capacitor bank at no extra cost.

n) The cubicle shall be fabricated out of 2.0 mm thick cold rolled sheet steel & shall comprise of :

i. Isolating ACB / MCCB
ii. Contactors
iii. Sequencing devices, timers and auxiliary relays for automatic sequential switching of capacitor units in and out of circuit.
iv. Auto-manual selector switch
v. Microprocessor based Automatic Power Factor Correction (APFC) Relay – minimum 8 stage relays.
vi. Push button for opening and closing the power circuit
vii. Red and Green lamps for capacitors ON/ OFF indication
viii. Protective relays
ix. Space heater and cubicle lighting & receptacles.

2.6.3. Principle of Operation: On deviations from set power factor, the power factor controller shall release command signals to switch on/ switch off capacitor bank stages and maintain the set power factor.

2.6.4. APFC Relay: APFC relay shall have following standard features:

a) The Automatic Power Factor Correction relay shall be of microprocessor based type and shall automatically switch ON/OFF the capacitor banks to attain the value of “pf” close to the set value.

b) Switching shall follow first in first out (FIFO) method to ensure uniform use of all capacitor banks. At least eight steps shall be provided for switching.

c) To measure/ monitor power factor and VAR continuously. Status of switching step shall be displayed through LED.

d) Following adjustment shall be available in APFC Relay.
i. Power factor
ii. Dead band capacitive region with respect to set power factor (PF).
iii. Inductive region with respect to set PF
iv. Operating time for programmable switching steps.
v. Auto/ manual selector switch.
vi. Manual step control.

e) All control knobs, LEDs for display and selector switches shall be mounted on the front face of relay casing/ panel.

f) It should be fully programmable. There should be a choice for customer to select operating sequence up to 4 to 5 which will have maximum number of steps of capacitors equal to fourteen (14). The sequence shall be arithmetic 1, 2, 3…..13, 14.

g) Operating time selection of time interval designation between switching stages shall be possible using time selector switches. The device shall take care that any stage which has just been switched out will only be reconnected by the pulse counter, after 60 sec. has elapsed so that it has safely discharged. This is a requirement for 415 V capacitors

h) Loss of voltage element. This would prevent abnormal switching surges on loss of supply. Also it would control the switching on/off surges.

i) Dead band features – Relay response sensitivity adjustable using dead band so that hunting is prevented.

j) Auto/Manual control – This would help testing and commissioning at site as well as ease in operation when either mode fails during service time.

2.6.5. Performance Tests:

a) Contractor shall carry out all routine tests as specified in relevant IS/ IEC standards on all major components and furnish copies of test reports for Purchaser's approval. Wherever required, Contractor shall conduct the necessary type tests in the presence of Purchaser/ Purchaser's representative.

b) Contractor shall also carry out all routine and functional tests as specified in the relevant IS on the assembled switchgear panels in the presence of the Purchaser's representative at works before dispatch and furnish copies of test reports for approval. If required stage inspection will be carried out by the Purchaser.

c) During inspection, Contractor shall furnish copies of routine test report for all bought out items for Purchaser's approval.

d) Primary Injection Test for various currents & time settings shall be provided in routine test.

e) All the components shall be tested for their entire operating range & certification for the same shall be provided at the time of inspection.

2.6.6. Maintenance Requirements

a) As far as possible the switchgear shall be so designed that no special tools are necessary for installation and maintenance. However, if special tools are required, the Contractor shall supply one complete set of such tools along-with the equipment.

b) Contractor shall furnish detailed inter panel wiring diagrams, internal wiring diagrams, detailed component layout drawings to carry out maintenance work.

2.6.7. Drawings / Documents Required:

a) Dimensioned general arrangement drawings of capacitor and capacitor control panel.

b) Justification for number of steps for switching.

c) Fully dimensioned general arrangement drawings of capacitor and capacitor control panel with elevation side view, sectional view and foundation details.

d) Complete schematic and wiring diagrams for capacitor control panel.

2.7. CABLING SYSTEM:

2.7.1. The scope shall be inclusive of supply, installation, testing & commissioning of power & control cables, cable terminations, cable accessories, stripping of cable insulation, supplying and fixing of Aluminium lugs for aluminium cables & tinned plated copper lugs for copper cables and crimping the same to the conductor, supply and fixing of double compression cable glands including all labour supply and consumable material required for jointing/ termination. The rate shall also include the laying of cable in ground/ in cable trays / cleating to structure etc.

2.7.2. Applicable Standards:

The cables shall confirm to the latest applicable standards specified below. In case of conflict between standards and this specification, this specification shall govern.

PVC insulated cables (for voltage up to 1100 V)	:	IS: 694
HRPVC & PVC insulated cables heavy duty	:	IS: 1554
Cross linked polyethylene insulated PVC sheathed cables	:	IS: 7098
Low frequency cables and wires with PVC insulation and sheath	:	IEC: 189-1 & IEC-189-2
PVC insulation and sheath of electric cables	:	IS: 5831
Polyethylene insulation and sheath for electric cables	:	IS: 6474
Conductors for insulated electric cables	:	IS: 8130
Methods of test for cables	:	IS: 10810
Specification for drums of electric cables	:	IS: 10418
Specification for PVC insulated cables for electricity supply	:	BS: 6346
Specification for PVC insulation and	:	BS: 6746

sheath of electric cables

2.7.3. Constructional Features:

a) The 11kV power cables shall conform to 11kV Earthed grade (E), three core, stranded, Aluminium conductor, screened by extruded semi-conducting compound, cross-linked poly ethylene (XLPE) insulated, cores screened with non-magnetic metallic tape laid up with inner and outer extruded PVC sheath compound Type-ST2 and galvanized steel strip armouring. The cables shall generally conform to IS 7098-1985 with relevant parts thereof.

b) Armouring shall conform to latest version of IS: 3975.

c) The LV Power cables shall be 1.1kV grade, 4/ 3.5/ 3 Core, multi-stranded, Al/ Cu conductor, XLPE insulated, extruded inner & outer PVC sheath compound type ST2 and galvanized wire (up to 6 sq mm) / steel strip(>6 sq mm) armoured cables. All single phase, Lighting cables, UPS cables shall have 100% Neutral.

d) All the control cables shall be 1.1kV grade, no. of cores (as per requirement/ application with minimum 2 spare cores for 7C & above) multi-stranded, Copper conductor, XLPE insulated, extruded inner PVC & outer PVC FRLS sheath compound type ST2 and galvanized steel round wire armoured.

e) All control cables shall be with following specific requirements:

i. Copper conductor stranded class 2.
ii. XLPE Insulated
iii. Provided with inner extruded PVC and outer PVC FRLS sheath of extruded black PVC compound.
iv. Galvanized steel armouring in the form of GI round wire.
v. Core identification shall be by printed numerals.
vi. The insulation over the individual conductor core will be colour coded.
vii. Minimum 2 spare cores for above 7C.

f) The DC power supply cable shall be two core, multistranded copper conductor, armoured cables with inner extruded PVC & outer PVC FRLS sheath. All control wiring shall be PVC FRLS insulated.

g) All the power & control cables used in the Hazardous area shall be flame proof type suitable for the intended application.

h) Earthing Cable shall be Single core multi-stranded Cu, 1.1 kV grade, XLPE insulated, un-armoured green coloured outer sheath with yellow strips/ band cable to be laid in trays, underground, trenches etc. as applicable.

i) Submersible Cables: Multi core flexible Cu conductor XLPE insulated & PVC sheathed heavy duty cable suitable for submersible application (in case of submerged pumps) shall be manufactured as per governing standards. High purity electrolytic grade, annealed Cu conductor shall be used. Cables shall be extruded inner & outer PVC sheathed. PVC compound shall be dielectric grade & shall be impervious to water, oils & grease etc. Similarly double PVC sheathing shall also be done as per IS: 5831/ 1984. Flexible inner sheath & high abrasion resistant flexible outer sheath is required for these cables. Double PVC sheathing shall be done so as to withstand abrasion & prevent ingress of water along the interstices of the cable. Core identification shall be by printed numerals. Conductors shall be as per IS 8130. Cable shall be constructed as per relevant IS/ IEC standards.

2.7.4. Cable Colours:

a) All cable cores shall be colour coded throughout their length and shall be so connected between switchboard, distribution board, plant and accessories, that the correct sequence or phase colours are preserved throughout the system.

b) The colour coding should be as follows:

i.	3 phase	Red, Yellow and Blue
ii.	single phase or dc supply	Red and Black
iii.	earth	Green/Green with Yellow coloured band
iv.	control	Gray (DC)

2.7.5. Cable Conductors;

a) Cables up to 4.0 sq.mm shall be Cu multi-stranded conductor with galvanized steel round wire armoured & balance cables shall be Al multi-stranded conductor with galvanized steel round wire/ flat strip armoured.

b) Single core cable shall have non magnetic material armouring.

c) Lighting final distribution circuits shall be of a minimum cross-section of 1.5 mm2.

d) Small control cables shall be of a minimum cross-section of 1.5 mm2.

e) Internal wiring of control panels shall be of a minimum cross-section of 1.5 mm2 flexible and multistranded.

f) Instrumentation and control cabling shall be of a minimum cross-section 1.5 mm2 for external use and 1.0 mm2 for internal use.

g) Cable Sizing shall be done as per design criteria specified in specifications.

2.7.6. Cable Numbering: All cables shall be allocated a unique number which shall be fixed to each end of the cable using a corrosion resistant label. Necessary loop at both ends shall be provided for future use and cables of different categories shall be tagged with the following subscripts and three digit number.

HV power	HV-P_ _ _
LV power	P_ _ _
Control	C_ _ _
Instrumentation	I_ _ _
Protection	PR_ _ _
Telecommunication	T_ _ _

2.7.7. Cable Terminations:

a) Cable Lugs

i. Cable lugs shall be of tinned copper, solder less crimping type for Cu cables & AL lugs for the AL cables.

ii. The current rating of the lugs shall be same as that of the respective cable conductors.

iii. Bi-metal strip/ Bi-metallic lug shall be used whenever two different metals are to be connected together.

iv. Double holes extended neck (long barrel neck) type lugs shall be used in case of cables above 185 sq. mm.

v. Anticorrosion/ anti-oxidation compounds shall be used for crimping lugs. This shall especially be ensured for Al cable terminations & bimetallic terminations shall be used wherever required.

vi. If termination is done with crimping tool employing crimping die then forming dies shall be used to make the sector shaped conductor into a round conductor before crimping the lugs on the conductor. The lug must not be crimped directly on the sector conductor. Before crimping the lug, the conductor shall be thoroughly cleaned and special jelly applied over it to prevent further oxidation.

b) Cable Glands

i. Glands shall generally be of the double compression hexagonal type brass glands. Earth continuity of brass glands shall be assured.

ii. Double compression type cable glands shall be used. Cable glands shall be brass casting, machine finished and Nickel-plated to avoid corrosion and oxidation. Rubber components used in cable gland shall be of neoprene.

iii. For single core cables, gland shall be with brass ring.

iv. Glands for single core cables shall be constructed from non-magnetic materials.

v. Cable glands shall be with metric threads.

vi. Where holes for cable entries are not provided it shall be the responsibility of the Contractor to mark out and drill such holes. Burrs and swarf shall be removed, care being taken to ensure that swarf and filings, etc do not enter the equipment.

vii. For non-hazardous areas cable glands in situations where moisture may be present shall be double seal weatherproof type, gland shrouds shall be used and entry shall be sealed.

viii. For dry indoor situations, standard industrial glands with shrouds are acceptable.

ix. For hazardous areas, glands conforming to EEE standard shall be used with double seal and shroud.

c) Trefoil Clamps for Single Core Cables.:

i. All the single core cables shall be laid in trefoil formation only.

ii. The grouping & sequencing of three single core cables arranged in trefoil formation shall be done in such a way to ensure balanced current distribution.

iii. Trefoil clamp of suitable size & having non magnetic material shall be used.

iv. The Trefoil groups shall be held in trefoil clamps at an interval not exceeding 3.0 meters.

v. In addition to trefoil clamps as mentioned above, the tre-foil groups of cables shall be additionally tied by means of 3.0 mm dia. nylon cord clamp at an interval not exceeding 750 mm.

d) Where ever applicable, supply & installation provision of bimetallic strip for connection between Al to Cu strip & GI to Cu strip shall be provided.

2.7.8. Cable Drums:

a) Cables shall be supplied in non-returnable wooden drums. The wood used for construction of the drum shall be properly seasoned and free from defects and wood preservative shall be applied to the entire drum. All ferrous parts shall be treated with a suitable rust preventive coating to avoid rusting during transit or storage.

b) Before winding the cables on drums, Contractor shall obtain Purchaser's approval for the drum lengths. Cable ends shall be sealed by non-hygroscopic sealing caps.

c) Contractor has to ensure reference of an arrow and suitable accompanying wording which shall be stenciled on the sides of the drums indicating which way it should be rolled. The number on each drum shall be either branded at the end of the drum or stamped on the metal attached to an end of the drum. The cable shall be placed on the drum in such a manner that it will be protected from injury during transit. Each end of the cable shall be firmly and properly secured to the drum. The drum shall be securely blocked in position so that the cable will not be displaced during transit. Cable ends shall be sealed by non-hygroscopic sealing caps.

d) It shall be the Contractor's responsibility to prepare the drum cutting schedule so that cable wastage is minimum while cutting.

e) Contractor shall obtain Purchaser's approval for the drum lengths.

2.7.9. Tests Before and After Laying of Cables at Site: Following Routine & acceptance tests on each drums as per IS 10810, IS 7098 standard & other specified relevant standards shall be performed by the manufacturer and witnessed by Purchaser/ Purchaser's Representative.

a) For 1.1 kV Power & Control cables:

i. Dimensional & visual check

ii. Conductor resistance test

iii. Insulation Resistance Test

iv. High voltage test

b) For 11 kV power cables:

i. Design and visual check

ii. Conductor resistance test

iii. Very low frequency AC HV test (instead of DC test)

iv. Insulation resistance including P.I. at rated voltage

v. Capacitance and tan delta

vi. AC leakage current

vii. Partial discharge measurement

c) All HV cables shall be subjected to DC or AC (preferably DC) high voltage test after terminating but before commissioning as per Table 6.0 in IS: 1255 (Code of practice for Installation & Maintenance of Power Cables up to and including 33kV).

d) Cables shall be checked for insulation resistance before and after jointing. The voltage rating of the Megger for cables of different voltage grades shall be as indicated below.

Voltage Grade	Megger rating
1.1kV	500V
11kV	1000V

e) Following tests in the presence of Purchaser/ Purchaser's representative shall be carried out at site before commissioning of cables.

i. Insulation Resistance test between phases and phase to Neutral and phase to earth.

ii. Continuity test of all the phases, neutral and earth continuity conductor.

iii. Sheathing continuity test.

iv. Earth resistance test of all the phases and neutral.

2.7.10. Drawings/ Documents Required:

a) As a part of the Bid, Contractor shall furnish the following :

i. General information

ii. Principal technical data

b) After award of contract it shall be the responsibility of Contractor to work out a detailed layout for the complete plant cabling system. The layout drawing shall be furnished for the approval of Purchase/ Purchaser's representative before commencement of installation including cable trays, cable racks/ trenches, accessories, tray supports, conduits etc.

c) Contractor to submit following Drawings/ Details after award of contract

i. Cable Sizing calculations
ii. Details of Installation of cables in trenches, on cable trays, directly buried etc at all locations inside the plant.
iii. Cable routing layout inside and outside the plant with route marker provided at 15 meter interval.

iv. Bill of quantities of cables, lugs and glands.
v. HV Cable termination and mounting Kit Layout drawing.

d) Following Type Tests reports as per relevant standard to be submitted for the same rating & type of Cables conducted in past for review of Purchaser/ Purchaser's Representative by the Contractor at the time of inspection & testing of equipment. Type test reports should be valid and not be older than the 5 years.

i. Annealing test

ii. Tensile test

iii. Wrapping test

iv. Test for thickness of insulation & sheath

v. Physical test for insulation & sheath

vi. Tensile strength and elongation at break of insulation and sheath

vii. Loss of mass test

viii. Ageing in air oven

ix. Shrinkage test

x. Heat shock test

xi. Insulation resistance test

xii. High voltage test

xiii. Flammability test

2.7.11. Cable tray and accessories:

a) Cable trays shall be of Galvanised Steel/ Fibre Reinforced Plastic and of ladder/ perforated/ solid type, complete with all necessary coupler plates, elbows, tees, bends, reducers, stiffeners and other accessories and hardware as detailed in the relevant drawings. All hardware (i.e. bolts, nuts, screws, washers, etc) shall be hot dip galvanized.

b) Cable trays of ladder and perforated types and the associated accessories such as coupler plates, tees, elbows etc., shall be fabricated from 14 gauge (2.0 mm thick) mild steel sheets. Cable tray covers shall be fabricated from 16 gauge perforated (1.60 mm thick) M.S. sheets.

c) The cable trays shall be supplied in standard lengths of 2500 mm and clear inside widths of trays shall be as follows:

i. Perforated type trays : 150, 300, 450 and 600 mm.

ii. Ladder type trays: 300, 450, 600 and 750 mm

d) Cable trays, accessories and covers shall be painted with one shop coat of red oxide zinc chromate primer and two site coats of aluminium alkyd paint for indoor use.

e) For outdoor use, cable trays, accessories and covers shall be either galvanized or made of aluminium as specifically mentioned in the layout drawings.

f) For use in corrosive atmospheres both indoors and outdoors, the cable trays, accessories and covers shall be as per serial no.(e) above.

g) The spacing of rungs for ladder type of trays shall be 250 mm unless otherwise noted.

h) All finished cable trays and accessories shall be free from sharp edges, corners, burrs and unevenness.

2.8. EARTHING & LIGHTNING PROTECTION SYSTEM:

2.8.1. Scope:

a) The scope includes collection of data, design of the system as per relevant National/International Standards preparation of layout drawing supply of earthing conductors, earth electrode, earthing strips installation and approval to the satisfaction of electrical inspector under this tender specification.

b) Earthing system shall be provided to ensure equipment safety, personnel safety and facilitate designed operation of protective switching during earth fault conditions in the associated system.

2.8.2. Applicable Standards: The earthing and lightning protection system shall conform to the CEA guidelines and the latest applicable standards indicated below:

a)	Code of Practice for Earthing	:	IS: 3043
b)	Code of Practice for the Protection of	:	IS/IEC 62305
c)	Building and allied structure against Lightning.		
d)	Hot dip galvanizing	:	IS: 2629, 2633, 4759
e)	Structural steel	:	IS: 2062 & 808
f)	Welding	:	IS: 816

2.8.3. Earthing & Lightning system:

a) The design basis for designing earthing conductor is indicated under design criteria for electrical system. Earthing system shall be provided for complete plant i.e. pumping stations, switchyard and all electrical equipments as per the latest edition including all official amendments and revisions of IS-3043 and CEA guidelines.

b) All materials and fittings used in the earthing installation shall conform to the relevant Indian Standards or shall be approved by the Engineer's representative & CEIG.

c) Contractor has to carry out soil resistivity test at, at least 4 locations for which locations shall be provided by Purchaser's representative. Testing to be done at each site.

d) Soil resistivity shall be carried out by Wenner four electrode method as described in IS 3043. Contractor has to carry out the test in presence of Purchaser's representative & test shall be carried out keeping electrode spacing as 1, 2, 4, 6, 8, 10, 15, 25 M (each, along all 8 directions) as per normal practice and report has to be submitted. Polar curves shall be used for measurement of mean soil resistivity, which shall be used in finding earthing resistance at a particular location. Mean soil resistivity values shall be approved by Purchaser's representative.

e) The Contractor shall base his earthing calculations on actual measurement carried out by him in the presence of Purchaser/ Purchaser's Representative.

f) Galvanized Iron flat / wire shall be used as earthing conductor.

g) The underground joints in the system shall be properly welded or brazed and the bolted type connection shall be made with structures/ equipments. Petroleum jelly shall be applied to contact surface of the bolted joints, which will be covered with bituminous compound and tapes.

h) Earthing conductor shall be protected against mechanical damages considering the installation conditions.

i) The earthing system shall comprise one or more earth electrodes, earthing grid or a combination of these in order to obtain the required earth electrode resistance of less than 1 Ohms.

j) For equipment earthing, two earthing leads will be used if rated voltage of the equipment is 250 volts & above and one earthing lead will be provided for equipment rated below 250 volts.

k) The earthing conductors in outdoor areas shall be installed at a minimum depth of 600 mm below FGL.

l) For each 11 KV DP Structure, minimum 2 nos. of CI plate type earthing electrodes shall be provided. The earth plate shall be buried in specifically prepared earth pit- 3 mtr. below ground with alternate layers of charcoal and salt, 40 NB GI pipe with funnel with a wire mesh for watering and bricks masonry block and CI Cover complete as per IS 3043 with necessary length of double GI earth flat 25x6 mm bolted with lug to the plate complete connected to the required point of DP with end socket as per direction and duly tested by earth tester conforming to IS as per drawing and specifications complete with 600 x 600 x 3.5 mm CI earth plate.

m) For each transformer neutral**,** minimum 2 nos. of Cu plate type earthing electrodes shall be provided. The earth plate shall be buried in specifically prepared earth pit 3 mtr. below ground with alternate layers of charcoal and salt, 40 NB GI pipe with funnel with a wire mesh for watering and bricks masonry block CI Cover complete as per IS 3043 with necessary length of double Copper earth flat 25x6 mm bolted with lug to the plate complete connected to the transformer neutral with end socket as per direction and duly tested by earth tester conforming to IS as per drawing and specifications complete with 600 x 600 x 3.15 mm Copper earth plate.

n) For other equipment & area, Earth electrodes shall be of heavy duty galvanized mild steel of not less than 40 mm NB and minimum 3000 mm long. Where multiple rods are used they shall be separated by a distance of not less than 2000mm.

o) Each earth electrode pipe shall be welded at the top to a mild steel plate to which the earthing strips shall be connected. These connections shall each be housed in individual inspection chamber set which shall project 100 mm above the finished ground level and shall allow disconnection for testing of individual electrodes. The chamber shall be permanently marked `Electrical Earth'.

p) All materials used for the earth electrode installation shall be purpose made for the application and site conditions and shall be approved by the Purchaser's Representative.

q) All civil works, such as excavation, boring, provision of charcoal & salt in adequate quantity, backfilling for the installation of the earth electrodes and the earth pit/ inspection pit shall be in the scope of Contractor.

r) After the earth installation has been completed the Contractor shall demonstrate to the Purchaser/ Purchaser's Representative that the resistance of the electrodes to earth and the continuity of the earth network are within the limits specified. Any additional earth electrodes and test instruments required for the tests shall be provided by the Contractor.

s) Main Equi-potential Bonding Conductor: Main equi-potential bonding conductors shall be provided to connect the earth electrode system to conductive parts forming the Works.

t) Circuit Protective Conductors: An independent circuit protective conductor shall be provided for each circuit and may comprise one or any of the following as appropriate:
   i. a separate core within a multicore cable
   ii. A separate conductor installed within a conduit or trunking. Steel conduit or trunking shall not be used as a circuit protective conductor.
   iii. The metal sheath of an armoured cable. The sheath shall be bonded to the metal work of the apparatus and to the apparatus earth bar, if any.
   iv. the copper sheath of a mineral insulated copper sheathed cable
   v. An independent earthing conductor MS or GS run adjacent to the circuit it protects.
   vi. The size of the circuit protective conductor shall be calculated in such a manner as not to take into consideration the contribution of any other parallel or fortuitous earth paths.
   vii. The armoring of the supply cable shall not form the sole means of earthing a switchboard or large electrical load.

u) Instrumentation Earth:

   i. An instrumentation earth bus shall be provided in each control panel. This shall comprise a GI flat of cross section not less than 25 x 6 mm and length to suit the number of connections. It shall be mounted on at least two insulated supports and be provided with a single earth connection to the control panel electrical power earth.
   ii. If due to the physical size of a control panel more than one instrument earth bar is required the additional bar shall be connected again with a single earth connection to the same point as before on the control panel electrical earth bar. In this fashion all instrument earths shall be connected radialy from the same earth point.
   iii. All signal cable screens (analogue and digital) shall be terminated on to the instrument earth bar. Signal cable screens shall be earthed at the control panel end only. Screens at the field end shall be tied back and insulated.
   iv. Surge Protector Devices (SPDs) associated with the control and instrumentation system shall be earthed to the instrument earth in accordance with the SPD manufacturer's recommendations.

2.8.4. Important Instructions for Earthing:

a) Each pole of lightning arrestors shall be earthed with separate earth pit.

b) Two-earth conductor shall connect outdoor CT secondary winding to earth grid.

c) The switchyard fencing shall be earthed at every alternate block and the switchyard gate shall be earthed with flexible GI wire.

d) All the earthing material with laying etc. shall be included in the scope.

e) The entire plant will have an earth grid laid in trenches/ trays/ buried in the ground outside. The main earthing grid shall be embedded at a minimum depth of 600 mm below FGL which shall be connected to earth electrodes.

f) All interconnections of the earthing grid conductors will have welded type joints except at electrodes with disconnecting facility and at equipment with bolted connections. All indoor earthing grids will be suitably interconnected to the external earthing grid.

g) Each steel/ RCC column of the building will be interconnected to the floor-earthing grid. Steel columns, steel strips / conduits, cable trays etc. will not be used as earth continuity conductors.

h) Disconnecting type facility shall be provided between Earthing grid & each earth electrode.

i) All connection between the conductors shall be welded/ brazed type. Metallic pipe, conduit, structures shall be bonded to lightning protection conductors to prevent the side flashover. But no metallic pipe, conduit, structure shall be used as air termination conductor or down conductor.

j) The down conductors shall be fixed with embedded brass posts (on concrete columns) with nuts & bolts used for fixing the saddle/ clamp (direct drilling of down comer and fixing with screw shall not be acceptable).

k) Cleats for ‘earthing and lightning protection systems’ shall be of GI.

l) The lightning protective conductor shall not be connected with the earthing above ground however both the systems shall be interconnected below ground.

m) The earth pits may require boring & drilling in the soil & the same shall be considered in Contractor’s scope.

n) Earth electrode with disconnecting facility shall be provided so that the resistance of the independent earth electrode may be measured.

o) Internal earth Bus of each panel shall be connected to both ends to the earthing system by means of earthing conductor.

p) Metallic frames of all current carrying equipment, structures supporting and adjacent to current carrying conductors, lightning protection system conductors, metallic structures, metallic stairs, hand rails, fences shall be connected to a single earthing system. Neutral points of various systems shall be connected to the dedicated treated earth pits and these earth pits shall be interconnected to each other below ground.

q) All connections in the equipment earth conductors buried in ground (or otherwise) shall be cad welded/ brazed, whereas connection at equipment end shall be of bolted type. All connections shall be of low resistance. All bimetallic connection shall be treated with suitable compound to prevent moisture ingression. For Bimetallic bolted connection, bimetallic washers shall be used. All bolted joints shall have minimum two bolts to ensure proper surface contact. Termination of stranded conductors at earth inserts shall be with ring type/ lugs.

r) Galvanized conductors shall be touched up with zinc-rich paint where holes are drilled at site for bolting to equipment/structure.

s) Suitable earth risers approved by the Engineer shall be provided above finished floor/ ground level, if the equipment is not available at the time of laying of the main earth conductor. The minimum length of such risers inside the building shall be 200 mm and outdoor shall be 500 mm above ground level.

t) Metallic conduits and pipes shall be connected to the earthing system unless specified otherwise.

u) All cable trays will be earthed at minimum two places by suitable sized GI flats to main earthing system earth conductor. The cable trays shall also be earthed at a regular interval of not more than 10 meters by 25 x 3 mm GS flat.

v) Earthing Pits

i. Adequate number of earthing pits shall be provided in conjunction with earthing grid for the earthing system. The minimum spacing between two adjacent earthing pits shall not be less than 2000mm and shall be kept 1500 mm away from footings of the structure.
ii. Earthing pits shall be located in ground, which has a reasonable chance of remaining moist. Arrangement comprising of GI pipe with top funnel with wire mesh shall be made to facilitate pouring of water to keep earthing pit wet.
iii. A galvanized iron strip of adequate size (as per calculations) shall be provided from plate electrode to about ground level to facilitate jointing with earth conductors. Each earth electrode ending at the pit shall be connected to suitable linking strips to connect and disconnect the earthing suitably.
iv. Earthing chamber shall be of RCC/ brick chamber of 600 mm x 600 mm, with Hinged cast Iron chequered cover plates. The covers shall have holes for handling. Earthing pits (chambers) shall be painted Green and the earth-pit number shall be marked on it.
v. Earthing cables crossing other metallic structures such as conduits pipelines etc shall be minimum 300 mm away from such structures.
vi. Earthing conductors shall be protected against mechanical damage.
vii. All earth lead connections shall be as short and direct as possible and shall be without kink.

viii. The main earth loop in plant area shall be generally routed along cables. When equipments are located away from main earth loops, suitable sub-loops shall be run up to them for deriving connections for individual equipment. The entire earthing system shall fully comply with the CEA guidelines and requirements.

ix. The contractor shall have to carry out any changes as desired by the Electrical inspector or the Engineer in charge, in order to make installation conforming to the CEA guidelines 2010 and IS 3043.

2.8.5. Lightning Protection:

a) The lightning protection system need will be established by calculating the risk factor value of each building, structure etc. as per procedure given in IS/IEC 62305-2010 and if found necessary the same shall be provided by the Contractor.

b) For Lightning protection of Civil Structures including RCC Buildings, fixing of 25x6 mm GI earth strip to roof as per IS/ IEC std, saddle clamp, down comer connector etc. as required with all hardware shall be in Contractor's scope.

2.8.6. Galvanizing:

a) Wherever galvanizing has been specified, the hot dip process shall be used. The galvanized coating shall be of uniform thickness. Weight of Zinc coatings for various applications shall not be less than those indicated below

Fabricated Steel	
i. Thickness less than 2 mm, but not less than 1.2 mm	340 gms/ sq.m
ii. Thickness less than 5 mm, but not less than 2 mm	460 gms/ sq.m
iii. Thickness 5 mm and over	610 gm/ sq.m
Fasteners	
i. Up to nominal size M10	270 gms/ sq.m
ii. Over M10	300 gms/ sq.m

b) Burrs shall be removed before galvanizing. Any site modification of galvanized parts should be covered well by zinc rich primer and aluminium paint.

c) Contractor shall ensure to use calibrated test equipment having valid calibration test certificates from standard laboratories traceable to National Standards.

2.8.7. Drawings/ Documents Required:

The Contractor should prepare Layout drawings, after award of contract and before commencement of work for Purchaser's approval, showing the location of earthing grid, electrodes, interconnection grids and earthing leads to various equipment, down comers, isolating links etc. should be accompanied by design calculations.

2.9. LIGHTING & RECEPTACLE SYSTEM:

2.9.1. Scope

a) The scope of the Contractor shall include design, supply and installation of all equipment necessary for a complete lighting and receptacle system. The lighting system includes Lighting fixtures (indoor/ outdoor), lamps, lighting panels (LP), switchboards, Receptacles, JBs, cables/ wires for lighting/ receptacles, conduits etc. The supply of street light / flood light poles as per IS 2713 is also included in the Contractor's scope.

b) The various types of lighting fixtures with lamps shall be installed based on the mounting arrangement shown in the typical drawings enclosed with the specification. Installation scope shall include all material to mount the fixtures in proposed manner.

c) The various types of lighting fixtures as specified in this specifications shall be assembled, installed, tested & commissioned by the Contractor.

d) The type of lighting fixtures and receptacles, illumination level and approximate quantity required shall be generally as per design criteria.

e) Lighting system installation shall be as per the tender specifications

f) It shall be the responsibility of the Contractor to work out complete detailed requirement of lighting and receptacle system for the whole plant and staff quarters including area lighting as per specification and accordingly procure and install them.

2.9.2. General Requirements: The Lighting system includes following items.

a) Lighting fixtures complete with Lamps and accessories

b) Lighting system equipment

c) Light control switches, receptacle units with control switch units, lighting wires, conduits, earth wires and other similar items necessary to complete lighting system.

d) Lighting fixture supports, street lighting poles and flood light towers/ poles.

e) Lighting main distribution board, lighting panels

f) Multi core cables for street, boundary and flood lighting

2.9.3. INTERNAL AND EXTERNAL ILLUMINATION:

a) It shall be the responsibility of the Contractor to work out a detailed layout for the complete plant in order to provide the levels of illumination as indicated in the relevant standards

b) The types of fixtures to be used in various areas are also indicated in the above mentioned drawing. The Contractor shall be responsible for measuring the levels of illumination and uniformity after installation and establish compliance with the specification.

c) The lighting system will comprise the following:

i. Normal A.C Lighting : Normal lighting in all indoor and outdoor areas will be operated on 230V, 1Phase, 50 HZ A.C supply

ii. Emergency Lighting: Emergency Lighting shall be designed such that at all junctions, exit passages & strategic locations, Lux level shall be maintained above 10 Lux. Emergency light fitting shall be 240 V self contained 2 x 20 W fluorescent tube with built in Ni-Cd battery having charging facility and six hours back-up time. The emergency light fittings shall be provided at strategic locations of Entry Exit points of Enclosed areas. Emergency fixtures shall come in service when AC supply fails. Minimum Pump room and Electrical room shall be considered for Emergency lighting.

2.9.4. Applicable Standards: The design, manufacture and performance of equipment shall conform to the latest standards specified below. In case of conflict between the standards and this specification, this specification shall govern.

a) Lighting Fixtures & Accessories

Electrical lighting fittings general and safety requirements	:	IS: 1913/ BS: 4533
Code of practice for industrial lighting	:	IS: 6665
Code of Practice for Interior Illumination	:	IS 3646
Code of Practice for Lighting of Public Thoroughfares	:	IS 1944
Calculation of co-efficient of utilization	:	IS: 3646 (Part - III)
Industrial lighting fittings with metal Reflectors	:	IS: 1777
Decorative lighting fittings	:	IS: 5077
Dust proof electric lighting fittings	:	IS: 4012
Dust tight electric lighting fittings	:	IS: 4013
Flood lights	:	IS: 10322/BS: 4533
Luminaries for street lighting	:	IS: 10322 Part 5
Water tight electric lighting fittings	:	IS: 3553/ BS: 4533, 5225(I)
Bayonet lamp holders	:	IS: 61184 / IEC: 61
Edison screw lamp holders	:	IS: 10276/BSEN 60238
Bi-Pin lamp holders for tubular fluorescent lamps	:	IS: 3323
Starters for fluorescent lamp	:	IS: 2215/BSEN 60155
Holders for starters for tubular	:	IS: 3324/BSEN 60400

fluorescent Lamps		
Ballast for use in fluorescent lighting fittings	:	IS: 1534 (Part 1)/ BSEN 60920 & 60921
Transistorized ballast for fluorescent lamps	:	IS: 7027
Ballast for HP mercury vapour lamp	:	IS: 6616
Capacitors for use in fluorescent, HPMV & LP sodium vapour discharge Circuits		IS: 1569/BSEN 61048 & 61049 / IEC: 586
Vitreous enamel reflector for tungsten filament lamp	:	IS: 8017
Tubular fluorescent lamps	:	IS: 2418 (Part-1)/ BSEN 60081/ IEC: 81
High pressure mercury vapour lamps	:	IS: 9900/BS: 3677/ IEC: 188
Tungsten filament general electric lamps	:	IS: 418/IEC: 432
Cast acrylic sheets for use in Luminaries	:	IS: 7569
Screw less terminal and electrical connections for lighting fittings	:	IS: 10322
High pressure sodium vapour lamps	:	IS: 9974
Emergency lighting units	:	IS: 9583
Ignition proof enclosures, dust-tight for elect. equipment	:	IS: 11005
Luminaries	:	IS: 10322(Part I to V)

b) Lighting System Equipment:

Arrangement for busbars, main connections and auxiliary wiring and marking	:	IS: 5578/ 11353/ BS: 159
Enclosed distribution fuse boards and cutouts for voltages not exceeding 1000V	:	IS: 2675/BSEN 60439
General requirements for switchgear and control gear for voltages not exceeding 1000 V	:	IS: 13947
Code of practice - installation and Maintenance of switchgear	:	IS: 10118/BS: 6423 BS 6626, BS 6867
Factory built assemblies of switchgear and control gear for voltages up to and including 1000 V AC and 1200 V DC	:	IS: 8623/BS-5486/ IEC: 439
Miniature air break circuit breakers for AC circuits	:	IS: 8828/BSEN 60898
HRC cartridge fuse links up to 650 V	:	IS: 9224/BS: 88/ IEC: 269

'D' Type fuses	:	IS: 8187
Current transformers	:	IS: 2705/BS: 7626/ IEC: 185
Voltage transformers	:	IS: 3156/BS: 7625/ IEC: 186
Direct acting electrical indicating Instruments	:	IS: 1248/BS: 89/IEC: 51
A.C. electricity meters	:	IS: 722/BS 5685
Electrical relays for power system protection	:	IS: 3231/BS: 142/ IEC:255
Switches for domestic and similar Purposes	:	IS: 3854/BS: 3676
Three pin plugs and socket outlets	:	IS: 1293/BS: 546
Boxes for enclosure of electrical Accessories	:	IS: 5133(1)
Rigid steel conduits for electrical wiring	:	IS: 9537/BS: 31
Accessories for rigid steel conduits for electrical wiring	:	IS: 3837/BS-31
Flexible steel conduits for electrical Wiring	:	IS: 3480
Rigid non-metallic conduits for electrical installations	:	IS: 9537/BS: 4607(2)
Fittings for rigid non-metallic conduits	:	IS: 3419/BS: 4607(2)
PVC insulated cables for working voltages up to and including 1100 V	:	IS: 694
Tubular steel poles	:	IS: 2713
Specification for copper rods and bars for electrical purposes	:	IS: 613
Code of practice for phosphate iron and steel	:	IS: 6005/ BS: 3189
Fittings for rigid steel conduits for electrical wiring	:	IS: 2667
National Building Code of India (NBC)	:	NBC 2005

2.9.5. Other Design considerations for Lighting:

a) Lighting panels shall be provided in as required and circuit wiring to the lighting fixtures shall be made from lighting panels. Lighting panel shall comprise of Four pole MCB + RCCB (100 mA) for incomer.

b) The same panel may be also used to feed the single phase power receptacles for miscellaneous usage and power equipments like Exhaust fans. SP MCBs shall be considered for each outgoing single phase circuits. Else a separate Raw Power DB may be provided for miscellaneous power equipments.

c) Three phase welding receptacles shall be supplied from PCC/ MCC directly. The receptacle shall be non metallic industrial type with plug top included in the supply.

d) The wiring for lighting circuits in indoor areas will be done by wires run in GI conduits. For outdoor lighting, wiring will be done by using armoured cables.

e) Lighting cable from PCC/ MCC or Main lighting DB (MLDB) to Lighting panels shall be Al conductor, XLPE insulated, 1.1KV grade, laid in cable trays otherwise cleated along the wall/ column/ beam.

f) For lighting fixtures (Pump room) 1100V grade, 4C x 2.5 sq. mm. PVC insulated, multistranded copper conductor armoured cables shall be used.

g) For lighting fixtures (For Office, electrical room, toilets etc. areas) 1100V grade, FRLS PVC, multi-stranded Copper conductor wires of area not less than 1.5 sq mm laid in min. 20 mm dia GI conduit shall be used.

h) For 5/15A decorative sockets (For Office, toilets etc. areas) 1100V grade, FRLS PVC, multi-stranded copper conductor wires of area not less than 2.5 or 4.0 sq. mm. laid in minimum 20 mm dia. GI conduit shall be used.

i) Wiring shall be laid on the surface on wall and ceiling with surface mounted switch boards. Minor civil work like chasing wall, cut outs for conduit, switch board, Lighting Panel in wall, entries for tray, conduits etc. is included in the scope.

j) Separate Lighting panel shall be considered for Outdoor and Building Periphery Lighting with Time Switch and contactor with manual over ride control. Lighting cable from MLDB to Lighting Panels and Lighting Panels to street light fixtures, shall be Al conductor, XLPE insulated, armoured, 1.1 KV grade, laid in cable trays otherwise cleated along the wall/ column/ beam and buried in the ground.

k) The point wiring for lighting/ receptacle/ exhaust fan/ wall mounted fan / ceiling fan shall include conduits, conduit accessories, FRLS PVC insulated multistranded Copper conductor wires and earthing wires, pull boxes, ceiling rose, clamps, cleats, hardware, accessories, anchor fasteners etc. It shall include wiring from lighting panel to switchboard and receptacles & switchboard to lighting fixtures.

l) For power sockets in wall / furniture, PVC switch box of approved make with switch plate & accessories and 16 Amp piano modular switches and 5/15A sockets etc. as applicable shall be considered. For all types of point wiring the receptacles with switches shall be included in the point wiring rate.

m) Lighting switchboard shall consist of (*) no. of 6A piano switch without indicator, 1 no. 6A piano switch with indicator, 1 no. white colour cover plate for (*) module(4/ 6/ 8/ 12 module), 1no. 2/ 3 pin shuttered socket of 5/ 15A and Surface box.

n) Decorative socket switchboard consisting of (*) no. of 16A piano switch with indicator, (*) no. 2/ 3 pin shuttered socket of 5/ 15A and Surface box, 1 no. white colour cover plate for (*) module(4/ 6/ 8/ 12 module).

o) Lighting fixtures and fans will be grouped on the circuit wherever required. However, separate circuits shall be used for receptacles wiring.

p) Lighting Control Philosophy as per mentioned below shall be observed. From each switch –
   i. Max. 2 (3 in case unavoidable) fluorescent luminaries (2x28W)
   ii. Max. 4 (5 in case unavoidable) down lighters luminaries (2x18W)

q) All MH fixtures, High bay T5 fixtures, Street Light fixtures shall be controlled directly from respective Lighting Panels, through MCB.

r) Each lighting panel/ Receptacle DB shall have minimum 2 spare circuits of 10/ 16A SPN outgoing feeders. A circuit consists of R, Y, and B Phase each.

s) Lighting for staircase shall be controlled with flushed modular switch. The conduit for main staircase shall be concealed. Lighting for all staircases shall be with 2 way switch

t) Contractor shall note that any chasing in walls or cutouts or openings such as fixing of LPs, DBs, switchboards, concealing conduit in wall etc. in walls required shall be made before plastering of brickwork wherever applicable and installation rates quoted shall be inclusive of chasing, cutting & making the plaster as per standard practice.

u) Lighting for street light fixtures/ flood light fixtures and metal halide fixtures shall be carried out with cables. The supply of cables, junction boxes, street light poles & structural steel required for mounting fixtures/ LPs etc. are in the scope of Contractor. The cable wiring shall include supply & installation of cable required from LP to the junction box mounted on street lighting pole / near indoor fixture and also between junction box mounted inside pole/near indoor fixture to control gear box and same for flood lighting, supply and installation of all termination accessories such as lugs, cable glands etc. Contractor's scope shall also include excavation, preparation of soil bedding, supply and installation of protection cover, back-filling, supply and installation of cable route markers etc.

v) Point Wiring for lighting/ raw power receptacle/ emergency lighting:

   i. Point wiring covers the wiring between a circuit of the lighting panel to switchboard and then from switchboard to lighting fixtures connected to that circuit of the lighting panel.

ii. For receptacle circuits point wiring shall cover wiring between circuit of the lighting panel to receptacles connected to that circuit of the lighting panel.

iii. The scope of the Contractor shall include the supply, erection, testing and commissioning of the above LPs/ DB boards for supply of power to the various sockets required for computers, raw power points etc. The point wiring rate from these DBs shall include supply of wires, conduits, cleats/ clamps etc. as may be required and shall be in the scope of electrical Contractor.

iv. The conduit point wiring rate for exhaust fan shall include conduits/ casing capping, conduit/ casing capping accessories, Switch boards, PVC insulated wires and earthing wires, pull boxes, ceiling rose, clamps, cleats, hardware, sheet metal switchboards fabricated out of 16 SWG. sheet steel housing 5 Amp piano switches. It shall include wiring from EXHAUST FAN DB/ RDB to switchboard & switchboard to exhaust fan as applicable. Neutral for individual circuit shall be run separate from DB to individual receptacles.

v. All mounting accessories like base channels, cross angles if required, nuts, bolts etc. shall be supplied by the Contractor under the scope of this contract.

vi. Required no. of 1-Ph & 3-Ph, industrial receptacles with respective 2P/ 4P ELCB (30mA) & 3/ 5 pin plug shall be provided for maintenance purpose.

vii. Receptacle & it's ELCB shall be mounted in prefabricated CRCA box of 16 SWG, epoxy painted with shade 631of IS-5. Earthing studs shall be provided for connecting external earthing with receptacle box.

viii. The Configuration of Industrial receptacle units shall be as per following – Combination
- 240V, 1-Ph, 50Hz, 3 pin, 15A Industrial receptacles with RCBO (30 mA).
- 415V, 3-Ph, 50Hz, 32/63A Industrial receptacles with respective RCBO (30 mA).

w) Lighting Fixtures and Accessories:

i. General

Normal supply voltage, phase and frequency		240 V, 1 ph, 2 wire, 50 Hz,
Variation in supply		
Voltage (AC & DC)		± 10
Frequency		± 5
Combined voltage & frequency		± 10
Design ambient air temperature		50^0C

ii. The Luminaries shall be designed so as to facilitate easy maintenance, including cleaning, replacement of lamps/starters etc.

iii. Connections between different components shall be made in such a way that they will not work loose by small vibration.

iv. For each type of Luminaries the Contractor shall furnish the utilisation factor tables to indicate the proportion of the light emitted by the bare lamps which falls on the working plane.

v. All Luminaries shall be supplied complete with lamps suitable for operation on a supply voltage and the variation in supply voltage, frequency and combined voltage and frequency of ±10%, ±5% and ±10% respectively.

vi. The Luminaries and accessories shall be designed to have low temperature rise. The temperature rise above the ambient temperature shall be as indicated in the relevant Standards.

vii. Fluorescent type luminaries shall be complete with accessories like lamps, electronic ballasts, power factor improvement capacitors, starters, re-wirable fuse and fuse base. These shall be mounted as far as possible in the luminaries housing only. If these cannot be accommodated integral with the Luminaries then a separate metal enclosed control gear box shall be included to accommodate the control accessories together with a terminal block suitable for loop-in, loop out connections. Outdoor type fixtures shall be provided with outdoor type weather-proof box.

viii. Fluorescent type Luminaries with more than one lamp shall be provided with capacitors connected in lead-lag circuit for correction of stroboscopic effect.

ix. Each luminaries shall have a terminal block suitable for loop-in, loop-out and T-off connection by 230/ 415 V, 1 core, FRLS PVC insulated Copper conductor wires up to 4 sq. mm in size. In outdoor areas the termination at the luminaries shall be suitable for 1100 V, PVC insulated, Cu/ Al conductor, armoured cables of sizes up to 6/ 16 sq. mm conductor. Terminals shall be of stud or clamp type. The internal wiring should be completed by means of stranded Copper wire of minimum 1 sq. mm size and terminated on the terminal block. Terminal blocks shall be mounted with minimum two fixing screws.

x. Mounting facility and conduit knock-outs for the luminaries shall be provided.

x) Earthing

i. Each luminary shall be provided with an earthing terminal suitable for connection to the earthing conductor of 12 SWG GI wire.
ii. Where separate control gear box is provided for housing the accessories the same shall be provided with an earthing terminal suitable for connecting earthing conductor of 12 SWG GI wire.
iii. All metal or metal enclosed parts of the luminaries/control gear box shall be bonded and connected to the earthing terminal so as to ensure satisfactory earthing continuity.

y) Painting/ Finish:

i. All surfaces of the Luminaries/Control gear box housing accessories shall be thoroughly cleaned and degreased. It shall be free from scale, rust, sharp edges and burrs.
ii. When enamel finish is specified, it shall have a minimum thickness of 2 mils for outside surface and 1.5 mils for inside surface. The finish shall be non-porous and free from blemishes, blisters and fading.
iii. The luminaire housing shall be stove-enamelled/epoxy stove-enamelled-vitreous enamelled or anodised as indicated under various types of fittings.
iv. The surface shall be scratch resistant and shall show no sign of cracking or flaking when bent through 90 deg. over 1/2” dia. mandrel.
v. The finish of the luminaries shall be such that no bright spots are produced either by direct light source or by reflection.
vi. External control gear box provided for housing accessories shall be painted or galvanised.

2.9.6. Flood Light Luminaries: General purpose flood light luminaries:

a) Flood light MH luminaries shall be provided for illumination of area lighting like transformer yard, switchyard, boundaries etc.

b) Flood light luminaries shall be of weather proof construction with cast aluminium housing, anodised aluminium mirror polished reflector, heat resistant, toughened glass cover and necessary neoprene gaskets to prevent ingress of dust.

c) The housing shall be supported on a cast iron base and capable of being swivelled in both horizontal and vertical directions and locked in any desired position.

d) For focussing purposes, knobs, shall be provided along with sector plate indicating the angle in degrees between 0 and 90 deg. in vertical direction.

e) The Luminaries shall be suitable for single and dual Metal Halide (MH) lamps of 150W/ 250W/ 400 watts etc. as required. The same shall be mounted in a separate sheet metal enclosed/ cast aluminium weather proof control gear box.

f) The luminaries shall be provided with cable gland on the canopy in down ward direction for cable connection.

g) It shall be possible to adjust the lamp position to achieve wide beam, medium beam or narrow beam.

h) It shall be possible to replace the lamp from the canopy without opening the front glass.

2.9.7. Outdoor / Street Lighting Luminaries:

a) Fluorescent Luminaries

i. Building peripheral lighting fluorescent luminaries shall be outdoor weather proof type for illumination of secondary roads, walkways, peripheral lighting of buildings etc.
ii. The luminaries shall be of semi-cut off or non-cut off type, with CRCA sheet steel housing, vitreous enamelled, plain or corrugated clear acrylic cover, complete with integral mounted control gear, neoprene gaskets, side pipe entry or top suspension type.
iii. The luminaries shall be suitable for 1 x 36 watts or 2 x 36 watts fluorescent tubes and for mounting heights up to 4.5 metres.

b) LED Street Lighting Fixtures:

The fixture shall ensure uniform distribution of light and maintenance free system. The lamps shall have a life of 50000 hrs at L70 with excellent thermal management and 100% system efficacy (Lm/W). The colour temperature shall be 5700 K and CRI shall be 70. The fixture shall be made of high pressure die cast Aluminium with Polycarbonate or glass cover conforming to IP67 protection. The THD shall be less than 10% and PF shall be greater than .98 operating on 240 V AC with 10% variations. The Luminaire shall be suitable for Mounting on octagonal/ tubular Poles with decorative bracket of length and tilt angle as per design.

c) Post Top Lantern:

i. Post top lantern luminaries shall be generally outdoor weather proof type for illumination of walkways, gate posts, gardens etc.
ii. The luminaries shall have cast aluminium spigot finished with corrosion proof paint for mounting, opal acrylic or high density polyethylene (HDP) diffuser bowl, complete with integral mounted control gear, neoprene gaskets, earthing terminal etc.
iii. The luminaire shall be suitable up to 125 W mercury vapour lamp or 70W sodium vapour lamp.

d) Bollard Luminaries:

i. Bollard luminaries shall be outdoor, weather proof type for illumination of lawns, gardens, pathways etc.
ii. The luminaries shall be of FRP housing, clear acrylic cover, louvers for directing light downwards and bottom cable entry.
iii. The luminaries shall be suitable for 9/ 11/ 18 W CFL.

2.9.8. Emergency Light Luminaries:

a) Emergency light fitting shall be 240 V self contained 2 x 20 W fluorescent tube with built in Ni-Cd battery having charging facility and six hours back-up time. The emergency light fittings shall be provided at strategic locations of each house / area.

b) Emergency fixtures shall come in service when AC supply fails.

c) Minimum Pump room and Electrical room shall be considered for Emergency lighting.

d) In addition to above emergency fixtures, every pump station shall be provided with two nos. of portable emergency luminary, which shall be with CRCA sheet steel enclosure, complete with metalized mirror reflector, leak proof re-chargeable battery rated for two hour discharge, battery charger, charger-on lamp, push button switches, automatic changeover switch/relay, two metre length cord with plug, mounting pads and other accessories required for satisfactory operation of the luminaries.

e) The luminaries shall be suitable for connection to 240 V, 50 Hz single phase supply. On failure of normal A.C. supply the luminary shall start automatically and on restoration of A.C. supply the luminary shall switch off automatically.

2.9.9. Accessories for Luminaries:

a) Reflectors

i. The reflectors shall be made of CRCA sheet steel/aluminium/silvered glass/chromium plated sheet copper as indicated for above mentioned luminaries.
ii. The thickness of steel/aluminium shall comply with relevant standards. Reflectors made of steel shall have vitreous enamelled finish. Aluminium used for reflectors shall be anodized/epoxy stove enamelled/mirror polished. The finish for the reflector shall be as indicated for above mentioned fittings.
iii. Reflectors shall be free from scratches or blisters and shall have a smooth and glossy surface having an optimum light reflecting coefficient so as to ensure the overall light output specified by the Contractor.
iv. Reflectors shall be readily removable from the housing for cleaning and maintenance without disturbing the lamps and without the use of tools. They shall be securely fixed to the housing by means of positive fastening device of captive type.

b) Lamp/ Starter Holders:

i. Lamp holders shall have low contact resistance, shall be resistant to wear and shall be suitable for operation at the specified temperature without deterioration in insulation value. They shall hold the lamps in position under normal condition of shock and vibration met with under normal installation and use.

ii. Lamp holders for the fluorescent lamps shall be of the spring loaded bi-pin rotor type. Live parts of the lamps holder shall not be exposed during insertion or removal of lamp or after the lamp has been taken out. The lamp holder contacts shall provide adequate pressure on the lamp cap pins when the lamp is in working position.

iii. Lamp holders for mercury vapour and sodium vapour lamps shall be of Edison Screw (ES) type.

iv. The starter holders shall be so designed that they are mechanically robust and free from any operational difficulties. They shall be capable of withstanding the shocks met within normal transit, installation and use.

c) Ballasts:

i. The ballasts shall be designed to have a long service life and low power loss. The ballasts shall be of the inductive, heavy duty type copper wire wound, filled with thermosetting, insulating, moisture repellent polyester compound filled under pressure or vacuum. Ballasts shall be provided with taps to set the voltage within the range of variation in supply voltage of ±10% of 240 V. End connections and taps shall be brought out to a suitable terminal block rigidly fixed to the ballast enclosure. Ballasts shall be free from hum and such of those which produce hum shall be replaced by Contractor free of cost.

ii. Ballasts shall be mounted using self locking, anti-vibration fixings and shall be easy to remove without demounting the fittings. They shall be in dust tight, non combustible enclosures.

iii. All the luminaries other than Flood Light Fixtures shall have integral control gear.

iv. All type of fluorescent light fittings shall be provided with high frequency electronic ballast of proven design with less than 10% THD, fully wired up to the connector block. The electronic ballast shall be suitable for operation with input voltage variation between 180-260V to give a constant light output.

v. All gas discharge/ MH type lamps shall be provided with control gear, with Copper wound and polyester filled low loss ballast, igniter and PF correction capacitor.

vi. Contractor to provide comprehensive technical details of the luminaries and the lamps being offered. The details must be sufficient to take in to consideration maximizing of energy efficiency and minimizing overall shop power consumption.

vii. In Crane bays, lighting fixtures shall be mounted with the min. 500 mm clearances above overhead crane clearance level as asked by Crane Manufacturer.

viii. All the outdoor purpose luminaries, including Street light luminaries shall be with ingress protection of IP 65 minimum.

ix. All the Mid Bay & Highbay fixtures, street light fixtures shall be provided with the toughened Glass covers.

x. In case of Hazardous areas, if any - Flame proof luminaries (complete with suitable lamp & accessories) in line with the requirements of IS 5572 shall be provided by the Contractor.

d) Starters

i. Starters shall have bimetal electrodes and high mechanical strength.

ii. Starters shall be replaceable without disturbing the reflector or lamps and without the use of any tool.

iii. Starters shall have brass contacts and radio interference capacitors.

e) Capacitors

i. The capacitors shall have a constant value of capacitance and shall be connected across the supply of individual lamp circuits.

ii. The capacitors shall be suitable for operation at specified supply voltage conditions and shall have a value of capacitance so as to correct the power factor of their corresponding lamps circuit to the extent of 0.95 lag or better.

iii. The capacitors shall be hermetically sealed preferably in a metal enclosure to prevent seepage of impregnate and ingress of moisture.

f) Lamps

i. Lamps shall be capable of withstanding small vibrations and the connections at lead in wires and filaments/ electrodes shall not break under such circumstances.

2.9.10. Drawings/ Documents Required:

a) As part of proposal, the Contractor shall furnish relevant descriptive and illustrative literature & drawings/ data for the respective lighting fixtures & accessories with manufacturer’s catalogue numbers.

b) It shall be the responsibility of the Contractor that, on award of contract to work out a detailed lighting layout for the complete plant in order to provide the levels of illumination as indicated under Design Criteria and shall be furnished for the approval of the Purchaser's representative before commencement of installation.

c) Detailed Room wise Lighting Layout with Type of fixture details, mounting detail arrangement and Circuit diagram showing phase wise load distribution and interconnection between switches, fixtures, Lighting panel, receptacles etc.

d) Conduit layout showing room wise routing of wires from lighting panel to lighting fixtures covering primary & secondary point wiring, receptacles etc.

e) Internal road Lighting and Area lighting layout with type of mounting details and fixture details.

f) Street Light pole details with Foundation details

g) General arrangement of lighting panel & lighting distribution board showing plan, elevation and typical section views.

2.9.11. Lighting System Equipment:

a) Main Distribution Boards and Lighting Panels:

i. Main Lighting distribution board (MLDB) shall have MCCB as incomer & outgoing feeder with thermal magnetic release for O/L+S/C+E/F protections.
ii. This MLDB shall feed to different Lighting Panels / Lighting DBs for further distribution.
iii. Where ever MLDB is not applicable, lighting feeder of appropriate rating shall be derived from the local distribution board. This feeder will feed to local LP catering to lighting requirements of that particular area.

b) Constructional Features:

i. Boards and panels shall be sheet steel enclosed and shall be fully dust and vermin proof, providing a degree of protection of IP 54 for indoor. Outdoor panels shall in addition be completely weather-proof with a sloping canopy for protection against rain and providing a degree of protection of IP 55. The sheet steel used for frame, frame enclosures, doors, covers and partitions shall be cold rolled 2 mm thick.
ii. The lighting panel for outdoor lighting shall have a programmable timer for automatic control of lighting along-with contactor, MCB, auto/ manual selector switch.
iii. All boards and panels shall be provided with hinged doors for access to equipment. Doors shall be gasketed all round with neoprene gaskets.
iv. A slotted metallic sheet shall be provided inside. Only the MCBs operating knobs shall project out of the metallic sheet slots for safe operation and neat appearance. Incomer to lighting panels shall be provided with Four pole MCB + RCCB in separate compartment.

v. All accessible live connections/metals shall be shrouded and it shall be possible to change individual MCBs from the front of the boards/ panels without danger of contact with live metal.

vi. For floor mounting type distribution boards, adequately sized mounting channels shall be supplied and for wall/column/structure mounting type panels suitable mounting straps shall be provided.

vii. Adequate interior cabling space and suitable removable cable entry plates shall be provided for top/bottom entry of cables through glands and or conduits as required. Necessary number of glands to suit the specified cable sizes shall be provided. Cable glands shall be screwed on type and made of brass.

viii. Two earthing terminals shall be provided to suit the earthing conductor.

ix. All sheet steel parts shall undergo rust-proofing process which should include 7 tank processing. The steel works shall then be painted with two coats of Zinc - chromate primer and two coats of final epoxy based finish paint of colour 63I as per IS 5.

c) Busbars:

i. Busbars shall be of copper conductor of hard drawn (HD) and high conductivity.

ii. Busbars shall be provided with at least the minimum clearances in air as per applicable standards.

iii. Busbars shall be adequately sized for the continuous current rating such that the maximum temperature of the busbars, busbar risers/droppers and contacts does not exceed 85° C under site reference temperature.

iv. The busbars, busbar connections and busbar supports shall have sufficient strength to withstand thermal and electro-mechanical stresses of the MCB's let through/cut-off current associated with the specified short-circuit level of the system.

v. Busbar supports shall be SMC type. Separate supports shall be provided for each phase of the busbars.

vi. The neutral bus of the main 3 phase, 4 wire distribution board shall be 100%. of the phase busbars.

d) Panels/ Boards' Component & Lighting Accessories:

i. MCB / ELCB :

- MCBs shall be C curve type for lighting panels.
- For all the lighting panels RCCBs shall be with 100 mA sensitivity & for all receptacles RCBO sensitivity shall be 30 mA.

ii. MCCB :

- MCCB requirements shall be as per specified in the LV switchgear requirements & as specified above.

iii. Indicating Instruments and Meters

- Whenever required, instruments and meters shall be of the flush mounting type. They shall be suitably mounted so as to provide for easy access to CTs and small wiring.
- Instruments shall be of minimum 96 mm square size, shall have provision for zero adjustment outside the cover and black numerals on white dial.
- Digital Multifunctional meters with minimum 96 sq mm size shall be provided for energy measurement.
- Ammeter/Voltmeter selector switches having 3 positions and off, with stay-put contacts rated 10A shall be provided when specified.
- Potential fuses shall be provided at the tap-off point from the bus bars for the voltmeters.

iv. Instrument Transformers:

- Current and voltage transformers shall be of cast resin type, with insulation class B, & accuracy class 1.0 unless otherwise specified, it shall be the responsibility of the Contractor to ensure that the VA burden of the instrument transformer is adequate for the meters connected to it.
- Test links shall be provided in both secondary leads of the CTs to easily carry out current and phase angle measurement tests. Facilities shall be provided for short-circuiting and grounding the CTs at the terminal blocks.
- Voltage transformers shall be provided with suitably rated primary and secondary fuses.

v. Indicating Lamps:

- Indicating lamps shall be of the clustered LED type, low watt consumption.

vi. Internal Wiring

- Panels/ boards shall be supplied completely wired, ready for the external connections at the terminal blocks. Wiring shall be carried out with 1.1 kV grade, FRLS PVC insulated, multistranded Copper conductors. Conductors of adequate sizes shall be used to suit the rated circuit current.
- Cross Ferruling i.e., 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 rated 500 V, of reputed make of approved list, preferably stud type for higher current ratings such that wires are connected by cable-lugs and complete with nuts and washers. Terminals shall be adequately rated for the circuit current, the minimum rating shall be 20 A.
- Terminals for circuits with voltage exceeding 125 V shall be shrouded.
- Terminals shall be numbered and provided with identification strip for identification of the circuit.
- Terminal blocks for CT secondary lead wires shall be provided with shorting and disconnecting/earthing facilities.

vii. Labels & Diagram Plate:

- All door mounted equipment as well as equipment mounted inside the switchboard/panels shall be provided with individual labels with equipment designation/rating. Also the boards/panels shall be provided on the front with a label engraved with the designation of the board/ panel.
- Labels shall be made of non-rusting metal, 3-ply lamicoid or engraved acrylic
- Inside the door of the 1 phase ways lighting panels a circuit diagram/ description shall be fixed for reference and identification.

viii. Conduits:

- Rigid steel/ non-metallic conduits and their associated fittings as required shall conform to applicable standards. The minimum size of conduit shall be 20 mm for surface installation and 25 mm for concealed installation.
- Steel conduits shall be seamed by welding and hot dip galvanised. They shall be supplied in standard lengths of 5 metre.
- Supply of conduits shall include all associated fittings like couplers, bends and tees as required for lighting system installation work.

ix. Junction Boxes

- Junction boxes with terminals shall be supplied for branching and terminating lighting cables when required for outdoor areas, 3 phase receptacles etc.
- The junction boxes shall be dust and vermin proof and shall be fabricated from 14 SWG sheet steel and shall be complete with removable cover plate with gaskets, two earthing terminals each with nut, bolt and washer. Boxes shall be additionally weather proof.
- The boxes shall have provision for wall, column, pole or structure mounting and shall be provided with cable/conduit entry knock outs, terminal blocks, and MCBs as required.

- The terminal blocks, with specified number of terminals, shall be mounted securely on brackets welded to the back sheet of the box. The terminals shall be 600 V, grade, one piece construction complete with terminals, insulation barriers, galvanised nuts, bolts and washers and provided with identification strips of PVC. The terminals shall be made of Copper alloy and shall be of box clamp type.
- The boxes shall be painted with one shop coat of red oxide zinc chromate primer followed by a finishing coat of paint.

x. Lighting Poles and Flood Light Pole Mounting:

- Lighting poles for street lights and flood lights shall be of GI Octagonal steel poles construction as per applicable standard.
- Poles for mounting flood lights shall be supplied whenever required and as per typical attached drawing. One steel ladder shall be provided separately. The length of each step of the ladder shall be at least 300 mm and spacing between two adjacent steps not more than 300 mm.
- The supply of poles shall be complete with fixing decorative bracket for fixing the fitting and also include the necessary associated embedded junction box.
- The JB shall be minimum IP 55 protected with proper fastening arrangement.
- Cable entry shall be from bottom.
- Terminal strip shall be provided for looping loop out of cables suitable for min 10 sqmm Al conductor XLPE insulated cable and for mounting a MCB.
- 3 core 1.5 sqmm PVC insulated Copper conductor flexible cable shall be laid from the Junction box to each fitting.
- Pole shall have two distinct earthing bolt/ stub for connecting atleast 25X6sqmm GI strip.

xi. Ceiling Fans/ Wall Mounted Fans:

- Ceiling/ Wall mounted fans shall be suitable for operation on 240 V, 1 phase, 50 Hz supply and shall be complete with standard mounting accessories such as suspension rods, top and bottom caps etc for ceiling fans and easy accessibility for wall mounted fans. The fans shall be supplied with appropriate speed regulators.
- Exhaust fans, where ever required shall also be provided. The exhaust fan with all parts shall be according to IS: 2312- 1967 & its latest amendment with IP-55 specification. The exhaust fan shall have epoxy powder coating with specially pretreated components for better resistance to corrosion and acid alkali flumes. The exhaust fan shall have totally enclosed highly efficient heavy duty motor with pressure die cast aluminum rotor mounted on two ball bearings.

- The fans shall generally conform to the applicable standards indicated in Tender. Details regarding blade sweep and suspension requirements shall be as per Project layout drawing/price schedule.

4.9 L.V. MOTORS

4.9.1 Motors shall be suitable of starting and accelerating the load with the applicable method of starting, without exceeding acceptable winding temperatures, when the supply voltage is 85% of the rated motor voltage.

4.9.2 The locked rotor current of the motor shall not exceed 600% of full load current (subject to tolerance as per the applicable standard).

4.9.3 Motors shall be designed to withstand 120% of rated speed for two minutes without any mechanical damage, in either direction of rotation.

4.9.4 Stator leads shall be brought to the terminal box as insulated cable through a suitable barrier and terminated in clamp type terminals.

4.9.5 INDUCTION MOTOR (SUBMERGED) (AS APPLICABLE)

4.9.5.1 The motor shall be of Squirrel Cage, Induction type, Air Filled yet capable of Water immersion up to 20mwc for S1 duty – Motors with Oil or Water filled windings shall not be allowed.

4.9.5.2 It is rated for 4l5 (+/-) 10 % V, 3 phase 50 (+/-)5% c/s A.C. Its winding should be of Class “H” insulation * (withstanding winding hot spot temperature of up to 185°C respectively) while the nominal temp rise of winding hotspot should not exceed that of class “B”.

4.9.5.3 It should be wound using Dual Coated, Super Enamelled; Copper wire with high temperature index as per I.S. 4800 Part-13. PVC / Poly propylene – poly ethylene insulation for winding wires shall not be allowed. Motor’s Insulation should be Vacum Varnish Impregnated & Oven Baked to ensure Moisture Impervious & Mechanically Robust insulation. Dip or Pour type Air Dry Varnishing shall not be allowed.

4.9.5.4 The Motor Rating should be higher of the two criteria: Maximum power consumption throught the range of performance at 50 Hz OR 15 % more power consumed at duty point at 50 Hz.

4.9.5.5 Selected Min Motor Rating (Round off to next available size contractor is to offer this as Minimum rating irrespective of the Pmax or BkW of his selected pumpset)Standard commercially available motor ratings are :

- 3.7, 5.5, 7.5, 9.3, 11, 15, 18.5, 22, 30, 37, 45, 55, 75, 90, 110, 132, 160, 200, 250, 315, 400, 450 kW
- Do not select less than 3.7kW under any circumstances

The motor Rotor shall be of Dual cage Copper Bar Braszed type* to assure:

Long Corrosion free Service life.

Easy of On site Repairing.

Beneficial Fly Wheel type Inertial effect which reduces detrimental effects of water hammer.

Better Motor Efficiency & Cooler Operating Temperature

4.9.5.6 Motor Cooling :

To restrict the Dead Water Level (in case of Vertical Installation) in the Sump to 1m, Medium & Large sized pumps (≥55kW) should have a Cooling Jacket – i.e. motor cooling is accomplished by circulation of pumped water between the motor casing & the jacket shell. This jacket shell is fed by cold water from the pump casing & discharges its heated water back into the sump (in case of Wet Installation) or Pump casing (in case of Dry Installation) by integrally cast ducts. There should not be any pipes, hoses, etc for this circulation.

In case the pumps are to be installed horizotally OR the dead water level in the sump or well exceeds 1.5 mts. From the pump center line, the motor can be cooled just by water immersion i.e. no jacketing is required. The mode of cooling (either direct immersion or via. Jacket cooling)

4.9.5.7 Motor Protection

Thermal Overload Protectors (Bi Metallic Over Load Relays) should be embedded in each phase of the stator winding to detect overheating & trip the motor from the control panel in the event of the temperature exceeding the safe operating limit (above 130°C).

To detect primary Mechanical Seal's Leakage a Moisture Sensor shall be provided in intermediately Oil Chamber (& not in the Motor casing or else where) – this shall detect water mixing in oil by mode of increased leakage current from the moisture sensor.

4.9.5.8 Cables

A watertight Cable Junction Box sealed from the motor shall be provided for the motor power and signaling cables.

The cable shall be brought directly out of the submerged motor without joints, and shall be of sufficient length as per price bid to be terminated in an IP 67 junction box outside adjacent to the wet well & above the HFL.They shall be sized in accordance with the electricity utility regulations and BS 7671.

It should have Power as well as Control Cables of Dual Sheathed EPRS / PVC Armored type with Copper Core of required size as per detail engineering. However the Cross Section of the cable shall be ample enough to ensure a Voltage Drop of not more than 2% at actual site conditions.

4.9.5.9 Shaft & Bearings

The Solid Shaft shall be supported by heavy duty Ball or Roller bearings with a minimum L10 life of 75,000 hours in accordance with BS 5512. The bearings should be Permanently Greased with Premium Quality,High Temperature, Long Life Grease thereby obviating the need of re-lubrication for upto L10 life of the bearings.The Bearing should be of metric series & not imperial only.

Oil Lubricated bearings shall not be allowed.

In case the motor is to be driven via a VFD, atleast one of the bearings (DE or NDE) should be Current Insulated to prevent “electric fluting damage” caused by Harmonics.

4.9.5.10 Stuffing Box / Oil Chamber

The pressurized entry of water into the motor (from the pump’s volute casing) should be prevented by Two separate mechanical seals in mounted in a Tandem mode within an oil chamber.

The Primary (Inboard) seal should be of Silicon Carbide or Tungsten Carbide faces to withstand erosive wear due to any silt particles.

The Secondary (Outboard) seal should be of Carbon v/s Cast Chrome Molybdenum Steel or Silicon Carbide or Tungsten Carbide – i.e. Thermally Unstable materials like Alumina/ Aluminum Oxide shall not be allowed.

4.9.5.11 Materials of Construction

Unless otherwise specified in Data Sheet, the Material of Construction for the pumps shall be as follows:

Motor casing, oil chamber &other parts	CI IS: 210 Grade FG 260 or GG25 or EN JL1040
Rotor of submersed motor	Aluminium Die Cast or Dual Cage Copper Bar (for motors ≤ 300 HP)
	Dual Cage Copper Bar (for motors > 300 HP)
Motor cooling jacket (if applicable)	SS 202 or Epoxy Coated MS

4.9.5.12 TESTS:

INSPECTION AND TESTING AT MANUFACTURER'S WORKS

The motor shall be tested in accordance with relevant IS with or without VFD.

In case of manufacturer not having adequate testing facility within reasonable distance; the motors should be tested at the Alternative Test Bed or at Field within 30 days of installation which the contractor/ manufacturer is bound to offer at no extra cost. The Field Testing shall include the following:

- Motor Routine Tests:
- IR
- HV
- No load amperes, Vibration etc.

Pump Performance Testing (in accordance with IS 5120 / IS ISO 9906, Grade 2 -5% / ISO 2548- 5%) :

(1) Measurement of Head, Discharge, Motor Input at at least 6 different points to plot the Actual Performance Curves

All the Extra Charges for such Field Testing shall be borne by the Contractor. It is clarified that, in case of Field Testing Failure; client reserves the right to detain the pumps in their custody until the contractor replaces the failed pumps with New pumps which shall again be subjected to Retesting. No extra charges shall be allowed by Client to the contractor.

Pump testing should be carried out preferably with VFD. In case the pump sets are to be used with VFD then the testing has to be conducted compulsorily with VFD.

5.0 SAFETY EQUIPMENTS / REQUIREMENTS AND MISCELLANEOUS ITEMS:

5.1. Following safety procedure and practice should be provided by Contractor in switchgear room/ sub-station as per latest edition of I.S. 5216.

5.2. 900 mm wide antiskid insulating mat as per IS 15652 and of reputed make to be spread in front of the 11kV, 415V switch gear panels & power DBs, DCDB etc.

5.3. First aid box with all the standard contents.

5.4. First aid chart made of cloth for electrical shock treatment printed in English, Hindi and Gujarati duly framed with front glasses.

5.5. Charts / drawings duly framed with front glass.

5.6. 11kV and 415V Single line diagrams in adequate sizes approved by Purchaser's representative & in line with the local electrical inspector

5.7. Routine maintenance schedule for High Voltage Switchgear, Distribution Transformers, Low voltage Switchgears, APFC panels, Fire Alarm System, UPS system etc.

5.8. Provision of portable type Class A, B, C, and D type fire extinguishers at various locations in line with the statutory requirements.

5.9. FIRE SAFETY:

a. The requirement of hand appliance in switchgear room, electrical equipment room shall be provided as per Clause 4.0 of Fire Protection Manual by Regional Tariff Committee, 10th edition 1988.

b. Water Sealing & Fire Barriers at appropriate locations as specified in this specifications & good engineering practices.

5.10. DEGREE OF PROTECTION:

5.11. The enclosures of the control cabinets, junction boxes and Marshalling boxes, panels etc. to be installed shall provide minimum degree of protection as detailed here under

i. Installed outdoor – IP 55
ii. Installed indoor – IP 42, 52, 54.

5.12. The degree of protection shall be in accordance with IS 13947 (Part I)/ IEC 947 (Part I)/ IS 2063/ IEC 529.

6.0 INSTALLATION, TESTING & COMMISSIONING – ELECTRICAL EQUIPMENT:

6.1. GENERAL:

6.2. In accordance with the specific installation instructions, as shown in Contractor's drawings or as directed by the Engineer In Charge the Contractor shall unload, erect, install, wire, test and place into commercial use of all electrical & instrumentation equipment included in the contract. Equipment shall be installed in a neat manner so that it is level, plumb, and properly aligned and oriented.

6.3. The Contractor shall furnish all supervision, labour, tools, equipment, rigging materials and incidental materials such as bolts, wedges, anchors, concrete inserts etc. required to completely install, test and adjust the equipment.

6.4. Drawings, instructions and recommendations shall be correctly followed in handling, settling, testing and commissioning of all equipment and care shall be exercised in handling to avoid distortion to stationary structures, the marring of finish, or damaging of delicate instruments or other electrical parts.

6.5. The Contractor shall erect and commission the equipment as per the instructions of the Purchaser/ Engineer In Charge and shall extend all co-operations to him. All the guidelines of original equipment manufacturer shall also be followed for erection, testing and commissioning

6.6. In case of any doubt/ misunderstanding as to correct interpretation of drawings or instructions, necessary clarification shall be obtained from the Engineer's Representative. The Contractor shall be held responsible for any damage to the equipment consequent to not following instructions correctly.

6.7. The Contractor shall move all equipment into the respective buildings through regular doors or floor openings provided specifically for the equipment. The Contractor shall make his own arrangement for lifting of equipment.

6.8. Where assemblies are supplied in more than one section, the Contractor shall make all necessary mechanical and electrical connections between sections including the connections between bus bars/ wires. The Contractor shall also carry out the adjustments/ alignments necessary for proper operation of the circuit breakers. All insulators and bushings shall be protected against damage during installation. Insulators or bushings chipped, cracked or damaged due to negligence or carelessness shall be replaced by the Contractor at his own expenses.

6.9. The Contractor shall take utmost care in handling instruments, relays and other delicate mechanisms. Wherever the instruments or relays are supplied separately, they shall be mounted only after the associated control panels have been erected and aligned. The blocking material/ mechanism employed for the safe transit of the instruments and relays shall be removed after ensuring that the panels have been completely installed and no further movement of the same would be necessary. Any damage to relays and instruments shall be immediately reported to the Engineer In charge.

6.10. Equipment furnished with finished coats of paint shall be touched up by the Contractor if their surface is spoiled or marred while handling.

6.11. Foundation work and grouting of fixing bolts or channels for all transformers, switchgear, motors, and control panels shall be carried out by the Contractor.

6.12. POWER/ DISTRIBUTION TRANSFORMERS:

Inspection, storage, installation, testing and commissioning of transformers shall be in accordance with the latest Indian Standards Code of Practice IS: 10028. All commissioning tests as applicable, vide Appendix B of IS: 10028 (Part II) shall be carried out. Fire Wall of 4 Hr fire rating shall be provided between two transformers.

6.13. HV/ LV SWITCHGEAR CONTROL PANELS:

a. Switchgear control panels shall be installed in accordance with the latest Indian Standard Code of Practice 10118. The switchgear panels shall be installed on finished surface or concrete or steel sills. The Contractor shall be required to install and align any channel sills which form part of the foundations. Tape or compound shall be applied where called for. The base of outdoor type units shall be sealed in an approved manner to prevent ingress of moisture.

b. Following minimum clearances shall be observed while finalizing the HV/ LV panel layouts-

i. Minimum clearance of 1.0 meter shall be maintained from the rear of the panel to the nearest wall /structure.

ii. Minimum clearance of 2.0 meter between panels facing opposite to each other.

iii. Side clearance for LV panels shall be either ≤ 200mm or ≥ 800 mm.

iv. For HT metal enclosed, indoor panels, Minimum 1 meter clearance from all sides & 2.0 meter in the front.

6.14. Emergency Exit doors shall be provided for electrical room, complying with the requirements of NBC 2005 latest edition.

6.15. After installation of all power and control wiring, the Contractor shall perform operating tests on all switchgear and panels to verify the proper operation of switchgear/ panels and the correctness of the interconnections between various items of equipment. This shall be done by applying normal a-c or d-c voltage to the circuits and operating the equipment. Megger tests for insulation, polarity checks on the instrument transformers, operation tests on equipment, and installation tests shall be carried out by the Contractor who shall also make all necessary arrangements for proper functioning of the equipment.

6.16. EARTHING AND LIGHTNING PROTECTION SYSTEM:

6.17. The Contractor shall install copper/ steel conductors, braids, etc., required for the system and individual equipment earthing. All work such as cutting, bending, supporting, painting/ coating, drilling, brazing/ soldering/ welding, clamping, bolting and connecting onto structures, equipment frames, terminals, rails or other devices shall be in the Contractor's scope of work. All incidental hardware and consumables such as fixing cleats/clamps, anchor fasteners, lugs, bolts, nuts, washers, bituminous compound, welding rods, anti-corrosive paint as required for the complete work shall be deemed to be included by the Contractor as part of the installation work.

6.18. The quantities, sizes, material of earthing conductors and electrodes to be installed as per requirement. Routes of the conductors and locations of electrodes shall be shown in the earthing layout drawings, which are to be prepared by Contractor & approved by Purchaser's representative.

6.19. The work of embedment of earthing conductor in RCC floors/ walls along with provision of earth plate inserts/ pads/ earth risers shall be done by the Contractor when the floors are cast or during construction of walls. Contractor's scope of installation shall also include, laying the conductors in position with 60 mm concrete cover, making welded connections to inserts/pads/risers above the floor near the equipments. The embedded conductors shall be connected to reinforcing rods wherever necessary.

6.20. If the tap connections (earthing leads) from the floor embedded main earthing grid to the equipment are more than 500 mm long then the same shall be embedded in floor by the Contractor where required, together with associated civil work such as excavation/chasing, concreting and surfacing. The concrete cover over the conductor shall not be less than 60 mm.

6.21. Installation of earth conductors in outdoor areas, buried in ground, shall include excavation of earth up to 600 mm deep 450 mm wide, laying of conductors at 600 mm depth, brazing/ welding as required, of main grid conductor joints as well as risers of length 500 mm above ground at required locations and then backfilling material to be placed over buried conductor shall be free from stones and other harmful mixtures. Backfill shall be placed in layers of 150 mm, uniformly spread along the ditch, and tampered utilizing pneumatic tampers or other approved means. If the excavated soil is found unsuitable for backfilling, the Contractor shall arrange for suitable material from outside.

6.22. Installation of earth connection leads to equipment and risers on steel structures/ walls shall include laying the conductors, welding/ cleating at specified intervals, welding/ brazing to the main earth grids risers, bolting at equipment terminals and coating welded/ brazed joints by bituminous paint. Galvanized conductors shall be touched up with zinc rich paint where holes are drilled at site for bolting to equipment/ structure.

6.23. Electrodes shall be installed in constructed earth pits, and connected to main buried earth grid, The scope of work shall include excavation, construction of the earth pits including all materials required for construction of earth pits, placing the rod and fixing test links on those pipe/ rod/ plate electrodes in test pits and connecting to main earth conductors.

6.24. Installation of lightning conductors on the roofs of buildings shall include laying, anchoring, fastening and cleating of horizontal conductors, grouting of vertical rods wherever necessary, laying fastening/ cleating/ welding of the down comers on the walls/ columns of the building and connection to the test links to be provided above ground level.

6.25. Installation of the test links shall include mounting of the same at specified height on wall/column by suitable brackets and connections of the test link to the earth electrode.

6.26. Whenever main earthing conductor crosses cable trenches, they shall be buried below the trench floor.

6.27. Suitable earth risers shall be provided above finished floor/ ground level. If the equipment is not available at time of laying of the main earth conductors, the minimum length of such riser inside the building shall be 200 mm and outdoors shall be 500 mm above ground level. The risers to be provided shall be marked in project drawings.

6.28. Earth leads and risers between equipment earthing terminals and the earthing grid shall follow as direct and short a path as possible.

6.29. An earthing mat shall be provided under each operating handle of the isolator and operating mechanism of HV breakers. Operating handle of the isolator and supporting structure shall be bonded together by a flexible connection and connected to the earthing grid.

6.30. A separate earth electrode bed shall be provided adjacent to structure supporting lightning arrestors. Each connection shall be as short and as straight as practicable. For arrestors mounted near transformers, earth conductors shall be located clear off the tank and coolers.

6.31. Wherever earthing conductors passes through walls, galvanized iron/PVC sleeves shall be provided for the passage of earthing conductor. The pipe ends shall be sealed by the Contractor by suitable water proof compound.

6.32. Earthing Connections:

a) All connections in the main earth conductors buried in earth/ concrete and connection between main earthing conductor and earth leads shall be of welded type.

b) Connection between earth leads and earthing terminal provided on the equipment shall be bolted type.

c) All bimetallic connections shall be treated with suitable compound to prevent moisture ingression.

d) Metallic conduits and pipes shall be connected to the earthing system.

e) Lightning protection system down conductors shall not be connected to other earthing conductors above ground level. Also no intermediate earthing connection shall be made to lightning arrester and transformer earthing leads which shall be directly connected to pipe electrode.

6.33. Earth Electrodes:

a) Electrodes shall as far as practicable, be embedded below permanent moisture level.

b) Test pits with concrete covers shall be provided for periodic testing of earth resistance. Installation of pipe electrodes in test pits shall be suitable for watering. The necessary materials required for installation of test pits shall be supplied and installed by Contractor. The installation work shall also include civil work such as excavation and connection to main earth grid.

c) Earth pits shall be treated with salt and charcoal. In case found necessary, then with the approval of Purchaser's representative, Back fill compound of suitable composition may be used. Back fill material shall not be water soluble & shall retain moisture & enhance conduction around electrode. Back fill compound shall be low resistance & non corrosive earth enhancement compound which shall provide safe discharge path to fault current & lightening current.

d) Ohmic value shall be within safe limits & it shall be stable & not fluctuating.

e) Soil, salt and charcoal placed around the electrode shall be finely graded, free from stones and other harmful mixtures. Backfill shall be placed in layers of 250 mm thick uniformly spread and compacted. If excavated soil is found unsuitable for backfilling, the Contractor shall arrange for a suitable soil from outside.

6.34. INSTALLATION OF CABLE RACKS AND CABLE TRAYS:

6.35. General

a) Lines and grade for trays may be measured from building steel and finished floor elevations. Change in line or grade, or the addition of offsets by means of cutting standard tray sections and inserting additional tray fittings to match with the existing arrangement shall be considered as a normal part of the work.

b) Where embedded steel inserts in concrete floors/ walls for welding the supports for cable racks/ trays are not available, Contractor shall provide suitable anchor fasteners at no extra cost.

c) Cable shall be clamped to the cable trays at every 750 mm distance.

d) Flexible metallic conduits shall be used for termination of connection to equipment such as motors, limit switches and other apparatus.

6.36. Cable Trays: All the cable tray shall be hot dipped galvanized with minimum galvanization thickness as per mentioned in this specifications.

a) Cable tray shall be of perforated sheet steel with formed flanges and of minimum thickness not less than 1.25 mm for trays up to 100 mm width, not less than 1.5 mm for trays from 100 mm to 150 mm width and not less than 2.0 mm for trays from 150 mm to 300 mm width.

b) All the cable trays above 300 mm width shall be of ladder type with minimum thickness of 2.5 mm.

c) Cable tray for use in areas where chlorine gas may be present shall be constructed from U-PVC or GRP. Cable tray supports shall be of a compatible finish with the associated cable tray.

d) All cable trays tees, intersection units, bends, turns and sets shall be prefabricated (made by the manufacturer) and shall be of a matching design to the main section of cable tray.

e) Tray shall only be joined by couplers supplied by the manufacturers. The joint shall be secured in accordance with the manufacturer's instructions.

f) Cable tray supports supplied by a manufacturer or made up on Site shall have adequate strength to maintain rigid support to the fully laden cable tray along its entire length and shall ensure that the deflection of any one section does not exceed 15 mm at mid span.

g) Wherever possible, cable trays shall be installed in full lengths without cutting. Should it be necessary to cut or drill a length of tray, the bared ends or damaged section of the tray shall immediately be given a coat of zinc rich cold galvanized paint. All site manufactured accessories, supports and metal fittings required to ensure correct installation of the cable trays shall be similarly treated.

h) All cables shall be firmly secured to the tray using purpose made saddles, as approved by the Purchaser's Representative, together with proprietary nylon fasteners and/or cable cleats. Following installation of cables, the tray shall remain rigidly supported and the deflection of any section shall not exceed 15 mm at mid span. All brackets and tray work shall be suitable for withstanding a temporary weight of 125 kgs.

i) Cable trays shall not be cut to allow the passage of cables through the surfaces of the tray

j) The sizing of the cable tray shall provide a minimum of 20% spare capacity.

k) The tray shall be run at least 300 mm clear of plumbing and mechanical services.

l) Bends in the installation shall take account of the minimum bending radii of cables to be installed.

m) All the cable trays shall be supplied with cable tray supports (of adequate size) at no more than 1.2 meter interval.

n) Other cable tray details & cabling system shall be as per typical drawings attached with the specifications.

6.37. Cable Trunking – Metal:

a) Cable trunking shall be manufactured from mild steel of not less than 1.25 mm and shall be hot dipped galvanized. The Contractor shall ensure that the size of the trunking is adequate for the number of cables to be installed together with 50% spare capacity and shall in any case be 50 mm x 50 mm minimum size.

b) Segregation of cables shall be carried out if required using continuous sheet steel barriers with the bottom edge welded to the trunking.

c) The trunking shall have two return flanges for rigidity. Where necessary, additional strengthening straps shall be fitted internally. The cover shall overlap the trunking and be made of the same gauge. Fixing screws for covers shall be recessed and be of the self retaining `quick fix' type. All bends, tees and intersections shall be of the gusset type and shall, wherever possible, be purpose made by the manufacturer and of a matching design to the main trunking.

d) Cables shall be retained in the trunking when the cover is removed by means of straps. Internal connecting sleeves shall be fitted across joints in the trunking and earth continuity ensured by bonding each section of trunking to a continuous earth wire.

e) Non-flammable fire barriers shall be inserted where the trunking passes through walls or floors. Conduit connections to trunking shall be made by flanged couplings and male bushes.

f) Trunking shall be supported at intervals not greater than 2 meter horizontally or 2.5 meter vertically.

g) Crossings over expansion joints shall be made in flexible conduit.

h) Should it be necessary to cut or drill a section of trunking or a trunking fitting the bared ends shall immediately be given a coat of zinc rich cold galvanizing paint.

i) Cable and conduit/ trunking runs shall be determined by the Contractor and agreed by the Purchaser's Representative before any work is started. The run shall be at least 300 mm clear of plumbing and mechanical services.

j) Conduit/ trunking systems erected outside a building shall be weatherproof.

6.38. CABLE INSTALLATION:

6.39. General:

a) Cable installation shall be in accordance with IS 1255: 2001- latest edition.

b) Cables shall be installed in such a way that the minimum bending radii are not reduced when installed or during installation. Cables shall not be installed in ambient temperatures below that recommended by the cable manufacturer.

c) Cables grouped together shall have insulation capable of withstanding the highest voltage present in the group.

d) Cables of different categories shall be installed so as to maintain satisfactory clearances for safety and in order to reduce the possibility of electrical interference. The following Table details the distances in mm that shall be maintained between the different categories of cable.

Table of Separation Distances in mm between different Categories of Cable

Cable Category	HV Power	LV Power	C&I/ Protection	Tele-communication
HV Power	N/A	300	500	500
LV Power	300	N/A	300	300
C&I/ Protection	500	300	N/A	100
Tele-communication	500	300	100	N/A

e) These separations are minimum and special circumstances such as the presence of high current flows, or harmonic content may necessitate larger separation distances.

f) A distance of minimum 300mm shall be maintained between the cables to be laid on trays/ conduits carrying low voltage AC and DC signals and a distance of minimum 600 mm shall be maintained between cables carrying HT and LT signals.

g) In order to make economic use of the cable support system, cables shall be arranged in groups having diameters in the close proximity. These groups shall be securely tied to the cable support system at intervals not exceeding 900 mm for horizontal runs and 300 mm intervals on vertical runs.

h) In order to make the most economic use of cable tray and duct capacity, multicore cabling shall be utilized in order to connect instrumentation groups by using suitably located sub-distribution junction boxes. The junction boxes shall be suitable for the area in which they are to be installed and for the type of circuit. They shall be readily accessible for maintenance and clearly labeled junction boxes shall be constructed of die cast Aluminium and provide degree of protection IP 65.

i) Instrumentation cables shall be continuous without any joints. Separate cables shall be used for digital and analogue signals at all times. Digital and analogue signals shall be segregated within junction boxes.

j) Cables shall be laid in a manner such that any electrical interference between cables shall not have a detrimental effect on the life and operation of Plant.

k) Where practical a separate cable support system shall be provided for power and non-power cables. Where this is not practical a separation as per indicated in above table shall be maintained between power and non-power cables when run on the same support system.

l) Heavy duty galvanized iron cable tray and ladder racking shall be used for cable support systems. FRP/ GRP cable support systems shall be used in areas used for the storage and handling of chlorine. These systems shall be used to route cables around walls and within cable trenches. Cables shall be securely fixed to the support systems. Bundling of cables shall be permitted where allowance for this practice has been made in sizing the cables.

6.40. Laying of Cables:

a) Each instrumentation and power supply cable shall be terminated to individual panel/ terminal box.

b) Identification of each cable shall be by proper ferrules at each junction as per cable schedule to be prepared by Contractor.

c) Cables shall be laid in accordance with layout drawings and cable schedule which shall be prepared by Contractor and submitted for approval.

d) All cable routes shall be carefully measured and cables cut to the required lengths, leaving sufficient amount for the final connection of the cable to the terminals on either end.

e) Various cable lengths cut from the cable reels shall be carefully selected to prevent undue wastage of cables.

f) A loop of 1.0 meter shall be left near each field instrument before terminating the cable.

g) Cables shall be complete uncut lengths from one termination to the other.

h) Separate cables shall be used for digital and analog signals.

i) All cables shall be identified close to their termination point by cable numbers as per cable interconnection schedules.

j) Identification tags shall be securely fastened to the cables at both the ends.

k) Cable shall be rigidly supported on structural steel and masonry, using individually cast or malleable iron galvanized clips, multiple cable supports or cable trays.

l) The Contractor shall take the actual measurement of the cables and the associated accessories such as cable trays, conduits etc required at site, prior to the placement of order on the cables.

6.41. Cables Laid Direct in Ground:

a) Buried cable up to 1.1 kV shall have a laid at a minimum depth of 750 mm measured from FGL to the top of the highest cable. On crossing roadways the cable shall be run through a PVC-U duct of minimum diameter 100 mm with a minimum of 1000 mm cover and encased on all sides by 150 mm of concrete.

b) Cables of greater than 1.1kV shall be buried at a minimum depth of 1 meter.

c) The bottom of the cable trench shall be freed of sharp stones and such like and 75 mm of sieved sand laid below the cable. After cable laying 75 mm of sieved sand shall be laid above the cable. For HT cables sand bedding shall be of 150 mm & cables shall be covered with half round Hume pipes of twice the diameter of cable.

d) Interlocking cable protective covers, minimum 1 m long x 300 mm wide, marked ‘Danger-Electric Cable' in English and the vernacular shall be laid on top of the sieved sand. Covers shall extend the whole length of the cable trench and shall overlap cables by a minimum of 50 mm.

e) Warning tape shall be laid a minimum of 200 mm above the protective covers.

f) Cables are to be installed without tees or through joints unless otherwise approved by the Purchaser’s Representative. Single core cables shall be run in trefoil formation.

6.42. Cables Laid in Underground Ducts:

a) Underground ducts shall be constructed of impact resistant PVC-U and laid at a minimum depth of 750 mm, ducts shall be surrounded by at least 75 mm of sieved sand except at road crossings where it shall be 1 meter deep and encased on all sides by 150 mm of concrete.

b) The Contractor shall ensure that sufficient draw-in points have been provided and that adequate room has been allowed for installation of cables. Drawstrings shall be provided in all ducts to enable additional cables to be installed when required.

c) Where cables pass in or out of any duct entries into or within buildings such entries, together with any spare ducts shall be sealed against the ingress of moisture by means of duct stoppers and bituminous compounds or by any other method approved by the Purchaser's Representative. The stopper shall have a fire resistance of at least 30 minutes. Single core cables in trefoil formation shall pass through the same duct and shall not be separated. However, for two different trefoil formations, they shall be laid in separate ducts.

6.43. Cables installed in Conduit:

a) Conduits shall be galvanized heavy gauge solid drawn or welded screwed steel type and be in accordance with IS 9537, Part 2 or BS 4568. Accessories shall either be malleable cast iron screwed type or pressed steel and galvanized.

b) A space factor of 40% shall not be exceeded, but in any case conduit of less than 20 mm diameter shall not be permitted. The tubing shall be perfectly smooth inside and out and free from flaws and imperfections of any kind. Both ends of every length of tubing shall be properly reamed with all sharp edges removed before erection.

c) Where a number of conduits converge, malleable cast iron or heavy gauge sheet steel adaptable boxes shall be employed in order to avoid crossings. Conduits shall be connected by means of male brass bushes and couplings.

d) Where conduits are greater than 25 mm, straight through joint boxes shall be of the trough type. Where conduit and/ or fittings are attached to equipment casings, the material or case of the casing shall be tapped for a depth of not less than 10 mm or male bushes and flanged couplings shall be used.

e) Heavy hexagonal lock nuts shall be used at all positions where running joints are required and care shall be taken to ensure that they seat firmly and evenly on to the mating faces of coupling or other adjacent accessories. All junction boxes, draw-in boxes, and inspection fittings, shall be so placed that the cables can be inspected and, if necessary, withdrawn and re-wired throughout the life of the installation.

f) Generally not more than two bends or offsets or one coupling will be permitted without a suitable inspection accessory. Fish wires shall not be left in conduits after erection. The whole of the installation shall be arranged for a loop-in type of system with joints being carried out at switches, isolators, etc. Intermediate joints in the cable will only be allowed by arrangement with the Purchaser/ Purchaser's Representative.

g) Ends of conduits which are liable to be left open for any length of time during building operations shall be plugged to prevent the ingress of dirt, cement, etc. and covers, either temporary or permanent, shall be fitted on all boxes.

h) Generally, conduits shall not cross expansion joints of buildings, but where they cannot be installed in any other manner then a flexible conduit shall be used across the expansion joint. A total 150 mm movement shall be allowed.

6.44. Surface Installation:

a) Surface conduits shall be secured and fixed by means of distance spacing saddles or approved purpose made clips at every 500mm, which allow the conduits to be taken directly into accessories without sets or bends. Conduits shall be run in a square and symmetrical manner. An efficient means shall be adopted to provide for the drainage of condensation and the runs shall be properly ventilated. All surface conduit runs shall be marked out for approval by the Purchaser's Representative before the installation is carried out. Where large multiple parallel conduit runs would occur, use may be made of galvanized cable trunking. Conduits installed on structural steelwork shall be secured at spacing not exceeding those for surface conduit by girder clips, otherwise fixing shall be as for surface conduits on walls, drilled and tapped to the metalwork. Power driven fixings shall only be used with the express permission of the Purchaser's Representative. Any drilling or access which is required through any structural member of the building shall be agreed with the Purchaser/ Engineer in Charge before carrying out the work.

b) Exposed threads and places where galvanizing has been damaged shall be cleaned and then painted with two coats of an approved metallic zinc based paint. This treatment shall be applied as the work proceeds.

6.45. Concealed Installation:

a) Concealed conduits shall be securely fixed to prevent movement before laying of screeds, floating of plaster, casting of columns or other building operations necessary after the conduit installation. Crumpets or similar fixings shall be used for attaching the conduit to blockwork, etc. Building nails will not be accepted.

b) At least 15 mm cover shall be allowed for finishes over the conduit. Where this cover cannot be maintained then expanded metal shall be fitted with the conduit. Conduit cast into reinforced concrete floors shall be fixed to the steel reinforcing with binding wire and the conduit boxes filled with expanded polystyrene or enclosed in a plastic bag to prevent the ingress of concrete when poured. Where possible, the conduit boxes shall be fixed to shuttering to give a flush finish. The conduit junction boxes shall be provided after every 30M straight line of conduit and at each bend.

c) Conduit installed in voids, false ceilings, and other concealed routes shall be installed as specified for the surface conduits. Wiring shall be carried out after the false ceiling or permanent ducts have been completed. Conduit installed in floors shall be sealed against ingress of moisture.

d) The conduit installation shall be inspected by the Purchaser's Representative before the building operation conceals the work.

6.46. Cable Installed in Flexible Conduit:

a) Flexible conduit shall be of the waterproof galvanized type or PVC wire-wound type with cadmium plated mild steel couplings. Lengths of flexible conduits shall be sufficient to permit withdrawal, adjustment or movement of the equipment to which it is attached and shall have a minimum length of 300 mm. Flexible conduit shall not be used as a means of providing earth continuity. A single earth conductor of adequate size shall be installed external to the conduit complete with earth terminations.

b) Where conversion from rigid conduit to flexible metallic conduit is to be made, the rigid conduit shall terminate in a through type box and the flexible conduit shall extend from this box to the equipment, the earth continuity cable shall be secured to the box and to the piece of equipment by properly designed earthing screws. The use of lid facing screws, etc., will not be permitted. Adapters shall incorporate a grub screw or a gland to prevent the flexible conduit becoming loose.

6.47. Cable Clipped Direct:

a) All cable hangers, clips, cleats and saddles shall be of an approved type and appropriate to the type and size of cable installed. Their spacing shall be such as to ensure a neat appearance and prevent sagging of the cables at all times during their installed life.

6.48. Cable Installed in Internal Floor Trench:

a) In shallow trenches (maximum depth 500 mm)

b) In shallow trenches used for electrical services only, cables may be laid in a neat and orderly manner on the floor of the trench. One layer only shall be allowed. Additional cables shall be installed on the walls of the trench in an acceptable manner & such a way that, in no case the distance between two different types of cable shall not be less than the separation distance tabulated above.

c) Where the trench is shared by other services, cables shall be installed on the walls of the trench in an acceptable manner & such a way that, minimum separation distance of 300mm shall be maintained.

d) All other trenches including walk through service ducts

e) Cable trenches & cable installation shall be in accordance with the attached typical cabling system drawings.

f) Where other services are present the cables shall be segregated from them by separation distances as mentioned above and wherever possible kept above `cold' wet services. Cables should not be run if at all possible above or in close proximity to `hot' services.

g) The cabling shall be installed in such a manner as to allow access to the other services for normal maintenance without disturbance of the electrical installation

6.49. Cable Terminations and Joints:

a) Power Cable Terminations

i. Power cables shall be terminated in suitable boxes arranged for bolting to switchgear, motor starters and motors.

ii. Cores shall have either crimped lugs or sleeves to match either post terminals or bolted clamp terminals.

iii. Each cable entry into a terminating box shall be made through a suitable gland, which shall have provision for securing the armour where applicable. Where single core glands are required these shall be of the non-magnetic type and the associated box bottom plate, where the core passes through, shall not have a continuous magnetic path.

iv. Adequate provision shall be made to bond the cable armouring to the box and/or switchgear casing of a suitable size to withstand the prospective short circuit fault current of the system, glands shall be fitted with earth bonding tags where intimate screwed contact between gland and cable box is not possible.

v. Where cable glands are exposed to the weather these shall be protected by heat shrink plastic sleeve or purpose moulded sleeves covering the gland continuously from overall sheath to the gland neck.

vi. Where terminations of multicore type have to be made on to items of Plant which have to be dismantled for maintenance, these shall be made off through glands into an adaptable box containing terminals and flexible single cores taken into the equipment via flexible waterproof plastic covered conduit, and a separate earth core linking the box to the equipment.

vii. Where single core cables are glanded to or pass through cabling plates the gland plate or cabling plate shall be constructed of non-magnetic material.

b) Power Cable Joints:

i. Through joints shall only be allowed with the approval of the Purchaser's Representative. Where such joints are necessary in thermoplastic and elastomeric cables, the cables shall be jointed with epoxy or acrylic resin cold setting compound, which has been premeasured and pre-packed ready for use. The boxes shall preferably be of split, moulded plastic type with filling vents for compound. Bonding straps shall be fitted with armour clamps across the joint and inspected by the Purchaser/ Purchaser's Representative prior to filling the box with compound. Wrapped pressure type joints will not be accepted.

c) Multi-core or Control Cable Terminations:

i. A sufficient number of terminals shall be provided to terminate all cable cores. For control and auxiliary wiring an additional 20% of this number shall be provided as spares.

ii. Not more than one core of internal or external wiring shall be connected on any one terminal. Where duplication of terminal blocks is necessary, purpose-made solid links shall be incorporated in the design of the terminal blocks.

iii. Terminals which remain energized when the main equipment is isolated shall be suitably screened and labeled.

iv. Terminal blocks for different voltages or circuit type shall be segregated into groups and distinctively labeled.

6.50. Cable Fixings:

a) Ties and strapping shall be suitable for securing cable and cable groups to cable tray or ladder. They shall be resistant to chemical and marine corrosion. Plastic coated metal ties used in order to obtain corrosion resistance shall not be acceptable. Nylon ties shall be resistant to the effects of ultra-violet light and shall be self-extinguishing.

b) Large single cables shall be secured with cable clamps or cable cleats.

6.51. Cable Identification:

At each end of each cable, in a uniform and visible position a label shall be fixed on the cable in accordance with the cable schedule. Labels shall be made of PVC and shall be indelibly marked to the approval of the Purchaser's Representative. The label shall be retained using proprietary nylon strips passing through two fixing holes at either end of the label. If the cable gland is not normally visible, then the label shall be fixed inside the panel by means of screws.

6.52. Marking Locations of Underground Cables:

a) The location of all underground cables shall be engraved on brass or other non-corrodible plates to be fixed to the exterior surface of all walls of buildings 300 mm above ground level and directly above the point where cables pass through the wall.

b) Cable route markers as per the attached drawing shall be installed at an interval not more than 15 meter & at bending/ road crossings the interval shall be at every 10 meter.

c) The minimum depth for laying of underground cable route markers shall be as per indicated in the typical drawings attached with this tender.

6.53. Additional Requirements for Cable Installations:

a) The Contractor shall install, test and commission the cables specified in the specification. Cables shall be laid directly buried in earth, on cable racks, in built up trenches, on cable trays and supports, in conduits and ducts or bare on walls, ceiling etc. as per drawings, which are to be prepared by Contractor & approved by Purchaser's representative. Contractor's scope of work includes unloading, laying, fixing, jointing, bending, and termination of the cables & all related accessories. The Contractor shall also supply the necessary materials and equipment required for jointing and termination or the cables.

b) All apparatus, connections and cable work shall be designed and arranged to minimize risk of fire and any damage which might be caused in the event of fire. Wherever cables pass through floor or wall openings or other partitions, suitable bushes of an approved type shall be supplied and put into position by the Contractor.

c) Standard cable grips and reels shall be utilized for cable pulling. If unduly difficult pulling occurs, the Contractor shall check the pull required and suspend pulling until further procedure has been approved by the Engineer's Representative. The maximum pull tension shall not exceed the recommended value for the cable measured by the tension dynamometer. In general, any lubricant that does not injure the overall covering and does not set up undesirable conditions of electrostatic stress or electrostatic charge may be used to assist in the pulling of insulated cables in conduits and ducts.

d) After pulling the cable, the Contractor shall record cable identification with date pulled neatly with waterproof ink in linen tags. Identification tags shall be attached securely to each end of each cable with non-corrosive wire. The said wire must be non-ferrous material on single conductor power cable. Tags shall further be attached at 10 meter intervals on long runs of cables on cable trays and in pull boxes. Cable and joint markers and RCC warning covers shall be provided wherever required.

e) Sharp bending and kinking of cables shall be avoided. The bending radius for various types of cables shall not be less than those specified below:

i. 11 kV, XLPE insulated, multicore cable : 15 times the overall dia of the

ii. armoured cables

iii. 1.1 kV, XLPE insulated, multicore cable : 12 times the overall dia of the

iv. armoured cables

v. (If shorter radius appears necessary, no bend shall be made until clearance and instructions have been received from the Purchaser/ Engineer in charge)

f) Power, control and instrumentation cables shall be laid in separate cable racks/ trays.

g) Where groups of HV, LV and control cables are to be laid along the same route, suitable barriers to segregate them physically shall be provided.

h) Where cables cross roads and water, oil, gas or sewage pipes, the cables shall be laid in reinforced spun concrete or steel pipes. For road crossings the pipe for the cables shall be buried at no less than one meter depth.

i) Cables laid in ground shall be laid on a 75 mm riddled earth bed. The cables shall then be covered on top and at their sides with riddled earth of depth of about 150 mm. This is then gently filled up to a depth of about 100 mm above the top of uppermost cable to provide bedding for the protective cable covers which are placed centrally over the cables. The protective cable covers for LV cables may be of earthenware and for HV cables of reinforced concrete. The RCC covers shall have one hole at each end, to tie them to each other with GI wires to prevent displacement. The trench is then backfilled with the excavated soil and well rammed in successive layer of not more than 300 mm in depth, with the trenches being watered to improve consolidation wherever necessary. To allow for subsidence, it is advisable to allow a crown of earth not less than 75 mm in the centre and tapering towards the sides of the trench.

j) In each cable run some extra length shall be kept at a suitable point to enable one or two straight through joints to be made, should the cable develop a fault at a later date.

k) Cables on cable racks, on cable trays and conduits shall be formed to avoid bearing against edges of trays, racks, conduits or their supports upon entering or leaving trays, racks or conduits. Cables shall be racked or laid directory into cantilevered cable trays where practicable, but in some cases it may be necessary that cables are pulled or threaded into trays. To facilitate visual tracing, cables in trays shall be laid only in single layers and unnecessary crossing of cables shall be avoided. Cables on trays shall finally be clamped in an approved manner.

l) Cable splices will not be permitted except where permitted by the Purchaser/ Purchaser's Representative. Splices shall be made by Contractor for each type of wire or cable in accordance with the instructions issued by cable manufacturer's and the Engineer's Representative. Before splicing, insulated cables shall have conductor insulation stepped and bound or penciled for recommended distance back from splices to provide a long leakage path. After splicing, insulation equal to that on the spliced conductors shall be applied at each splice.

m) Jointing of cables shall be in accordance with relevant Indian Standards Codes of Practice. Materials and tools required for cable jointing work, including cold setting bituminous compound shall be supplied by the Contractor. Cables shall be firmly clamped on either side of a straight through joint at a distance of not more than 300 mm away from the joints. Identification tags shall be provided at each joint at all cable terminations.

n) At cable terminal points where the conductor and cable insulation will be terminated, terminations shall be made in a neat, workmanlike and approved manner by men specialized in this class of work.

o) Control cable termination shall be made in accordance with wiring diagrams, using colour codes established by the Purchaser's Representative for the various control circuit, by code marked wiring diagram.

p) When control cables are to be fanned out and cabled together with cord, the Contractor shall make connections to terminal blocks, and test the equipment for proper operation before cables are corded together. If there is any question as to the proper connection, the Contractor shall make a temporary connection with sufficient length of cable so that the cable can be switched to another terminal without splicing. After correct connections are established through operating the equipment, cables shall be cut to their correct lengths, connected to terminals in the specified manner, and corded together where necessary to hold them in place in a workmanlike manner.

q) Cable seals shall be examined to ascertain if they are intact and that cable ends are not damaged. If the seals are found to be broken the cable ends shall not be jointed until after due examination and testing by the Purchaser/ Purchaser's Representative. Before jointing is commenced, insulation resistance of both sections of cables to be jointed shall be checked by megger.

r) After installation and alignment of motors, the Contractor shall complete the conduit installation, including a section of flexible conduit between motor terminal box and trench/ tray. The Contractor shall install and connect the power, control and heater supply cables as per equipment manufacturer's drawings.

s) Metal sheath and armour of the cable shall be bonded to the earthing system of the station. The size of conductor for bonding shall be appropriate with the system fault current.

6.54. LIGHTING SYSTEM INSTALLATION:

6.55. This covers the requirements of installation of the following:

a) Lighting fixtures complete with lamps and accessories

b) Main Lighting distribution board

c) Lighting panels

d) Receptacles and lighting control switches

e) Point wiring

f) Street lighting poles and flood light towers

g) Multi core cables for street and boundary lighting

h) Maintaining equipment/ materials during storage and being responsible for the equipment/ material until they are handed over to Purchaser.

i) Installation, testing and commissioning shall be carried out in accordance with the drawings and as stipulated in this specification.

6.56. Applicable Standards for lighting system installation

Electrical wiring installations	:	IS: 732
(System voltage exceeding 650 V)		
Code for practice for interior illumination (Part-1)	:	IS: 3646/ BS: 8206

Code of practice for street lighting installation	:	IS: 1944
Code of practice for industrial lighting	:	IS: 6666
Code of practice for fire safety of building	:	IS: 1646
Boxes for enclosure of electrical accessories	:	IS: 5133(Part-1)
Guide for safety procedures and practices in electrical work	:	IS: 5216
Ceiling roses	:	IS: 371

6.57. Lighting Fixtures:

a) The installation of lighting fixtures shall be based on the mounting arrangement shown in the drawings. The rates quoted for installation shall include all materials required to mount the fixtures. Hooks in RC slabs for suspension of high bay fixtures shall be provided wherever not already provided. Cost of supply and installation of such hooks shall be included in the cost of installation of lighting fixtures. Rate for installation of lighting fixtures shall include cost of installation of control gear box wherever applicable.

b) Installation of receptacles and switches shall be carried out suitably. Switch shall be mounted in flush with the front cover plate. Cost of supply and installation of necessary hardware shall be included in the lump sum rates quoted for installation of receptacles/ switches.

c) Lighting distribution boards shall be installed at the suitable location. Installation shall include supply and installation of base channels, foundation bolts, etc.

d) Outdoor lighting distribution boards shall be installed on a concrete plinth. The top of plinth shall be 1000 mm (min.) above the grade level. Cost of construction of concrete plinth shall be included in Contractor's scope. No cement and steel will be supplied by Purchaser. Installation cost of lighting distribution board shall include cost of installation of earthing conductor from LDB to the nearest earthing grid.

6.58. Point Wiring:

a) Contractor has to prepare the detailed conduit layout drawing showing primary & secondary point wiring points. Point wiring also covers the wiring of the associated control switches of lighting fixtures/control switches of receptacle units.

i. Primary Point Wiring:

Primary point wiring covers the wiring between a circuit of the lighting panel to the junction box of the first lighting fixture/receptacle unit and between junction boxes of the subsequent lighting fixture connected to that circuit of the lighting panel. In some cases where there are junction boxes, the primary point covers the wiring between junction box and the first lighting fixture/receptacle unit in that circuit.

ii. Secondary Point Wiring:

Secondary point wiring covers the wiring of the remaining lighting fixtures/receptacle unit other than that covered under primary point of that circuit in the lighting panel. Secondary point wiring also covers the wiring of the associated control switches of lighting fixtures/control switches and control switches of receptacle units.

b) Supply and Installation of Conduit Point Wiring:

i. The point wiring shall include supply of necessary materials for the conduit wiring such as galvanized rigid steel conduit, galvanized M.S. fixing saddles with spacer plates, nylon/fiber fixing plugs, galvanized M.S. fixing screws, 12 SWG galvanized steel earthing wire, FRLS PVC insulated Copper conductor wires, control switches and pulling, termination of the earthing/ FRLS PVC insulated wires as required, installation of control switches, drilling holes in brick walls/RCC roof slabs for taking the wiring conduits and refinishing and any other works/material necessary for making point wiring complete in all respects.

ii. Wires used for conduit point wiring of lighting fixtures/ceiling fans, 5A receptacles and receptacles above 15A shall be 1.1 kV grade, FRLS PVC insulated, single core, multistranded Copper conductor wires of sizes not less than 1.5 sq. mm and 2.5 sq. mm respectively. Wires shall conform to IS: 694 and shall bear the ISI mark.

iii. Contractor shall take into consideration necessary galvanized MS fixing clamps when the wiring conduits are to be supported from steel roof truss/structural members.

c) Supply & Installation of cabling for Street and Flood Lighting

i. Work includes supply and installation of cables required between LDB and junction box mounted on street lighting pole/flood lighting tower and also between junction box mounted on flood light tower to metal enclosed control gear box located near flood light fixture, supply and installation of all the termination accessories such as crimping type cable lugs and double compression cable glands at each junction box and fixture, termination, testing and commissioning of cables. Contractor's scope of work also includes excavation, preparation of riddled soil bedding, supply and installation of protective covers over the cable, backfilling, ramming, supply and installation of route markers, supply and installation of HDPE / Hume pipes for road crossing, etc, supply and installation of necessary cleating arrangement for cabling on flood light tower, supply of labour, supervision, welding equipment, all tools and tackles and testing equipment as required.

ii. Contractor shall plan and cut the cables in such a way that there is no wastage and no cable jointing is required in any run. However, should any joint become necessary the same shall be provided by the Contractor and a joint marker shall also be provided at no extra cost. Earthing of street light pole/flood light tower, lighting fixtures, etc. are included under Contractor scope.

d) Point wiring shall also include/ hold good for the following :

i. Supply and installation of lighting control switches and switchboxes complete with fixing accessories.

ii. Drilling holes in brick/ RCC wall and roof for taking cable or conduit, sealing and refinishing with cement plaster.

iii. Testing, commissioning and handing over the lighting system in commercial working condition.

iv. Marginal shifting of any fixture/accessory from the location indicated in the lighting layout drawings.

6.59. Outdoor Lighting (Street and Flood Lighting): The following shall be deemed to be included as part of the installation work for outdoor lighting point wiring.

a) Installation of multicore/ single core cables between LDB and junction box mounted on street light pole/flood lighting tower, from junction box to metal enclosed control gear box.

b) Supply and installation of crimping type cable lugs, double compression type cable glands at each junction box and fixture, termination, testing and commissioning of cables.

c) Contractor's scope shall also include excavation and preparation for buried cables. Supply and installation of route markers, supply and installation of HDPE/ Hume pipes for road crossing shall also be included in the scope of installation of point wiring.

d) Supply and installation of necessary cleating arrangement for cabling on flood light poles.

e) Contractor shall provide necessary foundation for erecting street light pole/ flood light tower and install the same. Contractor shall prepare foundation drawings with necessary details & Purchaser Representative's approval shall be obtained.

f) Contractor shall plan and cut the cables in such a way that there is no wastage and no cable jointing is required in any run. However, should any joint become necessary, the same shall be provided by the Contractor and joint marker shall also be provided at no extra cost.

g) Earthing of street light pole/flood light tower, lighting fixtures, control gear boxes, junction boxes, etc. are also included in the scope of installation of point wiring. Contractor shall earth street light pole/flood light poles and junction box with 25x3 mm G.S. flat tap off from the 25x3 mm M.S. flat earthing grid along the street lighting included in scope. The Contractor shall interconnect earthing grid to plant main earthing grid at first and last pole of each feeder circuit and at one intermediate poles.

h) Installation of lighting Poles and Towers for Outdoor Lighting (Street and Flood Lighting)-

i. Work includes supply and installation of street light poles and flood light towers including associated junction boxes with fuses, links and terminals for junction boxes and junction boxes near each flood light fixtures.

ii. All street light poles and towers shall be painted with one shop coat of red oxide oil primer followed by two coats of aluminium alkyd paint.

6.60. Installation of Lighting Distribution Board, Lighting Panels (AC & DC), 230 V, AC 1- Ph Distribution Boards.

Installation of above items shall include necessary foundation channels, bolts/ nuts, etc. for grouting lighting distribution boards, iron brackets/ grouting brackets, bolts/nuts for wall/ column mounted panels and associated civil works.

6.61. Details of work requirements are covered in lighting installation notes and details and typical drawings which form the part of specification. Any changes, if necessary due to site conditions/requirements shall be carried out after obtaining approval of Purchaser/ Purchaser's Representative. The changes carried out shall be marked clearly in the layout drawings by Contractor and 'AS BUILT DRAWING' shall be prepared by the 'Contractor' and this shall be forwarded to Purchaser's site / design office.

a) Wiring

i. Wiring shall be carried out strictly as per project drawings and technical specification. All exposed conduit wiring shall have provision for easy inspection. Where cable wiring is specified cable shall be cleated on to the wall as close to the ceiling as possible. In all types of wiring due consideration shall be given for neatness and appearance.

ii. Wherever DC emergency lighting is provided, emergency lighting wires shall run in a separate conduit. Colour of the wires used shall be as follows; white for positive, black for negative.

iii. Wherever lighting system has three phase distribution, separate conduits shall be used for different phases. For easy identification of phases and neutral wires the following colour wires shall be used.

R - Phase -	Red
Y - Phase -	Yellow
B - Phase -	Blue
N - Neutral -	Black

b) There shall be a circuit breaker on each live conductor of supply mains at the point of entry.

c) Conductors not arranged for connection to the same system or supply different phases of the same supply, shall be kept apart throughout their entire run.

d) Receptacles and lighting fittings in general shall be fed from different Circuits. Five amps receptacles for toilet or small rooms can be fed from the lighting circuit with proper isolating arrangement.

e) Each final sub-circuit from a lighting panel shall be controlled by a single pole switch connected to the live conductor.

f) For long conduit wiring runs, inspection/ pull boxes shall be provided at intervals not exceeding 10 meter. Such facilities shall also be provided at conduit bends.

6.62. General Practices for lighting:

a) All receptacles and switches to be installed in offices and control rooms shall be flush mounted within the wall and those in other areas shall be wall or column mounted.

b) Ceiling roses shall not embody fuse terminals as an integral part. For voltages exceeding 250 volts, a ceiling rose or any similar attachment shall not be used.

c) All exposed metal parts of the plug, when the plug is in complete engagement with the socket outlet, shall be in effective electrical connection with the earthing pin.

6.63. Earthing for lighting:

Conduits and fittings shall be earthed by 12 SWG GI wires run along the length of the conduit and secured by means of suitable clamps efficiently fastened to conduit tip. To achieve perfect electrical continuity, the conduits shall be bonded effectively on either end of a coupling and other joints.

a) Conduits shall be earthed at the ends adjacent to switch boards at which they originate or otherwise at the earth clip, clamp or gland, in effective electrical contact with the conduit.

b) For outdoor lighting poles & mast 8 SWG GI earth wire shall be run buried in ground at a depth of 600 mm along-with lighting cables and shall be terminated up to the junction box on the pole and 12 SWG wire shall be taken up to the pole fitting. In case of lighting poles where the main earth grid is far away from the pole, local pits shall be provided for pole earthing.

7. PRE COMMISSONING TESTS ON ELECTRICAL EQUIPMENT/ SYSTEMS TO BE CARRIED OUT AFTER INSTALLATION:

7.1. GENERAL:

Pre-commissioning tests in addition to mentioned in the specification requirements for various equipments but not limited to following shall be carried out by Contractor in presence of Purchaser/ Purchaser's representative. Commissioning shall be carried out only after obtaining satisfactory results, acceptable to Purchaser/ Purchaser's representative.

7.2. ELECTRICAL EQUIPMENT:

i. 11 KV Equipment (Lightning Arrestors, AB Switch/ Isolators & Insulators etc):

a) Visual checks for cracks in insulators.

b) Earth secured continuity check

c) IR Test with 5KV Megger

ii. Power/ Distribution Transformer:

a) Insulation resistance test HV side, LV side and HV - LV.

b) Magnetizing current test.

c) Winding resistance test.

d) Voltage Ratio & Tap continuity test at all tap.

e) Vector group test.

f) Magnetic Balance Test.

g) Buchholz Relay Test (if any)

h) Neutral CT Test (if any)

i) Winding Temperature Indicator/ Oil Temperature Indicator Test

j) Polarization Index Test (For LV windings 3.3 KV and above)

k) Local/ Remote operations of OLTC (if any)

l) Operational tests of RTCC panel (if any) as per schematic drawing.

m) No load test and performance observations

iii. HT Metal Enclosed Switchgear:

a) IR values of power and control circuits

b) Local/ Remote operations in test as well as service position including all electrical interlocks

c) Control circuit and operational tests as per schematic drawing.

d) Tripping through relays and trip circuit health.

e) Anti pumping device operation

f) Protection system operation stability and sensitivity by primary injection testing method including testing of metering circuits

g) HV Test on switchboard

h) Panel indication, annunciation, space heater circuits

i) Spare contact for customer use

j) Termination correctness & proper installation.

iv. LT Metal Enclosed Switchgears:

a) IR Values of power & control circuits.

b) Mechanical charging - closing - tripping of breaker.

c) Electrical charging - closing - tripping of breaker.

d) Trip circuit healthiness and tripping through relays.

e) Remote closing/ Tripping/ Interlocks circuits

f) Indication/ Annunciation/ Panel space heater circuit/ Spare contacts for customer use

g) Secondary injection testing of protective relays/ releases.

h) CT testing for polarity, ratio, IR values and magnetization for class PS characteristics

i) PT testing for ratio, IR values.

j) IR Values of breaker.

k) Testing of modules for DOL/ Star-Delta/ ATS/ Soft Starter starting or any other starting method as per the schematic drawings applicable.

v. Power and Control Cables:

a) IR Values before Hi-pot

b) Hi-pot Test - Measurement of leakage current

c) IR Values after Hi-pot

vi. Induction Motors:

a) IR Values

b) Polarization Index Test

c) Interlocks and simulation tests local / remote operations

d) No load test

vii. Control Panels for Miscellaneous Equipment:

a) IR Values of all power circuits

b) Operational test and scheme - wiring testing as per control schematics

viii. Lighting System:

a) Visual inspection for operating problems

b) System activation -burning in the lamps for 100 Hrs

c) Measuring light level & reflectance.

ix. Earthing System:

a) Earthing resistance of each electrode.

b) Earthing resistance of grid.

8. DRAWINGS / DOCUMENTS:

8.1. The following drawings shall be submitted by the bidder.

i) Load List.

ii) Single Line Diagram.

iii) Transformer sizing.

iv) General arrangement drawing of Electrical Equipments.

v) General arrangement, Data Sheet, Sizing Calculation, Bill of Material, Scheme drawing/Wiring diagram, Write up, inter-connection diagram, assignment drawing, as applicable for all the electrical equipment.

vi) Performance curves for pump motors capacity V/s head, efficiency, KW requirement.