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RSCDL
SMART, LIVABLE, SUSTAINABLE

RAJKOT SMART CITY DEVELOPMENT LIMITED
INVITATION FOR BIDS / TENDER
e-Tender Notice

स्वच्छ सर्वेक्षण 2021

RSCDL, a subsidiary company of Rajkot Municipal Corporation invites Bids from the experienced contractors registered in appropriate class in Municipal Corporation/GWSSB/State Government/ Central Government for following works under Rajkot Smart City Mission.

Sr. No.	Name of Work	a) Estimated Cost b) Amount of EMD c) e-Tender fee d) Time limit for completion of work
1	ENGINEERING, PROCUREMENT, CONSTRUCTION, COMMISSIONING AND 5 YEARS OPERATION & MAINTENANCE OF 8 MLD CAPACITY TERTIARY TREATMENT PLANT AT RAIYADHAR, RAJKOT UNDER RAJKOT SMART CITY MISSION **e-Tender No.: RSCDL/SMART CITY/21/1/2020-21**	**a) Rs. 17,15,00,000/-** **b) Rs. 17,15,000/-** **c) Rs.23,500/-** **d) 15 (Fifteen) Months (including 3 Month Trial Run)**

:: Milestone dates of e-Tendering ::	
1. Downloading of e-Tender documents	16-01-2021 to 11-02-2021up to 17.00 Hrs.
2. a) Pre-bid Queries to be submitted by e-mail only at mail ID rmc.smartcity@gmail.com / hnsheth@rmc.gov.in b) Pre-bid Meeting	a) 27-01-2021 up to 11.00 am b) 27-01-2021 at 4-00 pm
3. Online submission of e-Tender	11-02-2021 up to 18.00 Hrs.
4. Physical submission of EMD, Tender fee, Documents required for pre-qualification and other necessary documents.	Upto 16-02-2021 18.00 Hrs
5. Verification of submitted documents (EMD, Tender fee, Documents required for pre- qualification and other Necessary documents.)	Upto 19-02-2021 18.00 Hrs
6. Opening of online Primary Bid (Technical Bid)	17-02-2021 at 10.30 Hrs. onwards
7. Opening of online Commercial Bid (Price Bid) for technically qualified bidders only.	22-02-2021 at 10.30 Hrs. onwards (If possible)
8. Bid Validity	180 Days

1. All interested bidders must submit tender fee for an amount of INR 23,500/- (Rupees Twenty Three Thousand Five Hundred Only) inclusive of all taxes to be deposited directly through RTGS/NEFT/ Over the Counter in A/c No 70160100018496; Bank: Bank of Baroda, Para Bazar branch, Rajkot ; IFSC Code: BARB0DBPRAJ (fifth Alphabet is Zero) or submit at the below mentioned address in the form of Demand draft in favor of **"Rajkot Smart City Development Limited", Rajkot** from any Nationalized Bank or Scheduled Bank (except Co-Operative Bank) in India.

   While all bidders must submit bid security (EMD) either directly deposited in A/c No 70160100018496; Bank: Bank of Baroda, Para Bazar branch, Rajkot ; IFSC Code:

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ii) Experience Criteria:

The bidder should possess following minimum experience:

a) Bidder shall have experience of having completed (including successful trial run & commissioning) at least one work of similar nature of **60%** of the tendered capacity (**in MLD**) or two works of similar nature of **40%** of the tendered capacity (**in MLD**) or three works of similar nature of **30%** of the tendered capacity (**in MLD**) in last 7 years from the last date of the month of invitation of this tender.

b) "Work of Similar Nature" means experience of design, detailed engineering, procuring, construction, testing, commissioning of at least one **Sewage / Effluent / Tertiary Treatment Plant** having Treated Water results outlet parameters of BOD < 5mg/L, & TSS < 5mg/L or of better quality in any Municipal Body / Urban Local Body / Development Authority / State Government Body or undertaking / any department or undertaking of Government of India and out of these at least any one plant shall be in successful operation for minimum one year.

The Bidder who has no experience as well as specialty in such Sewage / Tertiary Treatment Plant, as required above, his tender will be rejected out rightly.

c) The bidder should further have experience minimum one year of successful completion of O&M of minimum one Sewage / Effluent / Tertiary Treatment Plant out of the "Work of Similar Nature" completed by bidder as specified above at a) and considered by bidder for pre-qualification experience criteria based any one of the process specified above for similar works.

d) Attested Copy of original certificates in support of above requirements shall be enclosed in hard copy for verification, certified by the respective employer or his authorized representative, not below the rank of an Executive Engineer or equivalent. Original Certificates of the same shall be produced for verification on demand by employer, failing which, will result in to rejection of tender.

e) For the purpose of bid evaluation, if the owner/owner's representatives feel necessary to visit a specific or all such plants as mentioned above by the bidder, the bidder shall make necessary arrangements for the same. The cost of such visits shall be borne by the bidder.

f) Joint Venture will not be permitted for this tender. However, experience of JV shall be considered for individual JV partner based on the proportionate share of each individual partner in the JV for the purpose of qualification criteria and based on this qualification individual JV partner can bid in the same name and style of individual company forming part of JV. For this purpose, the bidder shall enclose the notarized copy of JV agreement along with physical submission of technical bid.

g) The experience of Sub-Contractor / back to back works shall not be considered.

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such case all the losses that will arise out of this issue will be recovered from the tenderer / bidder and he will not have any defense for the same.

6. Reserve the right (i) to change, alter or to waive any technical or commercial terms, condition and qualification (ii) to reject all the bids or any bid in part or full without assigning any reason whatsoever (iii) for making changes / relaxation in eligibility criteria at any time in the interest of the public. The bidder shall have no cause of action or claim against the RSCDL or its Officers / Employee's successor or assignee for rejection of his tender/bid.

7. After opening of Technical Bid, the procedure for the pre-qualification shall be adopted and the Price Bid of only successful qualified bidder shall be opened for the contract. The decision of Chairman, RSCDL regarding the pre-qualification shall be final and binding to all the bidders.

8. The Tender of those bidder(s) who fail to submit the required documents physically within the stipulated date and time will be treated as non-responsive and their Price Bid will not be opened.

9. Conditional Tenders will be outright rejected.

10. **Chairman, Rajkot Smart City Development Limited** reserves the right to accept / reject any or all e-Tender(s) without assigning any reasons is hereby reserved.

4/1/21

Municipal Commissioner & Chairman
Rajkot Municipal Corporation
&
Rajkot Smart City Development Limited

Pl. Note: The tender can be uploaded and downloaded from www.rmc.nprocure.com only.

1.0 INTENT OF SPECIFICATIONS / SCOPE

1.1 This specification along with specific job requirements (if any) is intended to cover the design, engineering, supply, installation, testing and commissioning of entire electrical facilities / equipment and items and accessories including consumable against lump sum price for entire treatmemt plant / facility as indicated here in and else where covererd in the scope of this tender.

1.2 It is not intended to cover all aspect of system design but to indicate the basic requirements only. Contractor shall ensure that detailed design and installation is carried out as per good engineering practices and shall meet requirements of safety, reliability, ease of maintenance & operation, aesthetics, scope for future expansion and maximum interchageability of the equipment.

"Scope of Schedule of Item" as mentioned here in are minimum and suggestive but not conclusive and binding. The contractor shall furnish all, but not limited to equipement, materials and accessories and service as required to fulfill the performance of proposed new plant.

1.3 Bidder must quote the price according to intent, besides content of the of the tender. Engineer's / Consultant's interpretation of the meaning of the specifications, drawings shall be final who shall have the right to accept or reject any material or work which in his assessment is not complete to meet the intent of this specification and/or applicable standards.

1.4 The equipment and accessories shall be complete in all respects and any device not included in this specification but essential for proper operation of the plant shall be deemed to be with in the scope of this specification whether specifically mentioned or not.

1.5 Some parts of the total work may have tie ups with the existing system. Hence any commercial or technical implications thereof must be duly taken care of even if not mentioned/considered in this tender.

1.6 It is the responsibility of bidder to visit and assess the site conditions for the purpose of this work.

1.7 Bidder shall also ensure to take care of existing works / piping / cabling, if any, during execution and ensure no damage is done and obstruction be resolved in consultation with engineer in-charge at no extra cost. In case of any damage, it is the responsibility of bidder to rectify the problem to the satisfaction of engineer in-charge at no extra cost.

1.8 The equipment / items shall be supplied only as per approved vendor list for major items enclosed herewith as part of this tender document. Bidder shall furnish necessary technical catalogue and details and obtain approval for the make of items he proposes to procure before placement of order. The decision of engineer in-charge in the matter is final and binding. Approval for makes of items not mentioned in the approved list of

vendors will also be required to be obtained from engineer in-charge before procuring the same.

1.9 Compliance with this specification and / or review of any of the vendor documents shall not relieve the vendor of his responsibility towards his contractual obligation with regard to the completeness and satisfactory operation of the plant.

2.0 SCOPE OF WORK

Design, Engineering, Supply, Installation, Testing and Commissioning of the entire electrical facilities including electrical equipment, control devices, fittings, cables/wires, conduits, hardware and consumable and also including all relevant works like termination, cable jointing, earth excavation/backfilling, structural works for equipment support / GI (hot dip galvanized) ladder type cable trays, all allied civil works, etc.

In outdoor areas cables shall be mostly laid directly buried underground with adequate mechanical protection wherever applicable. Where as in indoor areas, cables shall be laid in trenches / walls / ceilings / structures through suitable trays / cleats.

Installation of the contract work including furnishing labour (Skilled / Unskilled) and supervisory personnel inclusive of the services of an experienced engineer, having authorized and valid supervisory license is included in the scope of work / services.

All installation are to carried out as per the staturoy requirement of local Electrical Inspectorate / I.E. rules / applicable I.S. Code / code of practices and obtaining statutory clearance from Electrical Inspectorate shall be in the scope of executing contractor.

2.1 SCOPE OF SCHEDULE OF ITEMS

"Scope of Schedule of Items" as mentioned here in are suggestive but not conclusive and binding. The contractor shall furnish all, and not limited to below equipment, materials and accessories and service, as required to fulfill the performance of proposed new plant.

Sr. No.	Item Description	Qty.
1.	Upgrading / Strengthening the existing 11KV supply for the additional demand of proposed Plant including all required modification / addtion in existing 11KV switchyard & GOD structure and required liaisoning with power supply company for total demand (for proposed TTP & Smart City project under execution)	1 Lot
2.	11 KV, 350 MVA, 630A Outdoor HT RMU, SF6 Extensible type and Motorized 5 way smart Ring main unit (1 Isolator +4 VCBs) complete with FRTU & FPI with IP Protection. I no. Isolator as Incomer and 4 nos. Outgoing VCB feeder with transformer protection (2nos. for Transformer of proposed TTP; 2 nos. for 250KVA Transformers of Smart City project under execution). RMU shall be suitable for Local & Remote operation. Scope of work shall be include Providing RCC Foundation (600mm above FGL), Chain link fencing & gate. Scope also includes SITC of Outdoor IP 67 weather proof	1 Lot

	& of polycarbonate, 2 Nos. Emergency Stop / Trip Push Button Station to be installed near transformer to stop/trip HT power to Transformer	
3.	11/0.433 kV Dyn11, ONAN, Outdoor type Transformers (Tx) Energy Efficiency Level-2 as per IS:1180(Part-1):2014 with OCTC, Buchloz relay and other standard fittings, continuous duty, each of required rating to cater to the entire proposed treatment plant load @80% loading. Required foundations, fencing, gates, etc. shall also be provided. The transformer shall be sized considering load factor of 0.9 and diversity as 1.0. KVA rating to be specified by the bidder along with necessary load calculations for plant peak load considering 100% stand by unit.	2 Nos.
4.	LT/MV Panels (PCC / PMCC / MCC) PCC/PMCC to be housed in LT room/ MCC room, shall be with necessary Incomers (2 nos. Tx/Grid) with electrical & mechanical interlocks, etc. with starter feeders, various outgoing power feeders to feed MCC panels & other feeders & spare feeders as per detail specification & Typical SLD enclosed. Contractor shall consider to provide separate MCC for proposed Plant to be housed in LT room/ MCC Room ACB / VFD / Soft Starter cubicles shall be in single front execution only. The derated current of VFD/Soft Starter for 50°C continuous operating temperature shall be equal to or greater than 110% of the rated current of driven motor.	1 Lot
5.	Automatic P.F. improvement capacitor with integral control panel to maintain minimum p.f. as per specifications	1 Lot
6.	PDB / Outdoor MLDB / Indoor MLDB / LDB (MCB Type TPN, LDB, Typically 4/6/8 way per phase, upto 20A SP per way). All LDB's & Junction Box shall be of IP 67, Polycarbonate enclosure with transparent cover. Gland also shall be suitable for the same.	1 Lot
7.	Industrial Plug & socket with MCB shall be Insulated type & enclosure /box shall be IP 67, weather proof & of polycarbonate suitable for harsh environment. Gland also shall besuitable for the same. Scope also includes SITC of Outdoor 2 Nos. Emergency Stop / Trip Push Button Station to be installed near transformer to stop/trip HT power to Transformer	1 Lot
8.	LT Motors, Minimum IE3 series as per Tender specification.	1 Lot
9.	Field/Remore mounted start/stop push button control station (Polycarbonate Enclosure), IP-65 for motor loads. Scope also includes SITC of Outdoor Emergency Stop / Trip Push Button Station to be installed near transformer to stop/trip HT power to Transformer	1 Lot

10. Indoor and Outdoor illumination system to achieve lux level as mentioned else where in this electrical specifications / Welding Sockets with necessary cabling / wiring, MDBs/LDBs, poles, fixtures etc. — 1 Lot

11. HT & LT Power / Control Cables (multistrand, extruded innersheath, FRLS outersheath) — 1 Lot
    a) 11 KV XLPE (E), Aluminum conductor, armoured power cable for Proposed TTP plant.
    b) 11 KV XLPE (E) , Aluminum conductor, armoured power cable from RMU panel outgoing feeder to 2 nos. Existing Transformer of smart City project of length 150mtr/higher per transformer as per site requirement.
    c) 1.1 KV, XLPE / PVC insulated, Alu. Conductor(stranded), armoured extruded innersheath power cable of suitable size and cores
    c) 1.1 KV, PVC/XLPE Insulated, Copper conductor(stranded), armoured, Control Cable of 2.5 sqmm. Dia, suitable number cores for LCS, ammeter, etc., minimum 1 no. or 20% spare cores to be provided
    d) 1.1KV PVC/XLPE insulated, Cu, 4 Core armoured cable of required size (min 2.5 sqmm) for lighting cable — Lot
    e) Other cables as required — Lot

11. Complete Earthing System (Maintenance free, Pipe-in-Pipe technology, Chemical Type Maintenance Free Earthing / Earth Pits only) — Lot

12. Cable Glands, Sockets, Steel, other erection hardware and accessories etc. — Lot

13. Supply / Fabrication / Erection / Painting of M.S. structural steel as Required for supports / hangers / cleats etc. to complete the entire electrical work. — Lot

14. Cable trays ladder type/ perforated type with coupler plate, bends, Tees etc (shall be hot dep galvanized only). — Lot

15. Indoor/Outdoor lighting (LED) with all accessories — Lot
    All lighting poles shall be GI, Octagonal Type only.

16. DG Set of required rating to cater to 100% of of working load of entire Treatment Plant (ZLD) @ 80% loading along with AMF Panel to operate entire — Lot
    plant load on DG Set in case of power failure. In case of DG Set rating exceeding 1000kVA, DG Sets shall be min. 2 Nos i.e 2 x 50% capacity as a minimum or such mutliples along with AMF cum load sharing Synchronizing panel. Additional 10% contingency shall be considered over and above the load requirement.

Note : 1. It is not the intent to specify herein completely all details pertaining to design, shop testing, installation, field testing and commissioning. However, these shall conform in all respects to high standards of engineering design, workmanship, meeting the requirements of all applicable codes and standards including local statutory

requirements. The scope shall include all the specified accessories as well as other required accessories for satisfactory / safe operation of the system.

3.0 SPECIFICATION OF ELECTRICAL WORKS (GENERAL)

General

Following clauses specify General Electrical requirements and standard of workmanship for the equipment and installations. General specification clauses shall apply where appropriate except where particularly redefined in the Special Specification Clauses.

3.1 Equipment Selection

The general basic requirements for design and selection of equipment shall be:

Safety of Personnel and Equipment
Adequate operational reliability
Ease of Installation, Operations and Parts
Interchangeability of Equipment and parts
Robust and economical design

The offered equipment shall be brand new with state of the art technology and proven field track record. No prototype equipment shall be offered.

Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment atleast for 15 years from the date of supply.

Vendor shall give a notice of atleast one year to the end user / owner of equipment before phasing out the product / spares to enable the end user for replacement of order for spares and services.

3.2 CODES & STANDARDS

The electrical equipment and complete installation offered shall comply with the relevant Indian Standards / Codes of Practices, this specifications, Statutory regulations and sound engineering practices.

The complete system shall conform to the latest revisions of the following:

- The Indian Electricity Act & Rules
- The Indian Electricity (Supply) Act, 1948
- Regulations laid down by local statutory authorities and CEA / Electrical Inspectorate.
- The requirement of Gujarat State Electricity Board.
- Fire advisory Committee Insurance Act / Fire Insurance Regulations
- Indian Petroleum rules and any other regulations laid down by the Chief Controller of Explosives
- The factory act and any other regulations laid down by factory inspectorate

3.2.1 Obtaining approvals from statuory authorities for materials, plant design / drawings and complete installation **(if required)** shall be the responsibility of the contractor. The contractor shall get the drawings, layouts of HT sub station etc. approved from local

electric supply company and Chief Electrical Inspector, as applicable. The contractor also shall arrange to get the installation inspected by CEIG and carryout modifications / rectification as required by CEIG, prior to commissioning of sub station / electrical equipments.

3.2.2 Wherever Indian Standards do not exist, the relevant IEC, British or German (VDE) / IEEE / NEMA standards shall apply. Any other Standard which is considered equivalent to or superior than applicable Indian Standards may also be acceptable. The tenderer however, shall have to substantiate equivalence or superiority.

3.3 **Deleted**

3.4 **VOLTAGE REGULATION**

During starting of heavy equipment the voltage may drop by a maximum of 15% for period of up to 45-60 seconds depending upon the duty of the driving equipment. All the electrical equipment shall, therefore, be suitable for trouble free and uninterrupted operation even during such voltage variation at the time of starting of heavy equipments.

3.5 **SITE / AMBIENT CONDITIONS**

All electrical equipment and installation shall be designed for the tropical climatic conditions and be suitable continuous operation under the site conditions as described below for design purpose :

Maximum ambient temperature	:	50 deg. C
Minimum ambient temperature	:	5 deg. C
Design Ambient temperature	**:**	**50 deg. C (unless otherwise specified for specific components/equipment)**
Relative humidity	:	94%
Climate	:	Tropical, dusty, Corrosive

If not specifically mentioned, an altitude not exceeding 1000m above mean sea level shall be taken into consideration for design purpose.

Where the equipment is installed outside and exposed to direct sunrise, these shall be suitable for operation at higher ambient temperature and rigorous weather conditions under which they are required to operate.

3.6 **DESIGN BASIS**

The distribution system shall be designed in accordance with project specifications and shall ensure continuity / reliability of supply, flexibility of operation and safety.

All components of the Electrical System shall be sized to suit the maximum load under the most severe operating conditions. Accordingly, the maximum simultaneous consumption of power, required by continuously operating loads shall be considered and additional margin shall be taken into account for intermittent service loads, if any.

The basic design data to be considered as follows:

Incoming Supply Conditions	11kV(E) ±10%
Frequency	50 Hz ±3%
Voltage and Frequency Combined variation	±10%
Fault Level at 11 kV	500 MVA symmetrical (1 sec)or higher as per Statutory requirement
System Grounding	Solidly Earthed
Fault Level at 415V (Design)	50 kA Symmetrical (1 sec)/ higher based on KVA rating of Transformer
Control circuit voltage	230V AC via Constant Voltage Transformer for LT panels and 110V DC/ 220V DC ,100AH for HT Panel via Battery & Battery charger with DCDB with battery backup of min 2 hours
HV Cabling	3C XLPE, 11kV(E) , Extruded Inner sheath, FRLS outer sheath.
LV Cabling	Alu. Multi-strand Conductor XLPE / PVC insulated, Extruded Inner sheath FRLS outer sheath. cable excepting for Motor upto and including 3.7KW for which to use 3C x 2.5 sqmm, Cu conductor, XLPE / PVC insulated cables subject to voltage drop within specified limits. Cables having aluminium conductor shall not be less than 6 sq.m. Cable sizing/selection shall be based on Incomer ACB/MCCB rating of PCC/PMCC/MCC Panels.
Control / LCS Ammeter Cables	Multicore 2.5 sqmm Cu multi-strand conductor, XLPE / PVC
LDB to Lighting Points	Multicore 2.5 sqmm Cu Multi-strand conductor, ¾ Core, PVC
Earthing	Earth Pit: Cu Plate/ Pipe-in-. Pipe electrode(maintenance free) as per detailed specification/SLD &IS: 3043 / Specification
Induction Motor	Squirrel Cage Induction Motor, TEFC, IP-55, Continuous Duty (S1) rating, Class F insulation with temp. rise limited to Class B, Energy Efficient Design of IE3 as per IS:12615-2018 amended up to date. However, motors operating with VFD shall be of shall have vacuum impregnated, double insulation winding with Class H insulation & of inverter duty
LT Panel Design (PCC/PMCC/MCC)	Fuse less design shall be used as per CPWD Guideline / Specification.
Soft starter	DOL starting, Soft starter De-rated current for 50º C operating conditions ≥ min.110% of rated motor current, with in-built or external bypass contactor,

	with in-line contactor & semi-conductor (fast acting) fuse protection, required protection parameters, etc.
Variable Frequency Drive (VFD)	VFD De-rated current for 50º C operating conditions ≥ min.110%of rated motor current, with in-line contactor & semi-conductor (fast acting) fuse protection, required protection parameters, etc.
Starting current for various types of starter application	DOL Starter- 6 times the Full load rated current Star- Delta starter- 3.5 times Full load rated current Soft starter -3.5 times Full load rated current VFD starter-3 times Full load rated current
LOAD FACTOR:	Main motors/Process equipments/blower : 0.9 Auxiliary load (Valve actuators,Crane/hoist,etc :0.4 Ligtiting load : 1.0
DIVERSITY FACTOR	Main motors/Process equipments/blower : 1.0 Auxiliary load (Valve actuators,Crane/hoist,etc :1.1 Ligtiting load : 1.1

3.7 Power is tapped/taken from existing 11KV DP **of the Power Company/ of client** and shall be transmitted through cables and terminated at proposed 11 KV Outdoor 5Way RMU SF6 type panel (1 incomer and 4 nos outgoing) HT Breaker panel for the proposed Tertiary Treatment Plant (TTP) and existing/under execution smart city project. The scope shall also include all required liasoning work for obtaining the power for additional demand of TTP.

3.8 The 11 kV supply from VCB breaker shall feed power to two nos. proposed Outdoor transformers of suitable rating 11kV/ 433V rating for the proposed plant). Scope includes providing HT cable with termination from HT RMU panel to 2 nos. transformers of existing/under execution smart city project. The proposed transformers are connected by cables to the Main 415V LT Panel (PCC/PMCC) at Panel room building. This PCC/PMCC shall in turn feed down stream MCC, PDB, ADB and MLDB etc. for feeding various loads.

3.9 The motors shall be suitable for outdoor installation with tropical insulation and weather proof to IP-55 as a minimum. All motors shall be started and stopped by push buttons at Local Control Stations located near respective motors. Starters shall be housed in PMCCs / MCCs with START / STOP (Mushroom head stay put type with padlocking facility) / OVERLOAD Reset Push Button and Auto-Off-Manual, local-remote Selector switches. Motors of rating less than 7.5 kW rating shall be provided with Direct-On-Line starting provision, motors of rating 7.5kW and above but less than 75 kW shall be provided with fully automatic Star/Delta Starters and motors rated 75kW and above shall be provided with Soft Starters unless specifically mentioned to operate with alternative methods like VFD, etc. Typical SLD of panel is enclosed. Motors shall be energy efficient as per IE3 Class as a minimum.

3.10 In outdoor areas cables shall be mostly buried directly underground with mechanical protection wherever applicable. In indoor areas, cables shall be laid in trenches through medium duty GI cable trays. Cables shall be so selected that voltage drop at consumer end does not exceed 3%. Cables having aluminium conductor shall not be less than 6 sq.mm.

Cables shall be sized based on the Incomer rating for Panels & maximum continuous rated load current after suitable derating, min. 10% overload capacity after derating and the voltage drop. The derating due to ambient air temperature, ground temperature, grouping and proximity of cables with each other, resistance@70°C max permissible temperature rise for cables, etc. shall be taken into account. The de-rated cable current shall be atleast 10% higher over the rated load current. A derating factor of 0.65 shall be used as a minimum or higher as per site conditions. Vendor will have to submit the calculations for the same.

3.11 Sub-station / MCC Room: Sub-station or MCC room, wherever required shall be located in a safe area close to load centre. The building shall be sized to take care of present and future needs and to maintain adequate clearances between equipment for ease of maintenance. Clearance around equipment shall be maintained as per IE rules and equipment supplier's recommendations, which ever is higher. The minimum clearances shall be as follows:

a) Front clearance for all Sw. board panels	1500 mm
b) Rear clearance for panels requiring maintenance from rear	Minimum 1000mm from the outermost edge of panel to any wall / obstruction / projection of column
c) Side clearance between two switch-boards or from nearest obstruction	1000 mm (But not less than twice the width of each panel
d) Wall mounted equipment front clearance	1000 mm
e) Vertical clearance measured from	
- Bottom of roof slab	1500 mm
- Bottom of lowest roof beam	500 mm

Battery Banks shall be located in a separate adequately ventilated room along with necessary exhaust system and water connection with sink. Floor of battery room and walls upto 1.0m height shall have acid/alkali resistant protective material coating/tiling.

Adequate safety equipment such as insulating mats, exit signs, shock/fire hazard charts, Warning signs, first aid boxes, portable fire extinguishers, etc. shall be provided in sub-station / MCC room as per statutory regulations.

3.12 Earthing system design and installation shall be genrally as per IS:3043. Earthing system shall be carried out by GI strips, electrodes by GI pipes. All equipment shall have two separate and distinct earth points. Earth reistance shall not exceed one ohm at any point.

3.13 Suitable rating automatic power factor improvement panel with integral capacitor bank shall be designed / provided at each Main bus to improve and maintain a lagging power factor of 0.98 or better (Max. 1.0, leading p.f. not permissible). **Under no circumstance the power factor shall be less than 0.95 lag at HT side / power supply company meter.**

3.14 Adequate numbers of small and welding power outlets to be provided at appropriate places. Appropriate numbers of Welding receptacles shall be provided at suitable locations such that it ensures accessability with a 50m length of trailing cable at any

point within battery limits of the plant. The welding receptacles shall be industrial heavy duty type rated for 415V, 60Amp, 3-Phase system, complete with scraping earthing facilities, necessary interlocks and associated plugs. The receptacles shall be weatherproof type and additionally flameproof type for hazardous areas.

3.15 Lighting design shall conform to relevant international codes and standards, IES hand book and shall take into consideration the requirements from point of view of safety and ease in operation & maintenance. A maintenance factor of 0.8 shall be assumed for lighting illumination level calculations for normal areas. Co-efficient of utilization shall be calculated as per fixture type and areas. It shall be bidder's responsibility to demonstrate the illumination levels as specified in these specifications elsewhere using lux meter and rectify by providing additional lighting fixtures, if necessary, in case if illuniations levels are found to be below the specified levels. Dark patches and uneven illumination shall be avoided. Indoor & Outdoor lighting shall be carried out by LED Light fittings.

3.15 DRAWINGS / DOCUMENTS

Execution Drawings / Documents

Following detailed design drawings / documents to be prepared in line with recommended specifications / details and submitted to engineer in-charge in a timely manner to allow for review and approval as a minimum:

a) List of Drives / Loads with Qty. / Rating / Specifications along with power load statement
b) SLD and control diagram of complete electrical system
c) Wiring / Schematic Drawings for complete electrical system (HT Panels, LT Panels, Lighitng Panels, PDBs, etc.)
d) Overall Cable Layout & Unit Wise Cable Tray layout
e) Earthing Layout with Earthing Calculations
f) Internal Lighting Layout with Calculations
g) External Lighting Layout
h) Cable Schedule with voltage drop calculation / sizing calculations
i) Interconnection Schedule
j) G.A. Drawings for all equipment including sectional drawing wherever necessary, and specifying recommended installation, weight, clearnance requirements, etc.
k) Filled in Data Sheets
l) Schedule of quantities along with brief specifications
m) Design / sizing calculations for equipment as applicable
n) O&M manual for all equipment

As-Built Drawings / Documents

All above final documents and drawings incorporating modifications, if any, done during erection / commissioning shall be furnished in number of sets as specified in scope of work.

3.15 HT Supply

The Contractor shall visit site and ascertain the details of existing HT panel, protection scheme, existing transformer, site conditions before quoting. ble for site location

wherever HT supply is to be availed and procure equipment accordingly. It is the responsibility of the bidder to liaison and complete the formalities for upgradation of existing system, if required, with chief Electrical inspector on behalf of client..

3.16 Approval by Fire Insurance Authority

The equipment supplied along with the accessories shall be those approved for use in Electrical Installations by the Fire Sectional Committee, Central Regional Council of the Insurance Association of India.

3.17 Condition of Operation

The equipment offered shall be suitable for continuous operations under high ambient temperature of 50^0C, which shall also be considered as design temperature for selection/sizing of equipment, unless otherwise specified.

All electrical equipment installed in hazardous areas shall be selected as per IS:5571 and DGMS regulations, where applicable, and shall meet the requirements of relevant IS, IEC or NEC standards. Area classification drawing shall be prepared by the contractor indicating the zone of hazardous area and the gas group. A hazard source list shall be prepared by the contractor including the list of all flammable materials handled along with their properties like flash point, ignition temperature, explosive limits etc. Motors for digester mixing and within hazardous area shall be Weather Proof & Explosion proof suitable for the hazard class. Electrical equipment for hazardous areas shall have test certificates issued by recognized independent test house (CMRI / BASEEFA / UL / FM or equi.) and have valid statutory approvals as applicable for specified locations.

Motor for outdoor installation shall be weather proof.

The switch board shall not be exposed to moisture or corrosive gases.

The Contractor shall submit layout drawings, showing the location of switch board and other equipment proposed to be installed for the approval of Engineer.

3.19 Standards and Codes:

- Applicable standards govern the materials and workmanship in the manufacture of all equipments / items of Electrical Equipments:

Codes	Description
IS: 731, BS:137, IEC:383	Pin & Disc Insulator
IS: 2544, IS:5350, BS:3297, IEC:168	Porcelain post insulators for systems with nominal voltage greater than 1000V
IS 5621	Hollow insulators for use in electrical equipment
IS: 398 (Part-	ACSR conductor

I&II) 1996	
IS : 9920 : Part 1 to 4 : 2002	Specification for High Voltage Switches for rated voltage above 1 kV and less than 52 kV (First Revision)
IS 9921	Alternating current disconnectors (isolators) and earthing switches for voltages above 1000 V
IS : 9385-1983	Governing spec. for GOAB switch
IS 3070	Lighting arresters for alternating current systems
IS 15086	Surge arresters
IS 8828	Electrical Accessories -Circuit Breakers for Over Current Protection for Household and Similar Installations
IEC 60529	Enclosure degree of protection IP-5X
IS 3231	Electrical relays for power system protection
IS-4047, IEC-408	Air Break Switches
IS-2208, IEC-259-1	Fuses
IS1248	Direct acting indicating analogue electrical measuring instruments and their accessories
IS 2419	Dimensions for panel mounted indicating and recording electrical instruments
IS 2705	Current transformers
IS 3156	Voltage transformers
IS 2026 , IEC 60076	Power transformers
IS 11171	Specification for Dry-Type Power Transformers.
IS 335	New insulating oils
IS1180 (Part-1) 2014	Outdoor Type Oil Immersed Distribution Transformers Up to and including 2500kVA, 33kV Specification
IS 8468	On-load tap changers
IS 2099	Bushings for alternating voltages above 1000 Volts
IS 6600	Guide for loading of oil immersed transformers
IS-4237	Switchgear General Requirements
IEC 60947	Low-voltage switchgear and control gear
IS-375	Panel Wiring
IS 3427	A.C. Metal Enclosed Switchgear and Control gear for Rated Voltages Above 1 kV and Up to and Including 52 kV
IS – 2516	Moulded Case Circuit Breakers
IS 3842	Application guide for electrical relays for ac systems
IS 13925	Shunt capacitors for ac power systems having a rated voltage above 1000 V
IEC 60831(1&2)	Shunt capacitor of the self- healing type for AC systems having rated voltage up-to and including 1000V
IEC 61921	Power capacitors -Low-voltage power factor correction banks

IS 16636	Automatic Power Factor Correction (APFC Panels for voltage Rating up-to and including 1000V
IS-2959, IEC-158-1	Contactors
IS-1822, IEC-292	Starters
EN 50081-1,50082-2 & 60204-1	Microprocessor Soft Starter
IEC 61800 and/or IEEE 519-1992	Harmonics Control & Reactive Compensation Of Static Power Converters
IEC 721-3-3, class 3C1	Max. Corrosion Level of the Cooling Air
IEC 721-3-3 Class 3C2	Max. Corrosion Level of the Chemical Gases
UL 508C	Solid state thermal protection of AC Drive
IS 722	Specification for AC Electricity Meters
IS 12615: 2018	Energy efficient induction motors-three phase squirrel cage.
IS 15999 (part 1)	Rotating electrical machines: part 1 Rating and performance
IS 15999 (part 2)	Rotating electrical machines: part 2 Method of tests, standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles)
IS 12065	Permissible limits of noise level for rotating electrical machines
IS 2253	Designation types of construction and mounting arrangement of rotating electrical machines
IS 8789	Values of performance characteristics for three phase induction motors
IS 9283	Motors for submersible pump sets
IS 9334	Electric motor operated actuators.
IS 8130	Conductors for insulated electric cables and flexible cords
IEC : 228	Conductors of Insulated Cables.
IEC : 230	Impulse tests on cables and their accessories
IEC : 502	Extruded solid dielectric-insulated power cables for rated voltage from 1 kV up to 30 kV.
IEC : 540	Test methods for insulations and sheaths of electric cables and chords
IEC : 229	Test on cable over sheaths which have special protective functions and are applied by extrusion.
IEC : 287	Calculations of continuous current rating of cables (100% load factor).
IEC 60751	Industrial platinum resistance thermometers and platinum temperature sensors
IEC 61537	Cable management -Cable tray systems and cable ladder systems
IS 1554 part1	PVC insulated (heavy duty) LT electric cables up to 1.1 KV
IS: 7098 Part I	XLPE Insulated LT Electric cables (heavy duty) up to 1.1 KV

IS : 7098 (Part II)	XLPE insulated PVC sheathed cable for voltage from 3.3 kV up to 33 kV.
IS : 5831-1984	PVC insulation & sheath of electrical cables.
IS 694	PVC Insulated cables for working voltage up to and including 1100 V.
IS 1255	Code of practice for installation and maintenance of power cables up to and including 33kV rating
IS : 3975	Mild steel wires, formed wires and tapes for armouring of cables
IEC : 885(2) – 1987 (Part-II)	Electrical test methods for electric cables partial discharge test.
IS : 10810	Methods of test for cables.
IEC : 811	Common test methods for insulating and sheathing materials of electric cables.
IEC : 230	Impulse test on cables & other accessories.
IEC : 859	Cable termination for gas insulated switchgear.
IS: 3961	Recommended current ratings for cables.
IS 3043	Code of practice for earthing
IS 2629	Recommended Practice for Hot-Dip Galvanizing of Iron and Steel
IS 2633	Methods for testing uniformity of coating of zinc coated articles
IS 1897	Copper strip for electrical purposes – Specification
IS 2309	Code of practice for protection of buildings and allied structures against lightning
IS 732	Code of practice for electrical wiring installations
IS : 1646	Code of practice for fire safety of buildings (General) Electrical installation.
IS : 2509	Rigid non-metallic conduits for electrical wiring.
IS : 6946	Flexible (Pliable) non-metallic conduits for electrical installation.
IS 9537	Conduits for electrical installations
IS : 3854	Switches for domestic purpose.
IS : 3415	Fittings for rigid non-metallic conduits.
IS 3837	Accessories for rigid steel conduits for electrical wiring
IS 14927	Cable trunking and ducting systems for electrical installation
IS : 4648	Guide for electrical layout in residential building Indian electricity act and rules.
IS : 1293	3 pin plugs and sockets.
IS 4795	Holders for Indicator Lamps for Electronic and Telecommunication Equipment
IS 3646	Code of practice for interior illumination
IS 1913	1969 General and Safety requirements for Electric lighting fittings
IS:1239, IS:2713	GI Lighting Poles
IS 1944	Code of practice for lighting of public thoroughfare

IS 374	Electric ceiling type fans and regulators
IS 1293	Plugs and socket-outlets of rated voltage up to and including 250 volts and rated current up to 16 amperes – Specification
IS 6665	Code of practice for industrial lighting
IS 8224	Electric lighting fittings for division 2 areas
IS 9583	Emergency lighting units
IS 9974	High pressure sodium vapour lamps
IEC 62305	Protection against lightning -Part 4: Electrical and electronic systems within structures
IS 1271	Thermal evaluation and classification of electrical insulation
IS 1544	Cotton calico
IS 1868	Anodic Coatings on Alluminium and its Alloys – Specification
IS 2190	Selection, Installation and Maintenance of First-aid Fire Extinguishers —code of practice
IS 2546	Specification for galvanized mild steel fire bucket
IS 5572	Classification of hazardous areas (other than mines) having flammable gases and vapours for electrical installation
IS 9677	Guide for limits of temperature-rise of the windings of electrical equipment when tested by different methods
IS 9678	Methods of measuring temperature rise of electrical equipment
IS 10118	Code of practice for selection, installation and maintenance of switchgear and control gear
IS 15652	Insulating mats for electrical purposes – Specification.
IS 5424	Rubber mat
IS 4770	Rubber Gloves -Electrical Purposes – Specification
IS 2551	Danger notice plates
ISO 3046	Diesel Engine
BS : 2613 / IS : 4722	Alternator
IS- 16101	General lighting LED and LED modules
IS-16102 (Part-1)	Self ballasted LED lamps for general lighting service-Safety Requirement
IS-16102 (Part-2)	Self ballasted LED lamps for general lighting service-Performance Requirement
16103(Part 1)	LED modules for General lighting-Safety Requirement
16103 (Part 2)	LED modules for General lighting-Performance Requirement
16107 (Part-10	Luminaries Performance-General Requirement
16108	Photo biological safety of lamps and lamp systems

- Use the latest issue of Standards.
- It is essential that the electrical power distribution system will comply in all respects with the relevant statutory and regulatory instruments of state of Gujarat / as applicable state and that of India.
- The relevant, state and national, statutory and regulatory instruments for electrical installations are, The Indian Electricity Rules 1956, The Electricity Act 2003, Gujarat State Electricity Act 2003, ECBC (Energy conservation & building code), Gujarat fire prevention & life safety measurement act 2013.

Safety & Security

- The design should include all reasonable precautions and provisions for the safety of operating and maintenance personnel.
- Electrical works design life shall be 15 years.

4.0 EQUIPMENT / TECHNICAL SPECIFICATIONS

All equipment shall be new and supplied by approved reputed manufacturer only. All equipment shall be complete with all necessary weather and anticorrosion protection including tropicalization to prevent damage due to climate, harsh atmosphere, dust and corrosive vapours.

Certain minimum requirement for the major equipments shall be as follows:

4.1 11KV SWITCHYARD : H-FRAME / TWO POLE STEEL STRUCTURE

Two pole structures shall be erected in switchyard to receive 11 kV power supply from power supply authority with following minimum equipment:

a) 11 kV M.S. pole structure with ISMB, ISMC, hardware, etc. grouting of M.S.Pole structured RCC foundation work.
b) Vertical 150mm dia. G.I. pipe for cable support.
c) Chain links fencing shall be as specified in this tender elsewhere.
d) Factor of safety: The Supports shall be suitable for the wind loads as per relevant IS. The minimum factor of safety for supports shall be as per CEA (Measures relating to Safety and Electricity Supply), Regulations as and when these are notified by the authority.

Generally the HT pole structure shall be as per enclosed typical Drg.

Following Equipment / Accessories shall be required for each 11kV Two Pole Structure as minimum and other as per drawing / statutory requirement at site shall be provided.

Sr.No.	Particulars	Qty.
1	11 kV Porcelain glazed Disc Insulator with hardware/ Polymer insulators suitable for expected environmental and pollution condition. For critical locations with high pollution level, anti-fog type insulators or polymer insulators shall be used.	3 Nos.
2	11kV, 10kA Single pole Gapless Lightning Arrestor (LA) with all required fitting accessories / hardware. LA shall be with Surge counter/Monitor.	3 Nos.
3	11 kV,9 kV LA clamp with nut -bolt	3 Set
4	11 kV, 10 kV LA jumper wire	3 Nos.
5	11kV, 400A, 3-Pole Gang Operated Air Break (GOAB) Heavy duty switch with gang operated mechanism & earth switch and all required fitting accessories/hardware. Insulators as per expected environmental and pollution condition	3 Nos.
6	11kV, D.O. Fuse assemblies with 400A fuse element with fuse barrel, fiber barrel insulated operating rod and all required fitting accessories / hardware.	3 Nos.
7	11kV, 10kA Insulator for 11 kV GOAB switch, DO fuse, etc. Porcelain glazed Disc Insulator with hardware/ Polymer composite insulators suitable for expected environmental and pollution condition. For critical locations with high pollution level, anti-fog type insulators or polymer insulators shall be used.	15 Nos.
8	Fiber operating insulated rod with mechanism & handle suitable for 11 kV GOAB switch	1 Set
9	ACSR Mink/Dog/Panther Conductor with required clamps, connectors, hardware etc.	30 Mtr. or as reqd.
10	25mm X 6mm thick copper / 50mm X 6mm thick G.I earth strips in two parallel runs in required quantity i.e. from LA to earthing chamber	as reqd.
11	Required foundation etc. and to be painted with two coat of red oxide and final two coat of Alluminium paint at site as per IS, Specification and Drg.	Lot

- All members shall be fabricated to suit the mounting / fixing of GOD, L.A, DOF, Disc / Pin / Post insulators, cable end termination kit / box etc. All members, nut & bolts, washer etc. used shall be **hot dip galvanized.**
- All Metallic supports shall be permanently and effectively Earthed.
- Earthing terminal shall be provided by welding 12mm size bolt / cleat of 50x6mm size M.S flat shall be fixed to each joist with a hole of 15mm dia. Fixing or joining of members shall be done by nut and bolt. Suitable M.S. flat supports and cleats shall be fixed to ISMB poles for supporting / fixing the earthing protection strip in the manner approved by the Client.
- Vitreous enamelled caution boards or any other statutory requirements shall be provided in accordance with CEA (Measures relating to Safety and Electricity Supply.
- Protective guard shall be used where an overhead line crosses or is in proximity to any telecommunication line of any other overhead line and in populated localities. Every guard wire shall be connected to earth wherever its electrical continuity is broken.
- DP structure / switchgear shall meet all statutory equipment laid down in I.E ACT/ CEA regulations.

STRUCTURE

- A pole structure shall be of rolled steel of minimum ISMB 150mm X 75mm size and min. 9meters in length with 400mm X 400mm X 6mm thick base plate welded at bottom end of the poles of structure.
- Mild steel cross members of minimum ISMC 100mm X 50mm size channels of required length & Nos. shall be provided with cross bracing angles ISA of 50mm X 50mm X 6mm size of required length & clamps, cleats etc. shall be fabricated from minimum 50mm X 6mm size MS flats as per actual requirements. All cross members, clamps shall be Hot DIP galvanised after fabrication. All bolts, nuts, washers, etc. shall be of minimum 15 mm dia.
- Welding at site should be avoided as far as possible, in case welding becomes necessary, the joint shall be covered with cold galvanizing paint.
- All MS part shall be painted with one coat of red oxide and two coat of aluminium paint. All MS part shall be HOT dip galvanized as per IS 2629.

11 KV GOAB SWITCH

- The GOAB switch shall be triple pole construction and shall be suitable for vertical / horizontal mounting. Each pole consist of galvanized steel base, insulators , copper alloy male and female contacts, arcing horns of adequate section to break magnetizing current of transformer, M.S. square coupling rod of adequate length for rocking operation, required length G.I. pipe for operation from ground level and operating handle, for smooth operation. Jumper is of EC grade braided copper of appropriate size to complete the current path from moving post to fix post.
- Disconnector and earthing switches, including their operating mechanism shall be designed such that they cannot come out of their open and closed positions by gravity, wind pressure, vibrations, reasonable shocks or accidental touching of the connecting rods of their operating mechanism.
- Isolators shall be provided with provision of locking in open and closed positions. The switch shall be single throw-single break or single throw-double break.
- The insulators shall be post type, high quality brown porcelain, highly glazed/ Polymer insulator and shall be of appropriate voltage rating, suitable for atmospheric conditions specified. For Grading rings may be provided to obtain uniform voltage stress distribution, where required.
- All poles of the switch shall be gang operated by a common operating mechanism such that all the poles close or open simultaneously. The mechanism shall be positive type. The operating mechanism shall be provided with two earthing terminals. Operating handle shall also be provided with an “equalizing braid” earth connection to prevent unequal potential between structure and rod during faults.

11 kV DROP OUT FUSE

- The D.O. Fuse assembly set has single pole construction suitable for 11 kV supply and shall be suitable for vertical mounting. Each pole consist of galvanized steel base, insulators, copper alloy DO Top & Bottom contacts and fuse carrier top & bottom contacts, epoxy extruded fiber fuse carrier. The assembly shall be mounted on pole structure complete with fuse elements of required ampere rating. The fuse link shall consist of iron channel base, stack insulator per phase, fuse carrier Bakelite tube, non-ferrous metal parts and spring loaded phosphor-bronze contacts. The insulator shall comply with impulse voltage test in accordance with relevant IS.

TECHNICAL REQUIREMENT FOR GOAB SWITCH & D.O.FUSE SET.

Rated voltage	12 kV
Rated current for D.O. Fuse set	250/400 Amp
Rated current for GOAB switch	400 Amp
Impulse withstand voltage to earth	60 kV
Impulse withstand voltage across the terminals	75 kV
Power frequency withstand voltage to earth	28 kV
Power frequency withstand voltage across the terminals	32 kV
Rated short time current for 1 sec.	10 kA

LIGHTNING ARRESTOR FOR 11 kV RATING

- Lightning arrestor shall be furnished complete with insulating base, anchoring hardware for mounting on steel structure. The arrestors shall be metal oxide gapless type comprising of a stack of zinc oxide valve elements as per IS 3070.
- The arrestors shall be single phase, single pole suitable for outdoor installation under atmospheric conditions as specified elsewhere.
- The arrestor shall have adequate thermal discharge capacity for severe switching surges, long duration surges and multiple strokes. Insulators shall be wet process porcelain, brown glazed and free from imperfection. All metal parts and hardware shall be hot dip galvanized.
- Independent Copper Earthing shall be provided for LA.

TECHNICAL REQUIREMENT FOR LIGHTNING ARRESTOR

Rated voltage	9 kV
Rated current	400 Amp
Creepage distance	Total :300 mm, Protected :140 mm
Type of lightning arrestor	Station class
(1) 1 Minute power frequency withstand Test Voltage (2) Impulse withstand Test Voltage	28 kV 75 kV
Minimum prospective for 0.2 sec. symmetrical fault current	21.86 kA
(1) Top Connection arrangement (2) Bottom Connection arrangement	ACSR Conductor Hot dip galvanized G.I. Strip / Galvanized stranded steel wire.
Nominal discharge current	10 kA

CONDUCTOR

- Aluminium conductor steel reinforced (ACSR) or equivalent All aluminium alloy conductors (AAAC), all aluminium conductor (AAC) as per site environmental and pollution condition shall be used. ACSR shall be hard drawn from 99.5% pure electrolytic aluminium rods with 60 % IACS conductivity. The vendor shall specify the conductivity. The aluminium shall have resistively of 0.028264Ωmm²/m at 20 degree centigrade temperature. Thermal conductivity shall be 0.563 calories/cm/ degree centigrade and density shall be 2.703 gram/cm³ shall be as per typical drawing and as per IS 398.
- The size of conductor shall depend upon the voltage regulation, factor of safety, power to be transmitted, length of line, line voltage and mechanical strength desired.
- Suitable insulating paint shall be provided on bare conductors in coastal areas to prevent corrosion.

STAY ARRANGEMENTS:

- To prevent tilting of a pole from its normal position due to abnormal wind pressure and deviation of alignment, the pole shall be kept in position by stays. The stays shall be provided at :
- Angle locations:
- dead end locations;
- tee off points:
- steep gradient location
- cut- point
- along the straight run at minimum two locations in 1 km.
- Galvanized iron stay wires and stay rods of adequate size shall be used. The individual wire used to form "stranded stay-wire" shall have a minimum tensile strength complying with relevant IS. For double pole structure, for stays along the line, two in each direction and two stays along the bisection of the angle of deviation or as required depending on the angle of deviation shall be provided.
- When two or more stays are provided on the same pole, each stay shall be grouted entirely separate from the other.
- The angle between the pole and stay wire shall be about 45º and in no case it shall be less the 30º.
- Stays shall be anchored either by providing base plates, angle iron or rail.
- Stay wires shall be connected to the pole with a Porcelain Guy Strain Insulator. The standard Guy Strain insulators shall be as per relevant IS. The Porcelain insulator shall be inserted in the stay wire at a height of minimum 3 m vertically above the ground level. The strain insulators shall be free from defects, thoroughly vitrified and smoothly glazed.
- Wooden insulators shall not be used for stay/guy wire.

4.2 (A) TECHNICAL SPECIFICATION OF 11KV SF6 / VCB METAL ENCLOSED, OUTDOOR RING MAIN UNIT (RMU). (IEC standard equipment)

SCOPE OF SUPPLY

This specification covers design, manufacture, shop testing, inspection, packing, delivery to site, erection, testing and commissioning of 11 **KV** Metal Enclosed, panel type, extensible Outdoor **SF6 RING MAIN UNIT (RMU)** fully type tested according to IEC 60298 standards.

This RMU should be complete with all components necessary for its effective and trouble free operation along with associated equipment etc. such components should be deemed to be within the scope of supplier's supply.

The design of the switchgear should be exclusive and specific responsibility of supplier and should be comply with current good engineering practice, the relevant codes and recommendation, the project specific requirements.

The RMU should be fixed type SF-6, insulated circuit breakers, with O/C & E/F relay for the protection of the transformer. It should be maintenance free equipment, having stainless steel robotically welded enclosure.

RMU shall be installed on RCC foundation and foundation height above FGL shall be minimum 600mm. Chain link fencing, Gate to be provided to restrict un-authorized entry.

STANDARDS AND REFERENCE DOCUMENTS

Codes and Standards

The **RING MAIN UNIT (RMU)** should be designed, manufactured and tested according to the latest version of:

IEC 60694 Common specifications for high-voltage switchgear and control gear standards.
IEC 60298: A.C metal-enclosed switchgear and control gear for rated voltages above 1KV and up to and including 72KV and the IEC Codes herein referred.
IEC 60129: Alternating current Disconnector (isolators) and earthing switches
IEC 60529: Classification of degrees of protection provided by enclosures
IEC 60265: High-voltage switches-Part 1: Switches for rated voltages above 1kV and less than 52 kV
IEC 60056: Circuit breakers
IEC 60420: High-voltage alternating current switch-fuse combinations
IEC 60185: Current transformers
IEC 60186: Voltage transformers
IEC 60255: Electrical relays

- Any other codes recognized in the country of origin of equipment might be considered provided that they fully comply with **IEC standards**.

The design of the switchgear should be based on safety to personnel and equipment during operation and maintenance, reliability of service, ease of maintenance, mechanical protection of equipment, interchangeability of equipment and ready addition of future loads.

Technical specification for 11KV SF6 / VCB OUTDOOR, MOTORISED, EXTENSIBLE, Ring Main Unit (RMU) comprising of 1 Nos. 630A Load break Switches as Incomer & 4Nos. 200 A SF6 / VCB Circuit Breaker with Numerical O/C & E/F Relays, Auxiliary relay for transformer protection, Master Trip relay etc. suitable for LOCAL/ REMOTE operation through SCADA

(A) Load break switch (630A) : Incomer- 1 No.

Load break switch should have the following as minimum.

- Manually & Motor operated **12 KV**, 630A Load Break switch and Earthing Switch
- "Live Cable" LED Indicators thru Capacitor Voltage Dividers mounted on the bushings.
- Mechanical ON/OFF/EARTH Indication

- Anti-reflex operating handle
- Cable Testing facility without disconnecting the cable terminations, cable joints and terminal protectors on the bushings.
- Cable boxes suitable for 1 X 3C x 300 sq mm XLPE Cable with right angle Cable Termination Protectors.

(B) Vacuum Circuit Breaker. (200A / 630A): Outgoing: 4 nos.

Circuit Breaker should have the following:

- Motorised & Manual operated 200 A / 630A SF6 / Vacuum circuit breaker and Earthing Switch
- Mechanical tripped on fault indicator
- Auxiliary contacts 1NO and 1NC
- Anti-reflex operating handle
- "Live Cable" LED Indicators thru Capacitor Voltage Dividers mounted on the bushings.
- Numerical O/C + E/F & Transformer Protection relay (self powered relay) with RS 485
- Shunt Trip circuit for external trip signal
- Emergency Trip PB
- Mechanical ON/OFF/EARTH Indication
- Cable boxes suitable for 1 X 3C x 300 sq mm XLPE Cable with right angle Cable Termination / protectors / boots

OUT DOOR RMU

- Hermetically sealed metallic Epoxy / Stainless steel enclosure for OUT DOOR RMU application. The manufacturers shall conform the normal current ratings mentioned in GTP at 45 deg. Ambient without derating.
- Enclosure with I.P.54 standard protection.
- Offered RMU must be extensible.
- Cable boxes shall be on Front / side/rear sides.
- 5 way type, with One nos. of 630 Amp isolator as incomer and 4 nos. 200 Amp circuit breaker as outgoing.

DIELECTRIC MEDIUM

SF6 / VCB GAS shall be used for the dielectric medium for 11KV RMUs in accordance with IEC376. It is preferable to fit an absorption material in the tank to absorb the moisture from the SF6 / VCB gas and to regenerate the SF6 / VCB gas following arc interruption. The SF6 / VCB insulating medium shall be constantly monitored via temperature compensating gas pressure indicator offering a simple go, no-go indication.

GENERAL TECHNICAL REQUIREMENTS

- Fixed type SF-6 gas insulated / Vacuum circuit breakers. It should be maintenance free,

having hermatically sealed metallised Epoxy Enclosure / Stainless steel enclosure for OUT DOOR RMU application.

- Live cable indicators- High operator safety.
- Fully Rated integral earthing switch on each device.
- Self Powered Microprocessor Based relay with RS 485- Does not require any external source of power.
- Units fully SCADA Compatible. Retrofitting at site possible at a later date. Line switches (Load break switches) as well as circuit Breaker can be operated by Local/remote
- For outdoor RMUs cable boxes shall be on sides/rear/front.
- Cable testing possible without disconnection of cables.
- Compact in dimension.
- Circuit Breaker with self powered O/C & E/F RELAY. Transformer protection relay for transformer feeders. Relays shall be with RS 485 for SCADA integration.
- Low pressure, sealed for life equipment, can operate at "0" bar pressure.
- Cable ear thing switch on all switching device-standard, for operator safety.
- Enclosure with IP 54 standard protection for OUTDOOR RMUs

TECHNICAL AND GUARANTEED PARTICULARS.

The bidders shall furnish all guaranteed technical particulars as called for in Schedule "A" of this specification. Particulars which are subject to guarantee shall be clearly marked. Bids lacking information in G.T.P. are liable to be rejected.

DESIGN
CRITERIA

Service conditions

The offered switchgear and control gear should be suitable for continuous operation under the basic service conditions indicated below. Installation should be in normal indoor conditions in accordance with IEC 60694.

Ambient temperature -1 ^{O}C to
+45 ^{O}C
Relative humidity up to 45%
Altitude of installation up to 1000m, IEC 60120

General structural and mechanical construction

The offered RMU should be of the fully arc proof metal enclosed, free standing, floor mounting, flush fronted type, consisting of modules assembled into one or more units. Each unit is made of a cubicle sealed-for life with SF6 / VCB and contains all high voltage components sealed off from the environment.

The units should be constructed from 3 mm thick stainless steel sheets. The design of the units should be such that no permanent or harmful distortion occurs either when being lifted by eyebolts or when moved into position by rollers.

For outdoor RMUs a weather proofing process shall be carried out. SHEET METAL MUST BE GRIT BLASED / THERMALLY SPRAYED AND POLYURETHANE PAINTED WITH ABOUT 70 MICRON THICKNESS, TO ACHIVE OUTDOOR WORTHINESS AND CORROSION PROOF NESS .

The cubicle should be have a pressure relief device. In the rare case of an internal arc, the high pressure caused by the arc will release it, and the hot gases is allowed to be exhausted out at the bottom / top / rear of the cubicle. A controlled direction of flow of the hot gas should be achieved.
The switchgear should have the minimum degree of protection (in accordance with IEC 60529)

- IP 67 for the tank with high voltage components
- IP 2X for the front covers of the mechanism
- IP 3X for the cable connection covers
- IP 54 for the outdoor enclosure.

No.	**General data, enclosure and dimensions (**TECHNICAL DATA)		
1	Standard to which Switchgear complies		IEC
2	Type of Ring Main Unit		Metal Enclosed, Extensible type, Compact Module.
3	Number of phases		3
4	Whether RMU is type tested		Yes
5	Whether facility is provided with pressure relief		Yes
6	Insulating gas		SF6
7	Nominal operating gas pressure		1.4 bar abs. 20° C
8	Gas leakage rate / annum	%	0,075
9	Expected operating lifetime		30 years
10	Whether facilities are provided for gas monitoring		Yes, temperature compensated manometer can be delivered
11	Material used in tank construction		Stainless steel sheet, 3 mm / metallised cast resin
No	**Operations, degree of protection and colours**		
1	Means of switch operation		Motorised &separate separate handle, Suitable for Loacal/ Remote operation
2	Means circuit breaker operation		Motorised &separate separate handle, push buttons, Suitable for Loacal/ Remote operation

3	Rated operating sequence of Circuit Breaker		O –3min-CO-3min- CO
4	Total opening time of Circuit Breaker		approx. 45ms
5	Closing time of Circuit Breaker		approx. 40ms
6	Mechanical operations of switch	CO	1000
7	Mechanical operations of CO earthing switch		1000
8	Mechanical operations of circuit breaker	CO	2000
9	Principle switch / earth switch		3position combined switch / earth switch
	Degree of protection:		
10	High Voltage live parts, SF6 / VCB tank		IP 67
11	Front cover mechanism		IP 2X
12	Cable covers		IP 3X
13	Outdoor Enclosure		IP 54
	Colours:		
14	Front cover		
15	Side and cable cover		

PANEL (MODULE) DESCRIPTION

Incoming cable module

It should be consist of an SF6 cubicle housing a switch dis-connector and an ear thing switch. Bus bars and all electrical connections are located inside the tank. The operating shafts for the switches should be have rotary seals where they enter the SF6 cubicle. The operating mechanisms should be located outside on the front of the SF6 tank. Cable bushings should be located on the front of the SF6 cubicle in a separate cable compartment. Front covers containing the mimic diagram and having a degree of protection IP2XC close the fronts.

The circuit breaker module (200 A)
The circuit breaker module should consist of an SF6 cubicle housing a circuit breaker unit and a dis-connector- earthing switch. An integrated relay and related CTs is used for tripping of the circuit breaker. Bus bars and all electrical connections should be located inside the tank. The operating shafts for the switches should be have rotary seals where they enter the SF6 cubicle. The operating mechanisms are located outside on the front of the SF6 B tank. Cable bushings should be located on the front of the SF6 cubicle in a separate cable compartment. Front covers containing the mimic diagram having a degree of protection IP2XC seal off the fronts.

CIRCUIT REAKERS

SF-6 / Vacuum bottles should be used as interrupters of the currents. The circuit breaker main circuit should be connected in series with a three-position dis-connector–earthing switch. The operation between circuit breaker and dis-connector earthing must be interlocked.

1. SF6 / VCB BREAKER must Self -TRIPPING AND HAS A SELF POWERED RELAY

Switch on to fault condition relay does not specify operation of O/C or Fault, so it should be visible indication.

2. THE RMU MUST BE EXTENSIBLE TYPE

OTHER MAIN FEATURES

Bus bars:
Comprising the 3 single phases copper bus bars and the connections to the switch or circuit breaker. The bus bar should be integrated in the cubicle Bus bars should be rated to withstand all dynamic and thermal stresses for the full length of the switchgear.

The cable switch
It should be a switch-dis-connector and ear thing switch using SF6 / VCB gas as an arc-quenching medium. The switch positions are closed – open – earthed. In the open position the switch satisfies the dis-connector requirements.

Earthing Switch
Ear thing switches should be rated equal to the switchgear rating.
Ear thing switches should be quick make type capable of making Rated Fault Current.
Ear thing switch should be operated from the front of the cubicle by means of a removable handle.

The mechanisms (Motorised as-well as Manual)
All mechanisms should be situated in the mechanism compartment behind the front covers outside the SF6 / VCB-tank.

The mechanism for the switch and the earthing switch is operating both switches via one common shaft. The mechanism provide independent manual operation for closing and opening of the switch, independent closing of the earthing switch and dependent opening of the earthing switch.

The mechanism for the vacuum circuit breaker (VCB) and dis-connector- earthing switch is operating the VCB and the dis-connector earthing switch via two separate shafts. The mechanism for the VCB has stored spring energy and provides independent Motorised & manual operation for closing and opening of the VCB. The mechanism has a relay with related CT's and/or remote tripping device. The mechanism for the dis-connector earthing switch provide independent manual operation for closing and opening of the disconnector, independent closing of the earthing switch and dependent opening of the earthing switch.

Front covers
The front cover contains the mimic diagram of the main circuit with the position indicators for the switching devices. The voltage indicators are situated on the front panels. Access to the cable bushings is in the lower part of each module.

Position indicators
The position indicators are visible through the front cover and are directly linked to the operating shaft of the switching devices.

Voltage indicator
The voltage indicators are situated on the front cover, one for each module, and indicate the voltage condition of each incoming cable. Identification of the phases is achieved with labels L1, L2 and L3 on the front of the voltage indicators. The voltage indicator satisfies the requirements of IEC61243.

Cable compartment
It should be possible to terminate up to a maximum of two single core HV cables per phase. The access to the compartment will be possible by removing the cable cover, bolted to the main frame.

Removable steel covers close the cable compartments. Arc proof cable covers should be available as option. Each module has a separate cable compartment that is segregated from each other by means of a partition wall. A partition wall should be fitted to divide the cable compartment from the rear side of the switchgear. In case of an arc inside the tank, followed by the opening of the pressure relief, the partition wall prevents the hot gases flowing out from the pressure relief to enter the cable compartments. All covers are removable. The ground continuity is achieved when the covers are in place by means of bolted connections.

Power connection.
The cables are installed in the dedicated compartment below the mimic front cover. At the bottom of the cable compartment, an earthing bar system made of copper with a minimum cross section of 120 mm2 should be fitted. In each compartment the earthing bar should be fitted with 4 screws M10. The earthing system is connected to the tank by a copper bar, which rises up to the connecting point of the tank behind the rear partition wall on the middle of the switchgear.

INTERLOCKING
The mechanism for the cable switch should be provide a built in interlocking system to prevent operation of the switch when the earthing switch is closed, and to prevent operation of the earthing switch when the switch is in the closed position.
The mechanism for the VCB and the dis-connector-earthing switch should be have a built in interlocking system to prevent operation of the dis-connector-earthing switch when the VCB is in the closed position.

Current Transformers
All current transformers should be comply with IEC 60185.
Current transformers should be of dry type, with ratings and ratios as required.

Ring core current transformer for protection with Ratio (400-200/1A) with suitable burden, class 5P10.
Ring core current transformer for Metering (400-200/1A) with suitable burden, class 1.

Metering:
Digital ammeter, Digital Voltmeter and Digital MFM with RS 485 for Incomer.
Digital Ammeter and Digital MFM with RS 485 for outgoing

Auxiliaries.
The switchgear should be prepared for options like motor operation, auxiliary contacts and short-circuit indicators. Necessary terminal blocks and wiring etc. should be placed behind the front cover of each module.

Fault Passage Indicators.

Each RMU shall be equipped to display the phase currents on feeder circuit.

Each RMU shall be provided with one no. fault passage indicator on the isolator to indicate the earth fault. This shall facilitate quick detection of faulty section of line. The unit should be self-contained requiring no auxiliary power supply and shall be an integral part of the RMU to avoid any thefts. The fault shall be displayed by means of LED indication / flag which can be reset with three options viz. manual / on restoration of supply / settable time.

The FPI shall have automatic reset facility and shall be suitable for trouble free operation.

The indicator flag of the FPI shall be visible till such time the relay is reset

FPI shall be provided with potential free contacts for SCADA compatibility and shall have provision for remote reset.

TESTING AND CERTIFICATION

TYPE TESTS
Units should be type tested in accordance with IEC standards 60056, 60129, 60265, 60298,60420,60529 and 60694. The following type tests have been performed and available if required

- Short time and peak withstand current test
- Temperature rise tests.
- Dielectric tests.
- Test of apparatus i.e. circuit breaker and earthing switch
- Arc fault test
- Measurement of resistance of main circuit.
- Mechanical endurance test.
- Duty cycle test.
- Internal arc test for HT chamber.
- Degree of protection for **IP –54 for OUT DOOR RMU**.

Type test reports for above type shall be submitted with the offer.

ROUTINE TESTS

Routine tests should be carried out in accordance with IEC 60298 standards. These tests should be ensure the reliability of the unit.

Below listed test should be performed as routine tests before the delivery of units;

- Withstand voltage at power frequency
- Measurement of the resistance of the main circuit
- Gas leakage test
- Withstand voltage on the auxiliary circuits
- Operation of functional locks, interlocks, signalling devices and auxiliary devices
- Suitability and correct operation of protections, control instruments and electrical connections of the circuit breaker operating mechanism
- Verification of wiring
- Visual inspection

DOCUMENTATION

An instruction manual should be provided with necessary information for receiving, handling, storage, installation, operation and maintenance.

Routine test certificate should be follow each unit, and standard schematic drawings should be delivered for Ring Main Units. Compact Switchgear should be have drawings that consist of system single line drawings, general arrangement and schematic drawings for order specific units.

All drawings shall confirm to International Standards Organization (ISO) "A" series of drawing sheets/Indian Standards Specification IS : 11065. All dimensions and data shall be in ink and suitable for microfilming. All dimensions and data shall be in S.I. Units.

List of drawings and Documents

The bidder shall furnish four sets of relevant descriptive and illustrartive published literature, pamphlets and the following drawings for preliminary study along with offer.

- General outline drawings showing dimensions and shipping weights, quantity of insulating media.
- Sectional views showing the general constructional features of the circuit breaker including operating mechanism, arcing chambers, contacts with lifting dimensions for maintenance.
- Drawings showing control cabinets and circuit diagrams for operating mechanism.
- Schematic diagrams of breaker offered for control, supervision and auto reclosing.
- Structural drawings and loading data for support structures.
- Foundation plan and loading data and foundation design.
- Drawings showing the complete operation cycle of the **RING MAIN UNIT** with description.

Note:

i) Whether the circuit breaker is fitted with closing/tripping devices necessitating an auxiliary supply shall be stated either on the circuit breaker name plate or any other acceptable position.

4.2 (B) 11kV H. T. SWITCHGEAR (VCB) PANEL

Design Criteria

- The Switchgear system shall be capable of continuous operation at specified rating under the design conditions specified here in.
- The switchgears will be located indoor / outdoor area as per requirement.
- The de-rating of the Complete panel include Bus bar section shall be done taking 50°C as an ambient design temperature if it is designed at lower temperature. The maximum temperature in any part of the equipment at specified rating shall not exceed 85 deg C considering reference **Ambient Temperature as 50°C.**
- Applicable standard: IS 13118-191, IEC 62271/100-200, IEEE 1584, IEC 60947

Specific Requirements

- The switchgear shall be metal-clad, Extensible on both sides, floor mounted, draw-out type with fuse-less design and suitable for Local/Remote operation (Both control and monitoring). Enclosure shall conform to the degree of protection IP-4X & IP5X for metering section as per IEC 62271/100-200, IEEE 1584, IEC 60947.
- The minimum thickness of sheet steel used shall be 2mm CRCA steel/ AlZn & Gland Plate of 3mm thick.
- The switch gear assembly shall comprise a continuous, dead-front, line-up of free standing, vertical cubicles. Each cubicle shall have a front hinged door with latches and a removable back cover. All covers and doors shall be provided with recessed neoprene gaskets. All doors shall have pad locking arrangement. The swing of the door shall be more than 90 degree.
- The design shall be such that failure of one equipment shall not affect the adjacent units.
- Each cubicle shall be separated from adjacent one by grounded sheet steel barrier and bus sealing arrangement.
- The switchgear panel shall be of arc proof version, with Internal Arc Protection equal to STC of the system i.e. 25KA for 3 Sec. and complete with Numerical protection relays. HT Panel shall be as per IEC: 62271-200/IEEE 1584/IEC 60439
- All relays, meters, switches and lamps shall be flush mounted on the respective cubicle door or on control cabinet built on the front of the cubicle.
- Each breaker shall be provided with 6 ways, 3 positions, spring return to neutral, angular movement, lockable pistol grip type handle Trip-Neutral-Close (TNC) Switch.
- Each breaker shall be provided with 4 ways, 2 positions, angular movement, lever type handle Local-Remote selector switch.
- Each switchgear cubicle shall be provided with a thermostat controlled space heater and single phase 3 pin 15Amp plug point & light point operated at 230 V AC. 50 Hz.
- Bus connection from bus compartment to breaker compartment & breaker compartment to cable compartment and bus compartment to adjacent panels shall be through sealed resin cast bushing assembly.
- Each breaker cubicle shall be provided with ‘service’ and ‘test’ position limit switches, each having at least 4 NO & 4 NC contacts. The swing of the door shall be more than 90 degree.

Bus and Bus Taps

- Bus bars shall be of uniform cross section throughout the entire length of the switch board and suitable for carrying rated current continuously and short circuit current for specified duration without overheating.
- The main bus bar and connections shall be of high conductivity copper.**Copper bus bars shall be sized for maximum 1.4 A/mm² current density only.**

- All Bus bars, Jumpers connection shall be fully insulated for working voltage with adequate phase/ground clearances and shall be sleeved with R,Y,B colour coded heat shrinkable sleeves. Bus bars, links, live parts, etc. shall have non-flammable Epoxy cast-resin shrouds. All jointing hardware shall have nylon caps.
- No paper/cotton based insulation shall be used anywhere in the switch gear.
- Safety shutter, phase barrier, Bus bar seal-off bushing plate, support insulators etc. shall be non-flammable high tracking fibre glass/epoxy insulation system.
- All buses and connections shall be supported and braced to withstand dynamic electro-magnetic stresses due to maximum short circuit current and also to take care of any thermal expansion.

CIRCUIT BREAKER

- Circuit breaker shall be triple pole, single throw, Vacuum type / SF6 type, electrically operated (on/off), Draw out type.
- Circuit breaker shall have SERVICE, TEST and DISCONNECTED (ISOLATED) positions with positive indication for each position.
- Circuit breakers of identical rating shall be physically and electrically interchangeable.
- Circuit breaker shall have manual spring charge as well as motor wound charging facility with Mechanical & Electrical anti-pumping features and shunt trip. Motor wound mechanism spring charging shall take place automatically after each breaker closing operation. The motor shall be suitable for operation with voltage variation from 85% to 110% of rated voltage.
- Mechanical safety interlock shall be provided to prevent:
  a) The circuit breaker from being raked in or out of the service position when the breaker is closed.
  b) Raking in the circuit breaker unless the control plug is fully engaged.
  c) Closing & opening of the breaker in an intermediate position between ‘service’ & ‘test’ and between ‘Test’ and ‘Disconnected’ position.
- Automatic safety shutters shall be provided to fully cover the female primary contacts when the breaker is withdrawn from service position.
- The manual trip device shall be located on the front door & Indicators with shrouds will be visible from front door even when breaker is closed.
- Each breaker shall be provided with following:
  a) Auxiliary switch with 6 NO + 6 NC contacts, mounted on the draw-out portion of the switchgear.
  b) Position/cell switch with minimum 3 NO + 1 NC contacts, one each for TEST and SERVICE position.
  c) Auxiliary switch, with 4 NO + 4 NC contacts, mounted on the stationary portion of the switchgear and operated mechanically by a sliding lever from the breaker in SERVICE position.
  d) Trip push button, mechanical ON-OFF indication, an operation counter and mechanism charge/discharge indicator.
- Limit/auxiliary switches & shall be convertible type i.e. facility for changing N.O. contact to N.C. and vice-versa. Switch contact shall be rated 10A A.C. and 2A D.C. at operating voltage.
- Each breaker shall be provided with suitable encased rollers.
- The trip coils shall be operated satisfactorily at voltage between 70 % and 110 % of rated control supply voltage.
- Each circuit breaker cubicle shall be provided with an earthing facility. Earthing facilities shall be fully interlocked to prevent faulty operation e.g. earthing of live parts.
- One set of Earthing truck for Cable earthing and Bus earthing shall be supplied along with Panel.
- For each breaker feeder following DI & DO shall be considered.

DI

Breaker ON
Breaker Trip
Breaker test position
Breaker service position
DC fail
Local/Remote Selection

Vibration sensor feedback-6Nos. (if applicable for motor feeder)

DO
Breaker On
Breaker OFF

RTD Input
Winding & Bearing temperature-8Nos (if applicable for motor feeder)

PROTECTION & MEASUREMENT
Protective Scheme Requirement

- Main protective relay shall be microprocessor based, current and voltage based/monitoringnumerical relays with combined protections and with communication facility as listed in the table given below. Relay shall have minimum 5 logic input and output each, with fault (minimum 10) and event record (Minimum 100). Front USB port for local downloading of fault, event records.
- Auxiliary relays, timers switches etc. required to make the scheme complete shall be considered as part of the scope of work.
- All CT-PT wires shall be brought to test terminal blocks before connecting to circuits.
- The circuits of various protections shall be connected to master trip relays though aux. relays (flag indicated).
- Aux. relays shall be provided for each transformer fault. Connection of the relay shall be through links to facilitate maintenance.
- For control supply distribution, panel to panel separate set of terminal blocks shall be provided. All items/accessories required for above in each panel and in incoming panels shall be provided by the supplier.
- All relays shall be self/hand-reset type with digital/flag indication. NO/NC contacts for relays shall be as per the requirement of approved protection, annunciation & interlock schemes. Wherever required, supplier shall provide aux. relays for contact multiplication.
- Annunciation facia shall be mounted on the switchgear panels and details shall be finalized during drawing approval stage.
- Emergency stay-put type off push button / mechanism to be considered.
- DC supply fails alarm and indication to be considered.
- Draw-out type line PT's, shall be provided on all incomers with suitable 110V AC secondary two winding transformer for Metering and Protection separately of minimum burden 200VA or higher as required .

Incomer of H.T. Breaker shall be with following as a minimum.

Sr. No.	**Relay**	**Indication and Monitoring**	**Digital Type Meter**
1	PT fuse failure relay	Phase Indication (R, Y ,B)	Ammeter+ ASS
2	Numerical Relay with RS 485 communication with Combined Protection with configurable Digital input and digital output (min. 5 each), fault record (min.10) and event record (min. 100), for the following:	Breaker ON ,OFF, Trip	Voltmeter+VSS
2.1	IDMT & Instantaneous 3 O/C + 1 E/F (50,51,50N,51N)	DC supply ON, AC supply ON	MFM with communication Port Equivalent to Schneider (Conzerv) EM 6400NG with RS

			485 (Cl. 0.2)
2.2	Under voltage & Over voltage with time delay.(27/59)	Spring charge	PF meter
2.3	Trip circuit supervision (95)	Test & Service position,	
2.4	Circuit Breaker Protection/failure (50BF)	Trip circuit healthy	
2.5	Anti-pumping relay	Minimum 12 window Annunciation panel	
3	Master trip relay (High Speed trip relay) with hand reset contact(2 NO & 2 NC Contact)		

Transformer H.T. Breaker shall be with following as a minimum.

Sr. No.	**Relay**	**Indication and Monitoring**	**Digital type Meter**
1	Numerical Relay with RS 485 communication with Combined Protection with configurable Digital input and digital output (min. 5 each), fault record (min.10) and event record (min. 100), for the following:	Breaker ON ,OFF, Trip	Ammeter + ASS
1.1	IDMT & Instantaneous 3 O/C + 1 E/F (50,51,50N,51N), Thermal overload (49)	DC supply ON,	MFM with communication Port Equivalent to Schneider (Conzerv) EM 6400NG with RS 485 (Cl. 0.5s)
1.2	Trip circuit supervision (95)	Spring charge	
1.3	Circuit Breaker Protection/failure (50BF)	Test & Service position,	
1.4	Anti-pumping	Trip circuit healthy	
2	Aux. relay for WTI, OTI, Bucholz. alarm indication & trip	12 window Annunciation panel or higher as required.	
3	Master trip relay (High Speed trip relay) with hand reset contact(2 NO & 2 NC Contact)		

CBCT shall be provided for SEF for transformer feeder.

Outgoing H.T. Breaker for Motor Feeder

Sr. No.	**Relay**	**Indication and Monitoring**	**Meter**
1	Numerical Relay with RS 485 communication with Combined Protection with configurable Digital input and digital output (min. 5 each), fault record (min.10) and event record (min. 100), for the following:	Breaker ON ,OFF, Trip	Ammeter + ASS

1.1	IDMT & Instantaneous 3 O/C + 1 E/F (50,51,50N,51N), Thermal overload (49), Negative phase sequence overcurrent (46), Locked Rotor during start-up (51S), Under Current/ Loss of load (37),Start/Stalled Protection/ Motor Re-Accelaration (48/51 LR), Number of Starts Limitation (66), RTD temperature monitoring (38/49T)	DC supply ON,	MFM with communication Port Equivalent to Schneider (Conzerv) EM 6400NG with RS 485 (Cl. 0.5s)
1.2	Trip circuit supervision (95)	Spring charge	
1.3	Circuit Breaker Protection/failure (50BF)	Test & Service position,	
1.4	Anti-pumping Relay	Trip circuit healthy	
2	Master trip relay (High Speed trip relay) with hand reset contact(2 NO & 2 NC Contact)	Minimum 12 window Annunciation panel or higher as required.	

CBCT shall be provided for SEF for outgoing feeder for cable protection.
Numerical protection relay for Motor feeder shall be MiCOM 220 with RS 485 of Schneider or Eqivalent of any approved make.

Relays & Meters

- MFM shall be Microprocessor based numerical and communicable type with RS-485 Port. Communication link shall be provided between MFM and numerical relays to further communication to PLC/SCADA.
- All instantaneous current protection relays shall be of 3 pole type.
- Relays shall be rated for operation on 110V DC secondary voltage and 1A secondary current. Number and rating of relay contacts shall suit the job requirements.
- All relays shall furnish, install & co-ordinate to suit the protection and interlock requirement of VCB Panel.
- Relay shall be Low burden, provided with RS 485 Computer communication Port for monitoring & operation from Remote location / PLC with suitable Software.

Current Transformer

- Current transformers shall be cast resin type and shall be as per IS-2705(Part-1 to 4).
- CT's shall have shorting link on secondary side to facilitate insertion of meters on secondary side without opening CT circuits.
- Accuracy class of the Current Transformers shall be:
  a) Class PS for differential & restricted earth fault relaying.
  b) Class 5P10 for other relaying.
  c) Class 0.2 for Incomer and Class 0.5 for outgoing breaker panel for MFM.
  d) ISF < 5 for metering.
- The current transformer shall be capable of safely withstanding the short circuit, stresses corresponding to the fault level as indicated & shall be able to meet the short-time requirement specified.
- All CT secondary shall be earthed through separate switch link on terminal block.
- CT terminals & their polarities shall be clearly marked.

Voltage Transformer

- Voltage transformer shall be provided in separate cubicle.
- PTs, connection, Insulation levels shall be similar to rating of associated breaker.
- VA burden shall be selected based on requirement for meters, closing, tripping & indicating circuit.

- Voltage Transformer shall be cast-resin, draw-out type, dual core (for secondary) for metering & Protection separately and shall have an accuracy class 0.5 & 3P for metering & protection respectively. Voltage Transformer mounted on breaker carriage is not acceptable.
- The PTs shall be of shell type single phase construction with HRC fuses at both ends and plug-in connection on primary side.
- High voltage windings of voltage transformer shall be protected by current limiting fuses. The voltage transformer and fuses shall be completely disconnected and visibly grounded in fully draw-out position.
- Control MCB of suitable rating shall be provided on the secondary side to prevent overload.The PTs shall be capable of operating continuously at 110% of the rated voltage, without any damage. When star-star connection is required in non-effectively or under grounded system, the PTs shall be suitable for continuous operation with a persistent phase to ground fault.

Indication & Monitoring Instruments

- Control cabinet, mounted on top of breaker cabinet, provided with suitable anti-vibration facilities & one number heavy duty spring return type TRIP-NORMAL-CLOSE control switch with pistol grip lockable handle.
- Indicating lights in front of compartments as a minimum:

  Green : Breaker Open
  Red : Breaker Closed
  Amber : Auto Trip
  White : Trip Circuit Healthy
  Yellow : Breaker Test Position
  Blue : Breaker Service Position
  DC supply ON: White.
- Indicating Lamp shall be 20ø LED type with series resistance with metal body. Lamp and lens shall be replaceable from the front.
- All indicating instruments shall conform to IS: 1248-1983 and IS: 2419-1979, Shall be capable of withstanding system fault current taking account CT saturation, back connected and located in the upper part of the panel.

Meters

- Indicating instruments shall be mini. 96sq.mm dial flush mounted digital type with accuracy class 0.5 minimum.
- Digital type Multi-function Meter shall be three line display of Accuracy Class: 0.2 for incomer and 0.5s for outgoing and Suitable for measuring and digitally displaying the following parameters: kVA, kW, kWh, kVA, kVAh, kVAr, kVArh, A, V, P.F., frequency, Harmonic, MD measurement and control (Md control only in incomer feeder). Minimum 2nos. Digital Output shall be available.
  Each meter will be provided with at least two output signals of 4-20mA and communication port (RS 485) for all the above parameters for monitoring & operation from Remote location / PLC with suitable Software.
- Meter selector switches shall maintain firm contact, stay put type with knob handle. Ammeter selector switches shall be four-position type having make before break contacts to prevent open circuit of CT secondary.

Annunciation

- Shall be static type suitable to work on AC supply as specified.
- Hooter and bell for trip and alarm indication respectively.
- Test, accept and reset facilities (with push button) shall be provided on each panel.
- Suitable audio-visual indication shall be provided on DC failure. Audio alarm with reset facility shall be provided. Visual indication shall be panel-wise.
- Spare annunciation points shall be wired up to terminal blocks. 20% spare facia shall be provided
- Sequence shall be as follows:

	VISUAL	AUDIO
On Occurring of Fault	Flashing	On
On Accepting	Steady On	Off
On Reset (Fault Cleared)	Off	Off
On Reset (Fault Persists)	Steady On	Off

- Warning and emergency points shall be as per the list approved during detail engineering stage.
- One common point shall be provided to indicate operation of annunciation system of the complete board (in case of any trouble in the board in tie feeder, bus coupler, incomer, etc.).Remote and annunciation facia window detail shall be finalized during detail engineering.
- A common audible alarm for each switchgear line-up shall be provided to alert the operator that circuit breaker has tripped. Means shall be provided for silencing the audible alarm whilst leaving it free to sound when any other alarm is initiated but the associated alarm indications shall continue until cancelled.

Secondary Wiring

- The switchgear shall be fully wired at the factory to ensure proper functioning of control, protection, transfer and interlocking schemes.
- Control MCB of suitable rating shall be provided to permit individual circuit isolation from bus wires without disturbing other circuits. All spare contacts of relays, switches and other devices shall be wired up to terminal blocks.
- Wiring shall be done with flexible, 650V grade; FRLS PVC insulated wires with stranded copper conductors of 1.5mm^2 for control current circuits and voltage circuits. All power wiring like space heater supply, etc. shall be carried out with min. 2.5mm^2 PVC insulated Copper Conductor wire.
- Each wire shall be identified, at both ends, with dependent & cross addressing permanent markers bearing wire numbers. Trip circuit shall have red colour ferrule.
- Wire termination shall be made with crimping type ring connectors with insulating sleeves. Wires shall not be spliced between terminals.
- The wires shall run preferably through PVC channel with cover adequately supported along its run to prevent sagging due to flexibility or vibration. The control & power wires shall be routed through separate channels.
- Inter-panel wiring PVC channel shall be furnished for wiring between switchgear cubicles. All wiring required for interlocking between the cubicles of any switchgear shall be furnished and installed. Wherever wires are passing through cut outs or openings they shall be protected by providing suitable grommet or gasket around the openings. Inter panel wiring at shipping sections shall be through terminal blocks placed suitably at intersection points.
- **The colour of wire shall be taken as follows:**

AC System	:	Black
DC System	:	Grey
Earthing System	:	Green
CT & PT Wiring System	:	Red, Yellow, Blue, color code

Terminal Blocks

- Terminal blocks shall be 660V grade box-clamp type with 10 mm^{2}marking strips.
- Terminal for P.T. Secondary lead shall be disconnecting link type. Power wiring circuits and PT secondary wiring circuits shall be terminated by bolt type terminal blocks and rest by screw type terminal blocks.
- Not more than two wires shall be connected to any terminal. Spare terminals equal in number to 20% active terminals shall be furnished. Multi connection terminal strip to be used if required.
- Wiring shall be so arranged that an external cable can be connected to consecutive terminals.
- Terminal blocks for external / Space Heater wiring shall be separate from inter panel wiring.
- All control wire shall be terminated with ring type insulated lug only.

- The terminal block shall be grouped according to circuit functions and individual terminals in each block shall be serially numbered in accordance with the drawings. Such numbering shall be legible, permanent and indelible.
- Communication port of Meters & relays of individual breaker panel shall be looped together and brought out at External Terminal Connector/block using instrument signal cable 1 pair, Annealed tinned copper conductor flexible cable.
- All spare contacts of Breaker, CT, Relay, Annunciator etc. shall be wired upto external TB.

Cable Termination

- Switchgear shall be designed for cable entry from the bottom. Sufficient space shall be provided for ease of termination and connection with suitable size gland plates with knock out plates for specified HT Cable connection.
- The design of the cable box shall be such that any type of jointing methods such as heat shrinkable/push on type/cold shrinkable type termination can be adopted.

Ground Bus

- A ground bus shall be minimum 40x6 mm tinned copper or higher as per requirement, shall extend full length of the switchgear in all compartments includes cable compartments etc.
- Each stationary unit shall be connected directly to the ground bus. The frame of each circuit breaker and draw-out P.T. unit shall be grounded through heavy multiple contacts.
- C.T. and P.T. secondary neutrals shall be earthed through removable links so that earth of one circuit may be removed without disturbing other.
- All hinged doors shall be grounded using silver plated and braided copper flexible of adequate size.

Name Plates

- Name plates shall be provided as per standard.

Space Heaters and Plug Sockets

- Each cubicle shall be provided with thermostat controlled space heaters and 5/15A, 6 pin plug socket, panel illumination lamp. Cubicle heater, Plug/socket circuits shall have Individual MCBs.
- 230 V A.C Supply to the HT panel will be made provided by client.

Auxiliary Power & Control Supply

a) Control Voltage shall be for

- Closing, Tripping Coil	:	110 V DC
- Indication Circuit	:	110 V AC
- Spring Charging Motor, Panel space Heater, 3 pin socket & Panel illumination	:	230 V A.C.

b) Bus-wires of adequate (minimum 4sq.mm copper) capacity shall be provided to distribute the incoming supplies to different cubicles.

c) DP MCB shall be provided at the switchgear for the incoming supplies 230 V A.C. supply & 110V DC supply (as applicable).

d) Battery backup Power pack unit shall be provided for each VCB panel for 110V AC / 110V DC for closing and trip CKT suitable for min. Two Successive open & close operations after failure of power. Power Pack connected on 110V AC P.T. supply OR 110V DC, min 100AH or higher as required Battery and Battery Charger & DCDB shall be provided as specified in scope of work.

Tropical Protection

- All equipment, accessories and wiring shall have fungus protection involving special treatment of insulation and metal against fungus, insects & corrosion.
- Screens of stainless steel shall be furnished on all ventilating louvers to prevent the entrance of insects.

Painting

- The HT Panel shall be treated with seven tank process with cleaning of scale, grease rust and foreign adhering matter & chemical de-rusting, sand blasting, degreasing, pickling in acid bath and phosphating as per IS : 6005 and primed.
- After cleaning, the surfaces shall be given 2 coats of epoxy primer.
- After seven tank process and primer coating the HT Panel shall be powder coated with **RAL-7035** for inside and outside of the entire HT Panel.

Inspection & Tests

The switchgear shall be completely assembled, wired, adjusted inspected and tested at the factory as per the relevant standards.

- **Routine Test**

The tests shall include but not necessarily limited to the following for switchgear:

a) Operation under simulated service condition to ensure accuracy of wiring, correctness of control scheme & proper functioning of the equipment.
b) All wiring and current carrying part shall be given appropriate High Voltage test.
c) Primary current and voltage shall be applied to all instrument transformers.
d) Routine test shall be carried out on all equipment such as circuit breakers, instrument transformers, meters etc.
e) Power frequency withstands insulation HV test for main circuits, auxiliary & control circuit as per relevant-IS.
f) Milli-volt drop test across main contacts of each phase of VCB and close and open time test for VCB shall be a part of Routine test.

- **Test Witness**

The manufacturer shall perform factory tests as per IS /IEC std./ Specs., on equipment in presence of customer's representative / TPI agency, at Vendor / Contractor's cost.

- **Test Certificate**

a) Certified reports of all the tests carried out at the works shall be furnished in Four (4) copies for approval of the Owner.
b) The equipment shall be dispatched from works only after receipt of Owner's written approval of the test reports.
c) The test report shall furnish complete identification of the equipment such as serial no., rating, equipment designation as per schematic etc. & date of test.

4.3 DISTRIBUTION TRANSFORMERS

Scope:

- The scope covers the detailed requirement regarding supply, installation, testing, commissioning and handing over of transformers required for the Indoor / Outdoor installation in sub-station, meeting the requirements specified in the equipment data sheet.
- Associated civil works i.e. RCC foundation, etc. as required for the Installation of the transformer are also included in the scope of this contract.

Standards & Compliances:

- The transformer shall comply with IS: 2026 (Part I to V) and as per IS:1180 (Part I) 2014 or latest edition andshall be suitableforserviceundervoltage and frequencyfluctuationcondition as permisible underIndianElectricityAct rules. Transformers shall meet the requirements specified in specifications of Transformers and capable of being loaded in accordance with IS: 6600.

General Construction & Requirements

- All transformers shall be capable of operating continuously and without adverse effects of overheating under all specified conditions of operation including variation in system of +10% voltage and +3% frequency or +10% combined voltage and frequency unless otherwise specified.
- The transformer shall be indoor or outdoor type as specified. Unless otherwise specified the transformer in addition shall have thermal and dynamic ability to withstand external short-circuit as per clause 9 of 2026 (Part I) 1977.
- Transformer shall be designed for frequent direct on-line starting of motors having an equivalent rating in kVA up to CMR of the transformer and shall be capable of withstanding the forces arising from the starting currents of these motors.
- Transformer shall be supplied with first filling of oil and 10% extra oil in non-returnable drums conforming to IS: 335. The BDV of oil shall confirm to IS/ IEE standards at the time of delivery at site and at the time of commissioning.
- Transformer rated 2000KVA and above shall be considered with OLTC and RTCC if specified elsewhere in tender / as per BOQ.
- For transformer rated 2000 KVA and above , neutral CTs for stand-by earth fault and REF protection shall be provided. Neutral CTs shall be provided before bifurcation of neutral.
- For transformers rated - 2000KVA and above, differential Protection shall be provided.
- Creepage distance shall be 31KV/mm to be considered.
- All hard ware shall be hot dipped GI.

The Maximum Total Loss & % Impedance without any tolerance for transformer rating up to 2500 kVA shall be as per **Energy Efficiency Level 2** as per IS:1180 (Part I):2014. For transformer rating above 2500 kVA the maximum permissible losses & Impedance shall be as per CBIP Manual/publication and given under:

Transformer Rating	**Max. Permissible Load Losses with IS Tol.**	**Max. Permissible No Load Losses with IS Tol.**	**% Impedance Voltage with IS Tol.**
3150 kVA	20 kW	2.9 kW	6.25%
4000 kVA	27 kW	3.2 kW	7.15%

Taps and Tap Change Gear / Device:

- The Tap changing device shall be provided on H.V. side, off circuit type, externally hand operated with necessary indication for tap position and pad locking arrangement at any of the tapping positions.
- Tap changing device shall normally be off circuit type (OCTC) or on load (OLTC) type if specified elsewhere in tender / scope of work.
- It shall be designed for bi-directional operation and shall be of self-positioning type and shall have the following steps:

  ±0.0% ±2.5% ±5.0% -7.5% -10.0%

Off Load Tap Change Gear:

- The tap changers shall be off circuit type mechanically rugged and arranged to provide for convenient inspection and maintenance without necessity for un-tanking.
- The position indicators shall be positive and there shall not be any ambiguity resulting into incomplete tap change with respect to the mechanical tap position indication.
- The operating handle of tap exchanger shall be brought out of the tank at the side at an accessible height from ground level. Tap changer operating switch mounted on the top of the transformer tanks will not be acceptable.
- Provision of padlocking the tap changers without interfering with visual tap position indicator shall be provided. The tap changing handle shall have locking arrangement of suitable size.

On Load Tap Changing Mechanism (if applicable as per specificaitons)

OLTC shall be with + 5% to –15% taps in steps of 1.25 % on HV winding of transformer; It shall have following technical features:

- 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.

- 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.

- 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.

- 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.

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

- 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:

    - Driving motor (415 V, 3 phase, 50 Hz, AC squirrel cage)
    - Mechanically & electrically interlocked motor starting contactors with thermal overload relay, isolating switch and MCCBs.
    - 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.
    - Control switch: Raise/ off/ lower (spring return to normal type) or independent push buttons.
    - Emergency **"**OFF" push button (maintained type).
    - Remote/ local selector switch (maintained contact type).
    - Mechanical tap position indicator.
    - Limit switches to prevent motor over-travel in either direction or final mechanical stops.
    - Appropriate scheme/ device to permit only one tap change at a time on manual operation.
    - Emergency manual operating device (hand crank or hand wheel).
    - A five digit operation counter.
    - Space heaters with thermostat and MCB.
    - Control transformers with MPCB/ MCBs on primary and secondary sides for each supply.
    - Interior lighting fixture with lamp, door switch/ ON-OFF switch and MCB.
    - Gasketted and hinged door with locking arrangement.

- Terminal blocks, internal wiring, earthing terminals and cable glands for power and control cables.
- Necessary relays, contactors, current transformers etc.
- Transducers or any other appropriate device for remote tap position indication.

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

- 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.
- Only one tap change from each taps change command even if the command is maintained.
- Cut-off of electrical control when manual operation is resorted to.
- 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.
- Cut-off of electrical control when it tends to operate the tap beyond its extreme position.

➢ 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:

- Control switches; Raise/ Off / Lower (spring return to normal type) or independent push buttons.
- If automatic operation is specified, auto / manual selector switch (maintained contact type) and other items as listed.
- If parallel operation is specified, master / independent / follower selector switch (maintained contact type) with „out of step" annunciation.
- Tap position indicator.
- Facia type alarm annunciators with "accept", "lamp test" facilities and hooter / buzzer for alarms as listed.
- Necessary auxiliary relays.
- Lamp indications for:
- Tap change in progress
- Lower limit reached
- Upper limit reached
- Transformer cooler control apparatus (if applicable)
- Cable glands for power and control cables.
- 240 V rated panel space heater with thermostat.
- CFL type interior lighting fixture with lamp and door switch.
- MCBs.
- Terminal blocks.
- Internal wiring.
- Earthing terminal.
- 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.

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

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

- Alarms: The following alarms shall be provided:

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

- **TESTS:**

    - 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.

    - 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 on a similar or higher rating OLTC & Motor drive mechanism shall be submitted for Purchaser's approval.

- 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.

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

  Fittings & Accessories :
  - Inspection cover.
  - Buchholz relay with alarm & trip contacts (for 250 Kva & Above)
  - Marshalling box suitable for IP-55 class of protection.
  - Sampling valve with plug or cover plate.
  - Magnetic oil level gauge & Plain oil level indicator with mini. Mark.
  - Conservator & conservator drain valve
  - Bi-directional rollers.
  - Oil temp. indicator with alarm & trip contacts
  - Bottom drain & Filter valve with plug or cover plate.
  - Double diaphragm Explosion vent
  - Silica-gel breather
  - Air release plug / device.
  - Separate neutral bushing
  - Top oil filter valve
  - Jacking pads
  - Lifting Lugs
  - Two Earthing terminals.
  - Thermometer pocket for O.T.I.
  - Winding temp. indicator with alarm & trip contacts
  - Pressure relief valve (for rating 2000KVA& above)

- Rating and diagram plate
- Neutral CTs (NCT) for REF and Back-up E/F protection, differential protection (For Transformer rated 2000KVA and above)
- OLTC & RTCC panel (For Transformer rated 2000KVA & above if specified elsewhere in tender / as per BOQ.)
- Oil surge Relay (for Tx. With OLTC)
- Any other required as per IS:1180 / IS:2026

Accommodation for Auxiliary Apparatus:

- Where specified, NCT to be provided for the protection such as, restricted earth fault, back-up earth fault and differential protection.

Rating Plates& terminal Plates:

The followings plates shall be fixed to Transformer in a visible position.

a) Rating Plate & Terminal marking plate shall be provided as per IS: 2026(Part:1)/IS:1180(Part:1):2014.

Gas and Oil Actuated (Buchholz) Relay:

- Buchholz Relay shall be provided with isolation valve on both the sides for transformers of capacity 250 kVA and above.
- The design of the relay mounting arrangements, the associated pipe work shall be such that mal-operation of the relays shall not take place under normal service. The pipe work shall be so arranged that all gas arising from the transformer shall pass through the gas and oil-actuated relay.
- The oil circuit through the relay shall not from a delivery path in parallel with any circulating oil pipe, nor shall it be tied into or connected through the pressure relief vent, Sharp bends in the pipe work shall be avoided.
- All wiring connections, terminal boards, fuses and links etc. connected with gas actuated relays shall be suitable for tropical atmosphere. Any wiring liable to be in contact with oil shall have oil resistant insulation and the bared ends of stranded wire shall be sealed together to prevent seepage of oil entering connection boxes used for cables or wiring.

Cable Box / Bus Duct Box

- Cable box shall not be mounted on the tank covers. It shall be feasible to remove the tank covers for inspection during maintenance etc. without recourse to breaking the joints or disturbing the cables already terminated. Necessary removable links in oil approachable through inspection cover in tank cover etc. after lowering oil shall be provided for test purpose.HV cable box shall be considered with disconnecting chamber.
- Cable box entry shall be suitable for the size and number of run of cables. Gland plate shall be provided withrequired number/size of knockouts for cable terminations.
- In case of bus duct, bus duct box of suitable type shall be provided.
- In case of ACSR conductor connection on HT side, vertical bushing of suitable type & size shall be provided

Parallel Operation

- Transformers shall be suitable for parallel operation. For parallel operation of transformers, the transformers shall have the identical percentage impedance, X/R ratio, voltage ratio, vector group, phase sequence, polarity, phase angle etc. as minimum

Test

1) Test at Works

- All routine (Impedance voltage and load loss, No-load loss and excitation current, applied voltage, Induced voltage, Resistance measurement, Ratio tests, Polarity and phase-relation, Insulation resistance Leakage etc. tests) and other tests prescribed by IS:1180 (Part:1):2014 shall be carried out at the manufacturer's works before dispatch of the transformer in the presence of client/consultant/Inspecting officer.

- Copies of the test certificates shall be furnished to the department.
- In addition to the prescribed routine tests Heat Run Test/ temperature rise test shall be invariably done on one transformer of each design.
- A copy of the impulse test certificate done on the same type/design of the transformer shall be furnished in accordance with IS for purpose of record. If no impulse test was done in an earlier unit of the same design and capacity, one transformer will be subjected to impulse test in consultation with the client/consultant/Inspector at the vendor/contractor cost.
- Copies of the certificates for pressure test.Bushings test and type test for short circuit shall be supplied to the client/consultant for review.

2) Tests at Site

- In addition to tests at manufacturer's premises, all relevant pre-commissioning checks and tests conforming to IS code of practice No. 10028 (Part II & III) shall be done before energization.
- The following tests are to be particularly done before cable joints or connecting up the bus bar trunking.
  a) Insulation test between HV to earth and HV to MV with 5000 volts Megger.
  b) Insulation test between MV to earth with 500 volts Megger.
  c) Di-electrical strength Test on oil.
  d) Buchholz relay operation by simulation test when fitted.
- All test result is to be recorded and reports should be submitted to the department.

Installation and Commissioning

- Fire protection system for transformers shall be provided as per CEA (measures relating to safety and electric Supply) Regulations/ IE Act/Electrical inspector. Separation walls or fire barrier wall shall be provided between the transformers as per the requirement. An oil soak pit/ common burnt oil pit of adequate capacity with necessary valves/ suitable pumping facility to keep the pit empty shall be provided as per applicable standard/ IE ACT/ Regulations/ Notification.
- The transformer shall be installed in accordance with IS 10028 (Part II & III) code of practice for Installation and maintenance of transformer. Necessary support channels shall be grouted in the flooring.
- The transformer shall be moved to its location and shall be correctly positioned. Transformer wheels shall be either locked or provided with wheel stoppers.
- Transformer oil supplied in drums shall be topped up into the transformer after duly testing/filtering up to the correct level required.
- Drying out of transformer winding will be necessary when the dielectric strength of the oil is lower than the minimum value as per IS-10028 or the transformer has not been energized within 12 months of leaving the works or where the radiator assembly is done at site.
- The transformer shall be dried out/filtration done by one of the methods specified in IS-10028. Drying out with centrifugal or vacuum type filters will, however, be preferred. The contractor shall carry out the process of drying without interruption and shall maintain a log sheet indicating time, oil temperature and insulation resistance. BDV test shall be carried out and records to be maintained.
- All tests specified in these specifications shall be carried out by the contractor in the presence of inspecting officer/consignee free of cost.

4.4 SWITCHYARD & TRANSFORMER YARD WITH FENCING & GATE

- Fencing around the outdoor transformer substation / 11 kV switchyard.
- The fencing shall be at a distance of not less than 1.5m on all sides of the substation (pole structure and transformer plinths, as applicable) to ensure free movement all round.
- Fencing shall be with GI Chain links with proper MS Angle supports for better look. The posts shall be 75x 75 x 6 mm angle/channel of 3 mtr long. The post shall be 2.4 m. above

finish ground level (FGL) and 0.6m. below FGL, fixed in 1:4:8 cement concrete foundation of size 250x 250mm.

- GI Heavy duty chain link fencing Panel of size 2 mtr width and 2 mtr height made from 50 x 50 mm angle frame and covering with GI wire chain mesh 75mm, 8SWG. Cross support of GI flat of min 50 x 6 shall be provided diagonally in the frame. Frame shall be fixed to post with heavy duty GI Bolts.
- A gate of minimum 3 metres (2 x 1.5 mtr) with GI heavy angle frame as above and with Chain link fencing as per above details shall be provided with necessary access (road/pathway) for easy mobility of each transformers / vehicular movement and for ease of O&M of switchyard / transformer yard. Minimum 2 hinges shall be provided on each side of the gate.
- Two coats of aluminium paint over a coat of aluminium primer shall be applied on fencing post, fencing panel and gate. Final one coat of paint shall be applied after completion of work at site at the time of handing over.
- Fencing & Gates shall be installed as per site condition/requirement
- Fencing shall be earthed properly covering all rows on all sides. Fencing shall be connected to Earthing Grid though suitable size Hot dip galvanized earth strip as specified else-where. Caution notice should be fixed one on the 2/4 pole structure and at suitable location near transformers and another on the gate.
- The sub-station shall be uniformly levelled after proper ramming, Brick soling of thickness 75mm including consolidating by proper ramming, providing 100mm thick layer of 1:3:6 cement concrete and then spreading 40mm aggregate stone jelly of thickness 100mm.
- The above shall be done for transformer yard and also 1 mtr all around the fencing.
- Transformer Details like Name of the Manufacturer, Rating, Year of manufacturing, Date of charging shall be painted on the Fire Wall at suitable location for clear visibility.

4.5 DELETED

4.6 LT PANEL – PCC / PMCC / MCC / APFC / OTHER LT SWITCH BOARDS

- The MV switchboard panels shall be floor mounting, free standing, compartmentalized, extensible, Modular type suitable for indoor installation. The panel shall be totally enclosed and dust, damp & vermin proof. Enclosure shall have IP-52 or better degree of protection for indoor unit & IP-55 or better degree of protection for outdoor unit as a minimum. Outdoor unit shall be double door and additionally provided with canopy or weather shed for protection.
- Panel shall confirm to Indian Electricity Act and rules CEA Notification/ Guidelines, CPWD guidelines 2019 as amended up-to date and shall be as a minimum.
- PCC/PMCC panel shall have 2 nos. outgoing MCCB/ACB power feeders, one number on each side of BUS to feed power to downstream MCC panel.
- All MCC feeders will have two incomers (One Incomer as stand-by) with electrical and mechanical interlocking between the two such that only one incomer is ON at a time.
- MV switch boards sheet steel shall be CRCA mini. 2.0 mm for load bearing members, mounting plate, partition, doors/covers, Canopy. Gland plate shall be CRCA sheet min. 3.0 mm thick. All the doors and others openings shall be provided with neoprene rubber gaskets or of durable material gaskets.
- All hardware shall be corrosion resistant. Star washers shall be used for effective continuity.
- Suitable lifting hooks and jacking pads shall be provided on each panel or on each shipping section for ease of lifting of switchboard.
- A base channel of 100mm x 50mm x5 mm thick shall be provided at the bottom of the panel on all four sides of each shipping section.

- Overall height of Panel shall not exceed 2300mm (For VFD, Soft Starter panel height up to Max.2500mm can be accepted) including min. 100mm ISMC base frame.. However, in case of panel mounted on floor without cable trench shall be mounted at least 500mm above the floor level to provide adequate bending radius for in & out cables.: Folding type stand of minimum height 500mm with folding CRCA cover/sheet of 1.6mm thick all around the stand shall be provided. **Operational height of starters and control switch gear shall not exceed 1800 / 1900 mm above FFL (irrespective of overall height of panel) for ease of operation.**
- Shipping section length shall be maximum 2500mm. Each shipping section shall have full side sheets of 2mm thick on both the sides. Vertical partition of Incomer/ Bus coupler/ Outgoing feeders etc. shall be of full depth of the panel. Detachable gland plate shall be provided at the top on both the ends of the shipping sections for connecting/ joining of bus-bars.
- Minimum dimension of Incomer, Bus-coupler, Starter , MCCB cubical compartment shall be as per the Table. Height of Main Horizontal Bus bars chamber shall be minimum 350mm and Vertical bus bar shall be Min. 300mm or higher as per KA level and temperature rise required. Minimum width of cable alley shall be 350mm or higher as per number of cable.
- All type of meters shall be digital type. Ampere meter and Voltmeter shall be single phase and Separate selector switches shall be provided. Meter with inbuilt selector switches is not acceptable.
- Control MCB shall be provided for control wiring circuit. Panel shall be of Fuse less design.
- CT on Y phase with Ammeter to be considered for 7.5KW to less than 15 KW starter feeder. 3Nos. CTs with Ammeter and ASS to be considered for 15KW and above rated feeder.
- LT Panel shall be of fixed type, single/double front. LT Panel shall be single tier for all incomers, bus couplers, VFD starter, Soft Starters and multi-tier for other outgoing feeders. Vacant space on incomer and bus coupler panel shall not be used for mounting the starter, switch gear modules, Fixed capacitor feeder, MCB feeders. VFD starter panel shall be stand-alone panel with minimum height of panel – 1800mm.
- All auxiliary devices for control, metering, protection, indication & measurement such as push-buttons, control and selector switches, indicating lamps, Ammeters, Voltmeters, kWh meters and protective relays shall be mounted on the front side of respective compartment, for easy operation without opening the door. Metering cubicle shall be separate/independent of ACB/ MCCB incomer feeder.
- Circuit breakers capability/suitability to interrupt applicable capacitative current shall be specifically verified / supported by manufacturer recommendation.
- The switch board components, Bus bars etc. shall be designed to withstand the maximum Designed short circuit level for minimum 1 sec.
- MCCB shall be TPN/4P, Microprocessor based release/ TM release as specified elsewhere. All MCCB's shall be suitable for Ics= 100% Icu. The rated service short-circuit breaking capacity (Ics) of MCCBs shall be more than or equal to the specified fault level. MCCB shall be supplied with Extended rotary handle, Terminal spreader, Auxiliary C/O + Trip contact as applicable.
- Rating of MCCB, Contactors, relay etc. of motor feeders as recommended by Equipment manufacturer and shall comply with Type-2 Coordination as per IS: 60947.
- Panel shall have Main horizontal and riser bus bars air insulated, with coloured Heat shrinkable sleeves, housed in a separate compartment, segregated from all other compartments, with sheet steel barriers, sufficient louvers with wire mesh for air circulation.
- The LT panels shall be provided with a continuous earth bus having sufficient cross section to carry the specified fault current for specified duration without exceeding the safe temperature throughout its entire length.
- All control wiring except C.T. secondary wiring shall be carried out with minimum 1.5 mm² FRLS PVC copper flexible wires (Grey). C.T. secondary wiring shall be carried out with 2.5 mm² FRLS PVC copper flexible wires (Color coded).
- Adequately rated anti-condensation heater with porcelain connectors shall be provided in each breaker panel and in cable alley to maintain inside temperature 5 deg C above outside ambient temperature. It shall be supplied from 240V AC auxiliary bus for space heater. The space heater shall be provided with a thermostat having variable setting of 30-70 deg C and manually operated switch fuse and link for phase and neutral respectively.

- All starters shall be provided with Auto-Off-Manual and Local-Remote selector switches (where Start PB provided at Panel End), to monitor & operate MCC or LCS, ICP / PLC.
- All ACB's, MFM, VFD, soft starters and MPR, where provided shall have inbuilt RS485 port to communicate with PLC/SCADA for monitoring and control.
- 240V AC control supply shall be fed from 415/240V AC Constant Voltage/control voltage Transformer, one number on each bus of minimum 1.5 KVA rating or higher suitable for connected total working load. Suitable control logic through contactors shall be provided such that Control supply is available to all feeders based on Incomer -1 & Incomer-2 status. Only one control transformer shall be ON at a time**. Separate control transformer of suitable rating shall be provided for Incomers. DP MCB of suitable rating shall be provided on both Incoming as well as outgoing side of control transformer.**
- All CTs, PTs and Constant Voltage transformer shall be cast resin type with terminals. CT shorting link type control terminal shall be provided. Only Ring type lugs shall be used for CT termination.
- 2Nos. auxiliary contactors to be considered for PLC interface.
- All capacitors generally shall be at 415V or 525V if provided with detuned reactor or as specified in BOQ, Heavy duty type with discharge resistors and with dielectric losses ≤ 0.2w/kVAR.
- Adequate no. of spare outgoing breaker / power feeders shall be provided in all switchboards. At least one number of power feeder with highest rated outgoing breaker shall be provided as spare in PCC/PMCC and at least two numbers of 4-pole 63A rating (or higher rating or higher nos. as per bidder's design requirement) shall be provided as spare power feeder in all panels (PCC/PMCC/MCCs) as applicable. For PDB / LDB, min. 2 nos. outgoing feeders of highest rating (for each phase) shall be provided as spare.

- Following Communication RS 485 Modbus, DI, AI and DO, AO to be considered for various type of feeder for PLC/SCADA interface:

	INCOMER (ACB/ MCCB)	**SOFT/ VFD/ SD STARTER (MPR)**	**MOV**
Communication	Inbuilt Modbus RS 485 (only for ACB) for (1) Control (2) Monitoring Metering, energy & protection parameter	Modbus RS 485 Monitoring and control (SS & VFD) & MPR –Only monitoring & Trip. In VFD : PF, energy saving also to be monitored.	-
Digital Input (DI)	Breaker ON/OFF/TRIP	Motor Run	Valve Open
		Motor Trip	Valve Close
	Auto/ Manual	Auto/ Manual	Local/ Remote
		Local/Remote	Trip/ Fault
Digital Output (DO)	Breaker ON/OFF (latched type)	Start/Stop(latched type)	Valve Open
			Valve Close
Analogue Input (AI)		Speed Feedback (only for VFD)	Valve Position feedback
Analogue Output (AO)		Speed Reference (Only for VFD)	Valve Position Reference (only for VFD)

In addition to above MFM &Temperature scanner with RS 485 Communication MODBUS shall be taken for interfacing with PLC/ SCADA for Monitoring & for controlling further as required.

Bus Bar

- Busbars shall be of high conductivity, electrolytic aluminium (E91E), suitable for carrying the rated and short time current without overheating supported on insulators made of non-hygroscopic, non-flammable material to ensure free thermal expansion. With tracking index equal to or more than that defined in IS.
- Aluminium bus bars shall be sized for maximum 0.8 A/mm² current density only.
- Whenever Incoming supply is through BUSDUCT, Incoming Bus-bar of Incomer shall be extended till the top end of panel and phase positioning/ orientation of bus bars shall be suitable for Transformer LT terminal arrangement to avoid additional Phase cross over chamber.
- Bus bars for risers shall be rated to carry minimum 80% or higher of the rated current of all feeders connected to the risers.
- The current rating of neutral shall be min. half that of phase busbars. For LDB neutral rating shall be equal to that of phase busbar
- Both horizontal and vertical TP & N, bus bars, bus joints and supports shall be capable of withstanding dynamic and thermal stresses of the specified short circuit currents for 1 second.
- Only **High Tensile Steel Bolts, Nuts and Washers duly** zinc passivated or cadmium **shall be used for all bus bars joints and supports.**
- The hot spot temperature of bus bars including joints at design temperature shall not exceed 85 deg C for normal operating conditions.
- All bus bars shall be insulated with heat shrunk PVC sleeves of 1100V grade.
- The bus bars shall be arranged such that minimum clearance between the bus bar for 50KA fault current shall be maintained as below:
    - Between phases : 27 mm minimum
    - Between Phase and Neutral : 25 mm minimum
    - Between phase and Earth : 25 mm minimum

For the requirement of 65KA for 1 sec, necessary clearance as per the relevant IS shall be maintained.

Auxiliary Supply Bus-bars

- Auxiliary control bus bars of suitable rated size shall be provided for all Soft Starters, VFD & all Starters above 15 KW rating. Cables / Wires shall not be acceptable. **Auxiliary busbar of Tinned copper of suitable size shall run through- out the length of the Main bus-bar alley/ Vertical bus-bar alley and supply shall be tapped to individual feeder directly from the Bus and shall not be looped between the feeders. Control MCB shall be provided for individual feeder. Separate control transformer of suitable rating shall be provided for Incomers**
- Auxiliary bus shall be provided for following application. Exact size/capacity of bus bar shall depend on various controls, metering and auxiliary power distribution requirement.
    - Panel space heater supply and motor space heater supply.
    - Control supply for breaker tripping, closing and indication circuits.
    - Control supply for breaker spring charging motors, motor starter control and indication circuits.
    - AC potential supply for MFM, Meters, starter, voltage operated relays, etc.

Power and Control Wiring and Terminal Blocks

- All wiring shall be done with IS approved FRLS PVC copper flexible wires. The insulation grade for these wires shall be 660V grade. The control wiring shall be enclosed in plastic channels/Race way and neatly bunched together.
- Control circuit wiring shall be FRLS PVC copper flexible wire of minimum 1.5 mm² size and CT circuit wiring shall be minimum 2.5 mm² size . CT wiring shall be R Y B BK colour coded and Terminals shall be CT Shorting link type only. Power wiring inside the starter module/ MCCB/MCB shall be rated for full current rating of Feeder MCCB/MCB.
- All feeder modules shall be provided with neutral link. Suitable size & Rating Terminal blocks shall be provided for all outgoing feeders in the cable alley for connecting Power & Control cables. Cable shall never be connected directly to MCCB/ MCB terminal.
- Flexible wire shall be used only upto & including 63A MCB/MCCB, above 63A bus bar shall be used. Minimum size of FRLS Copper wire shall be up to & incl. 10A: 2.5 mm²; 16A: 4 mm²; 20A: 6 mm²; 32A: 10 mm²; 40/50A: 16 mm²; 63A: 25 mm².

- Each wire shall be identified at both ends by PVC ferrules.
- Inter panel wiring shall be done through rubber grommets.
- A minimum of 2 nos. or 20%, whichever is higher, spare terminals shall be provided on each terminal block.
- Marking on the terminal strips shall correspond to wire numbers on the wiring diagrams. All spare contacts and terminal of panel mounted equipment and devices shall be wired to terminal blocks.

Earthing
- The minimum earth bus size shall be minimum **65x10mm (Hot dip galvanised strip) or 40 x10 mm (Aluminium) or** higher to suit the Fault Level/ KA requirement.
- All doors and movable parts shall be earthed using minimum 1.5 mm² FRLS Copper flexible wires (Green colour) to the fixed frame of the switch board. Provision shall be made to connect the earthing bus bar to the plant earthing grid at two ends. All non-current carrying metallic parts of the mounted equipment shall be earthed. Minimum 4 nos., 10mm dia hole shall be provided on the earth bus for termination of earth strip / wire.

Name Plate
- Nameplates shall be provided as per standard.
- LT Panel shall be with details like name of client (on first row / top row), project name (second row), name of contractor (third row) & panel manufacturer (in fourth row) all with equal of descending order letters size on top of front side of panel.
- LT Panel shall be with name plate (on front side of door of I/c) having minimum details like (1) Power supply voltage (2) control supply voltage (3) frequency (4) Panel fault level (5) Panel protection class (6) Panel manufacturing IS standard considered etc. details.

Painting
- The LT Panel shall be treated with seven tank/ Nine tank process with Degreasing, Water rinsing, De-rusting, Water rinsing, Phosphating, Water Rinsing, Passivation.
- After 7 tank cleaning, the surfaces shall be given 2 coats of epoxy primer.
- After seven tank process and primer coating the external paint shall be powder coated with Siemens grey RAL-7035 for inside and outside of LT Panel.
- Mounting plate shall be painted Glossy white.
- Thickness of paint shall be between 100 Micron to 120 Micron.

Switchgear Modules

Air Circuit Breakers
- Circuit breakers shall be air break, Electrical Draw Out type for feeders 630A and above. ACB shall be with Microprocessor based release with Overload, Short circuit and inbuilt Earth Fault protection.
- The ACB shall be min. 50kA (1 Sec.) or higher as per fault rating, I_{CS} = 100%$I_{CU=}$ Icw. All ACBs shall comply and tested as per IS – 13947 / IEC 60947-1 and IEC 60947-2 standards.
- ACB for all Incoming, Bus coupler and PCC outgoin Feeder should be Four Pole Type.
- ACB for Incoming and Bus-coupler shall be identicle and interchangeable.
- ACB Models shall be : Schneider - Master pact NW or Siemens -3WL or L&T U power or ABB E-Max; or Equivalent model from Vendor Approved list. Data sheet with parameter comparision shall be submitted for approval.
- ACB shall be with **inbuilt Communication Module** RS 485 for MODBUS for communication with SCADA/PLC for both control and monitoring.

ACB Trip Release LSIG (Micro Processor based)should have Minimum following
- Overload with time delay
- S/C with time delay and Inst. Trip Setting
- Earth Fault with Time Delay.
- Under/over Voltage for incomer
- LSIG Fault record Display (ONLY FOR INCOMER & Bus-coupler)

- Metering & Energy display (ONLY FOR INCOMER & Bus-coupler)
- Ammeter display (For Outgoing feeders)

ACB shall be fitted with following

- Heavy duty switches having not less than 4 NO + 4NC contacts
- Built in resin cast current transformer
- Shunt and under voltage tripping device.
- The ACB shall be suitable for locking the breaker in various positions. Interlocks shall be provided to: Prevent the breaker from being isolated unless it is in the 'OFF' Position; Prevent the breaker from being racked in to the service position unless it is in the 'OFF' position; Prevent the breaker from being accidentally pulled completely 'OFF' the guide rail.
- Safety shutters of an insulation material shall be provided to prevent access to all live contacts, when the breaker is in the inspection position or completely withdrawn.

Moulded Case Circuit Breakers (MCCB)

- All MCCBs shall be comply and tested as per IS - 2516 / IEC 60947-1& IEC 60947-2 standards.
- Incomer MCCB's shall be 4P, 50 KA or higher (and Ics = 100% Icu= Icw) with Micro-processor based release with in-built O/C, S/C and E/F protection. Outgoing MCCB TPN for power feeders up-to and including 200A shall be with thermal magnetic release with adjustable Overload, Adjustable Short Circuit protection. Outgoing MCCB's from 250A & above shall be with Microprocessor based release with in-built O/C, S/C and E/F protection. All MCCBs shall be with Extended Rotary Handle and Terminal Spreader. Auxiliary change over contact 1 No + 1 NC and Trip Contact shall be provided as per the requirement.
- MCCB of Soft Starter / VFD feeder shall be TPN with Microprocessor release with overload/ short circuit and inbuilt Earth fault release. VFD starter panel shall be Stand Alone panel.
- MCCB as part of DOL / Start Delta motor starter module shall be current limiting type, TPN, Motor duty (rating and protection type as indicated above) and type tested for Type-2 co-ordination as per IS: 13947 / IS/IEC: 60947.
- MCCB Models shall be : Schneider NSX or Siemens 3VL or L&T D Sine or ABB T-Max; or Equivalent model from Vendor Approved list

Switches/ Fuses

- The switches or fuse switches shall be load break, heavy duty / motor duty, air break type provided with quick make/break manual operating mechanism. The operating handle shall be mounted on the door of the compartment having the switch. Fuses shall be non-deteriorating HRC cartridge link type.
- Rating of heavy duty switches or motor duty starter modules shall meet the requirement of AC23 duty as per IS: 13947.

Contactors

- The contactors shall be air break type, equipped with three main contacts and minimum (2NO + 2NC) auxiliary contacts. All contactors shall be 3 Pole, AC3 duty except for lighting feeder where-in the contactor shall be 4Pole and AC1 duty. External Bypass contactor used for Soft Starter shall be AC1 or AC3 as recommended by Soft Starter manufacturer.
- Unless otherwise specified, the coil of the contactor shall be suitable for operation on 240V, 1 Ph., AC supply and shall work satisfactorily between 65 to 110% of the rated value.
- Contactor used for capacitor feeder shall be Capacitor duty contactor with inbuilt leading contact with wiper function for limiting/ damping the capacitor inrush current with NO NC Auxiliary contact.

Bimetal Relay

- All bimetal overload relays shall be with in-built single phasing prevention and with Manual / Auto reset type (selectable) with at least 1NO and 1NC contact with reset type push buttons in the front, mounted on door such that it shall be possible to reset the O/L relay without opening the compartment door.

Motor Protection Relay (MPR)

- Motor Protection Relay (MPR) shall be provided 15KW & above Star delta starters. Motor Protection Relay (MPR) shall be Numerical type with Overload, short circuit, Earth fault; under current, unbalance, Phase loss/reversal, Stall, Locked Rotor, No load running.
- Single Phasing prevention with adjustable Under/Over voltage protection shall be provided separately if the same is not inbuilt feature in MPR.
- **MPR shall be Numerical with adjustable parameter with inbuilt MODBUS over RS 485 interface**. **MPR shall be Din Rail mountable Base Module and LCD Display module shall be Panel door Mountable. ZCT/CBCT shall be provided for Earth fault/ leakage protection (range 0.1A to 2A). Shall have Programmable 2 DI and 2 DO.**
- MPR shall display 3 Phase current, Unbalance 9% as minimum and Earth current monitoring.
- MPR shall store Fault records/ Start- Stop records/ Motor run hours/ Maximum starting current etc.
- Upto 30 KW MPR with inbuilt CT may be used. For motors 30KW and above external CT (3 nos) 5A, Resin cast of suitable VA shall be used
- Make: C&S mPRO 200 with ZCT & RS 485 or equivalent model of other approved make. Data sheet with parameters comparision shall be submitted for approval.

Motor Starter

DOL starter to be considered for rating less than 7.5KW rating, Star-delta starter to be considered from 7.5KW and up to & including 55 KW. Soft starter to be considered for > 55 KW rating.

MPCB, AC3 duty contactor and Over load relays with single phase preventer with under and over voltage protection to be considered for DOL feeders and Start Delta feeders up-to and including 15KW.

Motor duty MCCB (with adjustable overload, adjustable Short circuit, Earth Fault) Microprocessor release or Thermal Magnetic release as per the MCCB rating , AC3 duty contactor and Numerical Motor Protection relay with ZCT/CBCT, single phase preventer with Over Voltage and Under Voltage protection to be considered for Start Delta starter 15KW & above/VFD starter/ Soft Starters. (for SS and VFD feeders MPR settings shall be lower than SS/VFD settings).

Provision for door mounting PMU shall be provided in the Starter of Submersible Pump motor. Wiring shall be done up to Terminal connector for PMU input from field.

Minimum 8 Channel or higher Temperature scanner shall be provided in starter feeder for 90KW and above rated feeder wherever motor is supplied with RTD & BTD. Temperature scanner/ Thermister & PMU (as applicable) shall be interlocked with starter feeder with control/tripping Circuit of Starter feeder. Temperature scanner shall be door mounted. Soft starter/ VFD shall be with input terminal for RTD (PT 100) and Thermistor for Motor Temperature (winding and Bearing) monitoring/ protection.

Specification of Temperature scanner shall be as specified below:

Temperature Scanner:

- Temperature scanner of required cahnnels with min. 2 spare channels shall be provided to detect high winding, and bearing temperature in order to generate tripping signals. The input signals to temperature scanner shall be derived from motor Industrial Type PT-100 resistance temperature detectors provided in the motor windings and bearing.

1	Service and type	Motor winding and bearing temperature measurements – microprocessor based
2	Range	0 to 200^{o} C
3	Alarm Contacts	Adjustable 4 Nos. (High temperature and very high temperature) for motor winding and bearing
4	Type of Relay contacts	One Single Pole Double Throw per set point (Relay)
5	Input Signal	From RTDs for each Motor winding and bearing winding
6	No. of channels	6 Nos. for Winding + 2 nos. Bearing + 2 spare
7	Accuracy	$\pm$ 1^{o} C
8	Communication	RS-485 for Instrumentation panel interface

Instrument Transformers (CTs/PTs)

- Current transformer & potential transformer shall generally conform to IS: 2705, IS/IEC: 60044-122 and any special requirement w.r.t. numerical relay shall be taken care of by contractor. All CTs shall be Resin cast type and secondary 5A. APFC feedback CTs, MFM CTs, MPR CTs shall be of Class-0.5 and 10VA. CT's (60A and above) of Digital Ammeter, APFC panel metering shall be Cl : 1 and 5 VA. CTs less than 60A shall be Cl 1.0 and 2.5VA.
- The current transformers in breaker feeders shall be capable of withstanding the applicable peak momentary short circuit and the symmetrical short circuit current for 1.0 sec.

Indicating / Measuring Instruments

- The meters shall be Digital type and generally of square pattern type of 96 x 96 mm suitable for flush mounting. Instrument shall generally conform to IS: 1248 & shall have accuracy class of 1.0 or better.
- Digital meters shall have 3 ½ Digit, LCD display as a minimum
- All auxiliary equipment such as shunt transducers, CT's, PT's etc., as required shall be included in the supply of switch board. The current coil of ammeters and potential coils of voltmeters shall continuously withstand 120% of rated current and voltage, respectively, without the loss of accuracy.
- Digital Ammeter and Voltmeter shall with separate Selector switches instead of meter with Inbuilt Selector switch.
- Digital type Multi-function Meter shall be with 3 line display, Accuracy Class: 0.5 Suitable for measuring and displaying the following parameters: A,V,F,PF,KW,KWH, KVA, KVAR, KVARh, Md, Harmonic & with inbuilt RS 485 communication port.(Schneider- EM 6400NG; L&T –MFM 4420; Secure – Elite 445 ; eqv. model of other approved make). Data sheet with parameter comparison shall be submitted for approval.
- MFM shall be provided for Incomers, Motor feeder Rated 15KW & above.

Push Buttons

- Pushbuttons shall be oil tight type with 2 NO + 2 NC contacts; each contact shall have rated operational current of not less than 4A (AC-11)
- Pushbuttons for START, OPEN, CLOSE, LEFT, RIGHT, FORWARD, REVERSE etc. shall be flush type with spring aided self-reset contacts.
- Pushbuttons for STOP/EMERGENCY STOP shall be mushroom headed type with stay put contacts & shall be colored red. The operation of the button shall be press to lock and twist to release. The stop PB for each outgoing feeder/starter at MCC and for field LCS shall be EMERGENCY STOP push button. Push buttons shall be in compliance with IEC 60947-5-5
- Illuminated PB is not accepted.

Push button colours shall be as follows:

Stop / Open / Emergency	-	Red
Start / close	-	Green
Reset / Test	-	Yellow / White

Indicating Lamps

- Colour shade for the indicating lamps shall be as below LED type:

ON indicating lamp	:	Red
OFF indicating lamp	:	Green
TRIP indicating lamp	:	Amber
PHASE indicating lamp	:	Red, Yellow and Blue
TRIP circuit healthy lamp	:	Milky

FIXED COMPENSATION:

- Fixed Capacitor for transformer compensation (for no load as well as lekage reactance) shall be provided. Shall not be mounted below Incomer/ Bus coupler feeder. MCCB 50 KA or higher as per specification mentioned elsewhere along with Ammeter, CT 3nos, Capacitor duty contactor, ON Delay timer, Heavy duty capacitor unit of suitable rating as per TFR KVA rating.
- 7% Detuned Reactor with thermostat, 440V shall be provided in series with 525V capacitor or as per BOQ, if working VFD load is more than 50% of total load or if required as per BOQ. KVAr rating of capacitor shall be suitable for reactor rating.

Danger Notice Plates:

- The danger notice plate shall be affixed in a permanent manner on operating side of the Panels. The danger notice plate shall indicate danger notice both in Hindi and English and local language with a sign of skull and bones as per IS 2551.

SHOP DRAWINGS

- Prior to fabrication of the Panels the supplier / contractor shall submit for consultant's approval the shop / vendor drawing consisting of Technical data sheet duly filled in (as per Annexure-1) G.A. drawing, GA drawing with front door open with mounting plate details and equipment, sectional elevation, single line diagram, Power/ Wiring drawing, bill of material etc. and design calculations indicating type, size, short circuiting rating of all the electrical components used, bus bar size and calculation, Power/ control wiring size, Panels dimension, colour, mounting details etc. in 6 sets..
- The contractor shall submit manufacturer technical catalogue of major equipments like ACB, Soft Starter/ VFD, MPR of offered make/model for approval along with drawings.
- Soft starter /VFD selection indicating Rated FL current, Derated current for design Ambient temperature, Full load current of motor, 110% rated FL current of motor as per IS 12615 shall be given by SS/VFD OEM. Derated current of SS/VFD shall be equal to higher than 110% FL current of motor as per IS 12615 / BOQ. Power drawing and control drawing of SS/ VFD shall be got vetted from SS/VFD OEM before submission of drawings.

TEST CERTIFICATES

- Testing of Panels shall be carried out at factory as specified in Indian standards in the presence of by client / consultant / client's representative. The test results shall be recorded on a prescribed form. All type test certificates and routine test certificate for the test carried out at factory and bought out material and at site shall be submitted in duplicate to the consultant for approval.

CUBILCE / FEEDER SIZE CRITERIA FOR LT PANELS

- **ACB MINIMUM Cubicle compartment size considering minimum height of 1800mm.:**

ACB Rating	Width of Compartment (I/C or O/G in mm)	Width of Compartment (Buscoupler in mm)	Depth (mm)	Remark
800A -1250A 4P	800	900	1000	Cable entry
1600A 4P	900	1000	1000	Cable entry
2000-2500A 4P	900	1000	1200	Busduct entry
3200-4000A 4P	1100	1200	1300	Busduct entry

NOTE: Dimension mentioned above is minimum. Height of ACB feeder 1800 excluding main Bus bar chamber. Breaker Feeder in Single Tier.

- **MCCB MINIMUM Cubicle compartment size:**

MCCB Rating	Width of	Height	Remark

	Compartment		
Up to 63A	350	300	Copper flexible shall be used
100A -200A	400	350(3P)/400(4P)	Bus bar/ strip
Above 200 to 400 A	500	450	Bus bar/ strip
Above 400 to 550A	600	500	Bus bar/ strip
Above 550A	600	600	Bus bar/ strip

NOTE: Dimension mentioned above is Minimum. Depth of panel as per required depending on cable size/ site condition and for ease of maintenance. Incomer MCCB shall be only single tier and height of incomer feeder shall be minimum 1800mm.

- **VFD & SOFT STARTER MINIMUM Cubicle compartment size considering minimum height of 1800mm.**

Motor Rating	Width of Compartment	Depth of Compartment
Less than75 Kw	700	800
75kw to & incl 132 KW	800	900
Above 132 to & incl 250KW	900	900
Above 250KW	1000	1000

NOTE: Dimension mentioned above is minimum. S/S & VFD Feeder in Single Tier only**.**

4.7 AUTOMAITC POWER FACTOR CONTROL PANEL (APFC PANEL):

- APFC panel shall be floor mounting, free standing, compartmentalized, extensible, Modular type suitable for indoor installation
- The panel shall be IP 52 for Metering and switchgear Module and shall be IP 42 for Reactor/ Capacitor section. Full partition shall be provided between Switchgear components and capacitor section. Each feeder module shall be fully compartmentalised. Capacitor/ Reactor shall be mounted in separate vertical section/cubicle adjacent to switchgear cubicle instead of mounting at the rear end/ backside of switchgear module as per availability of space .
- The control equipment including capacitors shall be mounted in a panel made of 2 mm CRCA sheet. Panel shall be fully compartmentalised, Extensible and with Main Busbars in Horizontal Busbar alley.
- APFC panel shall be operated on AUTO and MANUAL mode. Individual capacitor feeder shall be possible to be operated on AUTO / MANUAL mode even when A/M switch in Incomer feeder is on AUTO Mode.
- All capacitors shall be Heavy duty MPP / Heavy duty Gas filled with discharge resistor and as per the technical data sheet provided here-in.
- Heavy duty exhaust fan 8" with canopy shall be provided at the top. Louvers with wire mesh shall be provided at the bottom end of capacitor section.
- Minimum distance between two capacitors and from all sides of panel enclosure (including terminal) shall be 25mm.
- Earthing terminal of Capacitor shall be connected to Earth busbar.

The Automatic control panel/ Fixed Capacitor panel (for Transformer compensation) shall comprise of the following:-

- MCCB/MCB for Protection of Each Capacitor Bank (MCCB should be suitable for Capacitor Switching & KA rating shall be as per main panel KA rating)
- Incomer MCCB shall be TPN, Microprocessor based/ Thermal magnetic (adjustable O/L and Adjustable S/C) as per LT panel specification.
- APFC Relay shall be microprocessor based with inbuilt RS 485 for sensing and correcting the power factor of the system with required no. of steps to achieve the specified power factor. Minimum operating current/ sensing current shall be 10 mA. Minimum 2 nos. additional spare relay contact shall be available for future use.
- Two numbers vacant feeders with mounting plate and cutouts shall be provided for future use.
- A/M switch with Auto/ Manual indicating lamp shall be provided in addition to R Y B indicating lamp.
- Each Outgoing capacitor feeder shall be provided with suitable rating MCB / MCCB, Capacitor duty contactor with inrush damping resistor, A/M switch, 'ON' and 'OFF' push with ON indication lamp, ON Delay timer (only for Manual mode of individual feeder), 415V Capacitor unit with discharge resistor. Control circuit of individual feeder shall have control MCB for protection and Indicating lamp shall be only through Auxiliary contact.
- MCB's for capacitor feeder shall be D- curve only.
- Any other components required for satisfactory and safe operation shall be provided.
- Capacitor shall be compact in size and hermetically sealed. In built fuses & surge suppressors shall be provided for protection of each capacitor element.
- Capacitor Banks shall comprise identical delta connected three phase units. Capacitor Banks shall be non-flammable, non – toxic, Non PCB, Dry Technology, Inert Gas (N2)/ PU Resin impregnated, MPP, Heavy duty type/ Gas filled.
- Only one wire shall be connected to each Contactor terminal. i.e. whenever more than one capacitor is controlled from Contactor suitable size Bus-bar Strip shall be provided and power shall be tapped. Else separate contactors shall be used for each capacitor unit.
- **If Load is VFD driven and Working VFD driven load is more than 50% of total load or if required as specified in BOQ then APFC panel shall be with Detuned reactors. 7% detuned reactor, 440V, AL wound with Thermostat shall be provided in series with Capacitor unit. Capacitor voltage shall be 525V or as specified in BOQ and KVAr rating suitable for Reactor KVAr rating. Filter rating (Reactor + Capacitor) shall be Rating of APFC panel.**
- Except for the specific requirements of APFC panel specified here in, rest all specifications shall be as per LT Panel / MV Switchboard specifications specified above.
- APFC Panel / Capacitor rating generally shall be at 415V or 525V if provided with detuned reactor or as specified in BOQ & APFC Panel shall conform to IS-16636:2017

Three Phase Filter Reactor:

Anti-resonance three phase filter reactor, Aluminium wound, 440V detuned reactors (5.67% or 7%) as required are to be used in series with shunt capacitors to prevent harmonic resonance and harmonic overloading of capacitors, Transformers whenever Power electronic Equipments (Drives, UPS etc.) producing nonlinear currents are used. Detuned systems shall be such that the self-resonant frequency is below the lowest line harmonic.

Features of Reactors:

- High linearity, Low losses & noise level.
- High over loading capability
- Inbuilt temperature micro switch

Micro switch potential free contact shall be used in control ckt of respective capacitor feeder to trip the contactor in case of high temperature.

Reactor shall be kept in independent cubicle and adequate ventilation shall be provided.

Power Factor Correction Thyristor Switch Module:

Thyristor switching instead of Contactor switching shall be used when load variation is rapid. Semi conductor fuses shall be used for protection of Thyristor switches in addition to MCCB/MCB. HRC fuses shall not be used. Discharge reactors shall be used for fast discharge for fast reconnection of capacitor.
Technical Features:

- Suitable for real time power factor correction
- Switching time less than 5 milli seconds
- PIV : 2200
- Permanent self controlling of: Voltage parameter, capacitor current, temperature of the thyristor switch.
- Suitable for manual operation also.
- Automatic switch off in case of over current and over temperature.
- Display of : Operation, Faults, Activation.

APFC Controller with RS 485:
Microprocessor based intelligent control, menu driven, single/ 3 CT sensing, 1A/5A CT selectable, with RS 485 communication port and features as below:

- Display: LCD illumination, Large and multifunctional characters. Parameters: Voltage, monitoring of individual capacitor currents, Real time PF, Power KW, KVA, KVAr, Temperature, Harmonics % ITHD, %VTHD, Energy KWh, KVAh, KVARh
- Steps: 4, 6, 8, 12,16 as required
- Mounting: Panel mounting (size: 144 x 144mm)
- Current input: 1 A or 5A selectable
- Operating temperature: 0 to 60ºC
- Supply voltage: 230V AC
- Target PF: 0.8 inductive - 0.8 capacitive.
- Minimum operating current: 10/50 mA
- Sensing: single / 3 CT. 3CT sensing for unbalanced load.
- Dual target power factor setting: for utility and DG mode operation.
- Facility of including " Fixed capacitor bank" for purpose of transformer compensation. This can be set such that the controller doesn't 'see' this capacitor.
- Potential free contacts/ alarm output: insufficient compensation, over compensation, undercurrent, overcurrent, over temperature, harmonics exceeded.
- Suitable for Thyristor switching if Thyristors are used instead of contactor.

- **Minimum rating of MCB/MCCB, Cable/ flexible wire size for capacitor feeder shall be as below:**
- **CABLE SIZE SELECTION CHART (MINIMUM)**

Sr. no	Capacitor rating in KVAr	MCB/MCCB Rating	FRLS Copper Cable/wire size (mm^2)
1	Upto & incl 5 KVAr	16A	2.5
2	10 KVAr	32A	4
3	12.5 KVAr	32A	6
4	15 KVAr	63A	6
5	20 KVAr	63A	10
6	25 KVAr	63A	16

7	30 KVAr	100A MCCB	25
8	40 KVAr	125A MCCB	35 mm² /busbar from bus to MCCB
9	50/60 KVAr	160A MCCB	50 mm²/ busbar from bus to MCCB
10	75 KVAr	200A MCCB	70 mm²/ busbar from bus to MCCB

CAPACITOR DATA SHEET

Sr. no	PARAMETER	unit	
	Capacitor type		Heavy duty MPP/ Heavy duty Gas filled type
1	Conformance to standard		IS 13340/ IEC 60831
1	Rated Voltage	V	415/440/525 as required/ applicable
3	Inrush current	A	Upto 200. Ir
4	Maximum permissible current/ Over current	A (Imax)	1.5 Ir
5	Maximum permissible Voltage/ Over Voltage	V (Vmax)	1.1 Vr
6	Temp class	ºC	60
7	Losses (per phase)	W/Kvar	Dielectric : less than 0.2 Total : less than 0.5
8	Capacitance tolerance		-5%/ + 10%
9	Dielectric		Poly Propylene
10	Impregnation		Non-PCB PU Resin/ Inert gas Nitrogen
11	Number of switching operation		5000 as per IEC 60832
11	Useful life	Hours	125000 minm
12	Maximum THD in Voltage		3%
13	Maximum THD in Current		15%

Note: Rest all construction features and other requirments shall be as per the specificaitons of LT Panel.

Test and Test Reports

- All tests shall be conducted in accordance with the latest edition of IS – 2834 and as applicable for controls.
- Type test certificates for similar capacitor units shall be furnished.

Drawings to be submitted for the approval of the Engineers Representative:

- GAD of APFC panel with elevation side view, sectional view and foundation details.
- Complete schematic and wiring diagrams for capacitor control panel.
- Detailed BOM and GTP
- Manufacturer technical data sheet of Capacitor and APFC relay.

4.8 SOFT STARTER (FORMING PART OF LT PANEL)

SCOPE

This specification covers the requirement for design, manufacture, installation, testing and commissioning of step-less reduced voltage / solid state torque controlled soft starter for motors in MCC panel to provide linear ramp starting and stopping of A.C induction motors.

Constructional and Performance Features (Microprocessor Soft Starter)

- The PCB power structure shall consist of six SCR's mounted on a heat sink for ratings up to suitable rating of motor. PCB shall be self-tuning to accept control power input as per design.
- All phases should be controlled during start/stop.
- Soft starter shall consist of built-in RS485 MODBUS RTU for monitoring & control thro PLC/ SCADA.
- Soft starter should be built for continuous operation without need of by pass for any reason.
- The logic circuitry shall incorporate a latch circuit for two wire / three-wire control.
- Control terminals shall be easily accessible and located on the front bottom of the device.
- **Sizing / Selection Criteria for Soft Starters:**

  Soft starter de-rating factor for selection of soft starter shall be based on Design Ambient temperature (50°C), Altitude (up to 1000m above MSL as standard or higher as per site requirement), etc. declared by OEM as % de-rating in their published Catalogue available in the public domain only. Rating/model selection based on Design software/ certificate issued by OEM will not be considered for selection. Further the soft starter shall meet following conditions to be confirmed by soft starter manufacturer / OEM:

  Start current: 400% of In for 23seconds.

  Starting frequency: 10-12 no. of starts per hour.

Following shall be considered while sizing the soft starter and its enclosure:

- Soft Starter (S/S) shall be de-rated as per manufacturer's recommendation for 50°C operating conditions based on site/operating condition and such de-rated current of Soft Starter shall be min. 110% of Full load current of motor as per IS: 12615 revised upto date or as per BOQ.
- Soft Starter shall be rated for DOL starting and shall have **In-built / External Bypass** Contactor of AC1 or AC3 rating as recommended by SS OEM.
- Soft starter shall be provided with breaker (MCCB/ACB) along with F.A. Semi-conductor fuse protection and with series contactor of required rating as recommended by OEM (soft starter signal to be interlocked with PLC and in manual mode timer based interlock to be provided to ensure that signal to turn on S/S is fed only if contactor close signal is received) to switch off supply to contactor through PLC when soft starter is not ON.
- Contractor/Vendor shall furnish the heat dissipation load data and shall provide the cooling arrangement accordingly to ensure that the temperature rise within enclosure does not exceed 5°C over the max. Ambient temperature of 50°C.
- Min. Two cooling fans shall be provided or higher nos. as required. The enclosure cooling fans & temperature sensing device (RTD / Thermisters) with tripping arrangement shall be provided and shall also be interlocked with soft starter operation i.e. in case of cooling fan failure or excess temperature (55 deg C or as set), the soft starter shall be tripped / shall not turn ON. Vents shall be provided with washable filter.

- Soft Starter shall be provided with conformal coating according to IEC-60721-3-3 to withstand harsh environment.
- Aux. contact of incoming breaker & contactor shall be used in series to provide "Soft Starter Ready" interlock signal for PLC/remote operation
- Detachable display/key pad with Digital parameter adjustment, preferred with cable suitable for door mounting. The Control keypad and display shall have the option for remote mounting. For safety reasons the controller should have green lights for running and red for start/stop.

CONTROL MODULE DESIGN FEATURES

User Adjustments
- The two acceleration start ramp & stop ramp timers shall have individual adjustments from 1 to 60 seconds & 2 to 60 seconds respectively.
- The initial torque setting shall be adjustable from 0 to 200 % of motor torque.
- The end torque setting shall be adjustable from 50 to 200% of motor torque.
- Current limit starting shall be adjustable from 150% to 500% of the motor's full load current.

Pump Control (Standard Feature)
- The standard feature pump control shall be implemented to provide closed loop control of a motor to match the specific torque requirements of centrifugal pumps for both starting and stopping.
- Pump stop shall be initiated without the need for a dedicated Pump Stop input. A coast-to-rest stop shall still be possible with stop input.

Controller's Features and Modes

a) **Starting modes** required for controller includes Linear Torque control for Start, Pump Control Current Limit Start (Voltage ramp Start, Voltage ramp with current limit Start, Full Voltage DPL Start, Remote analogue control, Slow Speed time controlled, Slow Speed external controlled, Dual Ramp Start, Soft Start with Selectable Torque Boost), Bypass control & Bypass contactor mode with all the protection parameter working.

b) **Stopping modes** required for controller includes Linear Torque control for Stop, Quadratic Torque control for Stop, Pump Control (DOL/Cost to stop, Remote analogue control Stop, Slow Speed time controlled, Slow Speed external controlled, Dual Ramp Stop, Bypass control).

Protection and Diagnostics
- Protections of Controller shall meet applicable standards.
- **Protective Features:** Motor Thermal Overload – selectable for starting class 10A, 15A, 25A under load protection (to avoid dry run), Soft Start thermal overload, PTC input, Phase imbalance, Phase reversal, Over voltage, Under voltage, Locked Rotor, Excessive Starts per hour for application, Phase loss input / output etc.
- Shaft Power measurement without the need of external electro-mechanical sensors.
- Electronic thermal memory shall be provided for enhanced motor protection.
- All Protections should be available in bypass mode also.
- When fault conditions are detected, the controller shall inhibit starting or shut down SCR pulse firing.
- Soft starter shall be with input terminal for RTD (PT 100) and Thermistor for Motor Temperature (winding and Bearing) monitoring/ control/ protection.

- **Fault Indications:** Controller shall indicate latest fault indications/occurrence for Line failure, Phase imbalance, Over temperature – motor, Over temperature – Soft Starter, Shorted Thyristor, Open Thyristor, Locked Rotor, Motor output loss, Overload & Under load – Shaft Torque, Over voltage, Under voltage, Excessive Starts & Phase reversal etc.
  Viewing Functions: Motor Current, Three Phase Voltage, Shaft Power in kW / HP (selectable), Motor thermal capacity, Motor Energy consumption (kWh), Power factor & Run time in hours etc.

  Note: Rest all construction features and other requirments shall be as per the specificaitons of LT Panel.

4.9 SPECIFICATION FOR VARIABLE SPEED AC DRIVE (VFD) SYSTEM

GENERAL REQUIREMENTS/ SPECIFICATION

- VFD system shall consist of all components required to meet the performance, protection, safety and testing and certification criteria of this specification. These components may include harmonic filter / power factor correction unit, Input Transformer, VFD converter / DC-link / inverter, and output filter & necessary components, pre-assembled and wired as required.
- Any modifications to a standard product required to meet the specification shall be performed by VFD manufacturer only.

The VFD shall meet the following specific requirements as a minimum:

- The fabrication, painting and other such construction requirements of VFD cabinet/panel/enclosure shall meet the requirements as per the specifications for LT panels.
- The Incoming Breaker of VFD feeder shall have micro-processor based S/C, O/L and E/F protection (min. 50kA S.C. current rating) as minimum along with door interlock facility.
- VFD shall be de-rated as per manufacturer's recommendation for 50°C operating conditions and altitude based on specified site/operating condition and such de-rated current of VFD shall be min. 110% of Full load current of motor as per IS: 12615:2018 / as per BOQ.
- VFD shall be provided with TPN ACB/MCCB and as recommended by VFD manufacturer as per their published chartalong with F.A. Semi-conductor fuse protection and with series contactor. AC3 category (VFD signal to be interlocked with PLC and in manual mode timer based interlock to be provided to ensure that signal to turn on VFD is fed only if contactor close signal is received) to switch off supply to contactor through PLC when soft starter is not ON.
- Contractor/Vendor shall furnish the heat dissipation load data and shall provide the cooling arrangement accordingly to ensure that the temperature rise within enclosure does not exceed 5°C over the max. ambient temperature of 50°C.
- Min. Two cooling fans shall be provided or higher nos. as required. The enclosure cooling fans & temperature sensing device (RTD / Thermisters) with tripping arrangement shall be provided and shall also be interlocked with VFD operation i.e. in case of cooling fan failure or excess temperature (55 deg C or as set), the VFD shall be tripped / shall not turn on. Vents shall be provided with washable (front washable & replaceable) filter, with VFD in operation.

- VFD shall be provided with conformal coating to protection level 3C2 for water supply and sewerage (pumping station / treatment plant) projects and with protection level 3C3 for industrial effluent projects or such harsh environment and according to IEC-60721-3-3.
- VFD shall be with programmable keypad with graphical display mounted on door (Remote Mounting) and inbuilt RS-485 serial port for remote communication.
- Aux. contact of incoming breaker & contactor shall be used in series to provide "VFD Ready" interlock signal for PLC/remote operation.
- Input filters, transformer, power conversion, output filters and auxiliary equipment enclosure shall be NEMA-12 design. Air cooled units/enclosure shall be NEMA-12 ventilated, IP-52 or better degree of protection, with gasketed doors Voltage and Current Harmonics at the supply side of the drive system at PCC (point of common coupling) shall be restricted within the maximum allowable levels of current and voltage distortion as per recommendations of the IEEE-519 2014 or latest edition.
- VFD Manufacturer to provide the harmonic calculations and suggest the required harmonic corrections based on plant SLD at each VFD input and at PCC (Point of Common Coupling) as per the suggested harmonic mitigation plan / solution. Bidder shall provide complete plant SLD with all additional data as required to VFD manufacturer for this purpose.

Performance

- The VFD shall be capable of producing a variable AC voltage / frequency output to provide continuous operation over the normal 10-100% speed range. As a commissioning and troubleshooting feature, the VFD power circuit shall be capable of operating without a motor connected to the VFD output.
- The VFD shall be capable of producing standard / variable torque for centrifugal pumps & centrifugal blowers and shall produce full rated torque (constant torque) at any speed in the operating range for applications like Positive Displacement type Twin / Tri Lobe air blowers, Screw Pumps etc.
- The AC Drive shall be digitally controlled, using Pulse Width Modulation (PWM) with flux vector control open loop and closed loop. It shall have IGBTs in the inverter section throughout the power range.
- VFD shall be provided with required EMC filter complying to EN 61800-3 depending on the maximum length of the cable from VFD to motor.
- The VFD shall be capable of being reset and operating normally after clearing ground fault.

Harmonics Distortion and Power factor:

- The total harmonics distortion of the voltage and current at inverter output shall be as per IEC 61800 and/or IEEE 519-2014 / latest edition.
- VFD shall include an input filter / reactor / choke to protect itself against damage due to normal transients and surges on incoming power line & reduce harmonic distortion on the AC power line.
- VFD system including power factor correction system and/or harmonic filter shall never have a leading power factor under utility or generator operation.
- The system design shall not have any inherent output harmonic resonance in the operating speed range.

Motor Compatibility:

- VFD system shall provide an output waveform that will allow utilization of any standard motors, without any need for any special insulation or de-rating.
- VFDs utilizing output transformers are not acceptable.

- The VFD output shall produce no electrically induced pulsating torques to the output shaft of the mechanical system eliminating the possibility of exciting a resonance caused by VFD induced torque pulsations.
- VFD shall inherently protect motor from high voltage Delta V/Delta T stress, independent of cable length of motor. The VFD system shall be designed to produce no standing waves or over-voltage conditions based on a cable length. If cable length from VFD to motor exeeds 50m or is more than recommended maximum permissible length, then output filter shall be provided . If the VFD requires an output filter to meet this requirement, it shall be an integral part of the VFD system or external but as per specification certified by VFD manufacturer. VFD manufacturer to also recommend the maximum permissible length of cable without an output filter.
- The VFD system shall be capable of producing full rated torque in the event of a power loss of 5 cycles or less and continuous operations with a 30% voltage sag on the input power line.

Serviceability / Maintainability

- VFD system should be designed for front access only.
- The VFD system shall be provided with the capability for remote diagnostics via modem communication / inbuilt communication port RS 485 with PLC / SCADA system at main control room.
- VFD shall be suitable for Monitor & control from PLC/ SCADA.

PROTECTIONS & ANNUCIATIONS:

- Power Component Protection: VFD system shall include distribution class surge arrestors to protect input transformer and VFD against voltage surges. These shall be integral with the drive panel cabinet.
- Protective Features and Circuits (Main Protections): Over current, short circuit between phase, short circuit between phase and ground, impendent short circuit, input phase loss, output phase loss, motor overload, over voltage, under voltage, over speed, Solid state Thermal Protection, IGBT over temperature, heat-sink over-temperature, Phase Reversal etc. & other internal faults.
- Upon power-up the AC Drive shall automatically test for valid operation of memory, option module, loss of analogue reference input, loss of communication, dynamic brake failure, DC to DC power supply, control power and the pre-charge circuit.
- The AC drive shall have a selectable ride through function that will allow the logic to maintain control for a minimum of one second without faulting.
- The deceleration mode of the AC drive shall be programmable for normal and fault conditions. The stop modes shall include freewheel stop, fast stop, DC injection braking and as fast as possible.
- Upon loss of the analogue process follower reference signal, the AC Drive shall sense the fault and/or operate at a user-defined speed or last speed.
- The AC Drive should be able to protect the motor when PTC probes are connected.
- The VFD shall have interlocking with Forced Cooling Fan operation, where ever forced cooling is provided for the drive motor. VFD shall Start only when forced cooling fan is running and VFD shall Stop before forced cooling fan stopped / tripped.
- The AC drive should be able to limit the motor terminal voltage to twice the DC bus voltage.
- The following minimum controls shall be provided at the VFD control panel: START, STOP, Fault reset, Auto and Manual selection & Manual set points etc.
- The following minimum indications shall be displayed at the VFD control panel: Ready to start, Running, Motor Running On By-Pass, Alarms, Tripped, Input voltage and frequency,

Input power, Output voltage and frequency, Output power, Output current, Control supply ON & Cooling failure etc.

- Abnormal conditions shall initiate alarm and shut down drive based on the nature of the fault.
- The AC drive shall display all faults in plain text and help screens shall be available to guide the user in the troubleshooting. Codes are not acceptable.
- VFD shall be with programmable input terminal/probe for RTD (PT 100) for Motor Temperature (winding and Bearing) monitoring/ control/ protection.

Data Displays / Programming Terminal

- A door mounted LCD display shall be furnished, capable of displaying the VFD operational status and drive parameters.
- The Programming terminal of the AC Drive shall be accessible for programming and control even if the main door closed.
- As a minimum the following door mounted digital indications shall be available for viewing through 2/4 line or similar suitable English language display: Speed demand in %, Output current in Amps., Output frequency in Hz, Input Voltage, Output Voltage, Total 3-phase kW output, Kilowatt hour meter (Digital Energy meter) & Elapsed time running meter etc.
- Use of shuttle button shall carry out the navigation in the menu and the parameter setting.
- Parameter setting shall be easily accessible and user friendly with actual text messages and actual setting range.
- The programming terminal shall offer the possibility of memorizing and downloading 4 configurations of the AC drives to save time during the commissioning and to avoid mistakes.
- Preferably 4 programmable function keys shall be available for short cuts, application functions
- The AC Drive shall have self-diagnostic properties to display faults and warnings as they occur. The AC Drive shall be able to store at least 8 last faults into the fault memory including the value of 11 parameters of monitoring for each fault. The fault memory shall be accessible by the programming terminal.

Design criteria:

Operating conditions:

Rated Input Voltage	:	3-Phase, 380V to 480V, +10% / -15%
Rated Input Frequency	:	48 to 63 Hz
Fundamental Power Factor	:	0.97 or better at nominal load
Efficiency	:	≥ 98 % at nominal load
Output Voltage	:	0 - U_N, three-phase
Output Frequency Range	:	0 to 500 Hz or suitable as per mfr. Std.
Degree of Protection	:	IP-20/21 as a minimum (stand alone without panel enclosure)
	:	VFD Enclosure/Panel with IP-52 protection.
Operating ambient Temp.	:	Max. **50°C**with continuous current output.
Maximum operating altitude	:	1000 m without de-rating
Max. Relative Humidity	:	95 %, without condensation
Mounting	:	Within Enclosure / Panel (Vertical)
Max. Corrosion Level of the Cooling Air	:	IEC 60721-3-3, class 3C1/ as per site condition.
Chemical Gases	:	Coating shall be provided to comply with

		IEC 60721-3-3 Class 3C3/3C2 as specified above
Solid Particles	:	IEC 60721-3-3, class 3S2
Max. Vibration Level	:	According to IEC 60068-2-6
Shock Level	:	According to IEC/EN 60068-2-27
Noise / Sound level	:	Max. 80 dB(A) at a distance of 3m at any Speed / Load condition
Harmonic distortion	:	According to IEEE 519 – 2014 or latest revision
Short time Overload capacity	:	110% for 1 minute for Variable torque Application 150% for 1 minute for Constant torque Application
Speed regulation	:	±5.0 % without encoder or tachometer feedback
Efficiency	:	Min. 96% at 100% speed and 100% load Min. 95% at 80% speed and 50% load
Power factor	:	Min. 0.95 true pf lagging from 30% to 100% Speed
Control supply	:	could be internal so provided by the AC Drive itself, or provided by an external 24V DC supply

Safety

- The AC drive shall integrate the "Power Removal" safety function which prohibits unintended equipment operation. The motor no longer produces torque.
- The Power removal function shall comply with the definition of the draft product standard IEC/EN 61800-5-2 for both stop functions, Safe Torque Off ("STO") and Safe Stop 1 ("SS1")
- This safety function shall comply with standard for safety of machinery EN 954-1, category 3; standard for functional safety IEC/EN 61508, SIL2 capability (safety control-signalling applied to processes and systems)
- The AC drive manufacturer shall provide the certified schematics and the list of devices in order to comply with IEC/EN 60204-1 stopping category 0 and 1
- The relay contacts shall comply with EN-81 13.2.2.3

User Interface

- VFD offered with possibility to extend/expand the number of inputs / outputs of the AC Drive in future shall be preferred.

Two Analogue Inputs:	
- For Voltage	0 to 10V, Programmable
- For Current	0 to 20mA Programmable
Potentiomètre I/P	+10V, 10mA max.
Analogue Output	2 x Programmable analogue outputs (0 - 20mA) (programmable for speed and current)
Logic inputs	4 x Programmable logic Inputs, isolated from the mains (One of these inputs could be used for PTC /thermistor probe) All logic inputs may be used either in sink or source
Safety input	One input from above shall be dedicated to the Power removal safety function. In option, digital i/p may be used with 115V control supply
Relay Outputs	3 x Programmable digital o/p with a changeover dry contact

- Following I/Os shall be provided / wired to PLC as a minimum:

Description	**Type of I/O**

Drive On / Off Status	DI
Drive Trip Status	DI
Selector Switch in Auto Mode Status	DI
Drive Start Command	DO
Drive Stop Command	DO
Speed Control Command	AO
% Speed Indication	AI
% Current Indication	AI

Communications

- The AC drive shall have inbuilt communication port to communicate with PLC / SCADA system preferably over MODBUS. Alternately Profibus DP or Ethernet TCP/IP protocol or Device Net or FIPIO or other suitable protocol offered by VFD manufacturer suitable for communication with PLC/SCADA can be accepted subject to provision of same at PLC/SCADA side.
- Communication card/protocol and cable as necessitated by PLC/SCADA shall be provided. All drive status monitoring and control shall be possible from PLC/SCADA over communication cable / port.
- The AC Drive shall be able to accept / control speed or torque command which may come from different control sources as follows:
  - I/O terminals
  - Communication network
  - Programmable card
  - Remote graphic display terminal
- Advanced monitoring and diagnostic functions shall be available through the programming terminal like monitoring of:
  - The communication scanner
  - Command words sent by the different sources
  - Command words taken by the AC drive
  - 4 words which addresses are selectable, etc.

- **Application programming:-** The AC Drive shall have built-in application macros available in the Simply Start menu, to allow selection of the range of pre-programmed control configurations and further, the AC Drive shall be able to store at least two customer modified macro-configuration, to suit the specific application. It shall be possible to reset the parameter settings back to the original macro settings through the keypad. The parameter readouts shall be in text format and not coded.

Note: Rest all construction features and other requirments shall be as per the specificaitons of LT Panel.

4.10 INDUCTION MOTOR

SCOPE:

This specification covers the design, manufacture, inspection, testing at works, supply, delivery to site, installation, testing at a site & commissioning of three phase, squirrel cage, solid shaft induction motors with all accessories for driving various pumps / equipment required for the complete operation of the plant as per the scope of this work. All motors shall be as per these specifications unless for any other more stringent requirements mentioned elsewhere.

CODES AND STANDARDS:

The design, material, construction, manufacture, inspection, testing and performance of induction motors shall comply with all currently applicable status, regulations and safety codes in the locality where the equipment will be installed. The equipment shall also confirm to the IS 12615-2018 / IEC:60034 amended up to date.

GENERAL DESIGN AND CONSTRUCTION REQUIREMENTS:

Motors shall be continuous maximum rated as per IS:12615-2018 and IS: 4722 (latest edition) and preferably be designed for low starting current and smooth acceleration except for cases where the driven equipment characteristic demand otherwise. Motors shall be of 4/6/8 pole design as required and provided with terminal box large enough to accommodate armoured PVC /XLPE insulated Aluminium conductor cable of appropriate size / ratings. Motors shall be of energy efficiency class IE3 as per IS:12615-2018.

All motors shall be foot / flange mounted or as per pump / driven equipment coupling requirements and squirrel cage induction type and shall be capable of developing at least minimum 10% more power than demanded by the Pump / Sub. Pump or driven equipment over its duty point of operation.

The minimum power rating for motors to drive pump / sub. Pump / driven equipment should be selected as per table below to meet the power demanded over its duty point of operation:

Required BKW of pump / sub. Pump / driven equipment	**Minimum multiplying factor to arrive at motor rating**
Below 7.5 KW	1.3
7.5 KW and above but below 15 KW	1.2
15 KW and above but below 75 KW	1.15
75 KW and above	1.10

OPERATING CONDITIONS

1) Frequency and Voltage Variation

All LT motors shall be squirrel cage motor and the motor shall be suitable for the following.

Supply voltage	:	415 Volts, 3 Phase, 50 Hz AC supply
Voltage variation	:	$\pm$ 10%
Frequency variation	:	$\pm$ 5%
Combined variation of Voltage & Frequency	:	$\pm$ 10%
Design Temperature	:	50° C

2) STARTING

a) Unless otherwise specified, motors shall be designed for direct-on-line starting.

b) Motors shall be designed for re-acceleration under full load after momentary loss of voltage with the residual voltage being 100% and is in phase opposition to the applied voltage.

c) Minimum locked rotor thermal withstand time at rated voltage shall be 10 seconds under cold conditions and 8 seconds under hot conditions. The starting time of motor shall be less than the hot thermal withstand time to permit application of conventional bimetal relays or thermal release against locked rotor and overload conditions.

d) The motors shall be suitable for starting under specified load conditions with 75% of rated voltage at the motor terminals.
e) Motors shall be designed to allow the minimum number of consecutive starts indicated in Table - I below:

TABLE – I

Starts	Min. no. of Consecutive Starts
No. of consecutive start-ups with initial temp. of the Motor at ambient level (cold)	3
No. of consecutive start-ups with initial temp. of the Motor at full load operating level (hot)	2

3) Direction of Rotation

Motors shall be suitable for either direction of rotation. In case unidirectional fan is provided for motors, direction of rotation for which the motor is designed shall be permanently indicated by means of an arrow. When a motor is provided with bi-directional fans, a double headed arrow should be provided.

Normally clockwise rotation is desired as observed from driving (coupling) end. Ample space shall be provided in terminal box for interchanging any two external leads for obtaining reverse phase sequence.

PERFORMANCE

- Motors shall be rated for continuous duty (S_1) unless otherwise specified. For hoist / crane shall be S4 duty.
- All performance characteristics shall be as per IS:12615:2018 or latest revision and the torque and other specific requirement shall be selected by the concerned equipment vendor to suit the application.

CONSTRUCTIONAL DETAILS

Motor Casing and Type of Enclosure

Motors for use in safe area shall be of industrial type meeting the specified ambient conditions, starting and operating requirements. Motors for use in hazardous areas shall have type of protection Ex-d or other as per area classification and to meet requirement of applicable Indian Standards.

The motor enclosure including terminal boxes and bearing housing shall have IP:55 degree of protection.

Motor casing shall be provided with a suitable drain for removal of condensed moisture for motors operating in safe area.

All vertical motors shall be provided with suitable canopies covering the motors fully. Motors designed to handle external thrust from the driven equipment shall be supplied with a thrust bearing at the NDE.

Motors shall have standard frame sizes for various output ratings as per IS.

Motors installed in outdoor areas shall be provided with FRP type canopies/ covers of 2mm thick.

All external surfaces of the motor and it’s canopy shall be given a coat of epoxy based paint shade 632 as per IS.

Windings

Insulation and bracing

Unless otherwise specified, motors shall be provided with class 'F' insulation with the permissible temperature rise above the specified ambient temperature shall be limited to class 'B'. **VFD operated motor shall be with Class 'H' insulation with temp. rise limited to Class F.**
The winding shall be tropicalized. The windings shall preferably be vacuum impregnated. Alternately the windings shall be suitably varnished, baked and treated with epoxy gel for operating satisfactorily in humid and corrosive atmosphere.
Windings shall be adequately braced to prevent any relative movement during operation.
Overhung of winding shall be DOUBLE coated with epoxy gel.

However, motors operating with Variable Frequency Drive shall have winding and other features as follows:

- Winding shall be double insulated, vacuum impregnated
- Winding shall have Class H insulation.
- Motors rated 90 KW and above shall have forced cooling arrangement and for motors rated less than 90 KW, frame size shall be suitably selected for effective heat dissipation.
- Motors shall be suitable to continuously operate within 30% to 100% speed range variation.

Phase Connections & Terminal Box
The windings shall be connected in Delta. The ends of the windings shall be brought out into a terminal box. All motors shall be with six terminals and suitable links to connect them in star or in delta. Motors rated up to and including 2.2 KW which may be accepted with three terminals. The terminal box shall be located on the RHS as viewed from driving (coupling) end (for motors above 3.7 KW). The terminal box shall be rotatable in steps of 90 Deg. to allow cable entry from any direction. An adequately sized earth terminal shall be provided in the motor terminal box. Terminal box shall be provided at the side of the motor.

Bearing and Lubrication
Motors shall have grease lubricated ball or roller bearings with minimum L-10 rating life of 5 years (40,000 hours) at rated operating condition. Bearings shall be capable of grease injection from outside without removal of covers with motors in running condition. Necessary seal to prevent entry of dust/moisture and loss of grease shall be provided. Grease nipples shall be provided with appropriately located relief devices which ensure passage of grease through the bearings.

VFD operated motor shall be considered with insulated bearings for motor rating 90KW and above (not applicable for package product like turbo blower, etc.)

Cooling System
All motors shall be self-ventilated, fan cooled. VFD operated motors shall be VFD Duty.
Rotor
The motor shall be squirrel cage type, dynamically balanced to provide a low vibration level and long service life of the bearings.
Shaft Extension
Motors shall be provided with a single shaft extension with key-way and full key. Motor shaft shall be sized to withstand 10 times the rated design torque.
Lifting Hook
All motors weighing more than 30 kg. shall be provided with lifting hook of adequate capacity.
Earth Terminals

Two earth terminals of adequate size, located preferably on diametrically opposite sides shall be provided for each motor. Necessary nuts and spring washers shall be provided for earth connection.

ACCESSORIES

- Anti- condensation heaters of 240 V, Single Phase, shall be provided for motors rated 30 KW and above. Heaters shall remain ON when the motor is not in service and as such shall not cause damage to the windings. Heaters shall be metal encased with a low surface temperature.
- RTD/BTD : 2 number per phase and for Bearing both Drive end and Non drive end shall be provided for motors rated 90KW and above, suitably terminated in auxiliary terminal box. Separate terminal box shall be considered for Space heater and RTD/BTD.
- Name plates shall be provided on each motor as per IS/IEC.
- Noise level and Motor Vibrations shall be within the limits as laid down in IS.

MOTOR TESTING

Testing of motors shall comply with the requirements of IS:4029/ IS 15999. Motor shall be subjected to all routine tests as per IS 12615-2018/ IS 15999/ applicable standard with latest amendments, shall be carried on the motors in OEM factory, in witness of client / TPI agency. All type tests certificates shall be furnished during factory test. Generated values of efficiency and power factors at full load, ½ load and ¾ load shall be furnished by the tenderer

DRAWINGS: The contractor/manufacturer shall submit the following documents for review / approval:

- GAD & Preliminary outline dimensional drawings showing details of motor, Terminal box etc.
- Typical cross sectional drawing showing constructional details with complete bill of material and relevant standards.
- QAP, Performance curves, Marking & labeling plate details
- Data Sheets / Guaranteed Technical Parameter.

4.11A CABLES

All power and control cables for use on medium / high voltage shall be heavy duty type, multi strand aluminum / copper conductor. PVC/XLPE insulated, Extruded inner sheathed, armored and overall PVC sheathed as described below.

The Power and Control cables shall have the following minimum overall cross sectional areas:

a.	Meduim Voltage Power	6 sqmm (Aluminium) / 2.5 sqmm (Copper)
b.	Control Cables	2.5 sqmm (Copper)
c.	Lighting Cables	2.5 sqmm (Copper)/6 sq mm aluminium

Cables shall be sized based on the maximum continuous load current and the voltage drop. The derating due to ambient air temperature, ground temperature, grouping and proximity of cables with each other etc. shall be taken into account.

Below grade cables in paved areas shall be in concrete lined trenches with concrete covers having proper slope and suitable drainage arrangement to avoid water collection.

In unpaved areas cables shall be in lined trenches or directly buries in gound. In hazardous areas and transformer bays, trenches shall be completely filled up with sand. Concret lined cable trenches shall be sealed against ingress of liquids or gases wherever the trenches leave a hazardous area or enter control room or substation. The cable trenches shall be sized depending upon the number and voltage grade of cables. Where underground cables cross roadways, pipe sleepers at grade, etc., they shall be protected by being drawn through PVC sleeves/ducts or suitable RCC Pipes to provide a permanent crossing. Pipes laid for mechanical protection shall be sealed at both ends.

High voltage, medium voltage, control and signal cables shall be separated from each other by adequate spacing or running through independent pipes, trenches or cable trays as applicable. Cable trays, racks and trenches shall be sized to allow for 20% future cables. Cable installation shall provide minimum cable bending radii as recommended by cable manufacturer.

Cable route markers shall be installed at every 30m interval all along the routes of directly buried cable trench and also at locations where the direction of cable trench changes.

All power and control cables shall be of continuous lengths without intermediate joints. Where joints are unavoidable, these shall be provided with the permission of Engineer-in-charge. All cables shall carry tag numbers for easy identification. In case of control cables all cores shall be identified at both sides by their terminal numbers using PVC ferrules as per interconnection diagrams.

Sequential marking of the length of the cable in meters shall be provided on the outer sheath at every one meter. The embossing/engraving shall be legible and indelible.
Control cables having 6 cores and above shall be identified with prominent and indelible Arabic numerals on the outer surface of the insulation. Colour of the numbers shall contrast with the colour of insulation with a spacing of maximum 50mm between two consecutive numbers. Colour coding for calbles upto 5 cores shall be as per IS.

A H.T. XLPE CABLES

Scope

- The scope shall cover supplying, laying, testing and commissioning of 3 core cables of circular stranded aluminium conductors, XLPE extruded dielectric, copper tape screened, armoured, Extruded semi conducting compound inner-sheathed and PVC overall sheathed confirming to IS 7098 part 2 with latest amendments. The cables shall be armoured with galvanized steel strip/wire armour.
- Cables shall be capable of operating at a sustained conductor temperature of 90°C and suitable for a maximum conductor short-circuits temperature of 250°C.

Operating Conditions:

Electric system

- System Voltage : 11 kV
- Frequency : 50 Hz.

Environment

- Ground temperature : 35°C.
- Ambient air temperature : 50°C.

- Atmospheric conditions : Humid and dusty

Construction

11 kV grade stranded compact circular Aluminium conductor, Conductor screen with extruded semi conducting compound, cross-linked polyethylene (XLPE) insulated, insulation screening with extruded semi conducting compound in combination with copper tape, GI Flat/ round wire armoured, PVC outer sheathed HT cable as per IS 7098 (part II) with latest amendment.

Cable Marking:

- Embossing on outer sheath:
- The PVC outer sheath shall be legibly embossed / Printed with the legend: "ELECTRIC CABLE 11000 VOLT", cable size, IS specification No., identification of manufacturer and year of manufacture, sequential length marking etc., shall be supplied in non-returnable drums as per IS 10418 standard. Cable identification details as above shall be written on Drums also as per IS.

Testing:

Manufacturer shall carry out Routine tests and acceptance tests in accordance with the relevant IEC standards / IS. Routine / acceptance tests reports shall be furnished before dispatch of cables / supply of cables at site. The copies of Type test results shall be submitted along with each drum length. .

B LT POWER & CONTROL CABLES

- The scope shall cover supply, laying, testing and commissioning of medium voltage XLPE cables.
- All cables shall carry tag numbers for easy identification. In case of control cables all cores shall be identified at both sides by their terminal numbers using PVC ferrules as per interconnection diagrams.

XLPE Insulated Power/ Control Cables (Medium Voltage)

1.1 kV grade Stranded Alluminium / Copper conductor, XLPE insulated, Extruded Innersheath, GI Strip/ wire armoured (Aluminium armoured for Single core cable) LT XLPE cable as per IS 7098 (part I) with latest amendment.

RTD / BTD / Signal Cables:

Vendor is fully responsible for the sizing of all cables in their scope of supply considering factors like maximum distance between Panel/Control Room and the Units/Motors. Specifications for cables for RTD / BTD / Analog signals shall be as follows:

Cables shall be of 660V/1100V grade, single / multi-pair / Triad / Core cables as per requirement. Triad / Multi Core Signal cables shall be annealed, tinned, high conductivity 0.5/1.0/1.5 sq.mm stranded copper conductor, Polyester tapped PVC insulated nos. of cores twisted into pair, laid up collectively, individual pair / triad shielded and overall shielded with aluminum mylar tape, armoured with galvanized steel wire/strip, overall sheathed with PVC, conforming to IS:1554 & IEC:189 Part II.

Splicing and Termination

- Branch circuit wiring shall be spliced only in switch boxes, panel switch socket outlet boxes light fixtures outlets and circular junction boxes. They shall be made only with approved

polycarbonate type connectors. No joints shall be allowed within the conduit pipes, cable entry pipes or ducts for cable laying and wire pulling.

Testing:

Cables shall be tested in accordance with IS: 7098.

Finished Cable Tests at Manufacturer's Works:

The finished cables shall be tested at manufacturer's works. Following routine tests for each and every length of cable and copy of test results shall be furnished for each length of cable along with supply. If specified, the cables shall be tested in presence of client's representative.

1. **Voltage Test:**
   Each core of cable shall be tested at room temperature at 3 kV A.C. R.M.S. for duration of 5 minutes.

2. **Conductor Resistance Test:**
   The D.C. Resistance of each conductor shall be measured at room temperature and the results shall be corrected to 20° c. to check the compliance with the values specified in IS 8130 - 1976.

Cable Test before and after laying of cables at site:-

1. Insulation Resistance test between phases, phase to Neutral and phase to earth.
2. Continuity test of all the phases, neutral and earth continuity conductor.
3. Sheathing continuity test.
4. Earth resistance test of all the phases and neutral.

Sealing and Drumming:

- Cable shall be supplied in non-returnable drums as per IS 10418 standard. Cable identification details like Voltage, size, name, etc. shall be written on Drums also as per IS.

C Cable Accessories

All accessories like cable glands, lugs and terminal markings etc. shall be used conforming to relevant standards / as specified. The end termination for HT cables shall be heat shrinkable type. For 1100 V grade cables, Ni-Plated Brass Double Compression type glands WP to IP-65 as a minimum and tinned copper crimping type lugs shall be used.

D Cable Laying

HV, MV and control cables shall be separated from each other by adequate spacing or by running through independent pipes, trenches or cable trays.

Cable Laying and termination shall be such that chances of cable getting damaged are remote.

LT cable shall be laid in cable tunnel or tray racks or burried underground with appropriate protection. Black shall indicate the neutral, while red, yellow and blue for three different phases. All LT cables when laid on the cable racks shall be properly

dressed and clamped as required without crisscrossing and unnecessary overlapping. Cables shall be properly dressed and clamped.

Laying of HT and LT under ground cables.
Minimum depth of cable trench shall be 750mm for LT cables and 900mm for HT cables.The cables shall be protected by filling trench bottom with a layer of sand after clearing the bottom from all rocks, stones and sharp objects, before the calbes are placed. These sand shall be leveled and cables laid over it. These cables shall be covered with 150mm of sand on top of the largest diameter cable and sand shall be lightly compacted. A flat protective cover of 75mm thick second class red bricks shall then be laid and compacted and then remainder of the trench shall then be backfilled withy soil, rammed and leveled.

In routing, necessary barriers and spacing shall be maintained for cables of different voltages in case they lie side by side. Telephone cables shall cross the power cables only at about right angles and these two shall not run in close proximity.

LT cables shall be bent in radius not less than 12 times their individual overall diameters, while HT cable shall have bends not less than 15 times their individual overall diameter.

Cable routing between cable trench and equipment/motors shall be taken through GI pipe sleeves of adequate size. Pipe sleeves shall be laid at an angle of maximum 45 Deg to the trench wall. Bending radii of pipes shall not be less than 8D. It is ensured that both ends of the GI pipe sleeves shall be sealed with approved WP sealing plastic compound after cabling. In places where it is not possible, cables shall be laid on smaller branch trays.

All cable shall be identified close to their termination point by cable tag numbers as per cable schedule. Cable tags shall be punched on aluminium straps (2mm thick, 20mm wide of enough length) securely fastened to the cable and wrapped around it.

Routes of these cables shall be arrived at on the basis of the relevant drawings and after consulting the Engineer in charge.

E Drawings and Schedules

Size of cables shall be given in singe line power diagrams. A cable schedule shall be prepared on the basis of relevant drawings. All cables and wires shall be adequately sized to carry continuously the normal currents expected on the relative circuits. All trenches for electrical cables shall be separate from water or sewage pipe line trenches.

F Splicing and Termination

Straight through joints shall be avoided. In case, these are absolutely necessary they shall be made at convenient locations suitably protected as approved and sanctioned by the Engineer in charge but in no case within the conduit pipes or ducts. Branch circuit wiring shall be spliced only in switch boxes, panel switch socket outlet boxes light fixtures outlets and circular junction boxes. They shall be made only with approved porcelain connectors.

Cables shall be tested in accordance with IS : 1554 / 7098

4.11B CABLE ACCESSORIES & OTHER EQUIPMENT

This defines specifications and requirements mainly for the equipment and accessories, which are generally supplied by the erection agency.

- All materials, accessories, consumable to be supplied by the contractor shall be selected from the list of specified make and shall conform to the specification given here under.
- The equipment shall be manufactured in accordance with current Indian Standard specifications wherever they exist or with the BS or NEC specifications, if no such IS standards are available. In the absence of any specification, the materials shall be as approved by the owner / consultant or his authorized representative.
- All similar materials and removable parts shall be uniform and interchangeable with one another. Makes of bought out items selected by the contractor must be approved vender list of tender.

Cable Trays:

- These shall be channel type, fabricated from structural steel, hot dip galvanised, complete with all accessories such as bends, tees and reducers.
- MS / Aluminium flat clamps with G.I. / Chrome plated bolts, nuts/screws to be used for clamping cables.
- Sizes of these trays shall be as specified in bill of quantities/ drg. or approved by client.
- Size 150mm and above shall be ladder type and below 150mm shall be perforated type.
- Collar size of the ladder type cable tray shall be 100mm and 50mm for perforated type.

Cable Glands:

- Cable glands shall be heavy duty double compression type of Ni-Plated brass. These shall be suitable for armoured/Unarmoured cables, which are being used.

Cable Connectors:

- Cable connectors, lugs/sockets, shall be of copper/aluminium alloy, suitably tinned, solder less, crimping type.
- These shall be suitable for the cable being connected and type of function (such as power, control or connection to instruments etc.).

Cable Indicators

- All cables shall be identified by cable tag of 2 mm. thick, 15 mm wide of enough length of Aluminium straps securely fastened to the cable. PVC identification number, ferrules shall be used for each wire.

G.I. Pipe for Cables:

- For laying of cables under floor, Med. Duty G.I./UPVC/RCC pipes shall be used.
- Pipe shall be laid at on angle of max. 45 deg. to trench wall. Both ends of pipe shall be sealed with approved W.P. Sealing plastic compound after cabling work.
- Size of pipe shall depend upon the overall outer diameter of cable to be drawn through pipe.
- To determine the size of pipe, assume that 40% area of pipe shall be free after drawing of cable.

4.12 LOCAL CONTROL (PUSH BUTTON) STATION

Each motor shall be provided with a local control station in the field near the motor.

Construction Features:

- Push Button & related control switches shall be as per IS-6875.
- The local push button station / local control station (LCS) shall have Polycarbonate/ FRP / die-cast Aluminium enclosure or as specified in BOQ, IP 65 with gland plate with knock out holes suitable for outdoor application.
- All control stations shall be suitable for 10 A continuous current rating 240V AC as well as 110V/220V DC control supply.
- All push buttons shall be fitted with 2NO + 2NC rated to carry and break 6 Amps at 415 Volts (10 A at 240 V AC)
- The open/close/start push buttons shall be of the momentary contact push to actuate type and shall be green in colour.
- The stop push buttons shall be stay put type with mushroom knob and lockable in pressed position and shall be red in colour.
- All ammeters shall be of moving iron type having an accuracy class of 1.0 and suitable for 1 ampere CT secondary. The size of ammeter shall be 72mm x 72mm or minimum 65mm dia. The ammeter front glass shall be toughened/ shall be transparent Acrylic.
- 20% spare or minimum 2nos. Spare terminals shall be considered.

Type of Push Button Stations

Type of LCS	Application	Features required in LCS
Type-A	Motor without VFD	Start & Stop PB
Type-B	Motor with VFD	Start, Stop, Speed Increment & Speed Decrement. Ammeter if specified in BOQ / Scope of Work for Motor rated above 30KW.
Type-C	Motor above 30KW	Start, Stop PB. Ammeter if specified in BOQ / Scope of Work.
Type-D	MOV	Open, Close and Stop PB
Type-E	Reversible Motor	Forward, Reverse and Stop PB

4.13 SPECIFICATION FOR JUNCTION BOX:

Construction Features:

- The Junction Box shall be with Sheet steel enclosure of minimum 2 mm thick (14 SWG) and shall be with Canopy of 2mm for outdoor application. The enclosures shall be painted with two coats of epoxy paint with final colour shade (both internal and external) of Siemens grey shade RAL 7035 of minimum paint thickness 100 micron.

- Separate Junction box shall be provided for power and control cable termination.
- The boxes shall have Aluminium busbars supported on insulators suitable for termination of Power cables and Terminal connectors of required size for termination of control cables.
- The bus bar connections shall be suitable for terminations of Submersible pump motor flat cable / PVC/ XLPE copper cables and Armoured cable from PMCC/starter as per requirement. Double compression gland and Aluminium/ copper lugs shall be used for termination.
- Minimum 20% or minimum 2 Nos. (whichever is higher) of spare terminals shall be supplied in junction boxes for each size of terminals.
- JB shall be Wall / Stand mounting with Zinc passivated Bolts & nuts and earth terminals as per IS and name plate as required.
- Junction box shall be mounted on ISMC / Steel structure.

4.14 INTERNAL AND EXTERNAL ILLUMINATION.

General

The illumination system shall consist of lighting poles, lighting distribution boards, lighting panels / power panels complete with FSU/ELCB/MCB, Fixtures, Cables, Junction Boxes, terminal blocks, cable glands, 3 pin 5A/15A convenience socket outlets, conduits and accessories and supporting and anchoring materials, lighting fixtures with fluorescent tubes, sodim vapour lamps, wires, etc. All materials, fittings and appliances use in electrical installation shall conform to the relevant IS specifications, required area classification and environmental conditions and shall be anticorrosive painted / FRP enclosures.

The wiring for lighting circuits shall be done by wires run in PVC conduits for indoor areas. For outdoor lighting, wiring shall be done by armoured cables.

Illumination Level

The following minimum levels of illumination (avg. lux level) shall be provided in the respective areas :

	Area / Building	Illumination Level
a)	Pump House / Centrifuge or Press Area / Sheds / Blower Room	150 Lux
b)	Control Room / Laboratory	300 Lux
c)	Office	200 Lux
d)	Switchgear/MCC Rooms	200 Lux
e)	Sub-Station (Switchyard)	50 Lux
f)	Toilet block / Wash Room etc.	100 Lux
g)	Roads / Walkways	10 Lux
h)	Yard / Outdoor Area	10 Lux
i)	General Process / Outdoor Eqpt. Area	100 Lux

The lighting fixtures offered shall comply with the following requirements.

a) Luminaries shall have high efficiency Lumen Output/Watts

b) Enclosures shall preferably be FRP / Cast Aluminium with corrosion resistance paints.

c) All indoor and outdoor lighting fixtures shall be power saving long life LED type only.

All lighting fixtures shall be supplied complete with control gear and lamps. Special fixtures, wherever required to meet operational requirements, aesthetics etc. shall also be provided by the bidder. Make of lighting fixture shall be embossed on each lighting fixture.

Lighting wiring between LDB / SB and lighting fixtures shall be done by PVC insulated, copper wire (phase, neutral and earth) for non-plant buildings which shall be through surface run / concealed conduit. All lighting cables shall be 3C x 2.5 sqmm, 660 / 1100 V grade, copper conductor, PVC insulated, armoured type. Conduit wiring shall be done in 25mm dia minimum 16 gauge black enamalled steel structure conduit or PVC concealed conduit, with 1100V grade PVC insulated copper wire of min. size 2.5 sqmm for fixtures / 5A receptacles and 4 sqmm for power sockets. Not more than 7 wires shall be accommodated in each conduit. All lighting fittings / convenience outlets shall be earther through the third wire / separate core in conduit/cable.

On walkway, platforms and other outdoor areas, lighting fixtures shall be nearer to landing of stairs or ladders, gauges, flow meters, panel boards or other equipment requiring good illumination. In outdoor equipment area at ground level, lighting fixtures shall be mounted preferably 4m above floor level. Where this is impracticable, the minium height of any lighting fixture shall not be less than 2.5m. Socket outlets in process plant areas shall be approximately 1200mm above floor level and 300mm above floor level in office area. Lighting/Power panels shall be mounted such that the top of the panel is 1800mm above finished grade. Control grears of lighting fixtures with separate control gear shall be mounted at suitable height from ground / platform for easy access / maintenance.

All lighting circuits and convenience receptacles shall be fed from lighting / power panels. Main/Lighting Distribution Board (MDB/LDB) shall be dust and vermin proof and shall be provided with SFUs (HRC) / MCCB as incomer and outgoing feeders where fault level is more than 9kA.

Main and Branch Distribution Boards: Each Main DB should be provided with 4 Pole Isolator as Incomer and DP ELCB+MCB as Out going circuit in each phase and all sub DBs should be with Isolator+ ELCB as in comer and MCB as Outgoing to control and for protection of lighting circuits. All DBs should be Double Door type – a hinged door to cover the operations knobs shall be provided. MCBs shall not be loaded beyond 80% of rated capacity. A minimum of 20% MCB in each panel shall be kept as spare. Power and lighting panel shall be of 16 gauge sheet steel construction and shall be suitable for surface or flush mounting.

All outdoor lighting shall be automatically controlled by means of synchronous timers with manual override control. Normally about 8-10 fixtures shall be wired in each circuit. Lighting feeders requiring automatic control shall be provided with contactors of suitable rating.

Sufficient number of Three Pin type 5A/15A receptacles as per IS;1293 shall be provided. Flush mounting type receptacle shall be used where concealed wiring has been adopted and surface type shall be used for other areas. For exhaust fans and wall mounted air cirucaltors, socket and switch enclosure shall be separate where as for rest receptacle and controlling on/off switch shall be mounted in the same enclosure. In building such as Sub-station, D.G. Shed, Workshop, maintenance shop, etc. industrial type metal clad socket outlets and plugs shall be provided. The sockets shall be supplied complete with plugs.

Adequate number of ceiling fans of 1200mm sweep (with double ball bearing and regulator)shall be provided in offices and rooms allocated to operating and maintenance personnel etc. In places where ceiling fans are provided, lighting fixtures shall be suspended below fan level with the help of conduits / chains to avoid shadows on the floor.

Minimum 2 nos. or sufficient exhaust fans as required during detailed engg. / recommended by equipment manufacturer shall be provided at Battery room, laboratory room, Sub-station/Switchgear/MCC room, DG room, all pump houses, filter house, etc. The exhaust fans shall be provided with louvers / net to prevent insects. For pump house below ground level, suitable GI ducts for exhaust shall be provided as decided during detailed engineering and instructed by Engineer-in-charge.

Lux Levels shall be maintained at various Locations as indicated above and shall be backed up by Calculations from Manufacturer.

Switch Box :
Switch Box shall be made of metal on all sides, except on the front.

In the case of cast boxes, wall thickness shall be at least 3 mm and in case of welded mild steel sheet boxes the wall thickness shall not be less than 18 gauge for boxes, upto a size of 20 cm x 30 cm and above this M.S. boxes having minimum sheet thickness of 1.6mm shall be used. Switch boxes shall be galvanized after fabrication. Except where otherwise stated 3 mm thick phenolic laminaged sheets like summica shall be fixed on the front with brass screws. Clear depth of the box shall not be less than 60 mm and this shall be increased suitably to accommodate mounting of fan regulators inflush pattern. All fittings shall be flush pattern. It shall be provided with adequate number of knock outs on all sides for ease of wiring either with conduits or without conduits.

Wiring / Conduit System

Surface Conduit Wiring System
PVC conduits pipes of approved minimum 1.6mm wall thickness shall be used. The maximum number of The minimum PVC conduit diameter shall not be less than 25 mm. Maximum number of wires permissible in a conduit shall be seven/nine for wire size of 2.5 sqmm/1.5 sqmm respectively.

In long distance straight run of conduit, inspection type junction box at reasonable intervals shall be provided.

Fixing of Conduit

Conduit pipes shall be fixed by heavy duty G.I. pressure saddle with screws in an approved manner at an interval of nore more than one metre but on either side of the couplers bends, or similar fittings, saddles shall be fixed at a distance of 30 cm from the centre of such fittings. The saddle should not be less than 20 gauge for conduits .

Where conduit pipes are to be laid along the trusses, steel joints etc. the same shall be secured by means of ordinary clips or girder lips as required by the Engineer-in-Charge. Where it is not possible to drill holes in the truss members, suitable clamps with bolts and nuts shall be used. The width and the thickness of the ordinary clips or girders clips and clamps shall not be less than as stated below :

Recessed Conduit Wiring System.

Recessed PVC conduit wiring system shall comply with all the requirements of surface conduit wiring system specified in clauses above and in addition to the requirements specified in the following clauses.

The chase in the wall shall be neatly made and of ample dimensions to permit the conduit to be fixed in the manner desired. In the case of buildings under construction, fixed work, specials care shall be taken to fix the conduit and accessories in position along within the building work, to avoid damage to the finished wall etc.

All outlets such as switches, wall sockets etc. shall be flush type

The outlet box shall be same as above and shall be mounted flush with the wall. The metal box shall be efficiently eathed with conduit by an approved means of each attachment.

To facilitate drawings of wire in the conduit. GI mesh wire of 10 SWG shall be provided while laying of recessed conduit.

Lighting Poles

- **Steel Tubular swaged type:**

Street light poles shall be steel tubular swaged type made from GI pipe conforming to IS:1239 medium class and made as per IS:2713.

Street light pole, steel tubular swaged type, 9 / 7.5 / 6 meter long (6 / 4.5 / 3.0m x 1.5m x 1.5m) 139.7mm, 114.3mm, 88.9mm dia respectively, 4.85mm, 3.65mm, 3.25mm thick respectively, with M.S. base plate

- **Steel Octagonal Type:**

Steel octagonal pole with base plate made from CR sheet steel. The pole should be made as per IS and shall be coated with hot dip galvanizing as per IS 2629/4759 with required base plate and suitable to sustain local wind speed.

Lighting poles shall be of octagonal poles made from sheet steel confirming to BSEN 10025. Internal & external surface of octagonal pole shall be hot dip galvanized to min. 65 micron DFT. Octagonal poles shall be provided with base plate & provision for fixing foundation bolts. Base plate shall be as per IS 2062. All poles are tapered octagonal & shall be in single section.

The street light poles shall have min. 6.0m height, Top dia. – 70 mm, Bottom dia. – 130 mm. & 3 mm thickness sheet with bracket for mounting the light fittings & all required accessories. Base plate of min. dimension 200 mm x 200 mm x 12 mm.
The Flood light poles shall have min. 9.0m height, Top dia. – 70 mm, Bottom dia. – 155 mm. & 3 mm thickness sheet with bracket for mounting the light fittings & all required accessories. Base plate of min. dimension 260 mm x 260 mm x 16 mm.

All poles shall be supplied along with pipe cap, single/double arm of 1/0.5m height & and over hung 1/1.5m long GI pipe having dia. to suit the socket of 250/150/70W etc, 240V, HPSV/LED/MH/HPMV lighting fixture as applicable and with:

1. PVC junction boxes on pole with 8 way connector & 1 no. 4 A SP MCB.
2. Street light pole shall be as per approved drg.
3. Internal pole wiring with 3 core 1.5/2.5 sqmm flexible stranded copper conductor, FRLS insulated wire from junction box to up to Street light / Flood light / fixture as required.

Balancing of Circuits

The balancing of circuits in three phase installations shall be arranged before hand to the satisfaction of Engineer in charge.

Drawings

All wiring diagrams shall indicate clearly in plan, the main switch board, the distribution fuse board, the run of various mains and sub-mains and the position of all points with their classification.

Rating of Lamp, Fans, Socket Outlet Points and Exhaust Fans

Lamps installed in pump house & other means shall be LED Type only.

Table fans and ceiling fans shall be rated at 60 watts. Exhaust fans shall be rated according to their capacity.

5 Amps. Socket outlet points and 15 amp. Socket outlet points shall be rated at 100 watts and 1000 watts respectively, unless the actual values of load are known or specified.

Capacity of Circuits

Lights and fans may be wired on a common circuits, such circuit shall not have more than a total of ten points of light, fan and socket outlet or a load or 800 watts whichever is less.

Power circuits on buildings shall be designed with a maximum of two outlets per circuit, based on the loading.

Where, not specified the load shall be taken as 1 kW per outlet. Wherever the load to be fed is more than 1 kW it shall be controlled by an isolator switch or mini ature circuit breaker.

Indoor & Outdoor Light Fixtures / Lightings:

LED fixtures shall be generally having

- LED luminous Efficacy lumens/watt: - 100% min.
- Efficiency of Electronics system :- 80% - 85% min.

- LED Lamp/Light efficiency :- 85% - 90% min.
- Total Harmonic Distortion :- For Outdoor Fittings - ≤ 20%
  For Indoor Fittings - ≤ 20%
- Power Factor :- ≥ 0.85
- Colour Rendering Index (CRI) :- ≥ 70
- Colour temperature / apparent : ≥ 5700K (Cool day light)
- Radiation :- No Ultra-Violet (UV) or Infra-Red (IR)
  :- No RF to interfere with radio equipment
- LED Life :- Long Life, generally 50,000 Hrs.
- RoHS compliant, Eco-Friendly green technology, Mercury free
- Outdoor LED fixtures must be fully enclosed with minimum IP Rating of IP66/65 (Weatherproof). LED optical system must be gasketed (enclosed) to minimize light dirt depreciation.
- Electrical safety for outdoor LED Lights shall be of Class-IK.
- Luminaries must be clearly marked with manufacturer name, model number, electrical rating and agency approval (If applicable - CSA, UL, etc.).

Industrial Luminaire

Indoor LED wall mounting Industrial Luminaire shall be LED Type minimum 10watt to 48Wattage:
Each fitting shall be required LM-79 & LM-80 Certificates.

Tube Light shall be 20Watt or higher wattage with integral / non-integral driver, Surge-4KV,IP-20, 4 feet, with LEDs of wattage 0.2 Watt to 0.5 Watt assembled on single MCPCB, with housing used as a heat sink shall be made of thick sheet Steel conforming to IS: 513/CRCA polyester powder coated and high U.V. & corrosion resistance with diffuser and/or Polycarbonate optics with company mark/name.
120 to 300 V,Power Factor more than 0.9, THD < 20%
CCT 4000 K to 6500K, Uniformity ratio >0.7,
Luminaire efficacy> 85 lumens/watt ,
LED driver efficiency > 85 %

Fixtures shall be with earthing arrangement facility suitable for ceiling or pendant mounting suitable for 19 mm conduit with stove enameled reflector gray outside and white inside which can be installed without aid of any; tools, complete in all respects and ready for use.

Emergency Light

Emergency light unit working on 230 volts. A.C. supply shall be self containing LED type of minimum with 20 watts 600 mm long type 'SWITCH ON MAIN FAILTURE. It shall be electronic automatic type which incorporates a unit trickle charge circuit, which shall prevent over charging or battery The battery shall be maintenance free. The unit shall provide 4 hours illumination following power failure. The units shall generally conform to IS:9583.

Gate Lights

The gate lights shall be post top lantern LED type, weather proof and shall be suitable for use with one number 40 watt LED and asthetics appearance shall be as per approved by Engg.-in-charge of client.

Post Top Lantern LED fitting comprises of Copper dust finish cast aluminum spigot and spun aluminum canopy fixed with opal polycarbonate, pipe arrangement for vertical mounting,open construction driver and accessories wired upto terminal block.
The post top lantern shall be suitable for use with one number 40 watt LED.

G.I. Pipes of suitable dia. Shall be provided at gate concrete pillar as conduit for wiring and fixing post top lantern luminaire.

Outdoor Yard / Road Lighting:

Outdoor Luminaire
The luminaire shall be LED Type with minimum 40watt to 240watt LED complete with all accessories and each Street light / Flood light Industrial Luminaire shall be IP-65 & Surge -4KV & shall be required LM-79 & LM-80 certificates.

LED Outdoor Street light / Flood light / well glass Industrial Luminaire shall be with High power White LEDs wattage of 1Watt and above assembled on single MCPCB, efficiency more than 130 lm/w and corrosion free High pressure die cast aluminum housing with smooth finish powder coated and heat sink extruded aluminium with diffuser and Polycarbonate optics/ lenses with company mark/name engraved or embossed
120 to 300 V,Power Factor more than 0.95, THD < 20%, CCT 5000 K to 5700K,
Uniformity ratio >0.45, Luminaire efficacy> 85 lumens/watt . LED driver efficiency > 85 %.

LED LIGHTINGS:
LED fixtures shall be generally having

- LED luminous Efficacy lumens/watt: - 100% min.
- Efficiency of Electronics system :- 80% - 85% min.
- LED Lamp/Light efficiency :- 85% - 90% min.
- Total Harmonic Distortion :- For Outdoor Fittings - ≤ 20%
  For Indoor Fittings - ≤ 20%
- Power Factor :- ≥ 0.85
- Colour Rendering Index (CRI) :- ≥ 70
- Colour temperature / apparent : ≥ 6500K (Cool day light)
- Radiation :- No Ultra-Violet (UV) or Infra-Red (IR) radiation
  :- No RF to interfere with radio equipment
- LED Life :- Long Life, generally 30,000 – 50,000 Hrs.
- RoHS compliant, Eco-Friendly green technology, Mercury free
- LEDs shall produce almost no heat, nearly all of the energy used shall be converted to Light.

- Outdoor LED fixtures must be fully enclosed with minimum IP Rating of IP66/65 (Weatherproof). LED optical system must be gasketed (enclosed) to minimize light dirt depreciation.
- Electrical safety for outdoor LED Lights shall be of Class-IK.
- LED Light/Lamp shall be capable of resisting Mechanical vibration and shock.
- The PCB containing the electronics should be capable of solder free installation and replacement.
- Luminaries must be clearly marked with manufacturer name, model number, electrical rating and agency approval (If applicable - CSA, UL, etc.).
- Lamps shall only be used and installed accordance with manufacturer instructions (If applicable).

4.15 EARTHING SYSTEM

1 Earthing system design and installation shall generally be as per IS:3043. All metallic non current carrying parts of electrical apparatus, current and potential transformer secondaries, columns, vessels, towers, stacks, storage tanks, etc. shall be earther atleast by two distinct separate earth conductors from the earth plate connected to main earthing loop.

2 The main grid conductor shall be hot dip galvanized MS flat. The amount of galvanizing shall be minimum 610 gm per sqm. The main earth loop shall be laid at a depth of 500mm below grade level.

Earthing conductor shall be laid around the battery limit of the plant. Horizontal conductors shall be laid in both longitudinal and transverse direction to facilitate earthing of various equipment in most economical and reliable manner.

Cable Trays in process areas shall be earthed with the help of risers emerging from main earthing conductors laid below/adjacent to structures carrying calbe trays. Trays shall be earthed at an interval of approx. 30m and in any case shall be connected to the earthing grid at minimum two points.

Joints and tappings in the main loop shall be made in such a way that reliable and good electrical connections are permanently ensured. All joints below grade shall be welded and suitably protected by giving two coats of bitumen and covered with hessian tape.

3 Adequate number of min. 65mm dia. or higher size as per IS:3043, 3m long GI pipe earth electrodes with earth pit shall be provided. All earth electrodes shall preferably be driven to a sufficient depth to reach permanently moist soil.

4 Multiple earth connection shall be taken from suitably located earth plates connected to earth loop. All hardware used for earthing installation shall be hot dip galvanized or zinc passivated. Spring washers shall be used for all earthing connections of equipment. Unless otherwise specified, earthing connections to individual equipment shall be done in accordance with standard equipment earthing schedule.

5 Lightening protection shall be provided for equipment, structures and buildings as per IS:2309. Self-conducting structures may not be provided with aerial rod and down conductors but shall be connected to the earthing grid at minimum two points of the base. An independent earthing network shall be provided for lightening protection and this shall be bonded with the main earthing network minimum at two points at the buried electrodes.

6 The resistance value of an earthing system to the general mass of earth for the electrical system and equipment shall be as follows:

a) For the electrical system and equipment a value that ensure the operation of the protective device in the electrical circuit but not in excess of 5 ohms. However, for generating stations and sub-stations this value shall not be more than 1 ohm.

b) For lightening protection, the value of 5 ohms as earth resistance shall be desirable, but in no case it shall be more than 10 ohms.

7 **Connection**

The earth system connection shall generally cover the following:

Equipment earthing for personnel safety
System neutral earthing
Static and lightning protection
System neutral
Current and potential transformer secondary neutral
Metallic non-current carrying parts of all electrical apparatus such as transformers, switchboards, bus ducts, motors, neutral earthing resistors, capacitors, UPS, battery charger panels, welding receptacles, power sockets, lighting/power panels, control stations, lighting fixtures, etc.
Steel structures/columns, etc.
Cable trays and racks, lighting mast and poles
Storage tanks, vessels, and all other process equipment
Fence and Gate for electrical apparatus (e.g. transformer, yard, etc.)
Cable shields and armour
Shield wire

All main earthing shall be used for earthing of equipment to protect against static electricity.

All medium (LT) and high voltage (HT) equipment (above 250V) shall be earthed by two separate and distinct connections with earth.

Plant instrument system clean earthing, UPS system clean/safety earth shall be separate from the electrical earthing system.

All earthing connections for equipment earthing shall preferably from the earth plate mounted above ground wherever provided. Equipment foundation bolts shall not be used for earthing.

Earth connections shall be made through compression type cable lugs / by welded lugs.

All hardware used for earthing installation shall be hot dip galvanized or zinc passivated. Spring washers shall be used for all earthing connections and all connections adequately locked against loosening.

Lighitng fixtures and receptacles shall be earthed through the extra core provided in the lighting circuit/cable for this purpose.

The reinforcements of sub-station building and sub-station floor shall be connected to main earth grid.

The earth electrodes shall be situated at a distance not less than 3.0 m from the building fencing structure and equipment foundations. The surrounding the electrodes, soil shall be treated up with salt, coke and charcoal. The distance between two electrodes shall not be less than twice the depth of electrode.

Minimum requirement of earth pits as per I.E. rules are as under.

Two numbers independent for transformer body

Two numbers independent for transformer netural
Two numbers independent for four pole structure.

One number for lightning arrestors.

Two numbers for L.T. panel at sub-station and at pump house.

The main earth electrodes after being driven into the ground shall be protected at the top by constructing a concrete or block masonry chamber of size 300 mm x 300 mm x height 300 mm shall be provided with CI cover. The resistance of any point in the earth continuity system of the installation to the main earth electrode shall preferably not exceed 1.0 ohm. The remaining space in the bore hole shall be filled with bentonite. The bentonite will hold the earth road in position., The neutral conductor shall be insulated throughout and shall not be connected at any point to the consumers earthing system.

It shall not be allowed to use the armour of the incoming feeders cable to the sub-distribution board as the only earthing system.

Sheathed lugs of ample capacities and size shall be used for all underground condutors for sizes above 3 mm^2 whenever they are to be fitted on equipment of flat copper conductor.

The lugs shall be fitted on equipment body to be grounded or flat copper only after the portion on which it is to be fixed is scrubbed, cleaned or paint or any oily substance on a subsequently tinned.

No strands shall be allowed to be cut in case of stranded ground round conductors. GI embedded conduits shall be made electrically continuous by means of good continuity fixing and also rounding copper wires and approved copper clams.

8 Earthing of Lighting Poles

All external poles are to be looped together with continuous 8 SWG GI earth wire clamped a dollies provided on every fuse box of poles and looped onwards to the other pole. Every fifth pole shall be connected to earth through an earth electrode.

9 Recommended Size of Earthing Conductors

Below are the recommended minimum sizes of earth conductors. However, Earthing Strips/conductors, if required of higher size as per Ground Fault Calculations, should be laid as per BOQ or as per site requirement.

Type of Equipment	**Earth conductor size (See Note-1)**
Motors upto 3.7KW	8 SWG solid GI wire
Motors from 5.5KW to 30KW and welding receptacles	10mm dia GI wire rope
Motors above 37KW	16mm dia GI wire rope or 40 x 5 mm GI strip
Building columns,fencing	40 x 5 mm GI strip
Storage Tanks (Vert./Hor.) / Vessels	40 x 5 mm GI strip
Small equipment and instrument	8 SWG GI solid wire
Lighting, Power and Instrument Panels	10mm dia GI wire rope
Main Earth Bus / LT & HT Switchgear Interconnections / Power Transformer	75 x 8 mm GI strip
HV Sub-stations	50 x 6 mm Cu for Neutral 75 x 8 mm GI strip for rest
Push Button Stations (LCS)	8 SWG GI solid wire
Street Light Poles	8 SWG GI solid wire
Lighting Transformer	16mm dia GI rope
Pipe Rack	40 x 5 mm GI strip
Bonding of pipe	25 sqmm insulated flexible Cu cable

Note:

1. Earth connection to individual equipment from nearest earth plate / grid may also be done alternately using aluminium/copper conductor PVC insulated core of size note less than half the cross section of the respective power cable to equipment (motor, panel, etc.). Connections shall be made using crimpt type lugs.
2. No. of runs of Cu / GI earthing strips shall be as per ground fault calculations
3. The size of strip mentioned may be changed as per availability meeting the minimum area requirement of specified size of strip / conductor.

Maintenance Free Safe (Chemical Type) Earthing System:

- Chemical type earthing electrode shall be used for equipment body earthing. It shall be made with steel core and a copper exterior to provide increased conductivity and corrosion resistance. The electrodes shall be minimum 3 meter length, 17 mm diameter with 99.9% pure electrolyte copper coating of minimum 250 microns & ANSI / UL 467 approved. Adherence of copper to steel rod is achieved through a pioneered bright acid copper plating process using 14 stations using proper current densities, temperature and brightener additives

to achieve copper plating with finer grain structure and a smoother, harder and more uniform surface. It shall have minimum tensile strength of 80,000PSI and straightness tolerance 0.01" per linear foot and shall meet the requirement of ANSI / UL 467, CSA and ANSI / NEMA.UL logo and control number where applicable shall be stamped on each rod for easy inspection after installation. The rod shall be tested according to IEC-62561-2 and comply to the requirements of IEC-60364-5-54.The rods also should withstand short circuit currents. All fasteners used should confirm to the requirements of the above standards.

- Back filling compound used shall have resistivity less than20 ohm-cm in its set form.Earth resistance shall be remained same over a wide temperature variation of -60 deg to +60 deg.It shall be suitable to absorbs and retains moisture for long time and shall reduced soil resistivity, Dissipate fault current very fast, Eliminate needs of salt and chemical around electrode and maintain compatibility of soil and rod contact. Earth enhancing compound (Soil conductivity improver) used should be tested according to IEC62561 – 7 from an NABL accredited laboratory. Exothermic welding material used shall be tested as per IEEE 837

Construction Procedure of Chemical Type Earth Pit:

- A hole of 100 to 125 mm dia. shall be augured / dug to a depth of about more than 3 meters or as per instruction of Engineer in-charge.
- Earth electrode of minimum 3 meters length shall be placed into this hole.
- It will be penetrated into the soil by gently driving on the top of the rod. Here natural soil is assumed to be available at the bottom of the electrode so that min 150 mm of the electrode shall be inserted in the natural soil.
- Earth Enhancing material (min. 20 KG) shall be filled in to the augured /dug hole in slurry form and allowed to set. After the material gets set, the diameter of the composite structure (earth electrode + Earth Enhancing material) shall be of minimum 100 mm dia. covering entire length of the hole.
- Remaining portion of the hole is filled with backfill soil which is taken out during auguring / digging
- Construction of masonry earth chamber and cast iron cover with earth resistance result with date or as per instruction of Engineer In-charge.
- For interconnection to the main earthing grid, 40X 5 mm thick copper clamp shall be provided.

A) PIPE-IN-PIPE Technology Safe earthing:

- Two pipes of Co-Axial diameters joined together for enhancing the service life and performance of the overall earthing system.
- The cavity in between the electrodes shall be filled with crystalline conductive compounds for current dissipation and anti-corrosive properties.
- The electrode cross section shall be circular for the uniform distribution of fault current all-around from electrode to earth.
- Inner pipe of length 3 M shall be Hot dip galvanized / zinc coated with minimum galvanizing thickness 80 - 100 micron OR Copper plated (minimum 250mm) as per Drawing/BOQ. Minimum Size of pipe as per Drawing/BOQ.
- Outer pipe of length 3 M shall be Hot dip galvanized / zinc coated (minimum 150 micron) OR Copper plated (minimum 250mm) as per Drawing/BOQ. Minimum Size of pipe as per Drawing/BOQ.
- A hole of 200mm -225 mm dia. shall be augured / dug to a depth of about more than 3 meters or as per instruction of Engineer in-charge.

- Earth enhancing compound of minimum 50 KG shall be filled. **Earth enhancing compound shall be filled till top of Earthing Pipe electrode.**

B) Plate Type Earthing Stations:

- The earthing station shall be as per drawing / IS: 3043. The Equipment neutral earthing shall be with copper plate earthing station.
- The plate electrode shall be 600 x 600 x.3.15 mm copper plate for neutral earthing.
- The earthing conductors shall be of copper strip in plate type earthing.
- G.I. pipe with funnel of good quality shall be used for watering the earthing electrodes / stations.
- The brick masonry chamber with chequered plate shall be provided for housing the above referred funnel and pipe.

Earthing Unit Measurement:

- Earthing station / pit complete with excavation, electrode, watering pipe, soil treatment, masonry chamber with cast iron cover etc. as per tender specification / drg. shall be treated as one unit.
- Different sizes of stripes / wires per unit length covering / including cost of interconnection the earthing station to earthing grid, and to respective equipment with fixing accessories like earthing clamps, saddle, labour, etc. shall be traded as unit length.
- The earth system connection shall generally cover the following:
    1. Equipment earthing for personnel safety
    2. Transformer, DG and System neutral earthing
    3. Static and lightning protection
    4. Current and potential transformer secondary neutral
    5. Metallic non-current carrying parts of all electrical apparatus such as transformers, switchboards, bus ducts, motors, neutral earthing resistors, capacitors, UPS, battery charger panels, welding receptacles, power sockets, lighting/power panels, control stations, lighting fixtures ceiling fan & exhaust fan, Street light, flood light pole circuit / cable.
    6. Fence and Gate for electrical apparatus (e.g. transformer yard, etc.)
    7. Cable shields armour& Shield wire.

Scope also include followings:

The scope of work shall also cover supply, laying, installation, connecting, testing and commissioning of:

- Plate (600 x 600 x 3.15 mm Copper plate)/ Pipe type (Chemical type) Earthing station with G.I Pipe / Copper plate of size as per tender / IS.
- Earthing Copper strips from Plate earthing station & Hot dipped G.I strip for Pipe earth, to equipotential bar / earth grid.
- Earthing G.I / Copper strips / wires from earth grid / equipotential bar to power panels, DBs, motors, Indoor / Outdoor lighting systems, etc.
- Bonding of Non-current carrying parts, and metallic parts of the electrical installation.
- Qty. of pits mentioned are minimum or higher as per soil resistivity. Measurement of soil resistivity to be carried out by contractor at no extra cost.
- All the earthing material and installation&construction of Earth Pit, chamber etc.shall be as per IS 3043 and tender.
- Galvanising thickness shall be 86 micron & 610 g/m2 as a minimum.

4.16 SAFETY EQUIPMENTS TO BE PROVIDED

The contractor shall provide safety equipment for HV panels, Generator panels, LT/Control panels, etc. as per statutory requirement. Geneally following shall be provided as a minimum (forming part of scope of this work):

- Supply and spreading Synthetic Rubber mat, 1 mtr wide, 2mm thick, conforming to IS:15652 Class-A for 1.1kV LV voltage in front of LT Panel/ APFC/ MCC Etc
- Supply and spreading 1 mtr wide 2.5mm thick synthetic insulating mat as per IS 15652 (Class-B)suitable for operation of 11KV equipments in front of all the HT panel for their entire length.. The insulating mat should have ISI mark on every one meter.
- Pairs of electrically tested 22 KV rubber gloves. These are to be kept in a suitable wooden box.
- A shock treatment instruction chart in English and local language duly framed as detailed in IS:1355. Detail of the nearest medical facility available with phone number shall also be kept.
- First aid box containing First aid kit for treatment of electrical burns in the main switch room.
- ABC powder type 'Ceasefire' portable type Fire Extinguishers as per IS:13849 or suitable Kg capacity with necessary clamp for erection on wall for the individual substation, panel rooms requirement and fire safety guideline.
- Danger / Caution notices in English shall be fixed permanently on the equipment, LT/HT panel room, Switch yard etc to comply the requirement of IE rules.
- Safety posters for vigilance against electrical accidents as detailed in IS : 1255.
- Fire buckets with MS angle stand and with 4 Nos. round bottom fire buckets marked fire shall be provided in the LT panel room, HT sub station and at Transformer yard (Stand shall be with canopy). Stand shall be grouted in RCC.
- 3 Mtr& 6 Mtr. long folding aluminium ladders for safe maintenance of lighting system, etc.
- SLD and Earthing layout of suitable size duly framed/ laminated shall be fixed on the wall near the entrance.

4.17 DG SET (ALONG WITH AMF PANEL / AMF CUM SYNCHRONISING PANEL. AS APPLICABLE)

- Supply, Installation, Testing and Commissioning of D.G. Set KVA as per SOQ rating at 0.8 PF 415 V ± 1% and 50 ± 1% Hz or better, 3 Phase, 4 Wire Diesel Generating Set complete control panel, Controller, Cabling etc. as applicable, and necessary controls and safety devices in panel confirming to relevant IS specification. The set must be continuous operating with a speed regulation of ± 1% or better. Diesel engine shall be conforming to relevant ISS/BSS/ISO with latest amendments and as per latest CPCB norms.
- DG set rating shall be for prime rating power (PRP) in accordance with BS-5514 / IS / ISO-3046. DG set engine shall be as per CPCB-II / Present norms. DG set shall comply latest emission norms effective of Ministry of Environment & Forest (MOEF) by Government of India.
- DG Set shall meet all latest statutory / pollution control regulation requirement and applicable safety codes.
- Foundation as per OEM recommendation.

GENERATING SET:

- The DG set shall be Prime Duty, comprising diesel engine of adequate capacity directly coupled to an alternator mounted on a common base frame
- DG set is required to function at places situated at an altitude up to 1000 M, ambient temperature up to 50°C and relative humidity up to 95%.
- D.G. set should be able to start by push button starting.
- The entire DG Set shall be with 2 year comprehensive warranty & extended warranty of 3 years from there-on by manufacturer on the entire DG Set as specified in Warranty clause indicated else-where.
- The controller of DG panel shall be with RS-485 port (Modbus protocol) for remote data monitoring and logging.
- COP (confirmation of Product) of Nodal/Statutory authority shall be provided by manufacturer for noise and emission levels.
- Shall comply Noise level and emission levels as per latest revised norms of MOEF, GOI.
- Shall be with suitable Accoustic enclosure to meet MoEF / CPCB norms. Enclosure shall be made of CRCA sheet and high quality noise absorbent and fire- retardant grade acoustic insulation material to IS 8183.

A. ENGINE:

- Diesel Engine shall have constant speed, water cooled, suitable for generating set application 1500 RPM, powered by multi cylinder, turbo charged after cooled, cold starting, heavy duty type rated in accordance with ISO 3046 / IS with latest amendments
- Engine should be preferably from the engine manufacturers who maintain quality – assurance to international standard of ISO 9001.
- The noise level should not be more than 75db at 1m.distance and engine exhaust smoke emission level shall comply latest revised emission norms of MOEF, GOI.
- Diesel Engine below 140 kVA rating shall have mechanical governing system and 140 kVA and above rating shall be with Electronic governing system.
- The engine should have automatic belt tensioning arrangement for battery charging alternator system.
- The engine should have facility for the indication of oil level in oil sump during running of the engine.
- The engine water circular pump should be directly driven by engine gear system. V-belt driven system will not be adopted / accepted.
- The engine should have equipped with the following accessories:
- Fly wheel to suit flexible coupling with guard
- Dry type air cleaner
- Corrosion inhibitor liquid
- Fan blower type with guard
- Radiator with guard
- Water pump, centrifugal type, engine mounted
- Fuel pump PT type, Fuel filter
- Governor –Electronic type to meet test requirements as per ISO 8528

- Fuel injection equipment
- Exhaust silencer, Hospital Grade type with spark arrestor. Height of exhaust pipe above DG room height shall be as per pollution control regulation and supported with M S angle iron supports and stay wires. The exhaust pipe to be wrapped with asbestos rope till the end point.
- Electric starting equipment comprising starting motor with soft start engagement feature on 12/24 V DC supply.
- Lub oil cooler, Lub oil pump, Lub oil filter
- Turbo charger
- Solid state potentiometer for increase or decrease of speed which can be wired with remote operation. (For DG with synchronizing only, not applicable for solo application)
- Any other as required.

B. (Power Control Unit):

- Micro-processor based power control unit for monitoring, metering, protection and control system with LED Backlit-LCD display of D.G Set. Shall have Modbus interface

Engine Metering	**Alternator Metering**	**Engine Protection**	**Alternator Protection**	**Operator Interface**	**Data logging**
Speed of Engine in RPM	3 Phase voltage (phase to phase & phase to neutral)	Low lube oil pressure	Over/under Voltage	Manual stop/start	Engine hours
Lube oil pressure	3 Phase current	High/Low coolant temperature	Over current, short circuit	Remote start / stop	Engine starts
Coolant temperature	Frequency	Over/under DC voltage	Over/under frequency	---	Up-to 10 recent fault records
Battery Voltage	kVA	Fail to Crank/start	Loss of AC sensing		
Running hours		Weak Battery	Field overload	---	
---	---	Over-speed		---	
		Sensor failure			

C. ALTERNATOR:

- Alternator shall be rated for 50°C design Ambient temperature, altitude up-to 1000M, relative humidity 95%. Shall be based on 80% loading and 0.8 P.F. Short time overloading of alternator shall be as per OEM standard. Alternator shall be brushless, self-excited, Digital automatic voltage regulator, class 'H' insulation, double bearing AC generator in accordance with IS:4722 with latest amendments with screen protected drip proof enclosure and damper winding on pole faces. **One size higher rating of Alternator shall be provided to meet the above requirement**.

- Insulation class of alternator shall be of H but temperature rise shall be limited B. Space heater shall be provided for 250KVA and above rated alternator. 2Nos/Phase Thermisters with temperature scanner shall be provided for 500KVA and above rated alternator. Terminal box shall be suitable to terminate number of cables for respective rating, necessary terminal extension box shall be considered as per requirement.
- One size higher rating of Alternator shall be provided to meet the above requirement.

D. BATTERY:

- Set of staring batteries consisting of required nos. of 12/24 V, and of required AH capacity VRLA SMF (Valve regulated lead acid, sealed maintenance free) batteries connected in series with first charge of electrolyte with leads, lugs and terminals etc. duly installed on MS frame near the Engine.

BATTERY CHARGER:

- DG set shall be with offline battery charger and suitable to charge the battery when DG is on.
- Battery Charger consisting of:
    - Transformer & rectifier with surge protection network
    - D C Voltmeter
    - D C Ammeter
- Selector switch for Trickle, off & boost and current adjustment

E. BASE FRAME:

- The Engine and Alternator should be assembled on a sturdy fabricated, adequately machined base frame, made out of high quality MS channels. The base frame should be provided with lifting facilities and drilled foundation holes suitable for installation in concrete foundation with anti-vibration mounting. DG set is to be supplied with anti-vibration mountings pad suitable for the D.G. Set load.

F. FUEL TANK:

- Day fuel tank of adequate liters capacity with inlet and outlet pipe connections, filling cap, drain plug, level indicator and floor mounting pedestal along with hand operated fuel transfer pump and suitable hose.
- The fuel tank shall be inbuilt part of the Gen-set. The fuel tank shall be suitable for minimum 8 hours of operation of DG Set on full load. However, maximum fuel tank capacity shall be 990 liters.

G. CONTROL PANEL:

- The MV switchboard panels shall be floor mounting, free standing, compartmentalized, extensible, Modular type suitable for indoor installation. The panel shall be totally enclosed and dust, damp & vermin proof. Enclosure shall have IP-52 or better degree of protection for indoor unit & IP-55 or better degree of protection for outdoor unit as a minimum. Outdoor unit shall be double door and additionally provided with canopy or weather shed for protection.

- Panel shall confirm to Indian Electricity Act and rules CEA Notification/ Guidelines, CPWD guidelines 2019 as amended up-to date and shall be as a minimum.
- MV switch board sheet steel shall be CRCA mini. 2.0 mm for load bearing members, mounting plate, partition, doors/covers, Canopy. Gland plate shall be CRCA sheet min. 3.0 mm thick. All the doors and others openings shall be provided with neoprene rubber gaskets or of durable material gaskets.
- All hardware shall be corrosion resistant. Star washers shall be used for effective continuity.
- Suitable lifting hooks and jacking pads shall be provided on each panel or on each shipping section for ease of lifting of switchboard.
- A base channel of 100mm x 50mm x5 mm thick shall be provided at the bottom of the panel on all four sides of each shipping section.
- Current density of aluminum bus bar shall be max. 0.8 Amp / Sq. mm.
- All wiring shall be done with IS approved FRLS PVC copper flexible wires. The insulation grade for these wires shall be 660V grade. The control wiring shall be enclosed in plastic channels/Race way and neatly bunched together.
- Control circuit wiring shall be FRLS PVC copper flexible wire of minimum 1.5 mm^2 size and CT circuit wiring shall be minimum 2.5 mm^2 size. CT wiring shall be R Y B BK color coded and Terminals shall be CT Shorting link type only.

Painting

- The LT Panel shall be treated with seven tank/ Nine tank process with Degreasing, Water rinsing, De-rusting, Water rinsing, Phosphating, Water Rinsing, Passivation.
- After 7 tank cleaning, the surfaces shall be given 2 coats of epoxy primer.
- After seven tank process and primer coating the external paint shall be powder coated with Siemens grey RAL-7035 for inside and outside of LT Panel.
- Mounting plate shall be painted Glossy white.
- Thickness of paint shall be between 100 Micron to 120 Micron.
- Panel shall be suitable for auto start/auto changeover functions.

Panel shall be consisting of the following accessories.

Air Circuit Breakers

- Circuit breakers shall be air break, Electrical Draw Out type for feeders 630A and above. ACB shall be 4P with Microprocessor based release with Overload, Short circuit and inbuilt Earth Fault protection.

- The ACB shall be 50kA (1 Sec.)(or as specified in SLD) ICS = 100%ICU= Icw. All ACBs shall comply and tested as per IEC 60947-1 and IEC 60947-2 standards.
- ACB Models shall be : Schneider - Master pact NW or Siemens -3WL or L&T U power or ABB E-Max; or Equivalent model from Vendor Approved list. Data sheet with parameter comparison shall be submitted for approval.
- ACB shall be with inbuilt Communication Module RS 485 for MODBUS for communication with SCADA/PLC for both control and monitoring.

ACB Trip Release LSIG (Micro Processor based)should have Minimum following

- Overload with time delay

- S/C with time delay and Inst. Trip Setting
- Earth Fault with Time Delay.
- Under/over Voltage for incomer
- LSIG Fault record Display
- Metering & Energy display

ACB shall be fitted with following

- Heavy duty switches having not less than 4 NO + 4NC contacts
- Built in resin cast current transformer
- Shunt and under voltage tripping device.
- The ACB shall be suitable for locking the breaker in various positions. Interlocks shall be provided to: Prevent the breaker from being isolated unless it is in the 'OFF' Position; Prevent the breaker from being racked in to the service position unless it is in the 'OFF' position; Prevent the breaker from being accidentally pulled completely 'OFF' the guide rail.
- Safety shutters of an insulation material shall be provided to prevent access to all live contacts, when the breaker is in the inspection position or completely withdrawn.

Moulded Case Circuit Breakers (MCCB)

- All MCCBs shall be comply and tested as per IS - 2516 / IEC 60947-1& IEC 60947-2 standards.
- MCCB's shall be 4P, 50 KA or higher (and Ics = 100% Icu= Icw) with Micro-processor based release with in-built O/C, S/C and E/F protection.
- All MCCBs shall be with Extended Rotary Handle and Terminal Spreader. Auxiliary change over contact 1 No + 1 NC and Trip Contact shall be provided as per the requirement.
- MCCB Models shall be : Schneider NSX or Siemens 3VL or L&T D Sine or ABB T-Max; or Equivalent model from Vendor Approved list.

Other DG control panel accessories shall be minimum as below:

a) TNC/ Breaker control switch (for ACB incomer)
b) 0 – 500 Volts Digital Voltmeter with Selector switch
c) Digital Ammeter with selector switch
d) Current transformers Resin cast for metering and protection. Cl 0.5, 10 VA.
e) Digital type Multi-function Meter shall be with 3 line display, LCD, Accuracy Class: 0.5 Suitable for measuring and displaying the following parameters: A,V,F,PF,KW,KWH, KVA, KVAR, KVARh, Md, Harmonic & with inbuilt RS 485 communication port.(Schneider- EM 6400NG; L&T –MFM 4420; Secure – Elite 445 ; eqv model of other approved make). Data sheet with parameter comparison shall be submitted for approval.
f) Power factor meter.
g) Freuqency meter
h) Auto/Manual, Local/ Remote selector switch.
i) Emergency stop Push button.
j) LED Indicating lamps
k) Battery Charger consisting of:
    - Transformer & rectifier with surge protection network
    - D C Voltmeter
    - D C Ammeter
    - Selector switch for Trickle, off & boost and current adjustment

l) Electronic AMF/ AMF Cum Synchronizing Logic relay (Nb2 Or Equivalent) to cover the following functions as a minimum:
- Mains supply failure monitor
- Supply failure timer
- Restoration timer
- 3 impulse Automatic engine Start / Stop attempts
- Failure to start indication
- Off / Manual / Auto / test Selectors
- Power On / Off Switch
- Synchronizing relay with load sharing arrangement with arrangement to change over MASTER (for AMF cum Synchronizing Panel)

Sr. No.	Condition	Indication	Alarm	Trip Annunciation
	Phase Indicating lamp			
	ON,OFF,TRIP			
1	Mains on	Yes		---
2	Generator on	Yes		---
3	Load on Mains	Yes		---
4	Load on generator	Yes		---
5	Auto/ Manual	Yes		
6	Common Fault		Yes	
7	Over & Under Voltage		Yes	
8	Battery charger fault		Yes	
9	Low fuel oil level		Yes	
10	Over load		Yes	
11	Low Lub Oil Pressure	Yes		Yes
12	High water temperature	Yes		Yes
13	High Lub Oil temperature			Yes
14	Set fails to start (with alarm)	Yes	Yes	Yes

Construction parameters, accessories etc., shall be as per LT panel specification.

SPECIAL NOTES:
- Up to 70 kVA rating the engine can be Air cooled type and above 70 kVA rating engine shall be water cooled type.
- 70 kVA and above rating, the engine shall have turbo charged aspiration.
- Above 500 kVA, the engine shall have turbo charger with after cooling.
- The diesel engine generator set shall be with acoustic enclosure.
- The diesel engine can be naturally aspirated, turbocharged type or turbocharged with after cooler arrangement type as per respective manufacturer's standards.

H. ACCEPTANCE TEST

Following tests shall be carried out for DG set & control panel by the vendor to the entire satisfaction of the purchaser at manufacturer's works.

a) PHASE-I TEST :

- Insulation resistance test.
- Continuity test.
- High voltage test on power wiring of control panel
- Visual examination to ensure that the DG set, accessories, control panel etc. are provided for the finish and general appearance of the work as per specification / tender.
- Dimensions and alignment.
- A no load test for a period of five minutes to see that the engine, alternator and other accessories are functioning normal.

b) PHASE – II TEST :

- On successful completion of the phase I tests a full load test will be carried out for 30minutes continuously by loading artificially.
- The overall efficiency of the DG Set at ¼ load, ½ load and full load shall be worked out.
- All necessary arrangements for testing under artificial load conditions such as cables, electrodes, load and consumable like diesel, lubricating oil etc. shall be provided by the vender.

c) Documents Requirements:

- Alternator manufacturer's routine test certificate / prime power rating documents as per tender.
- Engine manufacturer's routine test certificate / MoEF certified power (BHP) documents as per tender.
- Calibration / Test certificates with setting manuals of manufacturer's of ACB/MCCB, Meters, all instruments and relays shall be presented for review during inspection and shall be part of dispatch documents.
- Transient response test for sudden application and rejection of loads of 25%, 50%, 75% & 100% of rated capacity.
- Wave form test (type test results are acceptable)
- Vibration, Noise level test shall be provided after installation at site.

I. SPECIFIC REQUIREMENT

- The vendor should be in possession of type and routine test certificate as per IS, issued by CPRI or any other testing laboratories and ISO 9001 certificate.
- On receipt of purchase order the vendor shall submit the following drawings for approval before manufacturing:
  a) General arrangement drawing.
  b) Foundation drawing.
  c) Termination details of cable.

d) GTP, BOQ, GA drawing, Power and Control wiring drawing of control panel of DG Set.

- The scope of work shall include all transportation of the DG sets and its accessories to the site of work with utmost care in handling. All loading and unloading arrangements with necessary plants / equipment and tools shall be the part of the scope and all required man power shall also be provided by the vendor for unloading / shifting of the DG set to the DG room and installing in position as required. Supply & laying of power and control cable between DG set & control panel is including in the scope of work.
- The vendor shall be responsible for all the safe custody of the DG sets and its accessories from the time of supply of DG sets, at site till installation, testing and commissioning and handling over the same to Client on satisfactory completion of work.
- The vendor shall co-ordinate with other agencies during the course of the installation testing and commissioning of the DG set and shall provide all supervision if any required to guide for safe commissioning of the DG Set.
- The installation work shall be started and completed immediately once the readiness of site is intimated to the vendor without any further delay.
- All minor civil works like opening in wall for exhaust pipe & fuel pipe etc. required for installation of DG sets shall be included in the scope of the vendor.
- The work of installation, testing and commissioning of DG set shall be done by qualified competent Engineer / Supervisors and all instructions shall be strictly followed for the completion of work with good workmanship as required and as per the IE rules and regulation of statutory body and other mandatory requirements.
- The vendor has to supply the following items free of cost on commissioning of the DG set.
  - Technical literature, control and power circuit diagram, manufacturer's manual of engine, alternator, Panel, etc. in number of sets as specified
  - List of essential spares,
  - One set of essential maintenance tools like grease gun, tool kit with Ratchet spanner set, torque wrenches, Allen keys etc.
- The routine test of engine and alternator shall be arranged at manufacturer's premises by the supplier. Prior intimation shall be given regarding the readiness of engine and alternator for conducting the routine test as per relevant IS standards
- Load testing of the entire installation or load as available (min. 40% of DG rating preferred) at site, shall be carried out at site, on commissioning of the DG set.
- Vendor shall be responsible for obtaining necessary statutory approval for installation & operation of D.G set (Electrical Inspector, Central / Local Pollution Control Board, etc.).

C INSPECTION & TESTING

- Major electrical equipments shall be tested and inspected at vendor manufacturer's works before dispatch to ensure compliance with the specifications/requirements mentioned in the tender / BOQ and applicable codes and standards and agreed quality assurance/testing plan.
- Inspection at manufacturers premises: Tests of major items like HT panel, LT panel(rated above 630A), Transformers (rated 500kVA & Above), HT Cable(Length 500Mtr and above) & LT cables (if Qty. > 2000mtr) and Motors (Except Pump/Equipments tested with Job motors)for 10% quantity for motors rated 75kW & above shall be conducted at manufacturer's work in presence of third party inspection agency (TPIA) and client' representative appointed by purchaser's representative. All the expenses like transportation, loading & boarding shall be borne by contractor.
- Rest items shall be cleared for dispatch based on review of manufacturer's Test Certificates / manufacturer's Test Report by TPIA/ Client's Engineer.
- The owner / Client or his authorized representative may visit the works during manufacture of various electrical equipment/materials to assess the progress of work as well as to ascertain that only quality raw materials are used for the same. He shall be given full assistance to carry out inspection. Owner/ client's representative shall be given minimum two weeks advance notice for witnessing of final testing.
- Field tests as per approved procedures / procedures available with engineer-in-charge or his authorized representative shall be performed on the electrical system / equipment before it is being put into service. All test equipment shall be arranged by the vendor. Test reports shall be approved by the engineer-in-charge before acceptance of the complete plant and equipment.
- All the cost pertaining to inspection including to & from travel, local conveyance, lodging and boarding expenses shall be borne by contractor for minimum 2 representatives of client / client's consultants / Third Party Inspection Agency.

5.0 ELECTRICAL INSTALLATION

- This specification covers the technical requirements for equipment, materials, and installation methods, testing and commissioning of electrical system.
- The contractor shall possess a valid contractor's license for the state in which site is located and shall ensure it's validity during the duration of the contract. The contractor shall furnish authenticated copies of certificates to the Engineer for himself and his workmen before commencement of work.
- The contractor shall employ adequate skilled and unskilled labour to complete all work accoriding to programme of work. Skilled workers shall possess the minimum qualifications stipulated by statutory or competent authorities.
- The contractor shall employ adequate numbers of supervisor to control the labour force and to carry out the work as per schedule. Supervisory staff shall also possess the minimum qualifications stipulated by statutory and competent authorities.
- Various types of equipment shall be installed in accordance with drawings and / or manufacturer's instructions and good engineering practice. Particular attention shall be paid

to lubrication of moving parts and bearings, alignment, tightness of all connections (mechanical and electrical) and wiring.

- The transformers shall be moved to its location and shall be correctly positioned on it's base.
- All parts of the transformers, which are supplied loose, such as conservator, radiator banks, buchholz relays, dial thermometers, bushings, etc. shall be fitted onto the transoformers.
- Transformer oil if supplied in drums shall be filled into the transformer after duly testing/filtering, upto the correct level required. The transformer may have to be dried out and oil filtered.
- The contractor shall place the switchgear correctly on the base of foundation prepared for the same. If the switchgear consists of a switchboard with number of panels bolted together, he will place all the sections of the switchboard correctly, align them and bolt the sections together to form one continuous switchboard. The switchgear shall then be secured to the foundation by means of nuts and bolts or foundation bolts grouted in the base. The contractor shall also make inter-section bus/wiring connections.
- In case of wall/structure mounted equipment, boards, the contractor shall fabricate and install the structural steel frame work suitable for mounting the various equipment boards. The contractor may have to prepare drawing showing the proposed general arrangement, of the structural frame which shall be subject to the approval of the Engineer. The fabrication and installation of the framework shall be recommended only after the approval of drawings. Various items of the equipment, board shall be mounted in accordance with the approved drawings.
- Motor shall generally be installed by others, along with the driven equipment. The contractor may, however, be asked to install motors in specific instances.
- Cable routes and mode of installation shall generally be as shown in the construction drawings.
- Identification tags indicating cable designation, shall be affixed to each cable at ends and at an interval not exceeding 15 mtrs or at the location where cables change direction or elevation. Signboards with necessary indication/arrow mark with necessary structure/foundation shall be also be installed, of edquate size as approved by Engineer, for the enture cabling system buried underground.
- H.V. XLPE / PVC armoured cables shall be terminated or jointed by means of cold setting epoxy based cast resin jointing system or heat shrinkAble or push on type cold setting kit.
- All cable glands should be of nickel plated brass, double compression type. All Alu/Cu cables shall be terminated through crimping type Alu/Cu lugs respectively.
- All electrical ewuipment viz. transformers, switchgear, motor control centres, motors, control stations, switches, lighting, fittings and other electrical apparatus shall be connected to the main earth loop by means of two separate and distinct external earth conductors. The material, type and size of earth conductors will be as shown in the drawings or as specified.
- Electrical installation in hazardous areas if applicable as defined in IS:5571 shall be carried out with utmost care and special precautions shall be taken to ensure operational safety.
- All personnel, especially supervisory staff, working on such installations shall be fully conversant with the applicable National Standards and Code of Practice and shall have previous experience of such work.

- The contractor shall take all reasonable safety precautions during construction and testing of the works. Particular attention shall be paid to the following:
- a) To prevent any conductor or apparatus becoming accidentally or inadvertently charged.
- b) Prior to electrical installation (or part there of) being connected to the main supply, the Contractor shall ensure that uncommissioned or incomplete circuits cannot be inadvertently energized and completed circuit cannot be used without the Engineer's consent.
- c) No hot work is carried out without work-permit issued by the Engineer in FLP zones (if stipulated by process application).
- The tests specified below/elsewhere as part of this tender document shall be carried out on the electrical equipment and installation before commissioning the same. The tests shall be performed by or under the direct supervision of a competent person, qualified to carry out the tests. All tests shall be carried out in the presence of the authorized representative of the Employer/Owner and/or the Engineer, unless this stipulation is waived in writing.

6.0 PAINTING

- All surfaces of equipment/structural steel shall be sand blasted, degreased and pickled in acid as required to provide a smooth & clean surface, free of rust / scale / grease.
- After cleaning the surface shall be given one coat of high quality red-oxide or yellow chromate and baking in the oven (for equipment only).
- All surfaces shall be then finished with 2 (two) coats of finished Synthetic Chemical paint of shade 631 of IS : 5 or with a paint shade of purchaser's choice unless otherwise specified.

7.0 DETAILS OF TESTS

I POWER & DISTRIBUTION TRANSFORMERS

i) Check HV & LV cable terminations, ground connections, fittings and accessories, oil level and oil leaks at various joints. Check breather, thermometers & buchholz relay for proper functioning and operation. Check junction box, marshalling box etc. for correct wiring.

ii) Oil Test

Crackle test and dielectric test as per Clause 7.11 of IS 10028. The oil shall withstand at least 40 kV with a gap of 4 mm.

iii) Insulation Resistance Test

This may be carried out on new transformer without drying out the transformer, provided the transformer has not been idle or stored for a long period. Otherwise, this test shall be carried out during drying out of transformers. Insulating resistance test shall be carried out between primary & secondary to ground as well as between primary and secondary. Windings not under test shall be grounded during the test.

A megger rated 1000 volts or higher shall be used for the test.

iv) Polarity & Phasing Out Test

Check external connection of the transformer in accordance with diagram of connection and phase sequence (anti-clockwise)

II HV & MV SWITCH GEAR

i) Check proper mechanical operation of circuit breakers including alignment of trolleys in case of draw–out type circuits breakers, smooth operation of all mechanical parts, lubrication, mechanical interlocks etc.

ii) Check contact alignment and wipe, proper sequence of closing and opening of main and arcing contacts.

iii) Check electrical relays, instruments & controls for correct wiring.

iv) Insulating test on bus bars – phase to phase and phase to ground. This test will be carried out with circuit breakers in service position, but contacts remaining open.

v) Insulation test on relays & control wiring including current and potential transformers and wiring of CT & PT secondaries.

vi) Insulation test on circuit breakers in withdrawn position – phase to phase and phase to ground with contacts closed.

vii) Adjust correct settings of relays and/or direct acting trips - as specified.

viii) Operation test

Energise only control circuits and carry out closing and tripping operations (where AC supply derived from main supply is used for operation, the switch–gear bus may be energised). Check operations of electrical interlocks. Check tripping of circuit breakers by manual operations of protective relays contacts. Check operations of mechanical closing and tripping devices. Check lockout conditions for closing of circuit breakers by simulating the required conditions. Check control, indications, sequence interlocks and alarms.

ix) Polarity and connections of instrument transformers – Check for correctness of CT & PT connections provided. Check electrical continuity of secondary with ELV tester.

x) Check operation of instruments, meters, relays and tripping of circuit breakers by primary / secondary injections as specified.

xi) Check continuity of power circuits and earth continuity of all non current metallic parts with a low voltage a (6 volts or less) continuity tester.

III MOTOR CONTROL CENTRES, SWITCHGEARS

i) Check equipment, internal wiring, smooth mechanical operation, interlocks, etc.

ii) Check continuity of power circuits and earth continuity of all non-current carrying metallic parts with a low voltage continuity tester.

iii) Insulation test for power & control circuits between phases, between phases and neutral and between phase / neutral and ground.

iv) Check operation by energizing control circuits (without energizing power circuits) for correct functioning. Simulate eternal controls and interlocks for the same. Note chatter or humming of contactor and rectify, in necessary.

v) Check fuse ratings and adjust relay setting (overhead, single phasing preventers etc) in accordance with load ratings.

vi) Polarity and connections of instrument transformers – Check for correctness of CT & PT connections provided. Check electrical continuity of secondary circuits with ELV tester.

IV MOTORS & ROTATING EQUIPMENT

i) Check equipment for free movement of rotor, and play, lubrication and for any other visual checks.

ii) Insulation test of motors – between winding and ground. Use 500 volts megger for M.V. motors and 1000 volts megger for HV motors.

iii) Check electrical continuity with ELV tester.

iv) No load running of motor noting down no load current and voltages in all three phases.

V CABLES

i) Insulation Test between each phase and neutral and between each phase / neutral and ground.

ii) D.C. High Voltage Test on HV cables in accordance with the relevant Indian Standards and Code of Practice. This test shall be carried out on cables installed in final positions, and all joints and terminations have been made. The cables, however, may not be connected to the equipment, so that the equipment may not be subject to the test voltage.

iii) In case of lighting wiring, insulating test shall be carried out on lighting feeders with branch circuits open. Branch circuits shall be tested separately with lamp holders, plug receptacles and lighting fittings in position, but without lamps. In case of lighting circuits will lamp ballasts and glow starters, insulation resistance may be measured between phase and ground only.

iv) In case of directly buried cables, insulate resistance of cables shall be measured before and after the back-fillings.

v) Test all receptacles for correct phase sequence.

VI EARTHING SYSTEM

i) Measure earth resistance of each electrode separately. If a number of earth electrodes are interconnected with one another, combined earth resistance shall also be measured. The earth resistance of each electrode and/or a group of electrodes shall not exceed the values specified.

ii) Carry out line earth loop impedance test. The loop comprises the line conductor from the point of fault, back to the supply transformer, the path through transformer winding, the earthed neutral point of the transformer and path for that point to the point of fault through the earthing system.

iii) Continuity test for earth continuity conductors with ELV tester.

8.0 STATUTORY APPROVAL

The Contractor shall be totally responsible for obtaining statutory approval from the electrical inspector or any other statutory authority for the entire installation carried out by him unless otherwise specified and agreed. Necessary test reports shall be submitted by him to electrical inspector. This will be an integral part of the contract and shall not be paid for separately. **The contractor shall liaison with local electric supply company for getting power supply and only necessary fees, if any, payable to supply company shall be borne by the Owner.**

9.0 ACCEPTANCE OF INSTALLATION

On completion of the work the Engineer, together with the Contractor, will carry out an inspection of the Installion. The Engineer will issue a completed copy of the Purchaser's Acceptance of Electrical Installation to the Contractor as confirmation that the work has been accepted, subject to any matters noted on the form being attended to.

APPROVED VENDOR LIST – ELECTICAL EQUIPMENT / COMPONENT

ITEM DESCRIPTION	APPROVED MAKE
COMPACT SUBSTATIONS	ABB / CGL / SCHNEIDER / SIEMENS
DISTRIBUTION TRANSFORMERS	ABB / AREVA / BBL / CGL / EMCO / GEC / KEC / RAYCHEM RPG LTD. / SCHNEIDER / TRANSFORMERS & RECTIFIERS INDIA LIMITED / VOLTAMP
400KVA & BELOW 400KVA DISTRIBUTION TRANSFORMERS	SKP TRANSFORMERS / POWERLITE ELECTRICALA / ATLANTA ELECTRICALA / GUJARAT TRANSFORMERS / EMCO/VIDHYUT TRANSFORMER PVT. LTD
TRANSFORMER LIGHTING - DRY TYPE (CAST RESIN)	ABB / AUTOMATIC ELECTRIC LTD. / CGL / INDCOIL / KOTSONS / VOLTAMP
SWITCHBOARD & SWITCHGEAR MV - 11 / 33KV - INDOOR / OUTDOOR TYPE (VCB/SF6)	ABB / AREVA / BHEL / CGL / GEC / JYOTI / L & T / SCHNEIDER / SIEMENS/HIGH VOLT (ABB)
HT RMU	ABB/ CGL / SCHNEIDER / SIEMENS
PROTECTIVE RELAYS (NUMERICAL TYPE)	ABB / ALSTOM / CGL / GE / L & T / SCHNEIDER / SIEMENS/ C&S
PROTECTIVE / AUXILLARY RELAYS (ELECTROMECHANICAL TYPE)	ABB / ALSTOM / CSPC / EASUN REYROLLE / GE / GEC L & T / SCHNEIDER / SIEMENS/ C&S
ELECTRONIC CIRCUIT RELAY	ALLEN BRADLEY / OEN / OMRON / PLA
CONTROL AND RELAY PANEL	ABB / ALSTOM / EASUN REYROLLE / L & T / SCHNEIDER / SIEMENS
INSTRUMENT TRANSFORMERS (CT / PT)	AEP / ASHMOR / AUTOMATIC ELECTRIC / CGL / CONTROL & SWGR / ECS / GILBERT AND MAXWELL / INDCOIL / JYOTI / KAPPA / PRAGATI / PRECISE / SILKAANS/NEWTEK ELECTRICALS
L.V. SWITCHBOARD - DRAWOUT / FIXED TYPE (PCC / PMCC / MCC / MLDB / MPDB / MOVDB / APFC)	ABB / ALPHA NIPPON / C & S / CGL / ELEMBICA / ELEMECH/HORIZON /INDUSTRIAL CONTROLS / L&T/ PATEL BROTHERS/ POSITRONICS/ POWER & INSTRUMENTATION (O) LTD./ SCHNEIDER / SIEMENS/ SUN AUTOMAT / SWATI SWITCH-GEAR/GSONS/HIGH VOLT

Note No.-1:

Any other LT Panel Manufacturer meeting / possessing the following requirements as a minimum shall also be qualified as an approved vendor for supply of LT Panels:

1. Should have obtained approval from CPRI / ERDA and obtained type test certificate for LT Panel with rated voltage of 415V (3-Ph. + N), 50Hz rated frequency and min. 3200A rated current and having short circuit withstanding strength of min. 65kA for one sec.
2. Should have obtained approval from CPRI / ERDA and obtained type test certificate for Degree of Protection Class IP-55 or above for LT Panel with rated voltage of 415V (3-Ph. + N), 50Hz rated frequency and certificates must have validation for current year..
3. The company should be in existence for min. 5years and shall have GST Registration Certificate.
4. Shall be ISO 9001:2015 or latest amended up to date certified

5. The panel manufacturer should have min. average turnover of 3 Crores for similar panel manufacturing in last Two (2) financial year (Trading or contracting turnover shall not be considered), duly certified by chartered accountant.

Necessary supporting documents / copy of certificates duly notarized shall be submitted along with the technical bid along with self-attested undertaking for manufacturing facilities on panel manufacturer's letter head (by bidder submitting bid as a panel manufacturer or by the bidder who is proposing to supply panel or carry out panel related work from such manufacturer including submission of back-up guarantee as per tender). Client reserves to inspect the works facility of such panel vendor at any stage of bid / execution to assess the facility and verifying the requirements as specified above (The cost of such visit by Client officials of up to two persons including travel, lodging, boarding, local conveyance, etc. shall be borne by bidder). Further bidder and vendor (LT Panel manufacturer) to note that at any stage if it is observed that the LT panel vendor details submitted are incorrect or fake or forged, Client reserves right to initiate action against such bidder / vendor including keeping their registration with Client in abeyance for up to 3 years or as decided by the concerned authority of Client..

AIR CIRCUIT BREAKERS	ABB / L&T / SCHNEIDER / SIEMENS/LEGRAND
MCCB'S	ABB / C & S / GEC / L&T / SCHNEIDER / SIEMENS/LEGRAND
SWITCH DISCONNECTOR FUSE UNIT (SDF) AND SWITCH DISCONNECTOR ISOLATOR	ABB / C & S / GEC / L&T / SCHNEIDER / SIEMENS/INDOASIAN
CHANGE-OVER SWITCH	BCH / C&S / GE POWER / HAVELLS / HPL / KRAUS & NAIMER / L&T / SCHNEIDER / SIEMENS
SOFT STARTER (MICROPROCESSOR BASED)	ABB / CG POWER (EMOTRON) / DANFOSS / L&T / ROCKWELL / SCHNEIDER / SIEMENS
VVVF DRIVES (VFD)	ABB / CG POWER (EMOTRON) / DANFOSS / L&T / ROCKWELL / SCHNEIDER / SIEMENS
MV CAPACITORS	ABB / EPCOS / SHREEM / UNIVERSAL/ VISHAY
LV CAPACITORS / POWER CAPACITOR	ABB / EPCOS / HAVELLS / KHATAU JUNKER / MADHAV / MALDE / NEPTUNE / SCHNEIDER / UNIVERSAL/ SHREEM/ POWER MATRIX / SIEMENS/VISHAY
DETUNED SERIES REACTORS WITH temperature micro switch (Harmonic Filter reactor)	EPCOS / WHEPL / YESHA/ NEPTUNE/ VISHAY
Dynamic Power Factor correction Thyristor Module	EPCOS/ SCHNEIDER/ NEPTUNE/
APFC PANEL	ABB / DATAR / EPCOS / L&T / NEPTUNE / SCHNEIDER / ALL APPROVED VENDORS FOR LT PANEL/EASUN/ ALSTOM / CSPC / SIEMENS
APFC RELAY / CONTROLLER	ABB / DATAR / ENERCON / EPCOS / L & T / SCHNEIDER / SIEMENS / SYNTEL / TRINITY / NEPTUNE
CAPACITOR DUTY CONTACTOR	ABB / EPCOS / L & T / SCHNEIDER / SIEMENS
MICROPORCESSOR BASED MOTOR PROTECTION RELAY WITH RS 485	C&S/ ABB / L & T / SCHNEIDER / SIEMENS
AC / DC POWER & AUXILLARY	ABB / BCH / C & S / GE / L&T / SCHNEIDER /

CONTACTOR	SIEMENS /INDOASIAN
BI-METAL / ELECTRONIC / MICROPROCESSOR BASED OVERLOAD RELAY	ABB / C&S / GE / L&T / SCHNEIDER / SIEMENS/CSPC/ALSTOM / CG/INDOASIAN
THERMISTER RELAY	ALSTOM / INSTA CONTROLS / MINILEC
SINGLE PHASING PREVENTER WITH UV/OV PROTECTION	ABB / C&S / GE / L&T / MINILEC / SCHNEIDER / SIEMENS
TIME SWITCH	GIC / LEGRAND / SCHNEIDER / SIEMENS / THEBEN
TIMERS / TIME DELAY RELAY	BCH / EAPL / L&T / LEGRAND / MINILEC / OMRON / PLA / SCHNEIDER / SIEMENS / TEKNIC / THEBEN/ELICO/INDOASIAN
MOTORS	ABB / BBL / BHEL / CG POWER / JYOTI / KEC / MARATHON / SIEMENS / L & T
BATTERY CHARGER & DCDB	AMARA RAJA / AMCO POWER / AUTOMATIC ELECTRIC / CALDYNE AUTOMATICS / CHHABI ELECTRICALS / EXIDE / HBL POWER SYSTEMS / HIREL-HITACHI / MASS-TECH CONTROLS / UNIVERSAL INSTRUMENTS
LIGHT FIXTURES	BAJAJ / C & S / CGL / GE / HAVELLS / PHILIPS / SURYA / WIPRO
CABLES H.V. - XLPE INSULATED	HAVELLS / KEI / NICCO / POLYCAB / PRIMECAB (RAVIN CABLES) / RPG CABLES (KEC International) / TORRENT CABLES / UNIVERSAL
LT POWER & CONTROL CABLES / EARTHING CABLES	AVOCAB / CCI / FINOLEX / HAVELLS / KEI / LAPP / NICCO / POLYCAB / PRIME CAB (RAVIN CABLES)/ RPG CABLES (KEC International)/ RR KABEL / TORRENT / UNIVERSAL CABLES
WIRES - FLEXIBLES (ALL TYPES)	AVOCAB / FINOLEX / KEI / L&T / LAPP / POLYCAB / RR KABEL / UNIVERSAL/ANCHOR/HAVELLS/ATLAS
LIGHTING / SMALL POWER DISTRIBUTION BOARDS / ENCLOSURES	ABB / BCH / C&S / ELDON / ENCLOTEK / HENSEL / INDO ASIAN / L&T / LEGRAND / RITTAL / SCHNEIDER / SIEMENS / HAVELLS / STANDARD ELECTRIC /ALL LV PANEL VENDORS
MCB, RCCB, RCBO / MCB ISOLATORS	ABB / C&S / INDO ASIAN / L&T / LEGRAND / MOELLER / SCHNEIDER / SIEMENS/GEC/ HAVELLS/S&S/INDOASIAN
MPCB	ABB / L&T / SCHNEIDER / SIEMENS/ INDOASIAN
ALARM ANNUNCIATORS (SOLID STATE TYPE WITH LED ILLUMINATION) / FACIA ANNUNCIATOR	ALSTOM / DIGICONT / ICA / IICP / MINILEC / PROCON INST. (P) LTD / PROTON ELECTRONICS/APLAB
DECORATIVE / MODULAR SWITCH & SOCKET	ABB / ANCHOR / CLIPSAL / CRABTREE / L&T / LEGRAND / MK - HONEYWELL / SIEMENS/SCHNEIDER/INDOASIAN
CEILING / WALL MOUNTING /	ALMONARD / BAJAJ / CGL / HAVELLS /

EXHAUST FANS	KHAITAN / ORIENT / USHA
CABLE TERMINATION / JOINTING KITS	3M / ABB KABELDON / M SEAL / RAYCHEM/XICOM/CCI
CONTROL / SELECTOR SWITCH	ABB / ALSTOM / BCH / GE POWER CONTROLS / HAVELLS / KAYCEE / L&T / SCHNEIDER / SIEMENS/RECOM/ SULZER/ EE/JYOTI
INDICATING LAMPS	BCH / L & T / SCHNEIDER / SIEMENS / TEKNIC CONTROLS / VAISHNO/
TERMINAL BLOCK / CONNECTORS	CONNECTWELL / ELMEX / PHEONIX / TELEMECHANIQUE / WAGO
CONSTANT VOLTAGE TRANSFORMER/ CONTROL TRANSFORMER	AE / ASHMORE / G&M / INDCOIL / NEC / PRAGATI / PRECISE / SILKAANS
SEMICONDUCTOR FUSE	BUSSMANN / FERRAZ / GE / SIEMENS
HRC FUSE (POWER & CONTROL)	ABB / C&S / L & T / SCHNEIDER / SIEMENS / TECHNOELECTRIC/INDOASIAN
PUSHBUTTONS	BCH / L & T / RASS / SCHNEIDER / SIEMENS / TEKNIC / VAISHNO
PUSH BUTTON STATIONS / JUNCTION BOX (CAST ALUMINIUM)	BALIGA / BCH / CEAG / EXPROTECTA / FCG / FLEXPRO / HANSU / HENSEL / PUSTRON / SCHNEIDER / SIEMENS / SUDHIR/EXCEL
NON METALLIC ENCLOSURES (INCLUDING INDUSTRIAL RECEPTACLES)	BCH / HENSEL / LEGRAND / PUSTRON / RITTAL / SCHNEIDER / SIEMENS / SINTEX
DIGITAL AMMETER/ VOLTMETER/ POWER FACTOR METER	AE / KRYKARD / L & T / MASIBUS / RISHABH / SCHNEIDER / SECURE / SIEMENS/IMP/MECO/ CONZERV/NEWTEK ELECTRICALS
10 CHANNEL TEMPERATURE SCANNER WITH RS 485 MODBUS COMMUNICATION	MASIBUS/NIVAM/NISHKO/ELECTRONET/REDIX
ELECTROMECHANICAL METERS – AMMETER & VOLTMETER	AE / IMP / MECO / RISHABH
KWH / LOAD MANAGER / MULTI FUNCTION METER	ABB / KRYKARD / L&T / SCHNEIDER / RISHABH / SECURE / IMP/ MECO / CONZERV/ ENERCON
CABLE LUGS	3D / COMET / CONNECTWELL / DOWELLS / JAINSON/3M
CABLE GLANDS (SINGLE / DOUBLE COMPRESSION, NI-PLATTED BRASS)	BALIGA / BRACO / COMET / ELECTROMEC / EX-PROTECTA / FCG / HMI / JAINSON / SIEMENS / SUDHIR
CABLE GLANDS – POLYAMIDE	FIBOX / GEWISS / HENSEL / LAPP
LIGHTNING ARRESTORS	CGL / ELPRO / JAYSHREE / OBLUM / WS / BIRLA NGK INSULATORS
SURGE SUPPRESSORS	ABB / EMERSON / ERICO / MTL / OBLUM / PEPPERL+FUCHS / PHOENIX / SCHNEIDER / SIEMENS / WEID MULLER
UNINTERRUPTED POWER SUPPLY (UPS)	ABB / EMERSON / FUJI / HITACHI / INVENSYS / SCHNEIDER / SOCOMEC
GI CABLE TRAYS	GLOBE / INDIANA / JACINTH / LEGRAND / M.M. ENGINEERING / SHARDA / SILVERLINE POWER

	/ VATCO/SUPER ELECTRO
UPVC CONDUIT & ACCESSORIES	AKG / CLIPSAL / L&T / POLYCAB / PRECISION / SALZER
MS / GI CONDUIT & PIPES	BEC INDUSTRIES / JINDAL / JK TUBE / SAIL / TATA STEEL / ZENITH
SMF / VRLA / NI-CD / LEAD ACID (PLANTE / TUBULAR) BATTERY	AMARA RAJA BATTERIES LTD. / AMCO / EXIDE / HBL POWER SYSTEMS LTD./AUTOMATIC ELECTRIC
MS / GI LIGHTING POLES & BRACKETRS	AMBICA ENGINEERING / BAJAJ / BOMBAY TUBES AND POLES / GAYATRI ELECTRICALS / INDIA ELECTRIC POLES / RIDDHI POLES / SHAKTI POLES / SURYA
HIGH MAST LIGHTING SYSTEM	BAJAJ / CGL / PHILIPS / SURYA/VALMONT
SANDWICH BUS TRUNKING	C&S/ SCHNEIDER/SIEMENS/ GODREJ
CONVENTIONAL BUSDUCT	ABB / C&S / L&T / SCHNEIDER / SIEMENS / STARDRIVE / ALL LT PANEL VENDORS
DIESEL ENGINES	ASHOK LEYLAND / CATERPILLAR / CUMMINS / KOEL / MAHINDRA POWEROL / MITSUBISHI / PERKINS / VOLVO / WARTSILA
ALTERNATORS FOR DG SETS	BHEL / CGL / JYOTI / KEC / KOEL / LEROY SOMER / NGEF / STAMFORD
AMF RELAY, SYNCHRONIZING RELAY (WITH RS 485)	DEAP SEA/ C&S/WOODWARD//DEIF
HANDHELD DIGITAL MULTIMETER / CLIP-ON METER / MEGGER	FLUKE / IMP / MECO / MOTWANE / RISHABH
BATTERY BACKED POWER PACK	ALAN/G'LEC/BHARANI/GOGATE
ALUMINIUM BUSBAR MATERIAL	BANCO/HINDALCO/JINDAL
PANEL CRCA/MS/GI PLATES & SHEET	ESSAR/TATA/JINDAL/SAIL
CHEMICAL TYPE EARTHING INCLUDING COPPER BONDED ELECTRODE & BACK FILL COMPOUND	ASHLOK / CURSP / ECO TECHNOLOGY & PROJECTS/ENNOV INFRA / ERICO/ISG GLOBAL / PRAGATI ELECTROCOM/SAARA EARTHING/ EQUI. REPUTED MAKE SUBJECT TO CLIENT APPROVAL
ACTIVE HARMONIC FILTER SOLUTION / PANEL	ABB / DANFOSS / SCHNEIDER / AMTECH / EPCOS / CONSULE NEOWATT / SCHNEFFER / AB LIFASA
PVC CONDUITS & ACCESSORIES	PRECISION / CLIPSAL / L&T
MODULE TYPE PLUG SOCKET	ANCHOR / HAVELLS / CLIPSAL / TOYAMA / MDS

The contractor shall distinctly understand that it will not be their perogative to insist on a particular brand from the list, and final selection will be done with the approval of Engineer in charge.

12.0 PRICE BREAKDOWN

12.1 Whenever requested by the engineer, the contractor shall furnish detailed price breakdown for supply and installation of each of the items of electrical works including for each type/size of applicable cable / light fitting / earth pit / earth stations.

12.2 This breakdown prices are required for the purpose of justification for progress payment and also for working out addition and deletion, if any, in the scope of work at a later date.

13.0 VENDOR DATA REQUIREMENT

Following minimum documents shall be submitted by contractor along with the bid as well for review and approval during detailed engineering, as indicated:

VENDOR DATA REQUIREMENT				
(ELECTRICAL)				
Sr. No.	**Description**	**With Bid**	**Info. / Review**	**As-Built**
1	List of Deviations to the specs	*		
2	Electical Load Data	*	*	*
3	Guaranteed Power Statement	*		
4	Single Line Diagram		*	*
5	Motor Data Sheets		*	*
6	O&M Manual		*	*
7	Technical details for major equipment		*	*
8	Data Sheets of Distribution Transformer along with sizing calculations / Data Sheets of other Eqpt		*	*
9	List of Recommended Spares		*	*
10	Type Test Certificates		*	*
11	Equipment / sub-station Layout		*	*
12	Bill of Material		*	*
13	GA Drgs of Switchgear / Dist. Tx. / Motors / etc		*	*
14	Interconnection / wiring Diagrams		*	*
15	Area Classification Drawings		*	*
16	Lighting Design Calculation		*	*
17	Test Certificates		*	*
18	Cable Layout / Earthing Layout / Lighting Layout		*	*

APPLICABLE NATIONAL/ INTERNATIONAL STANDARDS

AGA :American Gas Association, Gas Measurement Committee

ANSI/ASME :American National Standards Institute/American Society of Mech. Engineers

B 1.20.1	Pipe Threads
B 16.5	Steel Pipe Flanges and Flanged Fittings
B 16.20	Ring Joint Gaskets and Grooves for Steel Pipe Flanges

ANSI/FCI :American National Standards Institute/Fluid Controls Institute

70.2	:Control Valve Seat Leakage Classification

API :American Petroleum Institute

RP 520	:Sizing, selection and installation of pressure relieving systems in refineries. Part-I - Sizing and selection Part-II - Installation
RP 521	:Guide for pressure relieving and depressurising systems
RP 526	:Flanged steel safety relief valves
RP 527	:Seat tightness of pressure relief valves
MPMS	:Manual of Petroleum measurement standards
RP 551	:Process measurement instrumentation Part - I Process Control and Instrumentation
RP 552	:Transmission Systems
S 2000	:Venting atmospheric and low pressure storage tanks
S 670	Vibration, Axial-Position and Bearing Temperature Monitoring Systems

ASTM :American Society for Tests and Materials

BS :British Standards

BS-1042	:Measurement of Fluid Flow in Closed Conduits
BS-5308 Part-II	:Specification for PVC insulated cables
BS-7244	:Breather Valves

DIN :Deutsches Institut für Normung

DIN-43760	:Temperature Vs. Resistance curves for RTDs
DIN-19234	:Electrical Distance Sensors; DC interface for distance sensors and signal converter

DIN-50049 :Document on Material Testing

IEC :International Electrotechnical Commission

IEC 79 :Electrical apparatus for Explosive Gas atmosphere
IEC 85 :Thermal evaluation and classification for electrical insulation
IEC 332 :Test on bunched wires or cables Part III Cat. A
IEC 529 :Classification of degree of protection provided by enclosures
IEC 534-2 :Industrial Process Control Valves - Flow capacity
IEC 584-2 :Thermocouples - Tolerances
IEC 751 :Industrial Platinum Resistance Thermometer Sensors
IEC 801 :Electromagnetic compatibility for industrial process measurement and control equipment

IS :Indian Standard

IS-5 :Colours for ready mixed paints
IS-319 :Specification for free cutting brass bars, rods and sections
IS-1239 :Mild Steel tubes, tubulars and other wrought steel fittings
IS-1271 :Specification of Thermal Evaluation and Classification of Electrical Insulation
IS-1554 Part-I :PVC insulated (heavy duty) electrical cables – working Voltage upto and including 1100V
IS-2074 :Ready mixed paints, air drying, red oxide - zinc chrome
IS-2147 :Degree of protection provided by enclosures for low Voltage switch gear and control gear
IS-2148 :Flame proof enclosures for electrical apparatus
IS-3624 :Specification for Pressure and Vacuum gauges
IS-5831 :PVC insulation and sheath of electric cables
IS-7358 :Specification for Thermocouples
IS-8784 :Thermocouple compensating cables

ISA :Instrument Society of America

S-5.2 :Binary logic diagrams for process operations
S-7.3 :Quality standard for instrument air
S-75.01 :Flow equations for sizing control valves

ISO 5167 venture :Measurement of fluid flow by means of orifice plates, nozzles and tubes inserted in circular cross-section conduits

NACE :National Association of Corrosion Engineers - MR-01-75

NEC :National Electric Code

NEMA :National Electrical Manufacturer’s Association

ICS-6 :Enclosures for industrial control and systems

NFPA :National Fire Protection Association

NFPA-496 :Purged and pressurised enclosures for electrical equipment

OSHA :Occupational Safety and Health Authority

GENERAL PRINCIPLES

The contractor shall carryout all works wholly in accordance with the terms and conditions of the contract to fulfill the requirement of the project. All the material used, and the equipment installed shall be as per the specifications defined in the contract and the work shall be executed with good engineering practices.

Generally, the following activities shall be carried out for each component of this contract but shall not be limited to:

Preparation and submission of the drawings / documents as specified in this tender in minimum 5 sets for all components of the project. The drawings must be on scales as appropriate, subject to the prior approval of the Engineer in Charge / consultants to this project. In case of commented drawings, contractor shall re-submit their designs/ drawings / documents for approval after incorporating the comments.

Approval of all design and drawings, material to be used, equipment specifications and the samples, shall be obtained from engineer-in-charge prior to commissioning of work on site. Unless mentioned otherwise, if for any specific provision / references have been made in more than one specifications, the provision more stringent shall be applicable.

Submission of the design, specifications, catalogues and the technical data sheets of all the equipment, electrical & instrumentation system and design shall be made taking into account the interfaces to the other project components /packages and the second phase of Project.

Preparation and submission of all detailed working drawings on the basis of conceptual designs and plans approved by the Engineer in Charge.

Bidder shall adopt / adhere to below general engineering specifications and practice while designing / supplying the proposed system. The requirements mentioned below in this general engineering specifications, required for proper functioning of the instruments / equipment, shall be provided / fulfilled by the bidder at no extra cost, irrespective of whether separately mentioned or not with individual instrument / equipment specifications. Further bidder shall note that in case of any discrepancy or conflict in specifications or requirements or meaning, the provisions of below general engineering specifications shall be considered governing and shall override the requirements mentioned in the detailed specifications of any particular instrument / equipment, as applicable. The general engineering specifications and practice to be followed are as under:

a) Adequate measure shall be taken to prevent dry running of the pump. Low level to trip the pump shall be above the top of pump casing. Effective liquid depth of

units shall be considered between levels corresponding to lowest level switch and highest level switch. Flooded suction requires that lowest level switch shall not be lower than the elevation of discharge flange of pump / centerline of impeller eye. The levels shall be programmed for pump operation keeping this in mind. Bidder to either consider to provide separate level switches for LOW level or shall use potential free contact of level transmitter provided for tank/sump in reference to be interlocked to pump starters with relay contact multiplication as required to trip the pump in manual mode also.

b) All instrument indication facility shall be readable from grade.

c) All motors shall have running, fault (trip), & A/M selector switch postiion indication at HMI and shall be operated in auto mode through PLC / HMI. Similarly, all electric actuators shall have open position, close position, fault (trip), L/R selector switch position indication at HMI and shall be operated in auto mode through PLC / HMI.

d) PLC / SCADA Station shall be located at Control Room or as directed by engineer-in-charge providing monitoring and control facilities for entire proposed work under scope of this tender. The control room layout shall be planned after taking into consideration the space requirement of various PLC/SCADA panels, HMI, etc. It shall be properly air conditioned. Control room shall be aesthetically appealing. **PLC/SCADA system shall have spare Ethernet port with GSM/GPRS (4G) or such suitable modem for third party connectivity with overall SCADA system of Client in future or as required for complete water supply system of the city. All required data mapping details and other details as required for third party integration with master SCADA of Employer & remote data transfer to monitor entire proposed plant at master SCADA of Employer shall be provided by bidder at no extra cost**.

e) The material procured under this contract shall be offered for required factory / site inspection of client / consultant's representatives as specified below:

All the analysers and instruments shall be as per approved data sheets / drawings and shall be cleared for dispatch subject to review of test certificates and calibration certificates where specified in detailed specification of individual item. Calibration for analysers shall be carried out / demonstrated at site with required calibration kits / buffer solutions as per manufacturer standard. Factory inspection is not required for these items.

Factory Acceptance Test (FAT) shall be offered for PLC/SCADA sytem requiring correctnees of wiring / panel as per approved drawings and providing necessary simulation test at local manufacturer's / system intergrator's works. PLC/SCADA hardware and software shall be as per manufacturer's test certificates / confirmations. Stage inspection shall be provided / allowed by the bidder if client wishes to carry out the same.

Factory inspection and clearance by client shall in no case relieve the bidder of his responsibilities for the correctness of operation of the offered system / equipment as per application / logic requirement.

The contractor shall submit quality / inspection plan for all major equipment including stage/final inspection as specified above for the approval in engineer-in-charge and shall follow the same.

Expenses pertaining to inspection to be carried out by client (for a maximum of two representatives of clients) including travel, local conveyance at place of inspection, lodging and boarding shall be borne by successful bidder.

f) The drawings, if any accompanying the tender documents, are indicative of scope of work and issued for tendering purposes only. These drawings indicate the general scheme for the treatment as well as the location map to enable the contractor to make an offer in line with the requirement of the Owner. Final construction shall be as per approved drawings / documents furnished by the contractor and approved by engineer-in-charge / consultant.

Quoted price for the work must include cost of all such drawings and details to be furnished at the time of tendering/agreement, during execution and after completion.

Drawings prepared for the work after award of contract shall be the property of the Owner and shall not be used for any other work except the work under the relevant contract.

The operation and maintenance manuals and as-built drawings / documents shall be furnished in required number of sets as specified else where in this document (minimum 5 sets) for each instrument / equipment of the offered system as well as for the entire system as a whole. These shall be furnished free of cost to the Owner.

g) Where required, sampling through gravity flow with necessary manual flow control valves is preferred and piping up to drain point or as directed by engineer-in-charge shall be provided. However where sampling pumps are required, sampling pump of required capacity shall be provided for each application / requirement.

h) All the utility / sampling pumps and equipment including SOVs etc. shall be operated in auto mode through PLC only.

i) Bidder may offer dual / multi-channel controller, dedicated or plug and play / mix and match type for various process analyzers (pH, DO, FRC, Tu, MLSS, TSS, BOD/COD, etc).

j) PLC / SCADA system shall have necessary security / authorization defined for various functional level and object level. An operator can be provided access to one or more functional levels and functional groups shall be user definable and shall be assigned to different operators in different combinations.

Necessary support structure, hardware, fittings, mounting assemblies suitable for the application as per specifications, canopies for transmitter and for sensor where required, etc. as required for installation and proper operation of instrument shall

be considered and included by the bidder in the scope of supply at no extra cost for each instrument / equipment.

k) All instrument / equipment shall be suitable for continuous (on-line) operation, unless otherwise specified.

l) The specifications / scope of work for each item within this tender covers the design, manufacture, inspection, & testing at the manufacturer's works, proper packing for transportation for delivery at site, supply at site including transportation, taxes, duties, levies, etc. as applicable at actual at the time of delivery, loading & unloading, erection (including upgradation work where applicable), testing, commissioning, labour etc. and also including requirement of any structural steel, fittings, piping, cables, cable trays, accessories, utilities, associated civil or mechanical works, etc., complete in all respects for proper trouble free and reliable working of instrument / item, and as required for proper operation of plant as described / intended in this tender, whether specifically mentioned or not.

Bidder shall note that the actual cost of travel, lodging & boarding for the visit for inspection, if required, shall be borne by by the successful bidder for a maximum of two representatives of client visting for inspection. Bidder shall also make all necessary arrangements for the inspection by client's representatives. Client's representative shall be client's employee / engineer and / or authorized representative (third party inspection agency).

m) Applicable Codes and Standards - All the equipment/item specified herein shall comply with the requirements of the latest issue of the relevant Indian & International standards. The equipment / item shall meet the requirements of requirements of Indian Standards, where available and only in cases where Indian Standards are not available, relevant International Standards shall be followed.

n) Inbuilt PID controller of instrument shall not be used for process control. Process control shall be through PLC only and necessary I/Os shall be considered for the same.

o) Over voltage (lightning) protection shall be provided confirming to EN 61000-4-5 for power input of all outdoor (field mounted) 4-wire instruments.

p) In outdoor unpaved areas cables shall be directly buried in ground or suitably laid as per site conditions. The cable trenches shall be sized depending upon the number and voltage grade of cables. Where underground cables cross roadways, pipe sleepers at grade, etc., they shall be protected by being drawn through PVC sleeves/ducts or suitable RCC Pipes to provide a permanent crossing. Pipes laid for mechanical protection shall be sealed at both ends.

Cables shall be laid over cable trays within the pump house and in paved areas and for cables to be laid on outdoor units.

q) All Pressure Gauges and Pressure / Differential pressure transmitters, etc. shall be supplied complete in all respects with required 2/3/5 valve manifolds, required pipe (tubing) work shall be of SS316 steel tube / pipe as appropriate and at

required gradient, stop cocks, drain clocks and any similar ancillary item of equipment, and included in price, whether specifically mentioned in detailed specifications of individual instrument / transmitter or not.

r) Instrument installation hardware shall be supplied with each instrument whether specified or not. Generally it shall be as specified in the detailed / general specifications of instrument and as per clause "specifications of installation hardware" in this specifications, if specified or not specified elsewhere.

s) It is envisaged to operate the entire plant through a programmable logic controller (PLC) based panel for auto operation of various pumps / equipment, actuator operated valves, drives, etc.

OTHER GENERAL REQUIREMENTS / SPECIFICATIONS

1. **GENERAL:**

The Contractor shall obtain all instruments from manufacturers of international standing.

The design and quality of all instruments shall be fully suited to the conditions which will be met in service. The design of electronic instruments shall be in compliance with the electromagnetic compatibility requirements as per IEC-801.

The instrumentation and control system shall be designed, manufactured and installed to ensure highest standard of operational reliability. Major instrumentation shall be electronic type. Panel mounted receiving instruments shall be electrically operated miniature flush mounting type unless otherwise specified. All instruments shall be installed in accordance with the recommendations or instructions of the instrument manufacturer for particular application.

All instruments shall be capable of carrying their full load currents without undue heating. They shall not be damaged by the passage of fault currents within the rating of the associated MCB or through the primaries of their corresponding instrument transformers. All instruments shall be back connected and the cases shall be earthed. Approved means shall be provided for zero adjustment of instruments without dismantling.

All voltage circuits to instruments shall be protect by MCB's in each unearthed phase of the circuit placed as close as practicable to the main connection.

Analogue signals shall be 4-20 mA according to BS 5862:Part I 1986 or its latest edition. They shall operate over two wires and be isolated from earth. 1-5V DC signals shall only be permitted within the main instrument inclosure.

Analogue signals shall be so connected that the failure of a remotely transmitted signal to another panel can not affect other readings on instruments operated by the same signal.

The contractor shall furnish technical details / catalogues / drawings for the instruments and panels offered for monitoring and control of the entire plant to client/consultant for their approval prior to procurement of the same. Contractor shall offer inspection for the instruments/panel offered by him and in case of waiver of inspection by the client / consultant, necessary test certificates shall be submitted for approval of client / consultant before clearing the material for despatch. Contractor shall submit their inspection plan to client/consultant for their approval for this purpose.

All instruments procured by the contractor as per the Engineer's approval, and those which perform similar duties shall be of uniform type and manufacture throughout the scheme in order to facilitate maintenance and the stocking of spare parts. Moving parts and contacts shall be adequately protected from the ingress of dust, and all instruments shall be protected by moisture and dust-proof cases including those mounted in panels. All equipment shall be suitable for its environment.

Panel mounted receiving instruments shall be of the electrically operated miniature flush mounting type unless other wise stated.

Scales shall be clearly marked with black lettering and graduations on a white background. Instruments of the same type and range shall have identical scales.

Instrumentation System shall be designed as per good engineering practice.

2. **POWER SUPPLY TO PACKAGE:**

A) Power Supply shall be made available by the bidder at the following voltage levels, **unless otherwise specified**.

- For Instruments, Control Systems, Analysers : 230V AC $\pm$ 10%, 50 Hz $\pm$ 3 Hz
- Solenoid Valves, Relays, Lamps : 24V DC
- Input Interrogation Voltage : 24V DC
- Panel/Cabinets Lighting : 230V AC $\pm$ 10%

Contractor shall make provision for a separate feeder in the Plant MCC of suitable current rating to provide 230V AC $\pm$ 10%, 50 Hz $\pm$ 3Hz supply to Instrument Panel(s).

24V DC required for Input Interrogation, relays and lamps etc., same shall be generated by the bidder using **dual redundant power supply**. Power shall be suitably conditioned by providing on-line type UPS (with in-build AVR) to prevent damage to instruments & PLC/SCADA system against power fluctuation / disturbances.

B) Instrument power circuits shall be individually protected from fault with the help of fuses. Power supply to the individual instrument shall be disconnected with the help of fuses. Miniature circuit breakers (MCB's) may be selected in place of switch fuse unit in case protection is provided for overload protection.

3. **EARTHING :**

Vendor shall provide separate earth bus bar connections for shield and panel electrical earthing.

Any special earthing requirements, if required, shall be provided by vendor during detailed engineering.

Necessary earth pits shall be provided for the same by the vendor.

4. **ENCLOSURE :**

All instruments enclosure mounted in the field shall be weatherproof to IP-65 / NEMA4 as a minimum.

For Hazardous Areas (Not applicable for WTP/TTP project) :

All electrical instruments except solenoid valves shall be intrinsically safe while solenoid valves shall be explosion proof. All such instruments shall be suitable for the applicable hazardous area classification. All intrinsically safe/explosion proof instruments shall be certified by any statutory body for use in specified hazardous area.

All electronic instruments like field transmitters shall be certified intrinsically safe.

All solenoid valves, field switches etc. shall be certified explosion proof to NEMA7. Contacts shall be gold plated rated for 30V, 1 Amp.

5. **INTERLOCKS / LOOPS :**

All plant interlocks shall be carried out using PLC & electromagnetic relays to be supplied by vendor for fail safe and reliable operation. Vendor to indicate all process interlock requirements on the P&IDs.

Loop integrity must be maintained for each loop. No component of any loop shall be shared by other loop.

The system shall be designed fail safe and shall meet the following requirements, as a minimum :-

a) All initiating contacts shall be close under normal conditions and shall open under abnormal conditions.
b) All relays and solenoid valves shall be energised under normal conditions and shall de-energise under abnormal conditions.

The system shall be designed using PLC / electromagnetic relays unless specified otherwise and shall be located locally or remotely as per the operational requirements. The system shall meet the following requirements as a minimum :

a) The electromagnetic relays shall be low power continuously rated type and shall have LED for status indication.
b) The relays shall be plug-in type and their plug-in bases shall have screwed terminals for interconnection. Lug type soldered connection shall not be acceptable.
c) Each relay shall have two numbers of 'NO' and two numbers of 'NC' contacts as a minimum each suitable to drive the connected. Out of these, one 'NO' and one 'NC' contacts shall not be used.
d) Each shutdown/interlock logic shall be individually protected using separate switch-fuse unit and shall have a lamp for indicating power healthy status.

Each shutdown circuit and solenoid valve shall be provided with a switch-fuse unit seperately.

6. **DELETED**

7. **CONTROL PANEL :**

Control panels shall be prefabricated type, Sourced from Approved Vendors.

Control Panel shall be CNC machine prefabricated out of CRCA sheet steel of thickness not less than 1.5 mm, modular in construction, properly reinforced, powder coated and having rigid frame structure. Internal mounting plate 2 mm and the gland plate shall be 3 mm thick. The instrument panel shall have dimensions as per system requirement. However, the Control panel height shall not exceed 2100 mm.

The exterior corners and edges shall be rounded to give a smooth overall appearance with projections kept to a minimum.

Lifting lugs shall be provided for installation purposes and shall be replaced with corrosion resistant bolts after installation.

Control Panel shall be completely metal enclosed and shall be dust, moisture and vermin proof. Panel enclosures shall provide a degree of protection not less than IP 52 in accordance with IS: 13947 Part-I.

Control Panel shall be freestanding type. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation.

Metal sills in the form of metal channels properly drilled shall be furnished along with anchor bolts and necessary hardware for mounting the Instrument panels. These shall be dispatched in advance so that they may be installed and leveled when concrete foundations are poured.

Cable entries to the panels shall be from the bottom with fire retardant spray compound sealing. Instrument panels shall be provided with louvers along with washable micron filters AIRIN – AIROUT fans will be provided.

No process fluid of any kind, except instrument air, shall enter the instrument cubicle. All cable entry shall be from the bottom of the panel. Also power supplies greater than 230 V shall not enter the ICP/LCP.

The internal layout of the panel/cabinets shall be designed considering proper approach for each item for maintenance. Following point must be taken into consideration while deciding the internal layout :

a.) All wiring inside the panels shall be housed in covered non-flammable plastic raceways arranged to permit easy accessibility to various instruments for maintenance adjustment, repair and removal. No raceway shall be more than 70% full.
b.) Separate wiring raceways shall be used for power supply wiring, DC and low level signal wiring.
c.) Distance between terminal strips and side of the panel parallel to the strips up to 50 terminals : Min. 50 mm.
d.) Distance between terminal strip and top and bottom of cabinet : Min. 75 mm.
e.) Distance between two adjacent terminal strips : Min. 100 mm.
f.) Distance between cable gland plate and the bottom of strips : Min. 300 mm.
g.) 20% spare terminals shall be provided as a minimum.

Overall height of Control Panel shall not exceed 2100 mm. Panel mounted instruments and controls shall be such mounted that they are accommodated between 800 mm and 1300 mm from floor level.

Control Panel shall be provided with fluorescent type lighting fixtures controlled from totally enclosed door operated switches for internal illumination of the panel cabinets.

Contractor shall provide with necessary cooling fans and cut-outs covered with appropriate filters for necessary air changes to limit temperature rise within panel to 5 deg C over ambient temperature.

Contractor shall consider necessary power conditioning unit (On-line type UPS) to prevent power fluctuation and surge to damage the instruments, PLC/SCADA system as well as other electronic components.

For cases where PLC is to be mounted, panel shall be deisnged suitably as per PLC manufacturer’s recommendation. Necessary marshalling boxes may be considered if required as per design.

Control rooms including Main Control Room (SCADA Control room) shall be provided with air conditioners of sufficient numbers/quantities as recommended by Air conditioner manufacturer based on room size, heat load, etc. However, a minimum of 2 nos. 1.5TR capacity air conditioner shall be provided.

Windows in control room shall be provided with suitable louvers to prevent direct heat / glare.

Mounting

All equipments on front of panel shall be mounted flush or semi-flush. In case of semi-flush mounting, only flange or bezel shall be visible from the front.

Equipment shall be mounted such that removal and replacement can be accomplished individually without interruption of service to adjacent equipment.

Equipment mounted inside the panel shall be so located that terminals and adjacent devices are readily accessible without the use of special tools. Terminal markings shall be clearly visible.

Earthing for Instruments
The panel shall be equipped with an earth bus securely fixed along the inside base of panel.

Minimum two numbers of Dedicated Earth Stations to be provided each for Instruments / Panel Earthing and for Signal (Electronic) earthing. The earth station shall be of maintenance free pipe in pipe technology having earth electrode of 50 mm dia. and length of 3000 mm.

All metallic cases of instruments and other panel mounted equipment shall be connected to the instrument earth bus.

Looping of earth connections which would result in loss of earth connection to other devices when the loop is broken shall not be permitted. However, looping of earth connections between equipment to create alternative paths to earth bus shall be provided.

A separate instrument earth bus will be created which will be floating and all the cable shields will be terminated onto this bus. This bus will be connected to an electronic earth pit as specified above.

Frame Earthing
All metal parts other than those forming part of an electrical circuit shall be connected to a copper earth bar run along the inside bottom of the panel. The minimum section of the earth bar shall be 25 mm x 3 mm. A 15 mm diameter hole is to be provided at each end of the bar. Connection of the earth bar to the station earth shall be carried out by Contractor.

Space Heater
Strip type space heaters of adequate capacity shall be provided inside control panels to prevent moisture condensation on the wiring and panel mounted equipment when the panel is not in operation. The heaters shall operate on 230 V AC. Heaters inside the panels shall not be mounted close to the wiring or any panel mounted equipment. The operation of heaters shall be controlled by thermostats.

Interior Lighting and Receptacles
Each panel shall be provided with either a LED lighting fixture rated for 11 watt, 230V, 1 phase, 50 Hz supply for the interior illumination of the panel during maintenance. The illumination lamp shall be operated by door switch or manual switch. Each panel section shall be provided with separate lighting.

Each panel shall be provided with 230V, 1 phase, 50 Hz, combined 5 amps and 15 amps, 3 pin receptacle with a switch and neon indication. The receptacle with switch shall be mounted inside the panel at a convenient location. If the panel has front and rear doors then maintenance socket shall be provided at both locations.

Labels

All the equipment mounted on the front facia of Instrument panel as well as equipment mounted inside the panels shall be provided with individual labels with equipment designation engraved. The labels shall be mounted directly below the respective equipment. Also the panel shall be provided at the top with a label engraved with panel designation.

Switches and Miniature Circuit Breakers (MCBs)

Each instrument panel shall be provided with necessary arrangement for receiving, distributing, isolating and protecting of DC and AC supplies for various controls, signaling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with DP Miniature Circuit Breakers (MCBs). Potential circuits for relaying and metering also shall be protected by MCBs. All such major MCBs will be provided with an auxiliary contact to be used for providing MCB tripped alarm.

Intra-panel (i.e. Panel Internal) Wiring

Connections within a panel, between panel mounted devices and terminal blocks or between two panel mounted devices will be made by 600 volt grade, multi stranded copper flexible conductor insulated with FRLS Grade PVC and designed for a minimum conductor temperature of 70 degrees centigrade. The wires shall be shielded, where necessary.

Panels shall be supplied completely wired internally, with a colour coding scheme decided mutually between the Purchaser and the Contractor, to equipment and terminal blocks and ready for external cable connections at the terminal blocks.

Wires within the panel shall be continuous i.e. without splicing and shall comprise stranded copper conductors. Internal wiring or wiring between the two assemblies shall be commensurate with mechanical safety.

Wire termination shall be made with solderless crimping type of tinned copper lugs which firmly grip the conductor and insulation. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules, marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wires and shall not fall off when the wire is disconnected from terminal blocks. The ferrule system shall adopt single tube printed arrangement so that all the characters remain on one line always & hence easily readable

Terminal Blocks

Terminal blocks for power connection shall be 600V grade, 20 amps rated, one-piece moulded, complete with stud type terminals, washers, nuts and lock nuts and identification markings. Terminal block design shall include a white fibre marking strip with clear plastic, hinged terminal covers. Markings on the terminal

strips shall correspond to wire numbers on the wiring diagrams. All control output terminals will be fused type and all other input signal terminals will be clip on shrouded type.

All spare contacts and terminals of the panel mounted equipment and devices shall be wired to terminal blocks.

Panel internal wiring shall not be looped directly from instrument to instrument. The same shall be looped through the panel terminal block only.

If accidental short circuiting of certain wires is likely to result in malfunction of equipment, such as closing or tripping of a breaker, these wires shall not be terminated on adjacent terminal blocks.

Cable Supports
All external cables shall present a neat appearance and shall be suitably braced, placed in troughing clipped or laced to prevent effects of vibration.

Terminal / Identification
Every terminal plug shall be uniquely identified within the terminal cabinet by means of a terminal number. Appropriate labels shall be used to permit quick and unambiguous identification of each terminal and test plug.

Painting of System Cabinet/ Control Desk
All sheet steelwork shall be painted using seven tank processe in accordance with the following procedure:

i. The pre treatment shall be hot process with running water for rinsing.

ii. Oil, grease, dirt and swarf shall be thoroughly removed by emulsion cleaning.

iii. Rust and scale shall be removed by trickling with clean water followed by final rinsing with dilute dichromate solution.

iv. The control panel shall be powder coated. Thickness of coating shall be around 60 microns. QA test certificate shall be furnished for thickness adhesion and hardening of powder coating.

PLC & AUTOMATION REQUIREMENT FOR TTP:
The below are specific requirements are to read in conjunction with above control panel specifications, PLC specifications furnished & other automation requirements furnished else where in tender specifications.

The PLC systems shall be centralized configuration or with Distributed I/O or remote PLC configuration integrated over suitable communication network.

It should be possible to operate/control and monitor status of all electric drives, electrically / pneumatically operated valves, process parameters (level, diff/ level / flow INSTRUMENTS, water quality analyzers, etc.) of & treatment plant at main control room PLC HMI. Valves shall be monitored for full open, intermiediate and full close position and electrical drives for motor on, off and trip status.

Separate indication at HMI, Green indication for Valve close / motor off status, Red indication for Valve open / motor on status and Amber indication for Trip shall be provided.

ICP shall house the major hardware of programmable logic controller and shall be located in an environmentally controlled main control room. ICP shall be provided with necessary cooling fans and Louvers with washable filter set. Number of cooling fans shall be as per the recommendation of PLC supplier. Control room shall be provided with air conditioners of sufficient numbers / rating as recommended by air conditioner manufacturer based on room size, heat load, etc. Windows in main control room shall be provided with suitable decorative / aestheticaly pleasing louvres to prevent direct heat / glare.

HMI shall display process scheme of entire treatment plant showing status of all electrical drives, electrically operated valves, instrumentation (level, flow, dif. Level, process analyzers, field transmitters, LOH/ROF, etc.), major power parameters, etc. Screens depicting entire treatment plant and also for individual process units shall be developed and diaplyed at HMI with necessary process parameters / equipment status and operation buttons. It shall be easily possible to navigate through various screens.

The purpose is to minimize human intervention and increase reliability and ease in operation of entire treatment plant

Operating hours shall be logged for all electrical drives irrespective of auto or manual mode of operation. In auto mode, the equipment if available, shall be selected for operation based on operating hours so as to achieve uniform utilization of all equipment. OH shall be displayed on HMI/SCADA along with status of respective equipment. In case of more than one working pump in a set, no two pumps shall start or stop simulataneously. The start & stop shall be having user programmable delay to be finalized during detailed engineering.

The hardware of each basic controller shall comprise of main processing unit, memory units, stabilized power supply units, necessary communication interface modules, auxiliary storage, remote (distributed) I/O stations or remote PLCs as the case may be, and the programming, debugging tools etc. The monitor screen will be showing the total plant conditions covering number of pages; Graphic pages will give the details about all stationary and rotary equipment. Any equipment can be put into service or switched off from the service by the operator from the keyboard. Particular page on selection will display the corresponding information in the video display unit. In case of any ‘ALARM’ the equipment can be switched off automatically or by the operator from the keyboard display of the mode or by the operation selected earlier by the operator. Even in auto operation option receiving audio signals recording alarm condition operator should switch off the equipment from the keyboard. In any time during operation, the operator should have flexibility to interfere with the mode of operation depending upon ‘necessity’. Also there should be flexibility of changing the type of operation from one mode to another mode like manual to remote manual to remote manual to auto operation and vice versa.

Selection facility for all drives meant for PLC operations are provided in PLC. Status for all drives and access to all interlocks are available in PLC. Automatic switch over facility of pump operation is provided.

In case of bidder opting for non-integral starter for electrical actuators if permitted as per actuator specificaitons elsewhere in tender, he shall provide local push button station near each valve for operation of valves in semi-auto mode from the field. Suitable operating platform shall be provided wherever required for operating valves locally where integral starters are provided. All motorized valves mounted in channels / gallery shall be so mounted and protected that no water/fluid shall fall or splash over the actuators.

Necessary logic and selection shal be provided such that the valves / motors such that in semi-auto mode valves / motors can be operated only from one selected location i.e. either from ICP / HMI or from LCP or through Local Push Button, as the case may be.

Bidder to furnish indicative configuration drawing of PLC based system as envisaged to be provided for water treatment plant along with P&ID and list of instrumentation along with the bid for reference. The final instrumentation and logic shall be as finalized during detailed engineering.

PLC system shall comprise of the following items:

a) One industrial grade, time tested rack mounted CPU with necessary rack, memory modules, power supply module, scanner module, I/O modules etc. as applicable. Adequate PLC programming software shall also be included in scope of supply.

b) For Main Control Room (TTP Site): 02 (Two) nos. Personal computers for Programming and operator cum programming station comprising of required hardware, software and firmware. PC shall of professional grade and shall have min. 21" flat screen, high resolution LED backlit colour monitor, key board, mouse, multimedia accessories, speaker, Ethernet (LAN) connection system for linking server with client, commmunication with remote I/Os & PLCs thorugh FO cables, etc as per below specifications as a minimum. One runtime software (Windows based) and one (1) development software.

   Personal Computer minimum Specifications: PC of any approved make with Intel core i7 (quad core, 8MB, 3.6 GHz) CPU or better / 21" LED Backlit Monitor / 8 GB DDR4 RAM / 1 TB HDD / Optical Drive / PS/2 Keyboard / Scroll Mouse / Audio and Network Interface / Required External I/O Port viz. Headphone, microphone, and 2 USB 2.0, 1 standard serial port, 1 parallel port, PS/2 keyboard and mouse, 1 RJ-45, 1 audio in, 1 audio out, etc. / Licensed OS of latest version and supported by SCADA software (Windows 10 Pro or latest) / licensed version for entire contract period of Quick Heal Total Security anti-virus software package / any other specific requirements to fulfill the PLC / SCADA requirements.

c) PLC panels with adequate I/O capacity and other hardware.
d) A4 Laser Printer – 2 Nos. at control room
e) GPRS (4G) modem for remote data transfer
f) Console furniture for PC and Printer

GENERAL REQUIREMENT FOR PROGRAMMABLE LOGIC CONTROLLER:

PLC considered by the contractor shall meet the following requirements in general:

The Programmable controller execution engine should be true Pre-emptive Multitasking & Multi processing Operating system. The minimum task rate possible is 1(One) mSec. By virtue of design multiple processors can share the same I/O. This is to lower networking costs and efficient I/O utilization with reduced network load (lower usage of Network bandwidth).

The processors should support four languages: Ladder, Function Block Diagram, Seq. Function Charts and structured text. The function blocks requiring operator interaction should have ActiveX faceplates. The operator can interact with the process from platforms from Applications like Microsoft Excel, Internet explorer etc. (Any active X Container).

A clock/calendar feature shall be included within the CPU. Access to the time and date shall be from the programming terminal or user program.

The system shall have the capability to address software timers and software counters in any combination and quantity up to the limit of available memory. The CPU shall handle management of all these instructions into memory. Instructions shall permit programming timers in the "ON" or "OFF" delay modes. Timer programming shall also include the capability to interrupt timing without resetting the timers. Counters shall be programmable using up-increment and down-increment.

Timer instructions shall have a time base of 1.0 milliseconds. The timing range of each timer shall be from 0 to 2,147,483,648 increments. It shall be possible to program and display separately the timer's preset and accumulated values.

The system should preferably support multiple processors on the same rack. This is to reduce the cost of expanding the system as the power supply, rack and the comm. interfaces remain shared with the other processors on the same rack.

The PLC engineering interface should have facility for trending parameters with time resolution of 1mSec. The subroutine calls should have no restriction on the input and return parameters.

The PLC control engine should support statistical instructions like moving average, standard deviation etc. at the PLC CPU level to analyse various process parameters, and complete statistical Quality control and monitoring should be possible at the PLC and SCADA level.

The PLC control execution engines should be IEC-61131-3 compliant, along with 61131 compliant engineering interfaces.

I/O modules should have standard LED indications for monitoring the status of I/Os, Status of the I/O module electronic hardware, Status of the network, and other standard displays. Preferably, it should be possible to program the I/O modules for change of state programming, to reduce the overall network traffic.

For Analog I/Os, channel wise diagnostics, with open sensor detection should be possible. Analog Inputs should have minimum 16 bits resolution for inputs and 13 bits for outputs, and separate hardware for electronics and terminal strip. This is to remove the I/O card without removing the cabling.

Communication Network: The network shall be with sufficient throughput of data and status to enable fast control action. It should be possible to broadcast the relevant information/ commands from the PLC CPU to multiple I/O modules mounted in the field at the same time. At the same time, it should be possible for multiple I/O modules to "listen" to the data being broadcasted by the PLC CPU at the same time. The network shall have superior diagnostic features, and "change of state programming" and data transfer should be possible on all the modules residing on the network.

The entire network should be depicted graphically on the PC and configuration of all the modules on the network should be possible via this software. The network diagnostic software shall include all possible application modules, which will depict graphically all active node and all faulty node. A faulty node shall be depicted distinctly with a separate red color, or a cross mark, or like, to distinguish it from other healthy nodes. It should be possible to diagnose and re-configure a faulty node from the central PC.

SCADA: The system shall have two operator consoles, with one console designated at operations – cum – engineering console (Primary Console), and the second console shall be an operation console, unless specified other wise.

The engineering console shall have all the required software for network management and diagnostic, SCADA graphic development and programming, and PLC programming package.

It shall be possible to program the client connection for a backup communication link to the server, so that in event of communication loss to the server because of failure of communication hardware, the client connection to the server switches to the standby second connection.

Connection to the server from client is on Industry standard Ethernet connection to facilitate easy exchange on data between additional PCs if required at a later date.

It shall also meet the following requirements:

1. PLC shall be of modular, field expandable design and capability shall exist to allow for expansion of the system by the addition of hardware and/or user software.

2. The programmable controller shall have downward compatibility whereby all new module designs can be interchanged with all similar modules in an effort to reduce obsolescence.
3. All hardware of the programmable controller shall operate at an ambient temperature of 0° to 60°C, with an ambient temperature rating for storage of –40° to +85°C.
4. The programmable controller hardware shall function continuously in the relative humidity range of 5% to 95% with no condensation.
5. The programmable controller system shall be designed and tested to operate in the high electrical noise environment of an industrial plant.
6. The main CPU at shall have capability of addressing up to 4096 input and 4096 output points as a minimum.
7. The programmable controller shall have one dedicated serial port, which supports RS-232C signal. It shall be accessible in ladder logic and provide support for point to point and slave SCADA communication protocol system. Alternatively, it must be usable for programming purposes or for access to remote programmers via modems.
8. The program storage medium shall be of a solid-state battery backed RAM type. Memory shall contain battery back up capable of retaining all stored program data through a continuous power outage for 1-2 months under worst-case conditions. The capability shall exist to replace the CPU's battery without incurring a loss of user program.
9. The programmable controller system should provide the capability to use EEPROM as a back up for volatile memory to the full capacity of the controller.
10. Each input or output module shall be a self-contained unit housed within an enclosure.
11. It shall be possible to replace any input or output module without disturbing field wiring. Each I/O module shall contain a visual indicator to display ON/OFF status of individual input or output points. Isolation shall be used between all internal logic and external power circuits. This isolation shall meet the minimum specifications of 500 VRMS.
12. It shall be possible to manually set (force) either on or off all hardwired input or output points or Analog values through programming terminal (MMI) or the main chassis front panel. Removal of these forced I/O points shall be either individually or totally through selected keystrokes. The programming terminal shall be able to display forced I/O points.
13. The SCADA system shall be OPC compliant, and shall include features, by which it should be possible to exchange data between databases like Oracle/SQL (Two way communication).
14. The detailed specifications for PLC are furnished separately below.

8. ALARM ANNUNCIATOR :

(i) Microprocessor based alarm annunciators shall be provided, **if specified in detailed specifications for isntrumetns**, for generating audiovisual alarms for each abnormal condition. Alarms shall be initiated by the opening and closing of volt-free contacts which shall remain unchanged throughout the periods in which the alarm conditions exist. Alarm circuits shall be capable of conversion from open-healthy to open-alarm or vice versa by a simple modification after installation requiring no additional parts or special

equipment. Each alarm shall initiate the operation of both visual and audible devices. The sound intensity of each audible device shall be suitable for the maximum sound level of its environment. The sequence of alarm should be user selectable by dip switch.

(ii) The operation or acceptance of one alarm shall not inhibit the operation of the audible device or the flashing of the appropriate alarm indicator if a future alarm condition occurs.

(iii) Alarm circuitry shall be arranged so that spurious or transient alarm states persisting for less than 0.5 seconds do not initiate any action.

(iv) Isolation facilities shall be provided for the hooter using an MCB

(v) Alarm annunciator/indicator legends or labels shall be arranged with three lines of text as follows :

i.	top line	:	location
ii,	middle line	:	parameter
iii.	bottom line	:	status

e.g. RESERVOIR
LEVEL
HIGH

The annunciator will be split / integral architecture type and the facia will have Super Bright LEDs.

Alarm annunciator shall be provided on instrument control panel for annunciation of alarms in control room. A minimum of 20% spare windows with alarm modules shall be provided in alarm annunciator.

The technical particulars of alarm annunciator are as follows:

(a) Technical Particulars

i.	Type	:	Microprocessor based, split type / integral type with alarm windows mounted on the front door and electronic modules inside the panel
ii.	Mounting	:	Flush with panel
iii.	Construction	:	Modular
iv.	Inputs	:	Potential free, NO/NC contacts
v.	Size of windows	:	60 mm X 26 mm
vi.	Operating sequences	:	First up (user selectable dip switch)

vii.	Bulbs per channel	:	2 (Cluster LEDs)
viii.	Push Buttons	:	For Reset, Accept and Test
ix	Hooter	:	Required, electronic type
x	Power supply	:	24 V DC/240 V AC
xi.	Power supply status	:	Required indication
xii	Weather protection	:	IP-52 of IS 13947
xiii	No. of Windows	:	as per requirement + 20% spare windows

In case if hard wired annuciator is not specifed in detailed specifciaitons for instruments, then visual alarm at HMI and audio alarm through panel mounted hooter along with rest push button shall be provided for all the required alarms as per specifications / approved P&ID / process requirement.

9. **RECEIVING INDICATORS/CONTROLLERS :**

All indicators/controllers shall be electronic (microprocessor based) programmable indicator and shall be mounted on the control panel located in the control room.

Notes :

Indicating instruments shall indicate various process parameters as per following measuring units, in general :

Flow	M^3/Hr or MLD or LPS	as per process requirement
Level	m Meters	
Pressure	Mt. head of water or Kg/Cm^2	as pr process req.
Temperature	C	Degree Celsius
Concentration	ppm or mg/l	Parts per million or Milligram per litre.
Current	A	Amperes
Voltage	V	Volts
Power	W	Watts
Electrical Energy	Whr	Watt-hours
Frequency	Hz	Hertz
Speed	r.p.m.	Revolutions per minute.

Multiplying factors for flow scales shall be specified on manufacturer's name plate.

Subminiature recorder shall have 100 mm. Strip chart with chart speed of 25 mm/hr. Microprocessor based recorder shall have strip chart of 250 mm. Approx. and chart speed of 50 mm./hr. with a provision to change speed at site.

10. FIELD MOUNTED INSTRUMENTS

Field mounted instruments shall, where possible, be hermetically sealed. If this is not possible, they shall be of weatherproof construction with heavy cst cases. Transmitters and similar equipment shall be further enclosed in purpose made weatherproof, glass reinforced fire-retardant polyester resin cabinets.

Particular regard shall be paid to the case of access to all instruments. Serial number/calibration plates shall be visible when the instrument is in its cabinet.

Locally mounted indicating instruments shall be mounted in viewable positions.

Field mounted instruments shall be complete with all mounting brackets, pillars, fittings and fixings to complete the installation.

FIELD TRANSMITTERS :

All field transmitters shall have accuracy of 0.25% of span and shall be provided with output meter / output gauge at the signal output.

Smart transmitters when used shall be used in analog mode only. Smart transmitters when specified shall have accuracy of 0.1% of span, as a minimum.

DP Type Flow Transmitter if used for congealing, corrosive and highly viscous services shall have Diaphragm Seal element with Capillary.

Transmitter shall be capable of delivering rated current into external load of atleast 600 ohms when powered with 24V DC nominal voltage.

11. PUSHBUTTONS AND SWITCHES

Pushbuttons for operational circuits shall be provided with a shroud, guard or other suitable means to prevent inadvertent operation. They shall be in accordance with the high standard generally required by the specification as a whole and by the equipment with which they are associated.

Illuminated pushbuttons where used shall be of a design that allows easy replacement of the lamps from the front of the panel.

If legends are engraved on the pushbuttons they shall be clear and concise and shall be approved by the Engineer-In-Charge before manufacture.

Control switches shall be in accordance with the high standard generally required by the specification as a whole and by the equipment with which they are associated.

12. INSTRUMENT CONNECTIONS:

Electrical cable entry shall be ½” NPT(F). Suitable cable gland shall be used.

End connections shall meet the following unless, otherwise specifed:

Threaded end connection shall be NPT as per ANSI / ASME B.1.20.1
Flanged end connection shall be as per ANSI / ASME B16.5

13. INSTRUMENTS:

Instruments as per following details and specifications shall be provided by vendor as a minimum. Quantities mentioned, if any, are indicative only and contractor shall provide all necessary instruments described inthis section or as required for proper operation of the plant as described else where in this tender or found necessary during detailed engineering in addition to below mentioned instruments and their locations. Bidder choosing to supply instrument with communication port suitable for process / diagnostic data transfer with PLC/SCADA need not consider analog signal and alarm contacts inputs to PLC.

All instruments, gauges and control equipment shall be strictly procured as per the list of approved vendors enclosed herewith as part of the tender documents.

a) ON-LINE pH MEASUREMENT SYSTEM:

The specifications in general shall be as under:

a.	**GENERAL**		
1	Service		Water / Sewage Application
2	Function		To measure & indicate the pH / Transmit
3	Operating Temperature		0 to 50°C
4	Installation		Indoor / Outdoor
b.	**Electrodes & Electrode Holder (pH)**		
1	Type of Sensor		Combination Sensor, Digital type sensor
2	Measurement Range		0 - 14 pH
3	Sensor Design Philosophy		Shall be with soln. ground electrode offering long/extended life
4	Sensor Cable		Integral Cable or with Variopin /equi. Water tight (IP-68) connector with necessary cable
5	Temperature Compensation		Required, Automatic, In-built
6	Process Connection (Mounting)	Type	Flow through assembly / sensor mounting assembly
7	Pre-amplifier		Integral or Remote as per mfr. Std.
8	**Measuring Elements:**		
a	Measuring Electrode	Material	Glass
b	Reference System	Type	Double Junction
		Electrolyte	Ag/AgCl with saturated KCL

		Material	(Gelled Electrolyte)
		Ref. Junction / Diaphragm	Porous PTFE / Silicore / Equi. as per mfr. Std.
c	Soln. Ground Electrode		Required
		Material	Platinum / Titanium / Equi. as per Mfr. Std.
d	Temperature Sensor	Type	Pt 100 / Pt 1000 / NTC 300 Ohm Thermister / 3 K Balco, as per mfr. Std.
9	Sensor (Shaft) Body	MOC	Ryton (PPS) / PEEK / PP as per mfr. Std.
		Type	Refillable or Completely Sealed, Non-Refillable Type as per Mfr. Std.
10	Accuracy		± 0.25% of Measuring Range or better
11	Resolution		0.01pH
12	Repeatability		± 0.2% of Measuring Range or better
13	Protection Class		IP-68
14	Cable Length	Integral / after connector	Min. 5m length or higher up to 10m or more as per site conditions.
15	Sensor Calibration Kit		Required for on-site during O&M period for periodic calibration of Sensor as per manufacturer's recommendation.
16	Calibration Certificate		Required
c.	**TRANSMITTER**		
1	Function		Transmit and Indicate
2	No. of Inputs		Single / Dual / Multiple (Upto 8)
3	Transmitter Type		Microprocessor based, User Programmable, 2-Wire or 4-Wire type as per mfr. Std.
4	Location		Field Mounting
4b	pH Measurement range	Programmable	0-14 pH
5	Accuracy		± 1% of Measuring Value
6	Output Signal	For PH	4 -20 mA DC with HART / through suitable communication port - Profibus or Ethernet or Modbus with required connectivity with PLC
7	Instrument Power Supply		100 to 240 VAC ± 10%, 50 Hz ± 5% or 24V DC as per mfr. Std.
8	Cable / Conduit Entry		1/2" NPT or M20 or equi. As per mfr. Std.

9	Local Indicator / Display	FC	Backlit LCD Display
10	Scale Graduation / Measuring Units		Engg. Units
11	Security Access Code		Password protected
13	**Protection:**		
a	Elec. Area Classification		Safe
b	Enclosure	Type & Protection Class	Weather Proof to IP-66 / 67 as a minimum
		MOC	ABS with Clear Polycarbonate Windows or equi. as per mfr. Std.
		Paint	Chemical Resistant / Epoxy Coating
14	Mounting		Wall mounting
e.	**Options / Accessories:**		
1	Tag Plate		Required, SS 304
2	Cable Glands		Required, IP-65/66 as a min., Ni-Plated Brass / Polyamide
3	Plugs for addl. cable entries		Close up Plugs shall be provided for all unused cable entries, Ni-Plated Brass / Polyamide
4	Weather proof enclosure with glass cutout for Analyzer	To prevent from dust and water	Required. MOC: G.I. - min. 2mm thick

pH readings shall be continuously displayed locally as well as at PLC HMI at control room. Low / High pH level shall be annunciated at HMI in main control room. Real time and histroical trend shall be available for last 60 days.

b) ON-LINE RESIDUAL (FREE) CHLORINE MEASUREMENT SYSTEM:
The specifications shall be as under:

a.	**GENERAL**		
1	Service		Water / Sewage Application
2	Function		To measure & indicate the Free Chlorine / Transmit
3	Operating Temperature		0 to 50°C
4	Installation		Indoor / Outdoor
b.	**Electrodes & Electrode Holder (Chlorine)**		
1	Type of Measurement		Amperometric / Potentiostatic with pH compensation, Digital type sensor

2	Measurement (Calibration) Range	Free Chlorine	0-5/20 mg/l or as per mfr. Std., programmable
3	pH compensation		Required
4	Process Connection (Mounting)	Type	Flow through assembly / sensor mounting assembly with 50-micron filter and rotameter at inlet sampling line to FRC sensor / flow through assembly. Sampling Pump and pipe of required size and length upto instrument / sensor and sample drain pipe back upto sump. Flow through assembly / sensor mounting assembly shall be common for FRC and pH Sensor. Drain arrangement to be provided at all low point for drain/ flushing.
5	Protection Class		IP-68
6	Sensor Cable		Integral Cable or with Variopin /equi. Water tight (IP-68) connector with necessary cable
7	Accuracy		± 2% of Measuring Range or better
8	Resolution		0.1 mg/l
9	Repeatability		± 1% of Measuring Range or better
10	Cable Length	Integral / after connector	Min. 5m length or higher up to 10m or more as per site conditions.
11	Calibration Certificate		Required
d.	**TRANSMITTER**		
1	Function		Transmit and Indicate
2	No. of Inputs		Single / Dual / Multiple (Upto 8)
3	Transmitter Type		Microprocessor based, User Programmable, 2-Wire or 4-Wire type as per mfr. Std.
4	Location		Field Mounting
a	Free Chlorine Measurement Range	Programmable	0-5/20 mg/l or as per mfr. Std., programmable (Suitable to measure normal FRC range of 0 - 2 mg/l)

5	Output Signal	For FRC with pH compensation	4 -20 mA DC with HART / through suitable communication port - Profibus or Ethernet or Modbus with required connectivity with PLC
6	Instrument Power Supply		100 to 240 VAC $\pm$ 10%, 50 Hz $\pm$ 5% or 24V DC as per mfr. Std.
7	Cable / Conduit Entry		1/2" NPT or M20 or equi. As per mfr. Std.
8	Local Indicator / Display	FC	Backlit LCD Display
9	Scale Graduation / Measuring Units		Engg. Units
10	Security Access Code		Password protected
11	**Protection:**		
a	Elec. Area Classification		Safe
b	Enclosure	Type & Protection Class	Weather Proof to IP-66 / 67 as a minimum
		MOC	ABS with Clear Polycarbonate Windows or equi. as per mfr. Std.
		Paint	Chemical Resistant / Epoxy Coating
14	Mounting		Wall mounting
e.	**Options / Accessories:**		
1	Mounting Accessories		Mounting plate (min. 3 mm thick MSEP) for complete instrument,
2	Tag Plate		Required, SS 304
3	Cable Glands		Required, IP-65/66 as a min., Ni-Plated Brass / Polyamide
4	Plugs for addl. cable entries		Close up Plugs shall be provided for all unused cable entries, Ni-Plated Brass / Polyamide
5	Weather proof enclosure with glass cutout for Analyzer	To prevent from dust and water	Required. MOC: G.I. - min. 2mm thick

Readings shall be continuously displayed at PLC SCADA. Low / High FRC & pH levels shall be annunciated at PLC SCADA in main control room. Real time and histroical trend shall be available for last 60 days.

c) ON-LINE BOD/COD (UV ABSORPTION & TRANSMITTANCE) ANALYZER:

SPECIFICATIONS FOR UV ABSORPTION / % TRANSMITTANCE (BOD/COD) ANALYZER			
A.	**GENERAL**		
1	Service		Water / Sewage Application
2	Function		To measure & indicate / Transmit
3	Operating Temperature		0 to 50°C
4	Installation		Indoor / Outdoor
B.	**Electrodes & Electrode Holder**		
1	Type of Sensor		UV absorption measurement (2-beam technique), reagent-free Absorbance / %Transmittance Sensor determines the Spectral Absorption Coefficient (SAC) at a wavelength of 254 nm, Digital type sensor
2	Measurement Method		SAC 254 in accordance with DIN 38404 C3
3	Measuring Path		1 mm, 2mm, 5mm, or 50 mm path lengths as per process / application requirement
4	Measuring Range		As per process requirement
5	Measurement Unit		Measurements can be expressed in absorption units (m–1), mg/L, or ppm
6	Compensation		550 nm
7	Measuirng Interval		<= 1 min
8	Protection Class		IP-68
9	Cable Length		Min. 5m length or higher up to 10m or more as per site conditions.
10	Process Connection (Mounting)	Type	Suitable for immersion (open tank / sump) type mounting with immersion assembly Immersion assembly shall be Swivel / Pivot / Pipe Clamp Assembly suitable for hand rail mounting in SS / non-corrosive material
11	Calibration Certificate		Required
C.	**TRANSMITTER**		
1	Function		Transmit and Indicate
2	No. of Inputs	Channels	Single / Dual / Multiple (Upto 8)
3	Transmitter Type		Microprocessor based, User Programmable, 2-Wire or 4-Wire type as per mfr. Std.
4	Location		Field Mounting
5	Output Signal	Analog outout	4 -20 mA DC with HART / through suitable communication port - Profibus or Ethernet or Modbus with required connectivity with PLC
		Relay	Min. 2 potential free changeover contacts
6	Instrument Power Supply		100 to 240 VAC $\pm$ 10%, 50 Hz $\pm$ 5% or 24V DC as per mfr. Std.

7	Cable / Conduit Entry		1/2" NPT or M20 or equi. as per mfr. Std.
8	Local Indicator / Display	DO & Temp.	Backlit LCD Display
9	Security Access Code		Required, password protected
10	**Protection:**		
a	Elec. Area Classification		Safe
b	Enclosure	Type & Prot. Class	Weather Proof to IP-65 as a minimum
		MOC	Cast Alu. / Polycarbonate or equi. as per mfr. Std. suitable for withstanding harsh environment
11	Mounting		Wall mounting / Pipe mounting
D.	**Options / Accessories:**		
1	Mounting Accessories		Required, Universal 2" Pipe and / or Wall Mounting Kit
2	Tag Plate		Required, SS 304
3	Cable Glands		Required, IP-65/66 as a min., Ni-Plated Brass / Polyamide
4	Plugs for addl. cable entries		Close up Plugs shall be provided for all unused cable entries, Ni-Plated Brass / Polyamide
5	Canopy for Analyzer / Transmitter	To prevent from direct sun and rain	Required. MOC: FRP - min. 4mm thick / G.I. - min. 2mm thick

Readings shall be continuously displayed at PLC SCADA. High COD/BOD level shall be annunciated at PLC SCADA in main control room. Real time and histroical trend shall be available for last 60 days. Required correlation charts shall be prepared atr site by contractor.

d) ON-LINE TSS ANALYZER

SPECIFICATIONS FOR MLSS/TSS ANALYZER			
A.	**GENERAL**		
1	Service		Water / Sewage Application
2	Function		To measure & indicate the TSS / Transmit
3	Operating Temperature		0 to 50°C
4	Installation		Outdoor
B.	**Electrodes & Electrode Holder**		
1	Type of Sensor		Optical type, transmitted / scattered light measurement, colour independent measurement, Digital type sensor
2	Measurement (Calibration) Range		TSS: in mg/L as per process requirement (min. 50% safety margin in measurement range)
3	Sensor Design Philosophy		Shall offer colour independent measurement i.e. eliminate effect of coloring components
4	Sensor Cable		Integral Cable or with water tight (IP-68) connector assembly with necessary cable

5	**Measuring Elements:**		
a	Measuring Electrode	Probe / Shaft MOC	Stainless Steel
		Optical Window	Scratch proof / resistant Glass or Sapphire or equiv. as per mfr. Std.
6	Protection Class		IP-68
7	Cable Length		Min. 5m length or higher up to 10m or more as per site conditions.
8	Process Connection (Mounting)	Type	Suitable for immersion (open tank / sump) or pipe type mounting with mounting as under for both this applications:
		- For measurement on Pipe	retractable assembly with isolation valve
		- For measurement on Open Tank / Sump	Through suitable immersion mounting assembly.Immersion assembly shall be Swivel / Pivot / Pipe Clamp Assembly suitable for hand rail mounting in SS316 or of non-corrosive material.
9	Calibration Certificate		Required
10	Sensor Calibration Kit		Required for on-site periodic calibration of Sensor as per manufacturer's recommendation.
C.	**TRANSMITTER**		
1	Function		Transmit and Indicate
2	No. of Inputs		Single / Dual / Multiple (Upto 8)
3	Transmitter Type		Microprocessor based, User Programmable, 2-Wire or 4-Wire type as per mfr. Std.
4	Location		Field Mounting
5	**MLSS/TSS Measurement:**		
a	MLSS/TSS Measurement Range		As per process requirement, programmable
b	Accuracy		$\pm$ 5% of F.S. or better
c	Resolution		0.1 mg/l
d	Repeatability		$\pm$ 3% of F.S. or better
6	Calibration		Semi Automatic, 1 or 2 point calibration or as per mfr. Std. using reference / Manual adjustment to grab sample
7	Output Signal	Analog	4 -20 mA DC with HART / through suitable communication port - Profibus or Ethernet or Modbus with required connectivity with PLC
		Relay	Two potential free contacts
8	Instrument Power Supply		100 to 240 VAC $\pm$ 10%, 50 Hz $\pm$ 5% or 24V DC as per mfr. Std.
9	Cable / Conduit Entry		1/2" NPT or M20 or equiv. as per mfr. Std.
10	Local Indicator / Display	MLSS	Backlit LCD Display
11	Security Access Code		Required, password protected
12	**Protection:**		

a	Elec. Area Classification		Safe
b	Enclosure	Type & Protection Class	Weather Proof to IP-65 as a minimum
		MOC	Cast Alu. / Polycarbonate or equiv. as per mfr. Std. suitable for withstanding harsh environment
13	Mounting		Wall mounting / Pipe mounting
14	Operating Temperature		0 to 55 °C
D.	**Options / Accessories:**		
1	Mounting Accessories		Required, Universal 2" Pipe and / or Wall Mounting Kit
2	Tag Plate		Required, SS 304
3	Cable Glands		Required, IP-65/66 as a min., Ni-Plated Brass / Polyamide
4	Plugs for addl. cable entries		Close up Plugs shall be provided for all unused cable entries, Ni-Plated Brass / Polyamide
5	Canopy for Analyzer / Transmitter	To prevent from direct sun and rain	Required. MOC: FRP - min. 4mm thick / G.I. - min. 2mm thick

TSS readings shall be continuously displayed at PLC HMI. High TSS level shall be annunciated at HMI/SCADA.. Real time and histroical trend shall be available for last 60 days.

e) ON-LINE TURBIDITY ANALYZER

The specifications shall be as under:

a.	**GENERAL**		
1	Service		Water / Sewage Application
2	Function		To measure & indicate the Turbidity
3	Operating Temperature		0 to 50 °C
4	Installation		Indoor / Outdoor
b.	**Electrodes & Electrode Holder**		
1	Type of Sensor		Nephelometric measurement, As per ISO 7027 NIR scattered light method, Digital type sensor
2a	Calibration Range		Treated Water: 0-2 NTU Normal and max. upto 10 NTU
2b	Measurement Range		As per mfr. Std. suitable to measure turbidity range as per application
3	Sensor Cable		Min. 5m length or higher up to 10m or more as per site conditions.
4	**Measuring Elements:**		

a	Measuring Electrode	Probe / Shaft MOC	SS 304 / PVC equi. suitable as per mfr. Std.
		Optical Window	Scratch proof / resistant Glass or Sapphire or equiv. as per mfr. Std.
5	Protection Class		IP-68
6	Integral / after connector	Min. 5m length or higher up to 10m or more as per site conditions.	Integral / after connector
7	Process Connection (Mounting)	Type	Flow through assembly / sensor mounting assembly Sampling pump and pipe of required size and length upto instrument / sensor and sample drain pipe back up to sump. Assembly shall be in Black color only.
8	Mounting Accessories		Required
9	Calibration Certificate		Required
10	Sensor Calibration Kit		Required for on-site during O&M period for periodic calibration of Sensor as per manufacturer's recommendation.
c.	**TRANSMITTER**		
1	Function		Transmit and Indicate
2	No. of Inputs		Single / Dual / Multiple (Upto 8)
3	Transmitter Type		Microprocessor based, User Programmable, 2-Wire or 4-Wire type as per mfr. Std.
4	Location		Field Mounting
5	**Turbidity Measurement:**		
a	Turbidity Measurement Range		As specified above for sensor
b	Accuracy		± 2% of measured value
c	Repeatability		± 1% of measured value
6	Turbidity Calibration		Semi-Automatic, 1 or 2-point calibration or as per mfr. Std. using reference / Manual adjustment to grab sample
7	Output Signal		4 -20 mA DC with HART / through suitable communication port - Profibus or Ethernet or Modbus with required

			connectivity with PLC
8	Instrument Power Supply		100 to 240 VAC ± 10%, 50 Hz ± 5% or 24V DC as per mfr. Std.
9	Cable / Conduit Entry		1/2" NPT or M20 or equi. As per mfr. Std.
10	Local Indicator / Display		Backlit LCD Display
11	Scale Graduation / Measuring Units		Engg. Units
12	Data Safety		The Sensor / transmitter should store on board calibration data and diagnostic information
13	Security Access Code		Password protected
14	**Protection:**		
a	Elec. Area Classification		Safe
b	Enclosure	Type & Protection Class	Weather Proof to IP-66/67 as a minimum
		MOC	Cast Alu. / Polycarbonate or equi. as per mfr. Std. suitable for withstanding harsh environment
		Paint	Chemical Resistant / Epoxy Coating
15	Mounting		Wall mounting / Pipe mounting
d.	**Options / Accessories:**		
1	Mounting Accessories		Mounting plate (min. 3 mm thick MSEP) for complete instrument,
2	Tag Plate		Required, SS 304
3	Cable Glands		Required, IP-65/66 as a min., Ni-Plated Brass / Polyamide
4	Plugs for addl. cable entries		Close up Plugs shall be provided for all unused cable entries, Ni-Plated Brass / Polyamide
5	Weather proof enclosure with glass cutout for Analyzer	To prevent from dust and water	Required. MOC: G.I. - min. 2mm thick

Readings shall be continuously displayed at PLC SCADA. High Turbidity levels shall be annunciated at PLC SCADA in main control room. Real time and histroical trend shall be available for last 60 days.

f) ON-LINE DO MEASUREMENT SYSTEM:

SPECIFICATIONS FOR DO ANALYZER			
A.	**GENERAL**		
1	Service		Water / Sewage Application
2	Function		To measure & indicate the DO / Transmit
3	Operating Temperature		Ambient, 50 °C Max.

4	Operating Pressure		Atm., Max. 1 Bar
5	Installation		Outdoor
B.	**Electrodes & Electrode Holder**		
1	Type of Sensor		Optical / Luminescent Technology, Digital type sensor
2	Measurement (Calibration) Range		0 - 20 mg/l
3	Temperature Compensation		Required, Automatic, In-built
4	**Measuring Elements:**		
a	Measuring Electrode	Probe / Shaft MOC	SS 316
		Coating	Luminescent / Fluorescent layer
5	Protection Class		IP-68
6	Cable Length		Min. 5m length or higher up to 10m or more as per site conditions.
7	Process Connection (Mounting)	Type	Suitable for immersion (open tank / sump) type mounting with immersion assembly
C.	**TRANSMITTER**		
1	Function		Transmit and Indicate
2	No. of Inputs	Channels	Single / Dual / Multiple (Upto 8)
3	Transmitter Type		Microprocessor based, User Programmable, 2-Wire or 4-Wire type as per mfr. Std.
4	Location		Field Mounting
5	**DO Measurement:**		
a	DO Measurement Range		0-20 mg/l, programmable
b	Accuracy		$\pm$ 1% of Measuring Range / Span or better
c	Resolution		0.01 mg/l
6	Sensor Calibration		Single Point Calibration in air or other suitable as per mfr. Std.
7	Output Signal	Analog outout (DO + Temperature)	4 -20 mA DC with HART for DO & Temp. / through suitable communication port - Profibus or Ethernet or Modbus with required connectivity with PLC
		Relay	Min. 2 potential free changeover contacts
8	Instrument Power Supply		100 to 240 VAC $\pm$ 10%, 50 Hz $\pm$ 5% or 24V DC as per mfr. Std.
9	Cable / Conduit Entry		1/2" NPT or M20 or equi. as per mfr. Std.
10	Local Indicator / Display	DO & Temp.	Backlit LCD Display
11	**Protection:**		
a	Elec. Area Classification		Safe
b	Enclosure	Type & Prot. Class	Weather Proof to IP-65 as a minimum
		MOC	Cast Alu. / Polycarbonate or equi. as per mfr. Std. suitable for withstanding harsh environment
12	Mounting		Wall mounting / Pipe mounting
D.	**Options / Accessories:**		

1	Mounting Accessories		Required, Universal 2" Pipe and / or Wall Mounting Kit
2	Tag Plate		Required, SS 304
3	Cable Glands		Required, IP-65/66 as a min., Ni-Plated Brass / Polyamide
4	Plugs for addl. cable entries		Close up Plugs shall be provided for all unused cable entries, Ni-Plated Brass / Polyamide
5	Canopy for Analyzer / Transmitter	To prevent from direct sun and rain	Required. MOC: FRP - min. 4mm thick / G.I. - min. 2mm thick

DO readings shall be continuously displayed at PLC HMI. Low / High DO level shall be annunciated at HMI/SCADA.. Real time and histroical trend shall be available for last 60 days.

g) NITROGEN ANALYZER (AMMONICAL / NITRATE / NITRITE – AS APPLICABLE):

SPECIFICATIONS FOR NITRATE ANALYZER			
A.	**GENERAL**		
1	Service		Sewage / Water Application
2	Function		To measure & indicate / Transmit
3	Operating Temperature		0 to 50°C
4	Installation		Indoor / Outdoor
B.	**Electrodes & Electrode Holder**		
1	Type of Sensor		UV Vis / UV Absorption, Digital type sensor Note: Bidder may offer In-Situ / Potentiostatic or other suitable to meet the application requirement
2	Measurement (Calibration) Range		As per process requirement
3	Measuring Gap / Path Length		1 mm, 2mm, or 5mm path lengths as per process/application requirement
4	**Measuring Elements:**		
a	Measuring Electrode	Probe / Shaft MOC	Stainless Steel
		Meas. window	Quartz Glass or as per mfr. Std.
5	Protection Class		IP-68
6	Cable Length		Min. 5m length or higher up to 10m or more as per site conditions.
7	Process Connection (Mounting)	Type	Suitable for immersion (open tank / sump) type mounting with immersion assembly Immersion assembly shall be Swivel / Pivot / Pipe Clamp Assembly suitable for hand rail mounting in SS / non-corrosive material
8	Accuracy		$\pm$ 3% of Measuring Range or $\pm$0.5 mg/L,

			whichever is higger
9	Resolution		0.01 mg/l
10	Sludge Compensation		Required
11	Measurement Interval		≥ 1 to 30 min (fixed values selectable)
12	Sensor Calibration		Calibration Standard / Kit required as per mfr. Std.
14	Calibration Certificate		Required
C.	**TRANSMITTER**		
1	Function		Transmit and Indicate
2	No. of Inputs	Channels	Single / Dual / Multiple (Upto 8)
3	Transmitter Type		Microprocessor based, User Programmable, 2-Wire or 4-Wire type as per mfr. Std.
4	Location		Field Mounting
5	**NH4-N Measurement:**		
a	Measurement Range		As per process requirement & path length selection as per application, programmable
6	Output Signal	Analog outout	4 -20 mA DC with HART / through suitable communication port - Profibus or Ethernet or Modbus with required connectivity with PLC
		Relay	Min. 2 potential free changeover contacts
7	Instrument Power Supply		100 to 240 VAC $\pm$ 10%, 50 Hz $\pm$ 5% or 24V DC as per mfr. Std.
8	Cable / Conduit Entry		1/2" NPT or M20 or equi. as per mfr. Std.
9	Local Indicator / Display	DO & Temp.	Backlit LCD Display
10	Security Access Code		Required, password protected
11	**Protection:**		
a	Elec. Area Classification		Safe
b	Enclosure	Type & Prot. Class	Weather Proof to IP-65 as a minimum
		MOC	Cast Alu. / Polycarbonate or equi. as per mfr. Std. suitable for withstanding harsh environment
12	Mounting		Wall mounting / Pipe mounting
D.	**Options / Accessories:**		
1	Mounting Accessories		Required, Universal 2" Pipe and / or Wall Mounting Kit
2	Tag Plate		Required, SS 304
3	Cable Glands		Required, IP-65/66 as a min., Ni-Plated Brass / Polyamide
4	Plugs for addl. cable entries		Close up Plugs shall be provided for all unused cable entries, Ni-Plated Brass / Polyamide
5	Canopy for Analyzer / Transmitter	To prevent from direct sun and rain	Required. MOC: FRP - min. 4mm thick / G.I. - min. 2mm thick

Nitrate / Ammonium / NH_4-N readings shall be continuously displayed at PLC HMI. High process level shall be annunciated at HMI/SCADA. Real time and

histroical trend shall be available for last 60 days. Required correlation charts shall be prepared by bidder at site.

h) PHOSPHATE ANALYSER

SPECIFICATIONS FOR PHOSPHATE ANALYZER			
A.	**GENERAL**		
1	Service		Sewage / Water Application
2	Function		To measure & indicate the PO4-P (Phosphate) Levels / Transmit
3	Operating Temperature		0 to 50°C
4	Installation		Indoor / Outdoor
B.	**Electrodes & Electrode Holder**		
1	Type of Measurement		Vanadate / Molybdate yellow colorimetric measurement type
2	Measurement (Calibration) Range	Free Chlorine	As per process requirement
3	Sample Withdrawal		Built-in peristaltic pump with necessary tubing / piping, Sample Inlet / Drain connection size as per mfr. Std.
			The withdrawn sample shall be suitably transferred back to immediate down stream or upstream process - shall not be drained / discharged in open. Pipe / Fitting associated or grouted with civil unit / structure shall be in GI / SS only.
4	Sample preparation / conditioning / Filtration Unit		Required
5	Calibration Certificate		Required
C.	**TRANSMITTER**		
1	Transmitter Type		Microprocessor based, User Programmable, 2-Wire or 4-Wire type as per mfr. Std.
2.	No. of Input		Single / Dual / Multiple (Upto 8)
3	Location		Indoor Mounting / Outdoor mounting with canopy
4	**PhosphateMeasurement:**		
a	Measurement Range		As per process requirement
b	Accuracy		± 2% of Measuring Range or better
4	Measurement Interval		5 to 60 minutes, adjustable
5	Output Signal	Analog	4 -20 mA DC with HART / through suitable communication port - Profibus or Ethernet or Modbus with required connectivity with PLC
6	Contact Outputs		Two, SPDT, 5A @230V AC

7	Instrument Power Supply		230 VAC ± 10%, 50 Hz ± 5% or 24V DC as per mfr. Std.
8	Cable / Conduit Entry		1/2" NPT or M20 or equi. As per mfr. Std.
9	Local Indicator / Display	FC	Backlit LCD Display
10	**Protection:**		
A	Elec. Area Classification		Safe
b	Enclosure	Type & Protection Class	Weather Proof to IP-55 as a minimum
11	Mounting		Wall mounting
12	Operating Temperature		0 to 40 °C
D.	**Options / Accessories:**		
1	Reagents		Required for O & M Period
2	Mounting Accessories		Required, Universal 2" Pipe and / or Wall Mounting Kit
3	Tag Plate		Required, SS 304
4	Cable Glands		Required, IP-65/66 as a min., Ni-Plated Brass / Polyamide
5	Plugs for addl. cable entries		Close up Plugs shall be provided for all unused cable entries, Ni-Plated Brass / Polyamide
6	Canopy for Analyzer / Transmitter	To prevent from direct sun and rain	Required. MOC: FRP - min. 4mm thick / G.I. - min. 2mm thick

Phosphate readings shall be continuously displayed at PLC HMI. High Phosphate levels shall be annunciated at HMI/SCADA. Real time and histroical trend shall be available for last 60 days. Required correlation charts shall be prepared by bidder at site.

i) ON-LINE CONDUCTIVITY ANALYZER:

The specifications in general shall be as under:

SPECIFICATIONS FOR CONDUCTIVITY ANALYZER			
A.	**GENERAL**		
1	Service		Sewage / Water Application
2	Function		To measure & indicate the conductivity (TDS) / Transmit
3	Operating Temperature		0 to 50°C
4	Installation		Indoor / Outdoor

B.	**Electrodes & Electrode Holder**		
1	Type of Sensor		Digital type sensor
	Sensor Cell constant		0.05 – 10 or lower as per process requirement

2	Measurement Range		0-200000 microsimen/cm or lower as per process requirement
3	Temperature Compensation		Required, Automatic, In-built
4	Accuracy		± 2% of reading
5	Sensitivity		± 0.5% of reading
7	Protection Class		IP-68
8	Cable Length	Integral / after connector	Min. 5m length or higher up to 10m or more as per site conditions.
9	Calibration Certificate		Required
10	Conductivity Reference Solution for Sensor Calibration		Required for periodic calibration of Sensor of required range
C.	**TRANSMITTER**		
1	Function		Transmit and Indicate
2	No. of Inputs		Single / Dual / Multiple (up to 8 channel)
3	Transmitter Type		Microprocessor based, User Programmable, 2-Wire or 4-Wire type as per mfr. Std.
4	Location		Field Mounting
5	Output Signal	Analog outout	4 -20 mA DC with HART / through suitable communication port - Profibus or Ethernet or Modbus with required connectivity with PLC
		Relay	Min. 2 potential free changeover contacts
6	Instrument Power Supply		100 to 240 VAC ± 10%, 50 Hz ± 5% or 24V DC as per mfr. Std.
7	Cable / Conduit Entry		1/2" NPT or M20 or equi. As per mfr. Std.
8	Local Indicator / Display		Backlit LCD Display
9	**Protection:**		
A	Elec. Area Classification		Safe
B	Enclosure	Type & Prot. Class	Weather Proof to IP-65 as a minimum
		MOC	Cast Alu. / Polycarbonate or equi. as per mfr. Std. suitable for withstanding harsh environment
	Security		Password protection
10	Mounting		Wall mounting / Pipe mounting
D.	**Options / Accessories:**		
1	Mounting Accessories		Required, Universal 2" Pipe and / or Wall Mounting Kit
2	Tag Plate		Required, SS 304
3	Cable Glands		Required, IP-65/66 as a min., Ni-Plated Brass / Polyamide
4	Plugs for addl. cable entries		Close up Plugs shall be provided for all unused cable entries, Ni-Plated Brass / Polyamide

5	Canopy for Analyzer / Transmitter	To prevent from direct sun and rain	Required. MOC: FRP - min. 4mm thick / G.I. - min. 2mm thick

Conductivity/TDS readings shall be continuously displayed at PLC HMI. Low / High TDS/Conductivity level shall be annunciated at HMI/SCADA. Real time and histroical trend shall be available for last 60 days.

Note : Cleaning System required for all Analyzer Sensor and bidder shall be provided the same.The clening System comprise with Necessary Cleaning pump as recommended by Analyzer mfr. with necessary solenoid valve and all other required fittings and accessories, SS304 Nozzle, Nylon / equi. Flexible, non-corrosive and long lasting tubing, Mounting plate, etc. Periodic (Time Based) cleaning to be carried out with programmable wash time and washing interval or based on diagnosis of Sensor Scaling input to PLC.

j) ULTRASONIC TX. – LEVEL / DIFF. LEVEL / FLUME FLOW

Ultrasonic level measurement shall be accomplished by the use of non-contact, echo-time measuring equipment operating at ultra-sonic frequency. The equipment shall transmit pulses which are reflected back to the sensor from the surface of the liquid whose level is being measured.

The equipment shall consist of a sensor incorporating both transmitter and receiver, together with an integral or separate control unit. The control unit shall be micro processor based and user programmable. Control unit shall have IP-65 protection as a minimum.

The equipment shall be provided with automatic temperature comensation, shall be suitable for operation in the designated application under the specified climatic conditions.

The sensor shall be suitable for mounting in the open, or within an enclosed tank, and shall with environmental protection to IP-67 as minimum. The sensor / transducer range shall be as required to cover Liquid Depth + Free Board + Blanking Distance as a minimum. The sensor shall be able to monitor the overflow condition of the unit and shall not get submerged in case if the unit overflows.

The control units shall incorporate:

Facilities for independently adjusting both zero and span, and shall have an output of 4-20mADC with HART proportional to selected measurement parameter of level / diff. level / flow as per user selection / program.

LCD read out of selected measurement parameter in suitable engineering units.

Secure access for parameters via a removable keypad or in-built programmer.

The overall accuracy of the level measurements shall be within 0.5% or better of the instrument span.

The Contractor shall ensure that each part of the equipment is suitable for the application, particularly with regard to the blocking distance and transmitted beam angle or cone.

Each ultra-sonic level sensor shall be installed on a robust and rigid structure provided for the purpose under this contract. The structure shall include a means of levelling the sensor so that the transmitted beam is perpendicular to the liquid surface and shall provide a safe and easy access to the sensor for servicing and maintenance.

The contractor shall, where applicable, provide a cover / canopy around and/or above the sensor and / or the control unit the to provide a protection from direct sunlight.

Ultrasonic Transmitter for Level Measurement:

Ultrasonic transmitter shall be provided to measure liquid level for all tanks/sumps. The purpose is to monitor tanks/sump levels as well as provide low level trip for safety of pumps against dry running, start/stop of pumps in auto mode through suitable logic to be decided during detailed engineering, low/high level alarm annunciation on HMI at control room, etc. The brief specifications in addition to above specifications shall be as under:

Type	:	Ultrasonic, Fully User Programmable
Type of Tx. (controller):		Integral or Remote type
Mode of Operation	:	Level
Accuracy	:	$\pm$ 0.50 % of range
Repeatability	:	$\pm$ 0.25% of range
Outputs	:	4-20 mA with HART output proportional to level
Programming Device	:	In-Built in controller or Hand-held
Local Digital Display	:	Level in Engg. Units
Power	:	115 / 230 V AC, 50 Hz or 24V DC, 2/4-Wire
Control Unit Protection:		IP-65 as a minimum
Proc. Temp. Compensation:		Required, Built-in temp. sensor in transducer
Controller meas. Range:		As per design / total unit height for liquid application
Transducer Protection	:	IP-67/68
Blanking Dist.	:	0-3-0.4m max.
Transducer Cable Length:		10m (if applicable, for remote version)
Process Connection	:	2” or 3” Flanged as per mfr. Std.. Matching flange with required pipe / support structure shall also be provided
Transducer Meas. Range:		Minimum as per total tank/sump height + 300mm

Level readings shall be continuously displayed locally as well as at PLC HMI at control room. Associated pumps/MOVs shall be turned on and off in automatic mode depending on the level reached using these measured levels. Low / High level shall be annunciated at HMI in control room.

Hydrostatic Type Level Transmitter:
The brief specifications in addition to above specifications shall be as under:

A.	**General**		
1	Function		To measure & transmitt Level
2	Type		Hydrostatic Type
3	Service		Water
4	Max. Operating Temperature		Ambient, 50 °C Max.
5	Max. Operating Pressure		Atm./ Upto 1 Bar
6	Installation		Indoor
B.	**Transmitter /Sensor**		
1	Type		2 Wire type
2	Power Supply		24 V DC (2 wire)
3	Measurement Range, mtr		Suitable to Tank Height
4	No. of Measurement Channels		One
5	Accuracy		±0.5% of full scale
6	Out put signal	Analog	4-20 mA
7	Measuring Principle		Hydro-static Pressure Measurement
8	MOC - Body		SS-316L
9	Measuring Cell		Ceramic / as per mfr. Std.
10	Seal MOC		Viton / as per mfr. Std.
11	Protection Class		IP 68
12	Process Connection/Mounting		Mounting clamp,MOC SS 316L
13	Cable Length		10 mtr
14	Terminal Box/Housing		Required (IP-65 as a min)
15	Guide Pipe/Mounting Assembly		Required
C.	**Options / Accessories**		
a.	Mounting Hardware		Required
b.	Tag Plate		Required, SS 304
c.	Cable Glands		Required
d.	Canopy		Required

Level readings shall be continuously displayed at PLC HMI at control room.

Ultrasonic Transmitter for Differential Level Measurement:

The brief specifications in addition to above specifications shall be as under:

Type	:	Ultrasonic, Fully User Programmable
Type of Tx. (controller)	:	Integral or Remote type
Mode of Operation	:	Differential Level / Level
Accuracy	:	$\pm$ 0.50 % of range
Repeatability	:	$\pm$ 0.25% of range
Outputs	:	4-20 mA with HART output proportional to diff. level / level
Programming Device	:	In-Built in controller or Hand-held
Local Digital Display	:	Diff. Level in Engg. Units

Power	:	115 / 230 V AC, 50 Hz or 24V DC, 2/4-Wire
Control Unit Protection:		IP-65 as a minimum
Proc. Temp. Compensation:		Required, Built-in temp. sensor in transducer
No. of transducer per instru.:		Two
Transducer Protection	:	IP-67/68
Blanking Dist.	:	0-3-0.4m max.
Transducer Cable Length:		5m minimum (if applicable)
Process Connection	:	2" or 3" Flanged as per mfr. Std.. Matching flange with required pipe / support structure shall also be provided
Transducer Meas. Range:		Minimum as per total tank/sump height + 300mm

Ultrasonic Transmitter for Parshal Flume / Open Channel Flow Measurement:

Ultrasonic transmitter shall be provided to measure parshal flume flow. The brief specifications in addition to above specifications shall be as under:

Type	:	Ultrasonic, Fully User Programmable
Type of Tx. (controller):		Integral or Remote type
Mode of Operation	:	Flow
Accuracy	:	$\pm$ 0.50 % of range
Repeatability	:	$\pm$ 0.25% of range
Outputs	:	4-20 mA with HART output proportional to flow
Programming Device	:	In-Built in controller or Hand-held
Local Digital Display	:	Flow in Engg. Units
Power	:	115 / 230 V AC, 50 Hz or 24V DC, 2/4-Wire
Control Unit Protection:		IP-65 as a minimum
Proc. Temp. Compensation:		Required, Built-in temp. sensor in transducer
Transducer Protection	:	IP-67/68
Blanking Dist.	:	0-3-0.4m max.
Transducer Cable Length:		5m minimum (if applicable)
Process Connection	:	2" or 3" Flanged as per mfr. Std.. Matching flange with required pipe / support structure shall also be provided
Transducer Meas. Range:		Minimum as per total tank/sump height + 300mm

Flume Flow (Instantaneous and Totalised) readings shall be continuously displayed locally as well as at PLC HMI and panel mounted indicators/totalizers at control room.

k) DISPLACER OT FLOAT/BUOYANCY SWITCHES:

Displacer / Float type level switch shall be used for low level trip and dry run protection of pumps / agitators or other necessary interlocks of associated equipment etc. for auto or manual operation shall be provided with displacer or float operated level switches for providing low level alarm for tanks in use and also to prevent running of mixers/pumps when liquid level in tank is not sufficient as an additional safety. Switching element shall be a micro switch with switching ball. Contact shall be 1NO + 1NC and contact rating shall be minimum 2A rated at 230V AC resistive load. In short, all tanks and sumps, whether mentioned here

in or not shall be provided with low level switches. Also all dewatering pumps shall operate automatically through high and low level swithes and additionally high-high level switch shall be provided for alarm at HMI.

l) RECEIVING INDICATORS MOUNTED AT ICP/LCP:

All indicators/controllers shall be electronic (microprocessor based) type programmable indicator and shall be mounted on the control panel located in the control room. Multiplying factors, shall be specified on manufacturer's nameplate, if applicable. Specifications, as applicable are as follows:

Process Indicator:

Type	:	Microprocessor based, programmable
Input	:	4-20 mA
Display	:	4 ½ Digit, 7 Segment LED display
Display Units	:	% or Engg. Units, user programmable at site
Alarm Setpoint	:	Two nos., pot. free relay contact rated at 5A @230V AC resistive load, adj. over entire range
Transmitter Supply	:	Required, 24V DC @30mA
Retransmission Output:		Required, 4-20 mA in 600 ohm load
Accuracy	:	$\pm$ 0.25% of FSD
Terminals	:	suitable for up to 2.5 sq.mm. wires
Mounting	:	panel flush mounting
Power	:	110/230 V AC, 50 Hz

Flow Indicator cum totaliser shall also have following in addition to above:

Totalising Counts/Hr	:	User Programmable at site
Totaliser Display	:	6/8 Digit Digital Display with Battery Backup to retain totalized data in the event of power failure for a minimum period of 24 hours.

m) PRESSURE GAUGES:

All pumps, compressors and air blowers shall have PG at their discharge lines. Pressure Gauges for process fluids containing sludge/solids and corrosive chemicals shall be of diaphragm type.

PG dial face shall be marked with pressure element material. Ranges shall be so specified that the gauge normally operates in the middle third of the scale and shall confirm to IS-3624 standard dials, wherever possible.

Diaphragm seals, filled type or mechanical type shall be furnished where plugging of the element may occur or where suitable material is not available in highly corrosive services. When chemical seals are required, they shall be of clean out type with flushing connection.

Pressure Gauge Dial Size shall be of minimum 150mm and of white with balck engraving, shall be provided with blow out disc, toughened/safety glass window, bayonet type bezel ring, case material of SS304, Boudron Element / Socket of SS316, movement parts of SS, weather proof to IP-65, offering accuracy of $\pm$1% of FSD. Micro-zero adjustment at the pointer, bottom process connection shall be 1/2" NPT, over-range protection of 130% of FSD.

In case of Diaphragm type Pressure Gauge, Diaphragm / Lower Chamber Wetted Parts shall be os SS316, Upper Chamber of SS304 / SS316, with silicon oil sealing fluid, 2" ANSI B16.5 flanged process connection

Following accessories shall shall be supplied as a standard with all pressure gauges:

Syphon / MOC	:	Required,SS316,for process temp.range exceeding 60°C
Snubber / MOC	:	Required, SS316, for pulsating flow/output application (blower/compressor/dosing pump delivery, etc.)
Glycerine Filled	:	All pump delivery
Isolation Valve	:	Required, Gate / Ball Valve, SS 316
2-Valve/3-Way Manifold:		Required, SS 316

n) PRESSURE / DIFF. PRESSURE TRANSMITTER

Presure / Diff. Pressure readings shall be continuously displayed at PLC HMI. Real time and histroical trend shall be available. The transmitter specifications shall be as under:

Transmitters shall be manufactured from material suitable for use with the process medium and for the site ambient conditions. Only Smart transmitters of approved make shall be used.

The transmitter housing shall be WP to IP-66/68, yoke mounting, provided with mounting arrangements suitable for 2" pipe mounting. Body material shall be of Cast aluminium. The materials of construction shall be suitable for the climatic conditions described in the specification and where necessary suitable, heavy duty GRP weather proof enclosure with viewing windows shall be provided.

Transmitters shall provide 4 – 20 mA HART output signals proportional to the measured conditions. They shall operate on a 2 wire system receiving their power form the residual 4mA in the transmission signal. Transmitter power supply will be 24V DC. They shall be fitted with output meters to give an approximate indication of transmitter output scaled 0–100%. Output meter shall be of Digital LCD type.

Pressure / Differential pressure transmitters, which shall have capacitance or indicative type sensing element of SS 316L, shall be fitted with direct mounted, stainless steel, 3 valve manifolds. Pressure transmitters shall be fitted with two valve manifolds. For flow measurements with DP Transmitter, the transmitter shall be provided with in-built square root extraction facilty with switch selection.

Pipe work shall be of SS316 steel tube / pipe as appropriate with a minimum gradient of 1 in 12 after an initial rise (gas) or fall (liquid) or 300 mm.

Transmitter equipment should be supplied and installed complete in all details including tube / pipe work, stop cocks, drain clocks and any similar ancillary item of equipment.

Process data, calibrated shall, rang, output, protection, accuracy and connecting details shall be as necessary to satisfy the particular specification requirements.

The transmitter shall have non-induction external zero and span adjustment and shall have facility for an optional external damping adjustment.

Transmitter measurement accuracy shall be better than $\pm$ 0.1%

Each transmitter shall be equipped with a stainless steel nameplate, permanently attached, indicating the following specified data as a minimum :-

Transmitter tag no.
Purchase order no.
Name and address of Manufacturer
Type/Model No.
Serial No.
Calibrated range
Range and maximum working pressure, temperature, sped, vibrating level etc.
Materials of construction.
Electrical protection classification.

o) ELECTRO MAGNETIC FLOW MEASURING SYSTEM

Generally, the flowmeter shall be as follows:

Flowmetering System

Each flowmetering system shall consist of the primary transducer (Sealed to IP-67 for above ground / non-submerged application and IP-68 for below ground within chamber for submerged application), earthing rings, the necessary signal converter and power supply unit and all cabling between the primary transducer and signal converter and power supply unit. Flowmeter in general shall be sized considering maximum design line velocity as specified in this tender specifications (2.5m/sec for pumped flow) except for all sludge flowmeters which shall be of minimum 80mm size or higher as required as per sizing calculations.

Each of the signal converts / power supply units shall be supplied for remote mounting, unless otherwise specified.

The signal converts / power supply units shall be provided with a 4-20 mA output signal, linear with flow and suitable for retransmission to remote instrumentation. The above units shall operate from a 240V 50 Hz supply.. The supply voltage may vary by $\pm$ 15% and frequency between 47 and 53 Hz.

The contractor shall provide sufficient suitable cable to allow for the primary transducers to be situated up to 10 metres from their signal converters, unless a longer length is specified.

The Contractor shall provide full details of the cable, he proposes to use.

The general specifications for electromagnetic flow meter shall be as under:

Service		Water / Sewage / Sludge / Chemcial Application
Function		To measure & indicate Instantaneous Flow and Totalised Flow / Transmit (Flow)
Fluid Conductivity		> 5 µS/cm
Installation		Indoor or Outdoor, Below or Above Ground as per piping / site conditions
Flow Sensor / Tube / Element		
Type of Sensor		Full Bore type
Flange Materials		MS / CS Epoxy Painted or Better
Tube Material		SS304 or better
Liner Material		Clear Water Application: Hard Rubber / PU / Ebonite Rubber Chemicals/Alum Applicaiton: Teflon / Ebonite Rubber
Body Material / Coil Housing		MS Epoxy Painted or cast alu. with corrosion resistant paint of better as per mfr std.
Electrode Material	Clear Water	SS316L
	Chemicals	Ha-C
Power Supply		From Transmitter
Grounding	Type / Material	Metallic Line: Earth Electrode / Set of Earth Rings Non Metallic Pipe: Set of Earth Rings Only / SS316
Protection Class	Above GL or Indoor within Pump House / Bldg.	IP-67 for flowmeters installed above Ground Level or if installed indoor within pump house / building below ground level.
	Below GL outdoor	IP-68 for flowmeters installed outdoor below Ground Level (shall be mounted within RCC Chamber with water proof plaster)
Cable Entry (for separated / remote version) & Glands		Shall be as per mfr. Std. and suitable to maintain the specificed protection class at site
Cable Length	Sensor to Transmitter	Min. 10m, dual shileded cable
Painting, where applicable	CS / other	Chemical Resistant, Epoxy Painted
TRANSMITTER		
Function		Transmit and Indicate
Type		Remote (Non-Intergral) type, Microprocessor based, User Programmable, 2-Wire or 4-Wire type as per mfr. Std.

Flow / Velocity Measurement Range	Max. Flow Velocity	Flowmeter shall be capable to measure flow with velocity up to max. 10 m/sec.
	Velocity for Sizing	Flowmeters for clear water shall be sized to measure flow with max. flow velocity up to 2.5m/sec. or as per specified size in scope of work / specifications Meter size for backwash tank outlet flow shall be same as matching to pipe size.
	Minimum Flow Velocity	up to 0.3 m/sec. (shall measure flow without loss of accuracy up to 0.5 m/sec and below that, accuracy shall be as per mfr. Std.)
Accuracy	Flow Vel. >= 0.5 m/s	$\pm$ 0.5% of Flow Rate / Measured Value or better
	Flow Vel. < 0.5 m/s	as per mfr. Std. for flow velocity up to 0.5 m/s
Output Signal	For Flow	4 -20 mA DC with HART / through suitable communication port - Profibus or Ethernet or Modbus with required connectivity with PLC
Pulsed O/P		Required for Totalized Flow
Instrument Power Supply		100 to 240 VAC $\pm$ 10%, 50 Hz $\pm$ 5% or 24V DC as per mfr. Std.
Cable / Conduit Entry		1/2" NPT.
Local Indicator / Display	Inst. & Total Flow	LCD Display (Inst. Flow and 8/9 digit internal totalized flow)
Enclosure	Type & Protection Class	Weather Proof to IP-65 as a minimum or better
	MOC	Cast Alu. or equi. as per mfr. Std. suitable for withstanding harsh environment with chemical resistant / epoxy coating
	Type	Wall mounting / Pipe mounting
Vibration Conditions		Conformity with IEC 60068-2-6 or equi., shall be able to endure vibration, when in service, without any degradation in performance
Pipe not Full Detection / Empty Pipe Detection		Required
Canopy for Transmitter	To prevent from direct sun and rain	Required. MOC: FRP - min. 4mm thick / G.I. - min. 2mm thick
Expansion Bellows	SS 304	Required at suitable location to enable ease of removal / insertion of flow meter for maintenance

Flow (Instantaneous and Totalised) readings shall be continuously displayed locally as well as at PLC HMI and panel mounted indicators/totalizers in control room. Real time and histroical trend shall be available for last 60 days.

Flowmeter shall be mounted as per manufacturer's recommendation and good engineering practices and each flow meter shall be provided with a bellows at suitable location to enable ease of removal / insertion of flowmeter for maintenance. For flowmter mounted below ground level, chamber shall be sized suitably to accommodate flwometer and bellows in the same chamber.

The flow calibration and testing should be as per ISO 8316 (Calibration by Volumetric Method) or ISO 4185 (Measurement of fluid flow in closed conduits - weighing method) and shall be calibrated for minimum 3-Point Calibration. Performance Type Testing Certification (ISO 9104) strictly not acceptable. All electro-magnetic flow meters shall be provided with manufacturer's calibration certificates.

The manufacturers / supplier's flow calibration and testing facility if in India shall be strictly accredited by National Accreditation Board for Testing & Calibration Laboratories (NABL). If the supplier is outside India then suppliers flow calibration and testing facility should be accredited by a reputed International authority such as RVA, NMi, PTB etc.

14. PROGRAMMABLE LOGIC CONTROLLERS

These specifications shall be read in conjunction with control panels (ICP & LCPs / RIO Panels) and other PLC/Panel/Automation/Major Logic requirements specified above of thes instrument specifications and other requirement specified in scope of work, process description & specifications and else where in tender specificaitons..

Codes and Standards

PLC shall comply with International standards such as NEMA, IEC, ANSI, ISA, IEEE, DIN and VDE

DESIGN AND CONSTRUCTION REQUIREMENTS

PLC H/W & S/W shall be from the same family and should be sourced from approved Vendors only.

Programmable logic controller (PLC) shall be microprocessor based with 32 bit processor and be fully programmable and capable of performing control relay logic, including timing, counting, sequencing, and interlocking.

The PLC shall be high performance processors suitable for real time process application. High inherent reliability, self checking, error-recovery and trouble-shooting features shall be some of the features of PLC.

The PLC shall have a modular / modular chassis design which allows for ease of future expansion. The processor module shall be easily removed from the I/O chassis for service or repair. The I/O chassis shall have slots for installing I/O cards, communications, or other special function modules. All I/O cards and

modules shall be capable of being installed in any open slot in the chassis or DIN rail mounted. Module and channel level diagnostics should be standard feature.

The PLC shall have a suitable power supply and can be easily serviced or replaceable. The system shall be capable of being powered on 120VAC / 230VAC / 24V DC as per mfr. Std..

The PLC shall be rated to operate from 0 to 60 Degrees C, with a humidity rating of 5 to 95% (non-condensing). All module circuit boards shall be encased and protected such that, when properly installed, they are not exposed to accidental contact by personnel or other objects.

Basic Processor Functions

Real-time control of output points for turning on and off digital devices such as motor starters and solenoids.
Read the status of real world digital inputs from limit switches, float switches, and other field devices.
Real-time control of analog process control variables.
Read the status of real world analog set points and feedback values.
Perform timing, counting, sequencing, and interlocking functions for pump/equipment control.
Process local alarm handling functions

Math and Advanced Functions
Four function math in floating point or signed integer format
Convert to/from BCD
Data comparison and manipulation
Scaling from integer data into engineering units such as flow, level and pressure
Full PID Instructions for control of process control variables such as flow, level and pressure.
ASCII instruction set for interfacing to ASCII devices
Compute Instruction which executes a mathematical expression and can be used for totalizing functions
Trigonometric and Exponential math functions
Real-Time Calendar Clock for time stamping alarms and events.

Automatic restart of the system on resumption of power shall be provided.

The processor shall have solid state RAM memory to store the application program, process data, and alarm status. This memory shall have both capacitor and battery backup in the event that input power to the processor is lost. It shall also have the capability of EEPROM backup which automatically reloads the memory on a power cycle. The processor shall have the ability to automatically control the process on a power cycle, provided there are no major or unrecoverable processor faults.

Processor RAM memory shall be adequate and selected with at least 25-30% spare capacity for application program storage over the actual requirement, and also should be expandable for future expansions. Bidder shall demonstrate the spare capacity at the time of commissioning and after completion of entire logic

development for the plant controls and monitoring as per the logic write-up to be furnished by client / consultant to the successful bidder after award of work.

Sufficient program memory and data memory space shall be provided. System initialization and application software shall be stored in EEPROM or EPROM with necessary hardware. Running data shall be stored in a RAM with internal battery back-up

All process parameters and electrical parameters shall be monitored at HMI and necessary controls actions shall be initiated.

Specific Requirements for PLC

(a)	Expandability in future	:	30% of installed I/O capacity
(b)	Weather Protection	:	IP-20 for PLC hardware and shall be IP-52 of IS 13947 when mounted in ICP
(c)	Power Supply	:	230V AC / 24V DC
(d)	Interrogation Voltage	:	24V DC
(e)	CPU, communication module and power supply module	:	Required, high performance 32 bit or suitable CPU Module having modular configuration suitable for real time process application. CPU shall be of same family if provided at different locations.
(f)	Scan time	:	0.7 Milliseconds or better for 1K instructions
(g)	Key Switch for Processor	:	Shall be as per mfr. Std.
(h)	Three way to configure channel	:	(1) Via BOOT P or DHCP (2) Manually by software (3) Via LCD Display
(i)	Duplicate IP add. detection	:	Check every 2 Min. on network
(j)	Mounting	:	Inside the main instrument/local instrument control panel with viewing glass on the door
(k)	I/O Capacity of CPU	:	30% expandability in future over present I/O requirement (actual + spare I/O)
(l)	Inputs and Outputs	:	As required for process operation with an intention to maximise the automatic operation of equipment/plant and ease of operation and maintenance of the plant.
(m)	System Loading	:	Max. 60% under worst loading conditions
(n)	Power supply to sensor / transmitters	:	Required
(o)	Type of input	:	NO/NC – Contacts field selectable from programmer
(p)	Outputs	:	Relay outputs for driving MCC starter coils, driving motorized valves etc.
(q)	Spare I/O (Wired)	:	Min. 2 nos. or 10% of each type of I/O, whichever is higher, at each panel/location, wired to terminal block
(r)	Accessories	:	One no. Reporting Software Required
(s)	Interposing Relays	:	Shall be provided for all the Digital Output (DO) including spare DO & for Digital Input where ever required

(t)	Interface (Hardware and Software) to SCADA	:	Required (plug and play) ready to use type
(u)	Printers for alarm, status, report generation	:	2 Nos., A4 size Laser Jet Printer required at control room
(v)	Engineering and Operator Work Station at Main Control Room	:	2 Nos. PC Each With Min. Intel core i7 (quad core, 8MB, 3.6 GHz) CPU or better / 21" LED Backlit Monitor / 8 GB DDR4 RAM / 1 TB HDD / Optical Drive / PS/2 Keyboard / Scroll Mouse / Audio and Network Interface / Required External I/O Port viz. Headphone, microphone, and 2 USB 2.0, 1 standard serial port, 1 parallel port, PS/2 keyboard and mouse, 1 RJ-45, 1 audio in, 1 audio out, etc. / Licensed OS of latest version and supported by SCADA software (Windows 10 Pro or latest) / licensed version for entire contract period of Quick Heal Total Security anti-virus software package / any other specific requirements to fulfill the PLC / SCADA requirements. Other HMIs at other locations as per tender specifications / design & requirement
(w)	Type of Protocol on communication port	:	Standard Min. 10/100 MBPS speed for SCADA and 12MBPS speed for Distributed I/O.
(x)	Tests	:	Functional test (simulated) for complete system Test for monitoring function Voltage variation test (at ±10% of rated voltage. Factory acceptance test (to be witnessed by Purchaser / purchaser's representative Simulation test for all logic / loops (to be witnessed by Purchasers / purchaser's representative Vendor to submit all Test Certificates for purchaser / consultant's review.

Input / Output Modules

(a) Standard DIN Rail / rack mounted I/O modules with plug-in cards shall be provided. Field wiring shall be terminated in screwed terminal blocks and interconnected to the processor I/O system with preferably pre-fabricated cables and plug in card type connectors.

(b) Min. 2 nos. or 10% of each type of I/O, whichever is higher, extra I/O's of installed capacity for each type at each location shall be provided as spares and shall be wired to the terminal block of the control panel. Provision shall be made for future expansion of extra I/O modules of the installed capacity.

(c) Discrete Input Cards: Solid-state input circuits rated for 10-30VDC operation. Cards must be available in 8 or 16 or 32 point configurations and shall source current to the field device. Each input point shall have a status LED which indicates the ON or CLOSED condition for that field sensor or switch. Cards must have removable terminal strips so that module can be easily replaced without disturbing the field wiring online while system is running.

(d) Discrete Output Cards: Solid-state output circuits rated for 24VDC operation. Cards must be available in 8 or 16 or 32 point configurations and shall be able to operate a control relay. Each output point shall have a status LED which indicates the ON condition of the output. Cards must have removable terminal strips so that module can be easily replaced without disturbing the field wiring. The control Relay-contact shall be rated for 5A @240VAC or 5A @125VDC. The control relay shall have a LED indication to show the status of the control relay.

(e) Analog Input Cards: Analog inputs shall capable of reading in 0 to 20mA or 4 to 20mA signal. The A/D converter shall provide a minimum 12 bit resolution over the full range from module minimum to module maximum.

(f). Analog Output Cards: Analog Outputs shall be capable of outputting 0 to 20mA or 4 to 20mA signals. The A/D converter shall provide a minimum 12 bit resolution over the full range from module minimum to module maximum.

(g) All cards shall have optical isolation between digital and field side circuitry.

(h) Some of the common features of the I/O modules shall be as follows:

1) Filters for noise rejection.
2) Surges withstand facility as per standards.
3) All the modules shall be of addressable type.

Communications

(a) Minimum one port for High performance Ethernet communication at 10/100 Mbps network for program upload / download, on-line editing, peer- to –peer messaging, data acquisition and man machine interface.

Shall be open protocol for connectivity and communicaiton with third party hardware/PLC/SCADA in future (for monitoring at central control room of client in future). The PLC/SCADA system shall provide connectivity (through Ethernet/equi. Communication port) for remote connectivity and data transmission requirement by client as required. Ethernet switch or such required hardware/software shall be provided for this purpose for ready to use connectivity in future

(b) PLC system shall have one port for remote/distributed I/O communication to communicate with distributed I/O's @ Min. 12 MBPS or suitable other as per manufacturer standard.

(c) One RS 232C/RS485 port (Modbus or as required) for connecting devices over network for data acquisition from Energy analyzers/soft starters /VFDs / temp. scanners / HT Relays / HT & LT Breakers / etc.

(d) Additional ports or modules including necessary modems GPRS (4G) communication shall also be supplied for for third party integration and remote data transfer data to central SCADA of Employer as required during detailed engineering for communication facility to transfer data from Plant to remote central control room of client for which bidder shall consider to provide required RTU / modem, GSM/GPRS, SIM card and other required communication facilities and include the same in their price and also including any expenses for the same during entire teneure of O&M by bidder.

Engineering Station / Operator Work Station (at Control Room)
The engineering station & operator station shall consist of branded Personal Computer / Work Station as per specifications described above in requirement of PLC.

2 No. Laser Jet printer shall be provided for report & alarm generation.

Specificaitons for GSM/GPRS Modem shall be as under:

1	Modem shall support SIM900 Quad Band GSM/GPRS engine suitable to transfer data over GPRS for any 4G network
2	Modem shall have Built In RS232 Serial Interface Port/ Ethernet
3	Modem shall have Built In Network Status LED
4	Modem shall have Built In Sim Card Holder
5	Modem shall have configurable Baud Rate
6	Modem shall operate with Input Voltage of 24VDC

Programming Software

The programming software should help in maximizing performance, save on project development time and improve productivity.

The programming software should be able to operate on Microsoft Windows 10 or suitable version or such latest operating system.

The programming software shall have Online editing features which is used to modify the application program while the process is still operating.

Features like drop and drag editing to copy instructions or part of a program from within a project or across projects to save project development time.

Make system backup copies while the system is online.

Upload and down load programs to the PLC

Human Machine Interface (HMI) Software

HMI SCADA Software shall be of Server-Client architecture and One full development Runtime License is required. HMI SCADA Software for TSTP/TTP shall be unlimited tag / equivalent Screen Development cum Runtime License is required.

The operator interface software, herein described as the HMI (Human Machine Interface) shall be common for engineering and as operator works station. - an integrated package for developing and running automation applications and also to be just running the automation application.

The HMI shall be designed for use in suitable version of Microsoft Windows and shall use OLE, ODBC, DDE, OPC and ActiveX technologies for optimal performance and integration with other software systems.

The HMI shall have several Methods (relying on DDE server / OPC server / etc.) for collecting data from programmable controllers.

The tag database shall be organized in a hierarchy, each level represented by a folder that can be expanded or collapsed.

The HMI shall have the ability for the current value of a tag to be updated from the device it is connect to and stored in RAM so it is immediately accessible to all parts of the HMI.

The tag database shall provide the ability to generate tag names of up to 40 characters long. The tag names shall be able to contain the following characteristics: A through Z, 0 through 9 underscore (_) and dash (-).

The HMI shall have the ability to create a tag whose value is the result of an expression. The expression can be made up of mathematical operations, tag values, if-then-else logic and other special functions. The current value of the derived tag shall be stored in an analog, digital or string tag in a value table.

The HMI shall provide a Macro capability that will execute system commands, user defined commands and other macros.

The alarm system shall have the ability to monitor any analog or digital tag for alarms, up to a maximum of 10,000 tags.

The alarm system shall have the ability to define up to eight different severity classes to visually and audibly distinguish alarms.

The alarm system shall have the ability to use system default messages or create unique messages to describe an alarm log messages to a file, to a printer or to both suppress alarms for maintenance and tuning purposes and set up global alarm monitoring.

The alarm system shall provide a means of displaying up to 1000 tags that are in alarm. This alarm summary display shall be fully configurable.

The alarm system shall have the ability to create alarm log files periodically, at specified times and on event. This alarm log system shall have the ability to automatically purge old files after a specified time.

The HMI shall have the ability to trigger actions based on an event that has an expression applied to it. An expression is an equation containing tag values, mathematical operations, if-then-else logic, or other functions. An action shall have the ability to produce a variety of functions including, but not limited to, initiating a snapshot of tag values, displaying an error screen and changing a tag value.

The HMI shall have the ability to allow certain users or groups of users to access only certain parts of the system. The security shall be based on a series of codes. Each code shall allow the users, or groups of users, with security privileges for that code to access the HMI commands allowed by that code. Users shall be allowed to be assigned combinations of security codes, allowing for each user to access a different set of features.

The security system shall assign each person a user account with a login name, password, and any desired macros. The HMI shall have a minimum of 17 different security codes.

The HMI shall provide a graphics display editor for creating displays using graphic objects. The graphics display editor shall have the ability to drag and drop objects from a pre-configured graphics library, paste objects that are copied to the clipboard from another Windows application, and insert objects created by another Windows application using OLE. The graphic display editor shall allow the user to create libraries of graphic objects.

The graphic display editor shall have the ability to attach, as a minimum, the following control to objects: blinking colors, visibility, rotation, horizontal and vertical movement, resizing (width and height), fill and touch.

Additional requirements

The HMI package shall provide the following features:

Display status of Plant in a graphical and tabular format (i.e. running, stopped, fault etc.)

Display Analog values on the appropriate graphic screen.

Annunciator alarms associated with the area of the plant concerned including details of the time the alarm occurred

The HMI package shall also provide following facilities for the operator Station

Adjust process set points

Select process modes

Acknowledge alarms

View a journal of unacknowledged alarms

View a journal of the last 200 alarms acknowledged and unacknowledged.

Display process set points

Provide real time and historic trending of local analogue values

Provide data archiving of all local analogue values

Prepare daily and weekly reports (providing details of daily and weekly throughputs against numbers of pump running hours, power usage, etc.)

Display a total running hour’s log of local transmission pump drives.

Display preventive / planned maintenance schedules

Any additional features required to assist in the effective and efficient operation of the Treatment Plant / Pumping Station.

Power monitoring/management using various analogue / digital inputs & data through various communication ports provided from the HT switchgear / PCC / MCC / VFDs / Soft Starters / MFMs, etc. for Treatment Plant / Pumping Station.

Graphic screens shall be provided as follows but not limited to this:
Main and subsystem menus
Plant / Process overview (i.e. providing details of Nos. of pumps / blowers / equipment running, Flow, totalized flow, levels, process parameters / power supply status, etc.) for Plant.
Overview of power system
Overview of control system
Screens to permit viewing of process set points
Tabular screen of Pumping / Treatment Plant status and values
Running hours log for Pumping Station and treatment plant process pumps, etc.

All set points shall be user programamble as per client requirement to be finalized during detailed engineering.

The screens shall display data commensurate with their size and the area of and number of Plant items covered. In addition to the specific screen requirements stated above, any additional screens to ensure comprehensive coverage of the Works needs to be provided.

A comprehensive screen navigation system shall be provided giving access to all screens via a system of menus and short cuts (i.e. it shall be possible to follow the process from one screen to another by clicking the mouse cursor on screen 'hotspots' to effect the move from one screen to another).

The sample rates required for the displaying of trends shall typically be one sample every 15 seconds for flow values and one sample every 30 seconds for levels. The system shall be capable of storing real time data for one day and historic data for 90 days.

The sample rates for archiving shall be the same as for trending. The archives shall be stored in daily files. The system shall provide capacity to store archives for 90 days. A warning alarm shall be provided to the operator to advise that archiving to disk should take place or archived data will be overwritten.

The data derived from archiving to the MMI and the archived data viewed using the trend facility.

The HMI shall have the ability to record specific tag values under certain conditions. Several models shall define these conditions. This data that is collected shall be stored in MS SQL format for displaying in trends, archiving for future processing or analysis, and/or using with third-party software, such as FoxPro, Crystal Reports, and Microsoft Excel, for display or analysis .It shall be possible to log historical data directly to an ODBC compliant database

The Contractor shall provide a disc drive with the MMI in order to download archive data or to upload previously stored archive data onto electronic storage media.

Contractor shall provide minimum of 3 sets of as-built control panel wiring drawings, PLC logic write-up, I/O Schedule/assignment, ladder diagram and other relvant documents in hard copy format and 3 sets in soft copy form on CDs. Soft copy format shall be in editable form to enable incorporating any changes in future. 3 sets of application program as back-up shall also be provided in soft form on CDs.

All programs are client property and all passwords and register address data, etc. shal be shared with Client since commissioning stage / start of O&M date and bidder shall also be responsible to modify the program / PLC & SCADA software to suit the process as well as client requirement to benfit the client in terms of automation and data / reporting and with regards to operator friendliness of the system, etc. and same shall be carried out at no extra cost during entire period of O&M by bidder (Genrally the changes shall be effected once a month if required by client during first year of O&M and in subsequent period of O&M shall be once in a quarter or more if required by client).

Uninterruptible power Supply

UPS of suitable capacity as per following specifications for 60 minutes back-up shall be supplied for entrie load of instrument control panel including PLC/SCADA and essential / critical instrument supply for necessary shut-down in case of power failure.

(a) The UPS shall be floor mounted, self contained and metal clad and shall be suitable for supplying a non linear load.

(b) It shall be possible to open the enclosure front door when the unit is in use without exposing any live contact touch.

(c) The UPS shall be on-line type incorporating a six-pulse rectifier and pulse width modulation inverter technology with microprocessor control. It shall incorporate a static bypass switch that shall operate in event of UPS failure, overload or manual initiation in order to transfer the output supply to mains without disturbance to the output supply.

(d) The UPS shall incorporate a DC under voltage trip circuit to Electro-mechanically trip the UPS output in order to protect the batteries.

(e) The noise level of the unit shall not exceed 60 dB(A) at 1 m from the UPS cabinet.

(f) The output of the inverter shall be a sine wave having less than 2% THD for linear loads and less than 4% for 50% non linear loads. It shall be suitable for load power factors 0.7 lag to 0.9 lead.

(g) The unit shall have a dynamic response such that 100 % step load causes an output voltage transient of less than ±4% with a recovery of less than 4ms. The load crest factor shall not be less than 3:1.

(h) Indicators shall be provided for the following
i. UPS status
ii. PS alarm conditions

(i) The UPS shall provide volt free contact outputs for the following purpose:
i. Warning, (viz., low battery voltage)

(j) The UPS shall have an overloaded capacity of 150% for 30 seconds and shall be protected in the event of a short circuit of the output.

(k) The batteries shall be housed, within a separate matching battery cubicle suitable for location adjacent to the UPS. The batteries shall be of the rechargeable, sealed maintenance free lead acid type. The battery supply to the UPS shall be via a fused load break switch disconnecter circuit breaker. The battery recharge time to 90% of full charge shall be approximately ten times the discharge time at full load.

(l) Terminals shall be shrouded to prevent accidental contact
The Uninterruptible Power Supply (UPS) System with SMF Lead Acid battery shall conform to the minimum following specifications:

i. Input

Input Voltage	:	230 V, ± 5%
Frequency	:	50 Hz ± 5%
Nominal DC input (Battery)	:	Bidder to design and submit calculations

ii. Output

Output	:	230 V AC,applicable KVA with 25 % margin as per Load Calculation
Regulation mode	:	± 1%
Load power factor	:	0.8 to unity
Duty	:	Continuous
Ripple on DC	:	< 2%

iii. General

Principal of operation	:	Shall be solid state, pulse with Modulation (PWM)
Cable entry	:	Bottom

Cooling method	:	Forced air
Type of Battery	:	Sealed Maintenance free

15. LIGHTNING PROTECTION UNIT (L.P.U.)

Two numbers of lightening protection units shall be provided for each signal loop. The lightning protection unit shall be suitable for withstanding the surge arising out of high-energy static discharge/ lightning strikes and prevent the instrument from any damage. LPU shall be a passive unit and shall require no power for its operation. During a lightning strike it shall clamp ON the allowable voltage and pass the excess voltage to the ground. LPU shall be of self resetting type to minimize the down time of the measurement loop. Field mounted LPU shall have a weatherproof casing and the panel mounted LPUs shall be suitable for back of panel mounting. LPU provided shall be suitable for connecting in 24 V, 4-20 mA DC signal lines. There should be total isolation between input, output and ground terminals. The LPU shall have a minimum surge rating of 10 KA.

16. AIR CONDITIONING UNITS:

Contractor shall provide necessary air conditioning units in each control room as required to maintain environmental conditions as recommended by PLC vendor. However, contractor as a minimum shall supply min. two (02) nos. of 1.5 or 2-Tonne capacity window type air-conditioner (5-Star Rating) in the main control room.

17. **INSTALLATION MATERIALS:**

Vendor shall supply all erection hardeware required for the installation of complete instrumentation forming part of this tender.

This includes items like cables, cable glands, junction boxes, instrument valves and manifolds, mounting accessories, impulse piping / tubing, pipe/tube fittings, pneumatic signal tubes, air line pipes and fittings, filter regulator, insulation material, cable duct and trays, conduits, identification tags, structural material required for instrument supports and trays etc.

A) CABLES:

Vendor is fully responsible for the sizing of all cables in their scope of supply considering factors like maximum distance between Control Room and the Unit. Specifications for cables for analog signals, digital signals and instrument power cables shall be as follows:

Cables For Analog Signals:

Cables shall be of 660V/1100V grade, single or multi-pair cables, annealed, tinned, high conductivity 1.0 sq.mm stranded copper conductor, PVC insulated two cores twisted into pair, laid up collectively, individual pair shielded and overall shielded with aluminium mylar tape, ATC drain wire running continuously in contact with aluminium side of the tape, PVC inner sheath, armoured with galvanised steel wire overall sheathed with PVC, conforming to IS:1554 & IEC:189 Part II shall be used for analog signals. Sequential marking of the length of the cable in meters shall be provided on the outer sheath at every one meter. For multipair cable ,Pair identification as per BS 5308 Part-II marking pair

no. for each pair shall be provided at maximum 50mm between two consecutive numbers.

Cables For Digital Signals:
Cables of 660V/1100V grade, multi-core cables, multi-stranded high conductivity annealed 1.0 sq.mm stranded, tinned copper conductor, PVC insulated, overall shielded with aluminium mylar tape, PVC inner sheath, armoured with galvanised steel wire overall sheathed with PVC, conforming to IS:1554 & IEC:189 Part II shall be used for digital signals. Sequential marking of the length of the cable in meters shall be provided on the outer sheath at every one meter. The embossing/engraving shall be legible and indelible.Control cables having 6 cores and above shall be identified with prominent and indelible Arabic numerals on the outer surface of the insulation. Colour of the numbers shall contrast with the colour of insulation with a spacing of maximum 50mm between two consecutive numbers. Colour coding for calbles upto 5 cores shall be as per IS.

Cables For Instrument Power Supply:
Cables of 660V/1100V grade, multi-core cables, multi-stranded high conductivity annealed 1.5 sq.mm, stranded, tinned copper conductor, PVC insulated, PVC inner sheath, armoured with galvanised steel wire overall sheathed with PVC, conforming to IS:1554 & IEC:189 Part I & II shall be used for instrument power supply. Sequentialmarking of the length of the cable in meters shall be provided on the outer sheath at every one meter

Laying of Cables:
Cables shall be laid on trays, in trenches, conduits, ducts as necessary. Instrument cables shall not be buried in ground as far as possible. Cable joints in instruments signal and power supply cables shall not be permitted. In case if some of the instrument cables are to be buried in the ground, it shall be as per standard/good engineering practice and shall be subject to client's/consultant's approval.

The contractor shall also supply necessary materials such as junction boxes, glands, lugs etc. required for termination of cables. Each cable shall be terminated to individual panel/terminals box. Cable glands shall be of Nickel plated Brass and of Double Compression Weather proof type.

A distance of minimum 300 mm shall be maintained between the cables carrying low voltage AC & DC signals and a distance of minimum 600 mm shall be maintained between cables carrying HT & LT cables.

Identification of each cable shall be by proper ferrules at each junction as per cable schedule to be prepared by contractor. All cables shall be identified close to their termination point by cable numbers as per cable interconnection schedule. Identification tags shall be securely fastened to the cables at both ends.

B) CABLE GLANDS:
Cable glands shall be nickel-plated brass and shall be of double compression type suitable for armoured cables.

Flame proof gland swherever required shall be with Ex(d) certification.

C) INSTRUMENT VALVES (MINIATURE TYPE) AND MANIFOLDS:

Body rating shall be as per piping class or better. Valve body and Trim material shall be SS316 as a minimum. Packing material in general shall be PTFE. Valves and Manifolds shall be of forged type only.

D) PIPE AND TUBE FITTINGS:

Tube fitting shall be flareless compression type and of three piece construction of Swagelok / Parker Hannnifen make.

Ferrule shall be os SS in general.

Socket Weld type forged pipe fitting of suitable material and rating shall be supplied for pipe fittings. The minimum rsating shall be 3000 lbs. Weld neck fittings shall be used where socket weld is not allowed by piping class.

For air service instrument brass fittings suitable for use on copper tubes conforming to ASTM B 68 / B 68M shall be used. It shall be manufactiured from Bar Stock or equi and shall be nickel plated.

E) CABLE TRAYS:

All brach cables/tubes, cables on various civil units/structures shall run on cable trays only.

Cable trays shall be made out of galvanized mild steel sheets of 2.0 mm thickness with required accessories. All material shall be hot dip galavanized as per IS 2629. The width shall be so selected that 20-30% space is available for future use.

Suitable cable clamps shall be supplied for binding cables / tubes at every 500mm.

F) JUNCTION BOX:

Junction Box material shall be Cast Aluminium (LM-6) only and shall be weather proof to IP-65. Flame proof junction boxes shall be supplied with Ex(d) certification in addition.

The boxes shall have terminals suitable for a minimum of 4 mm2 cable termination mounted on rails. 20% spare terminals shall be supplied in junction boxes.

Each junction box shall have 10% or minimum 2nos., whichever is higher, spare entries of each size. Spare entries shall be provided with plugs.

18. **INSPECTION :**

Test / Calibration Certificates of all instruments shall be reviewed and approved prior to despatch clearance.

The PLC/SCADA based control panel shall be offered for inspection/FAT at manufacturer’s works prior to dispatch.

All material shall be dispatched only after obtaining dispatch clearance from client.

VENDOR DATA REQUIREMENT
(INSTRUMENTATION)

Sr. No.	Description	Info. / Review	As-Built
1	Piping & Instrument Diagram	*	*
2	Instrument index	*	*
3	Vendor List for Instruments & accessories	*	
4	Sizing Calculations	*	
5	Utility requirements	*	
6	Instrument Specifications and data sheets	*	*
7	Detailed loop drawings	*	*
8	Panel front arrangement	*	*
9	Wiring diagram for panels	*	*
10	Cable Schedule	*	*
11	Instrument Installation drawings	*	*
12	Bill of Material for installation items	*	*
13	Inspection and Test procedures	*	
14	Test Certificates and certific. from statutory bodies	*	*
15	Complete catalogues with part list for all vendor supplied instruments, controls etc.	*	
16	Installation, Operation and maintenance manuals		*

NOTE :- This list indicates the minimum drawing and document list. However vendor shall also furnish any other drawing or document required to be furnished during the course of job execution.

LIST OF APPROVED VENDORS FOR INSTRUMENTATION SYSTEM

Sr. No.	Item Description	Approved Vendors
1	Water Quality Analysers (pH , TSS, Turbidity, DO, Residual Chlorine, BOD/COD, Nitrogen / NH4-N, Phosphate, Conductivity, etc.)	ABB, E+H, Emerson, Hach, Polymetron, Yokogawa, Xylem (WTW), Krohne Marshall (for pH Analyzer, Conductivity Analyzer & Optex Japan make Turbidity Analyzer)
2	Ultrasonic Type Level / Diff. Level / Open Channel Flow Transmitter	ABB, E+H, Krohne, Siemens, Vega, Emerson
3	Hydrostatic type level transmitter	ABB, E+H, Siemens, Krohne Marshall, Emerson
4	Electro Magnetic Flow Meter	ABB, E+H, Krohne Marshall, Siemens, Yokogawa
5	Differential Pressure / Pressure / Temperature Transmitter	ABB, Emerson, Fuji, Honeywell, Siemens, Yokogawa, E+H
6	Pressure / Diff. Pressure Switch, DP Gauge	Dag Process Instruments, Danfos, E+H, Indfos, N.K. Instruments, Verma Trafag, Orion, Switzer
7	Pressure / Compound Pressure Gauges	General Instruments Consortium, Manometer (India) P. Ltd., Baumer, Wika , Pricol
8	Displacer / Float / Buoyancy Level Switch	ATMI, Baumer, E+H, Nivelco, P+F, Pune Techtrol, SBEM, Levcon, Nivo/Toshbro
9	Float & Board type Level Gauge, Tubular Type Level Gauge	Nivo/Toshbro, Pune Techtrol, Revathi, SBEM , Levcon , Jayati Instrumentation, General Instrument consortium
10	Electric Actuators	Auma, Rotork, Emerson
11	Pneumatic Actuator	Emerson, Rotex, Schrader, Festo, SMC
12	Programmable Logic Controller (PLC) System / HMI / SCADA Software	ABB, Rockwell (Allen Bradeley), Schneider, Siemens, Honeywell, Phoenix
13	Computer System / Laptop computer	HP, Dell, Acer, Lenovo, Sony, Samsung
14	UPS	APC / Schneider, Emerson, Hirel-Hitachi, Powerware, Merlin Gerin, Socomec
15	SMF Batteries	Panasonic, Exide, Base, Prestolite
16	Instrument Cables (Power , Signal, Control)	Associated Cables, Associated Flexibles & Wires, Brooks Cables, Delton, Havells, RPG Cables, Udey Pyro, Polycab, Brooks Cable, Thermo Cables
17	Communication Cables	D-Link, Delton, Finolex, Lapp Cable, Molex
18	Cast Aluminium Junction Boxes	Ex-protecta, CEAG, Sudhir, Baliga, FCG
19	Air Conditioners	General, Hitachi, Samsung, Daikin, Mitsubishi
20	Office Furniture	Godrej, Blind Men’s Associations, Equi. reputed
21	Panel Enclosures	BCH, Bartakke, Eldon, Enklotek, Rittal
22	Alarm Annunciator	Aplab, Minilec, IIC, ICA, Protons, Masibus

23	Solenoid Valves	Asco / Avcon Controls / Indfos / Rotex / Schrader
24	Instrument Valves and Manifolds, Tube Fittings, Pneum. Brass Fittings	Excel Hydropneumatic, Industrial Enterprise, Festo, Multimetal Industries, Placka, SMC, Technomatic, Wesmec, Fluid Controls, Aptek , Anmol (Superlok), General, Smart, General Instrument Consortium, Festo, Swagelok
25	Miniature Relay	ABB, Omron, Phoenix, Schneider, Rockwell
26	Indication Pilot Lamps (LED Type)	Teknic, Schneider, Siemens, Salzer (L&T)
27	Push Button/ Selector Switch (with NO/NC Element)	Teknic, Schneider, Siemens, Salzer (L&T)
28	DC Power Supplies (DIN Rail mounted)	Phoenix, Omron, Aplab, IFM, Schneider, Allen Bradeley, Siemens
29	Terminals	Elmex, Phoenix, Wago, Connectwell
30	Panel Wires	Finolex, Havell's, R R Kabel, L&T, Lapp Cable
31	Panel Illumination	Philips, Crompton, GE, Bajaj, C&S, Havells
32	Cable Glands	Ex-protecta, Braco, Sudhir, Comet, Connectwell, HMI
33	Cable Tray	Globe, Jacinth, M.M. Engineering, Tushar Tech, Silverline Power, Polycab, equi. reputed
34	Receiver Indicators (Panel Mounted)	ABB, Masibus, Nivam, Nishko, Electronet, Lektrotek , Yokogawa , Forbes Marshall
35	Lightning Protection Unit	Rittmeyer, MTL, Crompton, P+F
36	Printer (Inkjet/Laser Jet)	HP, Canon, Samsung. Epson
37	GSM/GPRS Modem	Maestro, Axitech, D-Link, Netgear Moxa, Robustel
38	Ethernet Switch	D-Link, Rockwell, Siemens, Schneider, Cisco
39	LED / LCD TV	Samsung, LG, Sony
40	FO Cable	D-Link, R& M, Panduit, Systimax, Finolex
41	Media Converter	Digisol, TP-Link, Microtek, D-Link, Moxa
42	Antivirus software	Quick heal, McAfee, Norton
43	Control Valves / On-Off Valves – Pneum. Actuator Operated	ABB / Samson Control / Fisher Xomox (Sanmar) / Arca (Forbes Marshall) / MIL Control / Tyco Valves / SPX Valves
44	Air Filter Regulators	ABB / Divya Control / Janatics / Shavo Norgren / V. Automat / Veljan Hydrair
45	Variable Area Flow meter (Rotameters)	Eureka / Transducers & Controls / Alflow Glass / Instrumentation Engineers / Rota Instrumentation / Krohne Marhsall
46	I/P Converters	ABB / MTL / Emerson / Moore

11 CHAPTER
OPERATION AND MAINTENANCE OF TERTIARY SEWAGE TREATMENT PLANTS (GENERAL)

PART A: SCOPE OF WORKS

1.0 The contract includes operation and comprehensive maintenance of entire Tertiary Sewage Treatment Plant **on round the clock basis for a period of 60 Calendar Months (Five Years) after successful completion of trial run of three months and acceptance of Plant.** Guidelines stipulated in Manual on Sewerage and Sewage Treatment, Second Edition, published by Central Public Health and Environmental Engineering Organization (CPHEEO), Ministry of Urban Development, New Delhi, December 1993 shall be followed. The contractor shall commission the plant and start trial run immediately after commissioning. Development of bio-culture to the extent that it can yield satisfactory performance shall be accomplished within a period of three months. The O & M period starts after completion of three months of trial run & acceptance of the plant. Additional information is given in the following sections to facilitate the monitoring works. Contractor shall note that preparation of Operation and Maintenance Manual for the TSTP designed and set up by them is included in Scope of Work. This manual shall be duly got approved from Employer prior to commissioning.

2.0 The Tertiary Treatment Plant set up on turnkey basis shall be operated and maintained by the contractor including all works. Contractor has to incur all the costs, taxes, vat, duties, transportation, labour, machining, welding, repairing, replacing and making good any and all parts / plant equipment, consumables, motors, pumps, aerators, gear unit, capacitor, HT/LT switchgear, PLC panel, lighting system, cables, battery charger, battery, instruments, meters, chemicals for laboratory etc.

Cost of diesel for operating DG set during power failure shall be reimbursed at actual by client after necessary verification by client based operating hours logged in hour meter & actual power generation in power meter of DG set. Contractor shall submit required supporting documents to client for verifications and to satisfaction of client.

Only Secondary treated sewage & electricity (grid power) shall be supplied free by client during O&M period.

2.1 Average Power Factor for the supply company Power Bill must be greater than 0.95 and if any Penalty/Charge levied due to low Power Factor, then the same shall be recovered from the contractor without any reasons in addition to the penalty for each instance of non-maintenance of desired power factor of 0.95 or better as per specifications at HT side / Supply Company Meter (or Bill) each month as mentioned separately below.**.** All the capacitor panel must be kept in working condition to maintain power factor generally of 0.98 lag or better by the contractor. Any spares required to keep capacitor panel in working condition is in the scope of the contractor. The spares required for LT capacitor panel must be procured and replaced immediately, if required. No spares for capacitor panel & LT capacitor panel in any circumstances will be provided by Client. Penalty on

account of poor power factor (i.e. less than 0.95) as explained elsewhere will be recovered from the contractor from his monthly O&M bill.

3.0 The Contractor will be held responsible for O & M and satisfactory performance of the TSTP. Major components and works shall include the following but not limited to:

a) Operate the plant efficiently for Five years (24 hours/day & 365 days/year) including all consumables, parts or components, labor transportation and other charges, except for cost of power and supply of Secondary treated sewage. Power cost shall be borne by employer. Secondary treated sewage shall be supplied by employer.

b) Operate and maintain all units and equipments of the Tertiary Treatment Plant as per the requirement of the process to meet continuously and consistently desired treated sewage characteristics in conformity with specifications and local PCB guidelines; maintain all equipment in good working condition as per the O & M manual as prepared by the contractor and duly approved by the Employer.

c) Attend breakdown of civil, mechanical, electrical, piping and instrumentation works and maintain the plant and equipment through out the Contract Period.

d) The operation and maintenance service provided by the Contractor for the period specified in the Contract shall ensure the continuous operation of the Plant and that the breakdown or deterioration in performance, under normal operating conditions, of any items of Plant and equipment and component parts thereof is kept to a minimum.

The contractor shall determine operating parameters, select settings (chemical dosages, etc.) and generally optimize the process, and working of the treatment plant. Excessive chemical dozing i.e. doze more than / less than normal should be avoided; otherwise penalty shall be levied and recovered from the contractor.

e) The Contractor shall adhere to the manufacturers' recommendations with respect to equipment maintenance, consumables, the types and grades of lubricants to be used, frequency of lubrication, adjustments to be made regularly and recommended spares to be held in store.

The spares, tools and tackles supplied by contractor as specified herein as a part of this tender obligation are property of employer / client and employer has no obligation to supply the same to contractor for carrying out any rectification work. Contractor for the purpose of O&M shall have required spares in stock at site and maintain a record of the same. In case if employer hands over any spare for carrying out rectification in emergency situation, the same shall be handed over back by contractor to client within reasonable period of time and not exceeding a maximum of 4 weeks duration in any case. Failing to do so, client reserves the right to deduct the price of same from O&M bill/Security Deposit of contractor. Arranging necessary tools and tackles for effective and efficient O&M of the plant is responsibility of contractor.

The contractor shall provide **timely planning** and **regular procurement of all required spares and consumable including chemicals, chlorine tonners, grease, lubricating oil, cleaning agents, laboratory reagents etc.** Contractor shall arrange for the requirement well in advance.

f) Maintaining Logbooks / Records of the work carried out to keep them in good working condition. He shall obtain approval of the format of logbooks and records from Employer.

g) The Contractor shall prepare and implement an effective plant maintenance program in consultation with the Employer. It is absolutely the Contractor's responsibilities to look after all sorts of maintenance whether routine, preventive or break down or any other type of maintenance. The Contractor will be responsible to carry out day to day as well as periodic maintenance necessary to ensure smooth and efficient performance/running of all equipment.

h) Submission of daily and monthly O & M report.

i) Carry out regular and frequent sampling, analysis and result recording of Secondary treated and Tertiary treated sewage as per the procedures laid out by the Owner and in conformity with standard methods; and complying with the GPCB norms and attend GPCB during the monitoring/ sampling and obtaining approval.

j) Employ appropriate and skilled manpower, provide all tools, tackles, equipment, laboratory instruments, glassware and chemicals, reagents etc. required for effective implementation of the Services detailed above.

k) Area lighting – The premises of various works are provided with metal halide / sodium vapor lamps, fluorescent tubes and also ceiling fans/exhaust fans inside the various structures. Daily on/off operation and routine cleaning of all type of electric fixtures. Replacement of lamps / Tubes / Fans in case of failure at contractor's cost.

l) Maintenance of garden – Normally watering the trees once a day or more if required. Grass cutting, removal of shrubs, weeds, around tree to be done as directed. Remarking the ponds around the tree after loosening with soil with supply of additional earth, if required. Cutting of branches, if required for straight growth of tree/plant and development of garden.

m) All buildings, bathroom, toilet to be kept swept, cleaned and washed daily. Consumable requirement for cleaning such as acid, harpic, phenyl, air freshner, washing powder, brooms, wire brushes, duster, bamboos, toilet shop, lotion waste, kharata (broom) shall be provided and used as required. All ventilators, windows/doors to be cleaned and to kept in good aesthetic condition.

n) To keep watch on overflowing of sump. If such overflow takes place the agency shall have to bear the damages caused to surrounding properties.

o) Maintaining laboratory and its all equipments. All materials, equipment and labour shall have to be employed by the agency to maintain the same.

p) Contractor shall ensure that the sewage entering the plant is not bypassed for more than half an hour, which is again subject to obtaining prior permission / approval of the employer. In adverse circumstances of heavy rainfall, contractor may use the plant bypass for the purpose of attending detritor for a period of maximum one hour. Generally major repair encountered in any unit of the plant shall be attended as quickly as possible. In case it is not possible, the reason for the same shall be informed to the employer within 2 hours.

q) Contractor shall submit six copies of the O & M Manual for approval of Employer, which may be modified, if required by Employer, and two copies would be returned by Employer duly approved and signed.

r) The contractor shall monitor the performance of the Tertiary Treatment Plant, conduct the analysis of the influent as well as effluent quality after treatment. Contractor shall initiate and take adequate actions to ensure smooth and satisfactory performance/ running of the plants on a 24 hours/ round the clock basis.

s) For the smooth running of the plant all the required equipment, machineries, accessories, major and minor spares, consumables including chemicals, greases, lubricants, all cleaning agents, packing, rubber sheet, laboratory reagents, all hardware, required quantity of white wash, oil paint color, all types of epoxy paint, material required for house- keeping and cleaning etc. are to be brought by the contractor. The quality of all consumable and spare etc. i.e. technical requirements as per manufacture recommendation shall remain unchanged.

t) To remove/suitably collect dewatered sludge from mechanized dewatering system (belt filter press), screenings and grit from grit detritor etc. and loading the same into vehicle and conveying and unloading the same at Low lying area as suggested by Client.

The grit and sludge from the plant is to be transported away from the plant and disposed as instructed by CLIENT / engineer-in-charge.

The disposal shall be done at a site as indicated by CLIENT and contractor to consider disposal within 10 km radius from the treatment plant.

If the contractor fails to remove silt / sludge in the treatment plant for any reason and beyond the notice period issued by the employer, the same shall be removed by employer by engaging other agencies and the cost shall be recovered from the contractor.

u) The contractor shall carry out cement paint/ enamel paint/ white wash for exterior finish of civil units once before the end of third year of O & M of the plant and before the end of fifth year of O&M and similarly shall also carry out painting on mechanical

equipments/ above ground pipe lines/ hand railing before the end of second year and fourth year of O & M of the plant.

v) The contractor shall carry out maintenance of all instrumentation works and SCADA on daily, weekly. Monthly and yearly basis as recommended by the concerned vendor.

w) **Important Note for O&M Scope**: The bidder shall supply 50% of the total design quantity of UF membranes during the last month of completion of 5 years O&M / prior to handing over of plant to Client at the end of O&M tenure as free supply. This free supply of membranes is in addition to the membrane replacement to be carried out by bidder as required during O&M / up to the end of O&M tenure of 5 years.

x) The contractor shall hand over the plant back to CLIENT on expiry of his contract in fully working condition satisfying the requirement of treated sewage. All the electrical, mechanical and instrumentation including standby shall be in perfect working condition.

4.0 The Contractor shall procure, keep at site and use necessary tools, tackles and safety equipments for day to day routine maintenance, preventive maintenance and break down maintenance. Also minor and major repairs to the equipment involved in the plant have to be carried out by the contractor during the O&M period. Contractor shall submit report, discuss and finalize with the Employer on the major repairs required to be carried out and how these repairs will be undertaken, to the satisfaction of the Employer and obtain written approval from the Employer before carrying out any major repairs.

4.1 The scope also includes cleaning of units, sludge drying beds, clarifier, removing of foreign materials like debris, sand, fish, frogs or any other dead or live animals and also cleaning of strainers of each pump quarterly so that required quantity of sewage is treated properly.

4.2 The disposal of the foreign particles like sand, dead or alive animals etc. from all the units of the plant to suitable place as shown by CLIENT is in the scope of contractor.

The scope of works also includes the calibration of all meters e.g. pressure gauge, Ammeter, voltmeter, relay, trivector/multifunction meter, Energy meters, temp scanners, flow meters etc. for measurement of accurate readings.

The scope of work of contractor includes operation & maintenance of 11 KV incoming power line, Lighting Arrestors, D.O. fuse, earthing works, or any other maintenance required on two/four pole D P structure.

5.0 Contractor to ensure that the sewage entering the plant is not bypassed for more than half an hour. In case it is not possible, the reason for the same to be informed to the employer within 2 hours.

5.1 Scope of CLIENT will be only to the extent of supplying Secondary treated sewage (at Plant Inlet) and bear the energy charges to be paid to power supply company. In case of

non-availability of sewage due to break-down in sewage pumping station / treatment plant or sewage network or any other reasons, stipulations in other parts of the tender shall be referred to.

PART B: OPERATION AND COMPREHENSIVE MAINTENANCE SPECIFICATION

1.0 SUFFICIENCY OF TENDER

1.1 The prices entered in the Price Schedule shall, except in so far as it is otherwise provided, be deemed to cover all the Contractor's obligations under the Contract and all matters and things necessary for the operation and comprehensive maintenance of the Plant. Particular requirements set forth in the Specification are given without prejudice to the aforementioned general obligations of the Contractor.

2.0 DOCUMENTS / INSTRUCTION FURNISHED BY THE EMPLOYER

2.1 The Employer may issue at such times as he may think proper during the contract period instructions as may appear to him to be necessary for the guidance of the Contractor in the operation and maintenance of the Plant. The Contractor shall be bound by the same, obey and execute.

2.2 The Contractor shall acknowledge the receipt of such instructions in writing or by fax. The Contractor shall carefully check all such instructions before commencing any Works. The Contractor shall inform the Employer in writing, within 3 (three) days from the receipt of the same, of any errors or omissions discovered, or of the difficulty to execute any Works or part thereof in compliance with the written instructions received from the Employer. Failing to do so contractor shall be liable to execute at their own cost the necessary alterations to any Works resulting from these errors or omissions.

2.3 The Contractor will also be furnished with two copies of all instructions as may be issued by the Employer. One copy of all such O & M manuals and instructions issued to the Contractor shall be kept in his office at the site. The O & M manuals or instruction shall be considered valid only if the Employer has signed it.

3.0 CONTRACTOR'S ORGANISATION & ADMINISTRATION OF THE CONTRACT

3.1 The Contractor shall provide experienced administrative, managerial, technical, supervisory, non-technical personnel and labour necessary to operate and maintain the plant properly, safely and efficiently on a continuous 24 hours basis for the full term of the O & M Contract Period. During O & M period if any expert / technically knowledgeable / special persons or manpower needed, he shall have to arrange & bear / pay any and all cost, charges, fare, allowances etc. for the same. The employer will not pay any cost / charges for the same.

3.2 The qualifications and capability of the Contractor’s personnel shall be appropriate for the task they are assigned to perform. The staff provided shall be fully trained in the operation of the various units of the Treatment Plant before being given responsibility for operating any part of the Plant. If in the opinion of the Employer, any member of the Contractors staff is considered to be insufficiently skilled or otherwise inappropriate or

not doing the work properly he is required to perform, he shall be replaced by the Contractor with a person with the appropriate skills and experience for the task, to the satisfaction of the Employer. The Contractor will be required to submit to the Employer the Schedule of 'Manpower' and 'Organization Chart' .The contractor shall keep all the details, bio-data, photograph, references, application, and all such records with him even after he is removed or resigned from work of this site. Guilty person or undisciplined person shall not be employed by the Contractor.

3.3 The CV/Resumes of the Contractors personnel shall be submitted to the Employer for acceptance at least 7 days before the anticipated commencement of the O & M period. Any change of personnel shall be promptly informed to the Employer within a day's time. Normal time duty hours for the contractors' operation & maintenance personnel may be modified as necessary and agreed by the Employer. A rotating shift schedule shall be established by the Contractor and agreed by the Employer which will ensure that an adequate number of the Contractor's staff, fluent in Hindi as well as Gujarati is on duty at Plants 24 hours per day, 7 days per Week, including all holidays. The contractor shall have to issue **identify cards** with photographs to all the state employed for O & M. All the employees of contractor should be in specified **uniform indicating contractor logo**.

3.4 The Contractor shall submit with his tender a diagram showing the structure of the organization for his administration of the Contract. The structure shall include a Project Team consisting of Project Manager. The Project Manager and his site team shall be stationed in Jaipur. The Project Manager shall have authority and powers to take decisions on the spot and/or incur expenditure(s) in the interest of the work whenever required by the Employer.

3.5 All correspondence and communication between the Employer and the Contractor including the Contractor's sub-contractors shall be directed through the Project Manager.

3.6 The sub-contractors proposed by the Contractor shall be subject to the approval of the Employer.

:

3.7 Contractor shall provide minimum manpower as per qualification and experience mentioned below:

Sr. No.	Designation	Qualification	Experience	No. of Personnel
1.	Plant Manager	B.E.(Env.) or B.E. (Chem.)	3 years experience. 1 year experience in the field of O&M of TSTP or ETP	01
2	Senior Chemist	M.Sc. (Micro) or M.Sc. (Chem.)	3 years experience and knowledge in identifying micro-organism and testing procedures	01
3.	Instrument Engineer	D. I.E. (Inst.) or higher	3 years experience in maint. of Instrumentation & Automation Eqpt. works for STP / WTP plant	01

6.	Mechanic / Electrician	ITI (Elect. trade) or PWD super-visory Cert.	3 years experience of relevant Mechanical / electrical equipments for O&M.	01
7.	Plant Operator	ITI fitter	3 years experience of operating pumping machinery	04
8.	Helpers	8th Standard Pass (only Male)	Knowledge of Gujarati, Expert Swimmer / Experience of gardening and house keeping	04
8.	Sweeper	8th Standard Pass (only Male)	Knowledge of Gujarati, Expert Swimmer / Experience of gardening and house keeping	01
			TOTAL PERSONNEL	**13**

3.8 Minimum manpower required in various shifts is as follows:

				Personnel per Shift			
Designation	**Duty**	**Nos.**	**Gen Shift**	**Ist Shift**	**IInd Shift**	**IIIrd Shift**	
a)	Project Manager	General	1	1			
b)	Senior Chemist	General	1	1			
c)	Electrician/ Mechanic	General	1	1			
d)	Instrument Engineer	General	1	1			
e)	Plant Operator	Shift	4	1	1	1	1
h)	Helpers	Shift	4	1	1	1	1
i)	Sweeper	Shift	1	1			
	Total		13	7	2	2	2

Note: The staff as per above qualification and in specified numbers shall be deployed by contractor at the time of commencement of O&M. However, as the plant is provided with various instrumentation and suggested for automated operation as far as possible as per scope of work / specifications of tender, it is envisaged that the number of personnel under various categories may be optimized in order to optimize the O&M cost of client. For this purpose, client shall observe the performance of plant and assess the requirement of manpower during the initial months of operation and after that shall carry out meeting with contractor for mutual agreement on optimization of staff. Based on this understanding and with a clear intent that any such action shall not lead to unsatisfactory operation of the plant and that contractor shall not be absolved of any penalty or from providing satisfactory operation, maintenance and performance guarantee of the plant, client shall provide one month advance notice in writing to contractor regarding the staff to be retained / deployed in the month coming in effect after one month from the date of notice. Contractor shall deploy the staff accordingly and shall be paid for the actual staff deployed during as month as mutually agreed between client and contractor. For this

purpose contractor shall quote the rate for person to be deployed under each category to enable the payment to be made as per actual deployment.

3.9 Relaxation in qualification and number of staff shall not be allowed. The above staff shall be distributed in three shifts. General shift shall be considered as 09:00 Hrs to 18:00 Hrs. Various personnel shall attend the plant during general shift as tabulated above. Preferable timing of shift shall be 06:00 Hrs to 14:30 Hrs, 14:00 Hrs to 22:30 Hrs and 22:00 Hrs to 06:30 Hrs (with half an hour of overlap). **The arrangement of reliever for weekly off / all holidays etc. shall be made by the Contractor over and above the required persons mentioned in 3.8 above.**

As per agreement, the No. of staff in each shift should always remain present; otherwise penalty towards absence of any staff shall be levied and recovered from the contractor. The penalty shall be decided by the Engineer-in-Charge / CLIENT / as specified in tender or as per quoted rate of manpower in price bid. The arrangement of reliever for weekly off/holiday/leave etc. shall be made by the contractor. Absence on any ground like weekly off or holiday shall not be considered . The presence of staff in each shift should be marked in register to be maintained at office of Engineer of the Client at Tertiary Treatment Plant; which shall be considered as final. The contractor's staff must mark their presence in this register. The contractor may maintain a separate register for his own purpose.

3.10 The staff of Contractor will always remain in contact with Employer and follow his instructions. The Contractor shall have to issue identity cards with photograph to all the staff employed for operation and maintenance; otherwise they will not be allowed to enter the plant premises.

3.11 The Contractor shall employ all the required staff (and in no case less than the number specified in the tender which is mandatory) within 7 days of award of the Contract, otherwise full payment will not be made. In such case, the commencement of the Contract Period and payment thereof shall be reckoned only from the date of employment of full numbers of staff. If at any stage it is felt necessary that additional manpower over and above the specified minimum manpower is required for the proper operation of the treatment plant, contractor shall employ necessary additional manpower at no extra cost within 7 days from the date of issue of notice by engineer-in-charge.

3.12 The Contractor will comply with all safety rules and regulations and all inter-disciplinary measures as followed by the Employer. The Employer will not be responsible for any accident / injury to the staff or any person of the Contractor or loss or damage to any property. Further, the Employer will not provide any insurance or free medical facility to the staff of Contractor.

Providing necessary security arrangement for safety of the plant and contractor's personnel will be the responsibility of contractor.

3.13 All Central / State Government / Semi-Government / Local Body's rules and regulation pertaining to this contract, all legal formalities pertaining to provident fund, factory act, all legal formalities shall be followed and observed by the Contractor without any extra cost to the Employer. Please note that failure in complying so, all liabilities arising as per laws will be to the Contractor's account.

3.14 No accommodation / guesthouse / transportation facility will be provided by the Employer/ Employer to the Contractor.

3.15 Due to strike by the Contractor's employees, the operation and maintenance of plant must not be affected and the property of CLIENT should not be damaged. In such case any dispute / discrepancy occurs, the decision of Engineer-in-charge will be final and will be binding to the contractor. Also if any expense will be made by CLIENT, it will be deducted from Contractor's bill/ SD.

3.16 The duration of contract shall be Five years from the date of issue of completion certificate / taking over certificate.. However the client reserves the right to terminate the contract at any time by giving 3 months notice to the contractor.

3.17 The contractor shall provide necessary chemicals for polyelectrolyte tank mixture, lubricating oil, grease in their store room. Stacking and day to day preparation of solution shall be arranged by the contractor. Similarly, chlorine tonner / cylinder shall also be provided by the contractor at the door – step of the chlorination plant. Disconnecting and removal of empty tonners and reconnection of filled tonners shall be carried-out by the contractor. The minor spares required for disconnection/reconnection i.e. clamp/'O' rings/washers shall also be arranged by the contractor.

3.18 Plant shall be handed over on "**as is where is basis**" to contractor on the award of contract. Thus, the contractor has to takeover the plants for said contract without any insistence for any change in the plants.

3.19 The scope of work also includes **regular cleaning of complete plant area including floor, railing, door, windows, light fixtures and ceiling etc.** similarly, minimum 5 mts. from the construction boundary on the outside of the plant area shall also be cleaned and maintained by the contractor.

3.20 This work is inclusive of but not limited to **operation, comprehensive maintenance, house keeping, cleaning, removing sludge by its own carrier arrangement, painting, white colour washing, preparing data, recording, correspondence work to the client and Government Departments, etc.** All this work should be done as per standard practices and by following labour, factory, electrical, GPCB, and all other old and new law and order, Indian standards etc. as applied of Local, State and Central Govt. of India.

3.21 Nothing is to be provided by the client excluding electricity and Secondary treated sewage flow. All the formalities to all government authorities for factory, electrical, GPCB, etc. for having NOC, water consent, Hazard waste concern, approval etc. shall be

done by the contractor . However, necessary legal fees to all government authorities shall be borne by the client.

3.22 Monitoring shall be done as per guidelines given by Engineer-in-charge. Contractor has to maintain all the parameters of treated effluent within the stipulated limits or he will be penalized for not maintaining the parameters given by GPCB and client. All expenditure incurred for the same like, suite, fee, court fee, case fee, or the penalty as decided by CEO, RSCDL and penalty charged by GPCB shall be deducted from his pending bills or Security Deposit.

3.23 The Contractor shall have to test the sewage samples of the influent and effluent from each of the treatment units as per frequency as specified in table above at 3.0 (r) through the laboratory provided at the plant; as per the schedule fixed by the Engineer in charge. The same have to be verified and checked by the Client once a week by taking parallel sample from the same point and at the same time and analyzing the same at the clients laboratory/laboratory approved by client. Proper register/record shall have to be maintained by the contractor and any modification /rectification, on the basis of analytical results of samples if required, in performance of each unit shall be carried out immediately. The daily analysis report along with steps for the rectification / modification taken, if any, shall also be reported to the client with the daily report. The weekly report shall also be submitted to the Engineer-in-charge of the Client, with remarks and the steps taken for modification, if any, taken during the period of report.

3.24 No equipment shall remain idle or unrepaired or damaged or unutilized for the period exceeding 5 days. If any equipment is not repaired, rectified and or replaced within 3 days, the contractor shall be penalized **with no limit at the rate of Rs. 1000/- per day of delay per each individual equipment of the plant.**

3.25 If a man on the duty remains absent and there will not be any replacement in his place, the contractor will be penalized at the rate of **Rs. 500/- per man per day upto no limit**.

3.26 The successful bidder shall have to enter into a contract agreement for O&M on successful completion of 3 Months satisfactory trial run, PGR and acceptance of plant and deposit an amount equal to 5% of total order value for O&M contract.

3.27 The quoted rate shall remain firm and valid for five years of O&M contract.

3.28 The payment of O&M charges will be made as per relevant clause of Special Conditions of Contract for O&M.

3.29 The other terms and conditions described in this tender documents, wherever applicable, shall remain unchanged.

3.30 However, **during O&M period, the contractor has to consider in his scope and supply all the spares and also consider part of complete replacement of equipment / components and any consumables including membranes, UV lamps, etc. at his cost during major-minor breakdown and also maintenance works.**

3.31 Contractor shall be responsible for health check-up of O&M staff on regular basis as per statutory requirements.

4.0 COMPREHENSIVE MAINTENANCE

4.1 The maintenance service provided by the Contractor for the period specified in the Contract shall ensure the continuous operation of the Plant and that the breakdown or deterioration in performance, under normal operating conditions, of any items of Plant and equipment and component parts thereof is kept to a minimum.

4.2 The Contractor shall carry out the Comprehensive Maintenance of the plant installations in accordance with the requirements of the O & M Manual and also to the approved Maintenance Plan as mutually agreed.

4.3 The Contractor shall adhere to the manufacturers' recommendations with respect to equipment maintenance, the types and grades of lubricants to be used, frequency of lubrication, adjustments to be made regularly and keep in safe custody recommended spares, which may be required for smooth & trouble-free operation of the plant on day to day basis.

4.4 The Contractor to operate and maintain all equipment as recommended in the O & M manual and maintain logs and records of the work carried out to keep them in good working condition. The Employer shall approve the format of logs and records.

4.5 The Contractor shall prepare and implement an effective plant maintenance programme in consultation with the Employer. It is absolutely the Contractor's responsibilities to look after all sorts of maintenance whether routine, preventive or break down or any other type of maintenance. The Contractor will be responsible to carry out day to day as well as periodic maintenance necessary to ensure smooth and efficient performance / running of all equipment being a comprehensive maintenance contract.

4.6 The contractor shall along with the O & M Manual submit a write-up covering vision, mission, plan for smooth & trouble-free operation & maintenance of the Plant. It shall include all activities, their duration and planned deployment of manpower and resources.

4.7 Contractor shall set-up and maintain laboratory at plant site complete with all equipment, testing instruments, glassware, weigh scale, chemicals, reagents, consumables and carry out necessary calibration from time to time to conduct tests as stipulated in 5.3 below and any other test required to check some of the basic parameters, not specifically mentioned.

5.0 DOCUMENTATION / REPORTS

5.1 The Contractor will be furnished with two copies of O & M manuals (prepared by him) approved by Employer. The Contractor will also be furnished with two copies of all instructions as may be issued by the Employer. One copy of all such O & M manuals and instructions issued to the Contractor shall be kept in his office at the site. The O & M manuals or instruction shall be considered valid only if the Employer has signed it. The Contractor will be responsible for keeping & updating record of documents including History Card for equipment and maintaining every day logbook. The Contractor shall

maintain and update logbook and details of operational parameters like pumping hours, aerator operation hours, Amperes, Flow meter reading, H.T. Voltage, Power Factor, energy meter reading, pressure and other reading required are recorded in every shift at regular interval e.g. hourly or as agreed mutually (by CLIENT).

5.2 Printing of log sheets, registers and all necessary stationery required for maintaining records of operations and maintenances has to be arranged by the Contractor at his cost, duly approved by Employer. Format of log sheets, registers will be made available to the contractor by the CLIENT.

The contractor has to **provide at site one computer of latest technology (HP-Compaq / Acer / Lenovo make) with HP Laserjet Printer as part of this tender requirements** to keep all the records, data maintenance schedules, spare available for the plant. Monthly statements for electricity consumed, total hours of pump operation, total qty. of pumping in MLD, average power factor, monthly consumable and repair maintenance during the month shall be furnished by the contractor. The computer system shall be property of employer.

5.3. The Contractor shall submit to the Employer every week and within first seven days of every month, a copy of the weekly/ monthly O & M report. This report must include the following:

a) Sampling of Secondary treated sewage & Tertiary treated sewage analysis highlighting all important parameters, grab samples collected three times a day (peak hours, lean hours, average) at every 8 hrs as well as 24 hour composite samples collected through Auto Samplers; DO measurement etc. Major parameters to be covered include BOD, COD, SS, VSS, MLSS, MLVSS, chlorides, Total Kjeldahl Nitrogen, pH, O&G, Alkalinity as CaCo3, sulphates, phosphorous, Grit analysis at every week including % organic content/ size distribution

b) Qty. of screen material removed on every day and gross. Type of screen material.

c) Qty. of grit removed on every day and gross.

d) Qty. of sludge cake removed per day and gross.

e) Qty. of gas generated per day.

f) Details of plant visit made by any govt. authority like CLIENT, GWSSB, GPCB, etc.

g) The duration of each pump operation per day.

h) The nos. of aeration blowers operated per day and the duration in hours a day tank wise.

i) Power consumed by each pump and by each unit per day.

j) Plant output on each hour and total for the day in MLD and PST wise flow recorded. However the contractor should adjust the equal flow through both the line leading to PST. (in case flows received at TSTP are less during initial period, single module shall be taken out of line one by one depending on total incoming flow of Secondary treated sewage in order to establish power saving and verify performance)

k) Preventive maintenance work carried out during the month.

l) Preventive maintenance work that will likely to be carried out in the next week.

m) Maintenance carried out due to fault / breakdown of equipment.

n) The details of each equipment that was not available for operation due to preventive maintenance or breakdown of equipment related to that pump equipment, giving the reason for breakdown. The details shall include number of hours the pump equipment could not be operated and whether standby capacity was available and put into operation.

o) Details of parts and consumable replaced.

p) Number of days & hours per day the plant was run whether fully or partly if the case may be and specifying the reason why the plant could not be operated fully. Whether all or single unit is operated in cases of where twin/more nos. of a particular unit processes (SCREEN, GRIT, PST, AERATION TANK, SST) are provided.

6.0 TELEPHONE FACILITY

6.1 The Contractor shall have to arrange for mobile phones to minimum two personnel of Key Staff for communication pertaining to plant O&M with employer. Any cost to the repair to the telephones and the telephone bills will be borne by the Contractor.

7.0 SAFETY, HEALTH AND ENVIRONMENT

7.1 The Contractor shall be responsible for safety on Site during the O & M of the Works by the Contractor. Health of workers shall be protected against infectious and contagious diseases. Medical check-up at every six months shall be done. Environmental protection shall also be given priority so as to conserve the environment.

7.2 The Contractor's duties with respect to Safety shall include the following:

(a) Utilise safety awareness procedures in every element of operation and maintenance.

(b) Give emphasis to safety including:

i. Safe working and safety procedures as per rules and regulations of Department of Explosives, factory inspector, electrical inspector regarding use of protective clothing, gloves, boots and helmet etc.
ii. Cleanliness of the Plant as a whole
iii. Awareness of hazardous conditions and accident reporting and necessary compliance
iv. Safe practice in Treatment Plant

7.3 The Contractor shall be responsible for all safety measures and those procedures adopted shall comply with the Indian regulations pertaining to such work and local safety codes currently in force. Where such codes do not adequately cover the Plant then the Contractor shall ensure that proper safety procedures are followed. Those given below are minimum standards and the works shall not be limited to these, if higher standards prevails. The Contractor will comply with all safety rules and regulations and all interdisciplinary measures as followed by the Employer. The Employer will not be responsible for any accident/ injury to the staff of the Contractor. Further, the Employer will not provide any insurance or free medical facility to the staff of Contractor.

7.4 If the work in the vicinity of electrical equipment has to be carried out after connection has been made to the electricity supply the Contractor shall comply with any "Permit to Work" system approved by the Employer.

7.5 Suitable scaffolds shall be provided for workmen for all work that cannot safely be done from the ground, or from solid construction except such short period work as can be done safely from ladders. When a ladder is used an extra man shall be engaged for holding the ladder and if the ladder is used for carrying materials as well, suitable footholds and hand holds shall be provided on the ladder.

7.6 All necessary safety equipment as considered adequate by the Employer shall be available for use of persons employed on the Site and maintained in a condition suitable for immediate use. The Contractor shall take adequate steps to ensure proper use of the equipment by those concerned, in the following manner:

(a) Those engaged in handling any material which is injurious to eye shall be provided with protective goggles.
(b) Those engaged in welding shall be provided with welder's protective eye-shields.
(c) Those involved in works in areas where there is a risk of drowning shall be provided with life jackets.
(d) Electrician, wiremen and helper shall be provided with shock-proof shoes.

7.7 Adequate provision shall be made for prompt first aid treatment of all injuries likely to be sustained during the course of the work. When work is done near any place where there is risk of drowning, all necessary equipment shall be provided and kept ready for use and all necessary steps taken for the prompt rescue of any person in danger. Only after arranging such equipment, tools/ tackles etc. at site work shall be started.

7.8 To ensure effective enforcement of the rules and regulations relating to safety precautions, arrangements made by the Contractor shall be open to inspection by the Employer or his Representative and the inspecting officers.

7.9 Notwithstanding the provisions made above the Contractor is not exempted from the operation of any Act or rule in force.

8.0 TOOLS AND TEST EQUIPMENT

8.1 A complete set of necessary tools and test equipment required for operation & maintenance of the plant shall be available with the Contractor. This shall enable erection, dismantling, repairing, replacing or testing to be carried out on any part of the Plant whether of an electrical, mechanical or other nature, during the contract period. All tools and test equipment shall be procured, kept at site in good condition and used properly by the Contractor at his expense. The contractor shall prepare and implement an effective plant maintenance program in consultation with the Employer. It is absolutely the contractor's responsibilities to look after all sorts of maintenance whether routine, preventive or break down or any other type of maintenance. The Contractor will be responsible to carryout day to day as well as periodic maintenance necessary to ensure smooth and efficient performance/ running of all equipment.

9.0 INSURANCE CERTIFICATES

9.1 Within 14 days of the acceptance of this tender the Contractor shall produce to the Employer a certificate or certificates signed by the Contractor's insurers or their duly authorised agents covering all the persons with accidental policy of sufficient amount as per their grade (30 times monthly salary) with disability benefit provision for them stating that insurance’s complying with the requirements of the contract have been effected. No such certificate shall relieve the Contractor of his obligations under the Conditions of Contract to produce to the Employer if required by him the insurance policies and the receipts for payment of premiums.

10.0 ASSISTANCE FOR THE EMPLOYER'S STAFF

10.1 The Contractor shall provide all necessary assistance to the Employer and his staff in carrying out their duties of checking setting out, inspecting and measuring the Works. The Contractor shall provide staff, office attendants, labourers and other help as may be needed from time to time by the Employer.

10.2 The Contractor shall provide for the Employer and his staff such protective clothing, safety helmets and rubber boots of suitable sizes, 440 volts series hand lamps and the like as may reasonably be required by them. These articles shall remain the property of the Contractor.

11.0 FIRST AID BOX

11.1 The Contractor shall at his own cost provide and maintain at the Site of Works standard first aid boxes at minimum six locations as directed and approved by the Employer for the use of his own as well as the Employer's staff on Site as stipulated by local regulations. Contractor shall arrange to train all their staff in first aid treatment within 3 months.

12.0 NOTICE BOARDS / DISPLAY BOARDS

12.1 The Contractor shall provide a Notice Boards/Display Boards at appropriate locations detailing precautions to be taken by operation and maintenance personnel in work in conformity with Industries and Labour Regulations and Department of Explosives.

13.0 APPLICATION

13.1 These general conditions of the contract shall apply to the extent that they are not superseded by provision in other parts of the contract.

14.0 GENERAL ROUTINE MAINTENANCE

To operate and maintain the Tertiary treatment plant and equipment in accordance with the aim and purpose of treatment. The plant and equipment covered under the above contract will be promptly attended by the contractor including any "Trouble shooting" to ensure smooth and trouble free operation. The contractor will be responsible for smooth and satisfactory operation and maintenance of the Tertiary Treatment Plant on the round the clock basis for 5 years period from the date of taking over the plant after 3 months trial run period is completed and on acceptance of plant.

A Technical expert of the contractor shall visit the plant on every fortnight and will suggest if required, to improve the efficiency and working of the plant. The visit must be recorded at Employer's document and out come of the visit/ minutes of meeting should be got signed by Employer's authorized representative without which the visit shall not be considered.

The employer shall check the operation of the plant or designate an organization of his choice to carryout inspections. The employer or the organization appointed by him shall check that the Contractor is performing the tasks for which he is responsible with due diligence.

14.1 Below routing maintenance shall be carried out as a minimum and as applicable for the type of plant / process:

(1) Regular cleaning of screens in all shifts depending upon load
(2) Cleaning of screens by high pressure water jet (preferably between 1100 hrs to 1200 hrs) on daily basis
(3) Cleaning of belt conveyor
(4) Checking Alignment, tightening of fasteners, and lubrication of gear and other moving parts of screens, conveyor belt, detritor, classifier units, PST/SST bridge & scrapper, scum removal system, rail alignment etc.
(5) Checking and inflating types of all trolleys
(6) Checking of all aerators for their submergence and making necessary adjustments if found necessary, based on the DO analysis and cleaning/maintenance of diffusers, as applicable.
(7) Checking of all pumps, motors, gears etc .for it’s proper operation.

(8) Checking of gas mixing system, gas holder unit for it's proper operation.
(9) Observing/monitoring sludge level in digester unit.
(10) Setting SV & Telescopic valve on sludge withdrawal line of PST/SST to suit with the sludge consistency by sample analysis.
(11) Checking all the pipelines for preventing choking, water tightness etc.
(12) Monitoring parameters in incoming and treated effluent/water.
(13) Checking development of foam in Aeration tank and diminish it by water spraying.
(14) Safe disposal of screening, grit and dry sludge cake generated on daily basis at a site indicated by employer within 10 km radius of the treatment plant (TSTP).
(15) Avoid strictly the accumulated sludge decomposing in the settling tanks and buoyed to the surface. Septic condition should not arise in the tanks.
(16) Watering of plants and trees

14.2 General routine maintenance schedule for various plant units shall be adopted from O&M Manual. However, the general routine maintenance to be carried out by the Contractor's personnel will include but not limited to the following:

a) If it is observed that power consumption per MLD of sewage treated or guaranteed power on daily basis exceeds the quoted or guaranteed value, the contractor has to trace out the fault and rectify the same to bring to the standard Value.
b) De-weeding and cleaning of the Transformer yard and other places.
c) Checking and refilling of silica-gel in the breather of the transformer and checking temperature gauge, vent pipe, voltage tap changing switch
d) Regular watering in the earth-pits.
e) Check for any oil leak in the transformer and intimating and repairing of the same.
f) Opening of end cover & cleaning of dust by Air blowing of induction motors, PMCC and other panel & PCC
g) Checking and replacement of bulbs, tubes, chokes, starters, switches, control etc. throughout the plant and including outdoor lights and high mast pole installation.
h) Replacement of LT panel fuse base, links, fuse, relay, contactor kit (main and auxiliary) and timer.
i) Replacement of HT panel C/T or PT whenever required.
j) Check for any loose connection in electrical equipment and rectification of the same.
k) Monitoring power factor, take corrective steps and ensure optimum power consumption.
l) Replacement of gland packing for the pump, sluice valves etc. whenever required.
m) Greasing of bearings and lubricating all moving parts as per the schedule
n) Tightening of all loose nut-bolts and other fasteners
o) Cleaning of sump tanks
p) Lubricating and test operation of the valves
q) General cleaning of all equipment and building
r) Replacement of pump rubber bush, gland packing, sleeve, bearing, oil seal, shaft, liquid ring and impeller.
s) Replacement of motor bearings and terminal plate and rewinding of motor when needed.
t) Replacement of non-return valve T bolt, hinge pin, flap/ gate.

15.0 PREVENTIVE MAINTENANCE CHECKS

15.1 The Contractor shall adopt a preventive maintenance check's schedule as agreed mutually between the Contractor and the Employer.

15.2 The following checks as a minimum to be performed daily by the Contractor's personnel

a) Whether there is a change in the sound of a running pump, abrupt changes in bearing temperature and seal leakage?
b) The pump capacity, pressure, power consumption and vibration level to check if outage is required to address deterioration of specified performance values.
c) Rise in temperature of bearings in motor, in moving parts and other units, etc.
d) Working of gauges, sensors and other flow measuring devices
e) Average power factor, kVARH, kWH consumed

15.3 The following checks as a minimum to be performed weekly by the Contractor's personnel

a) Pipeline and valve leakage
b) Functioning of non-return valve
c) Tightness of all electrical connections of PMCC, APFC, PLC panel etc.
d) Tightness all cable connections
e) Temperature rise due to loose connections
f) Operation of valves and sluice gates.
g) Current and voltages in all electrical equipment
h) Average power factor, kVARH, kWH consumed

15.4 The following checks as a minimum to be performed monthly by the Contractor's personnel

a) Battery voltage, battery charger, topping of distilled water, tightness of terminations etc.
b) Gland packing
c) Wear and tear of moving parts
d) Adoption of Electrical energy conservation methods and energy consumption
e) Electrical contacts
f) Motors
g) Meggering of electrical equipment
i) Watering of earthing pits

15.5 The following checks as a minimum to be performed quarterly by the Contractor's personnel

a) Relay testing and calibration if possible of meters, gauges, instruments
b) Speed of motors
c) Level gauges and flow meters signals
d) Cleaning, checking/tightening of L.T. Circuit/Panel

e) Tightening of PMCC components
f) Auxiliary DB, Capacitor bank
g) Battery and Battery charger

15.6 The following checks as a minimum to be performed bi-annually by the Contractor's personnel

a) Free movement of stuffing box glands, gland bolts to be cleaned & lubricated and packing to be inspected to determine whether it requires replacement.
b) Pump and motor alignment should be checked and corrected if necessary.
c) Grease lubricated bearings should be checked to see that they contain the correct amount of grease and that it is still of suitable consistency.

15.7 The following checks as a minimum to be performed annually by the Contractor's personnel

a) Vibration should be reviewed. If the pump is tending towards unacceptable vibration levels:
i. The bearing should be removed, cleaned and examined for flaws and wear.
ii. The bearing housing should be carefully cleaned.
iii. Rolling element bearings should be examined for scratches and wear.
iv. Immediately after cleaning, rolling element bearings that are considered acceptable for reinstallation should be coated with grease. If the bearings are damaged it shall be replaced with new bearing of the correct size and type as per O&M manual.
b) Shaft sleeve and shaft should be examined for wear.
c) When coupling halves are disconnected for an alignment check, the vertical shaft movement of a pump with sleeve (journal) bearing should be checked at both ends with packing or seals removed. Any movement exceeding the original design clearance should be investigated to determine the cause. Endplay allowed by bearings should also be checked. If it exceeds that recommended by the manufacturer, the cause should be determined and corrected.
d) Stuffing boxes should be repacked and the pump & motor should be realigned and reconnected
e) Overhauling requirement of all equipment
f) Improvement required if any in operation of plant
g) Testing and Calibration of all instruments
h) Transformer cleaning, checking silica gel, oil checking filtering/replacing

15.8 This work is also inclusive of painting of plants as per following schedule and paint shall be of the same specification as described in respective unit/ mechanism as per original specification of the executed work.

Sr. No.	Item	Duration
1.	Civil work	Once in two years i.e at the end of 2nd year of O&M
2.	Doors and windows	---do----
3.	Shutters, grills, collapsible gate etc	---do----
4.	All H.T./ L.T. panels	---do----
5.	All process equipment with its accessories and GI railings etc.	---do---
6.	Street / flood light pole	---do----
7.	Pump sets, valves, C.I. fittings, sluice gate, etc.	---do----

Note: However, if any unit mechanism will found to have some defect in paint work at any time, the Contractor has to repaint the same under the instruction of Employer.

16.0 MINOR REPAIR GENERALLY ENCOUNTERED IN THE PLANT

16.1 The minor repairs which have been most often encountered are as given below:

Electrical works

a) For H.T. Installations
   i) Replacement of jumpers
   ii) Replacement of insulator (Porcelain)
   iii) Replacement of Air-Break Switch

b) For Both H.T. & L.T. Installations
   i) Replacement of no-volt coil for VCB
   ii) Replacement of Cable lugs including terminations
   iii) Replacement of burnt out HRC fuses
   iv) Replacement of moving and fixed contacts or contractors
   v) Repairs to isolators and switch fuse units and replacement of it and fuse base units.

Pump sets

a) Replacement of coupling bolt and nuts including rubber bushes
b) Replacement of worn out impeller nut
c) Replacement of spindle nut in the sluice valve.
d) Replacement of terminal plate in the motor
e) Replacement of faulty/dead spares in the battery charger and battery control panel.
f) Replacement of gland packing, graphite packing from the pump sets.

17.0 ADDITIONAL SCOPE OF WORK

17.1 For other incidental additional work, if any, the Contractor on authorization in writing from the Employer shall execute which is not specifically mentioned in the scope at present.

18.0 ELECTRIC POWER AND WATER

18.1 CLIENT shall directly pay all the power bills but the Contractor will be required to furnish Electricity Consumption in the Schedules provided. If the average power factor in the electric supply company bill is less than 0.95, the penalty / charge for the same, if levied by power supply company, shall be recovered from contractor's O&M Bill / Security Deposit.

18.2 Contractor will have to make his own arrangements for supply of clear potable water in the plant. Contractor shall bear cost towards distribution of water within premises.

19.0 PLANT INSPECTION AND VISITS

19.1 The Employer shall check the operation of the plant or designate an organisation of his choice to carry out inspections. The Employer or the organisation appointed by him shall check that the Contractor is performing the tasks for which he is responsible with due diligence. The Contractor shall at his cost provide all the assistance required by the Employer to complete these inspections.

19.2 Before any inspection, the Employer shall give prior notice of three days to the Contractor, indicating the name(s) of the person(s) empowered to carry out such inspection in the name of the Employer. In case of surprise visit, vigilance or other checks, such notice shall not be given.

19.3 At the end of each quarter period, or at the initiative of the Employer, a JOINT VISIT shall be organised so that both parties can check the condition of the installation at the plant.

19.4 A report shall be drawn up to record the suggestions and opinions of both parties. The Employer reserves the right to call in equipment manufacturers or specialised technicians for these visits.

19.5 These visits shall provide an opportunity for examining maintenance programs and operating procedures and improvements requiring therein..

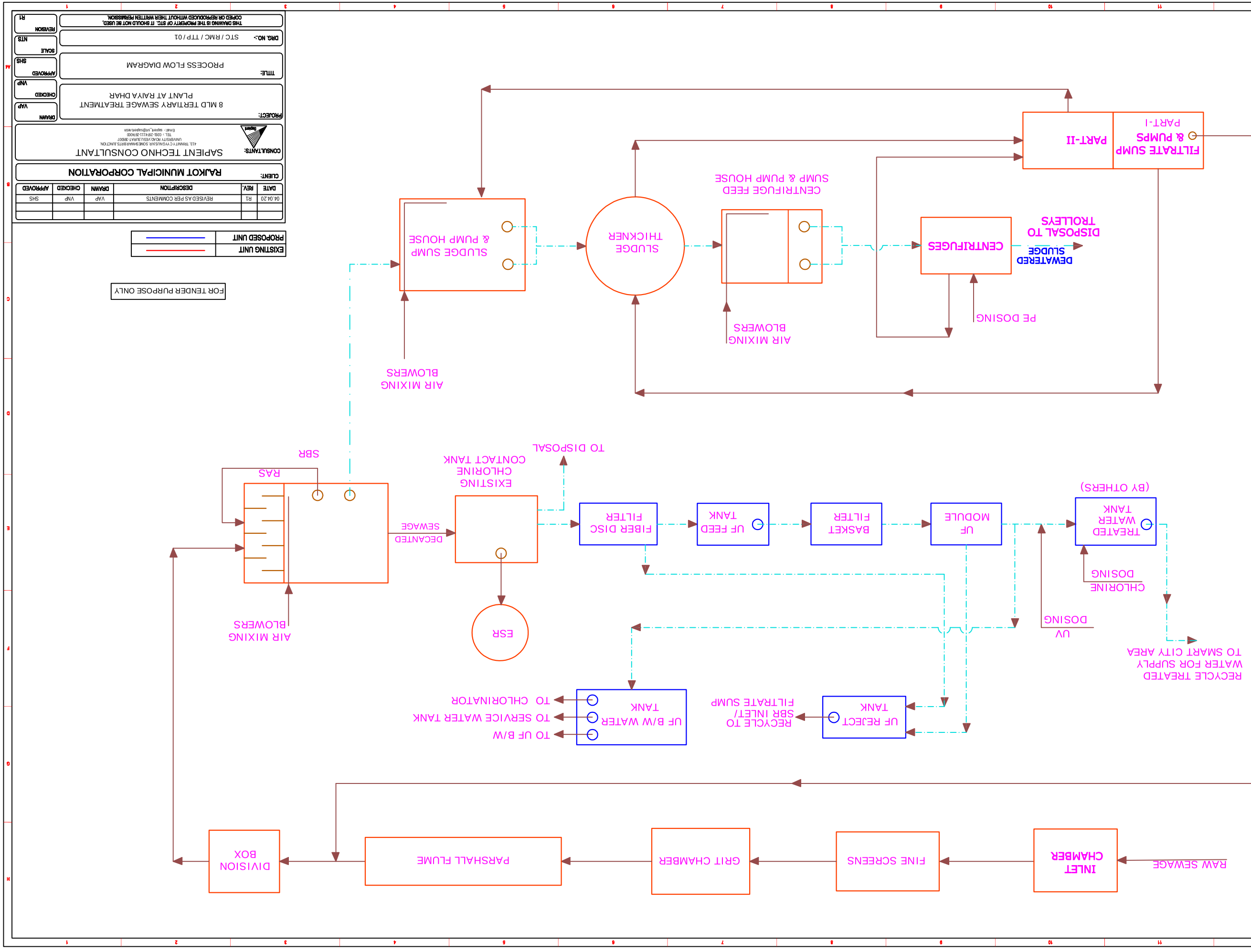
19.6 In addition to the above, the Employer reserves the right to arrange the visits of. VIP's dignitaries and other persons of Social or Political repute, as and when necessary, at the Treatment Plant. The Contractor shall offer full cooperation to the Employer on the occasions of such visits.

20.0 MEASUREMENT AND ANALYSIS

20.1 The Employer has the right to perform any analysis or inspection he deems necessary.

20.2 The Contractor shall be responsible for the security and protection of flowmeters at the designed point. If there is any malfunctioning of the meters, action will be initiated by the Contractor to rectify the same and it shall be reported to the Employer immediately.

Drawings



FOR TENDER PURPOSE ONLY

EXISTING UNIT	
PROPOSED UNIT	

DATE	REV.	DESCRIPTION	DRAWN	CHECKED	APPROVED
04.04.20	R1	REVISED AS PER COMMENTS	VAP	VNP	SHS

CLIENT:
RAJKOT MUNICIPAL CORPORATION

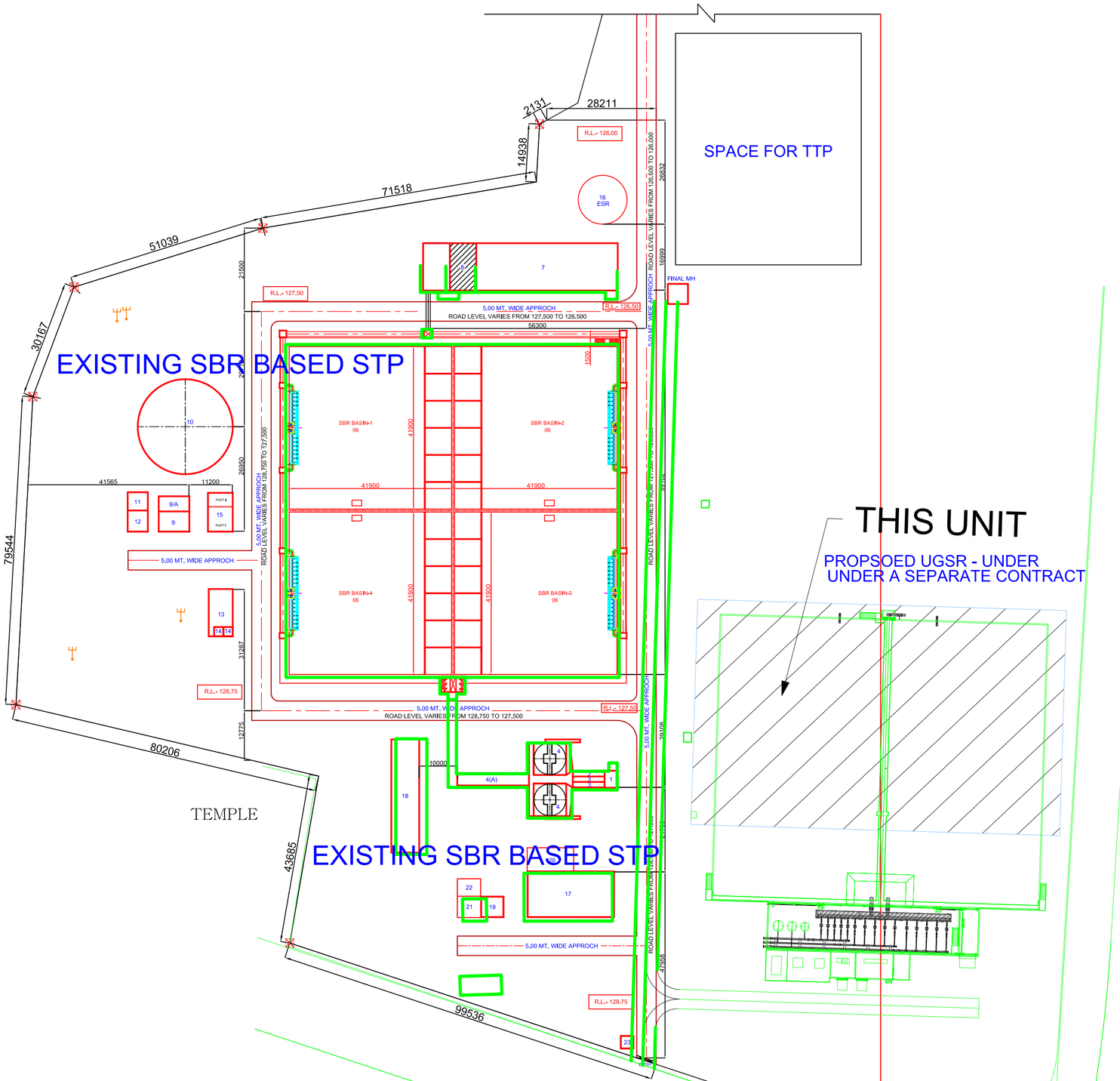
CONSULTANTS:
SAPIENT TECHNO CONSULTANT
412, TWENTY-C TYCOON,NR. SONESHWAR MAHETA JUNCTION
UNIVERSITY ROAD,VESU,SURAT-395007
TEL : 0261-2974112/2974100
Email:- sapient_tcl@yahoo.in.com

DRAWN	VAP
CHECKED	VNP
APPROVED	SHS
SCALE	NTS
REVISION	R1

PROJECT:
8 MLD TERTIARY SEWAGE TREATMENT PLANT AT RAIYA DHAR

TITLE:
PROCESS FLOW DIAGRAM

DRG. NO.:- STC / RMC / TTP / 01



TERTIARY TREATMENT UNITS

Sr. No.	DESCRIPTION	QNTY.	SIZE
A	FIBER DISC FILTER	01	10.00m X 12.00m
B	UF FEED TANK	01	15.00m X 25.00m X 3.00m LD
C	UF BUILDING INCLUDING MCC & CONTROL ROOM	01	40.00m X 15.00m
D	UF REJECT TANK	01	6.00m X 6.00m X 2.50m LD
E	UF BACKWASH SUMP	01	6.00m X 6.00m X 2.50m LD

EXISTING UNIT	
PROPOSED UNIT	

NOTE:-

- ALL DIMENSIONS ARE IN MM & ALL LEVELS ARE IN METER.

FOR TENDER PURPOSE ONLY

DATE	REV.	DESCRIPTION	DRAWN	CHECKED	APPROVED
04.04.20	R1	REVISED AS PER COMMENTS	VAP	VNP	SHS

CLIENT: RAJKOT MUNICIPAL CORPORATION

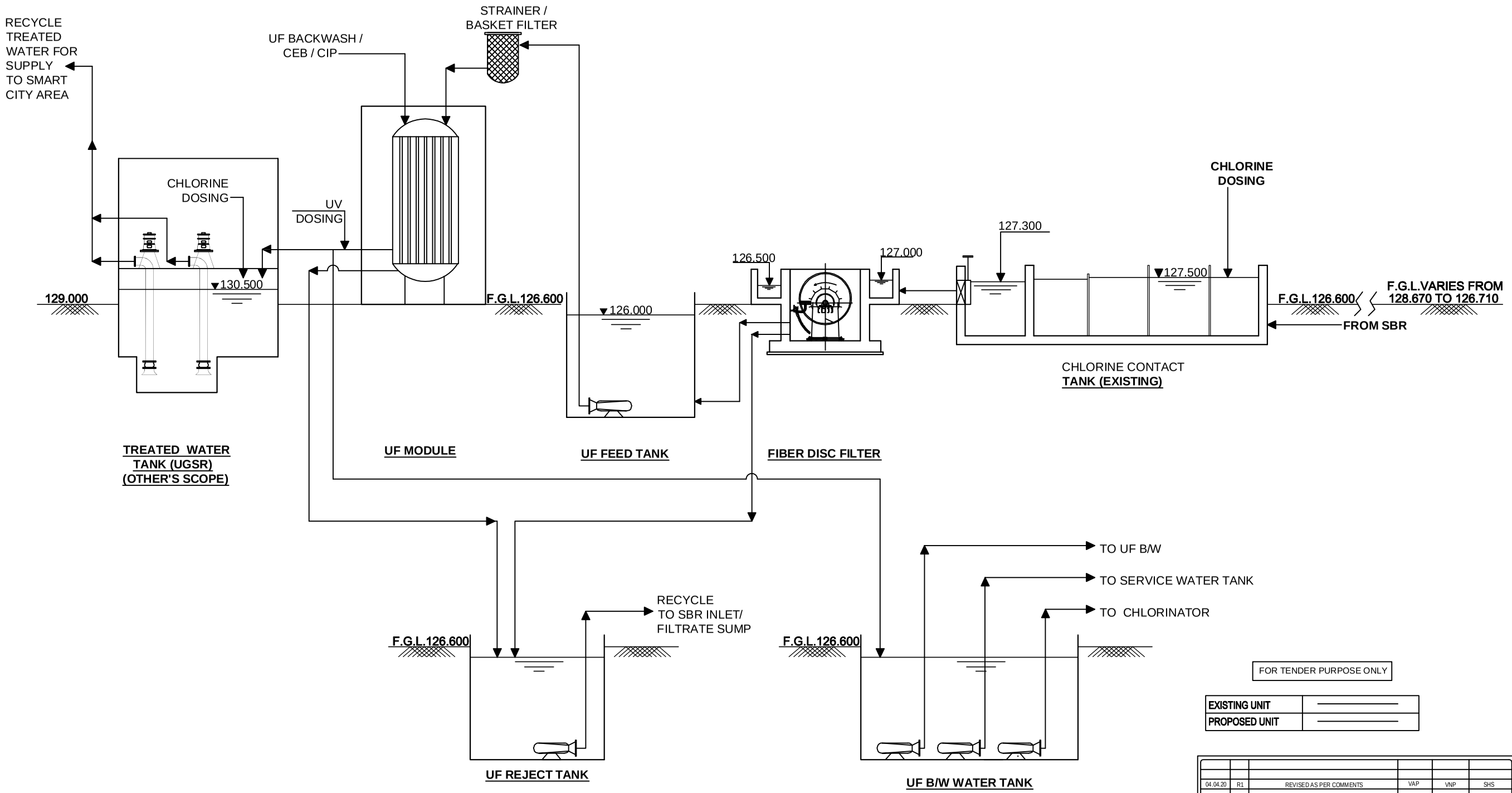
CONSULTANTS: SAPIENT TECHNO CONSULTANTS
413, TRINNITY CYYGNUS,NR, SOMESHWAR BRTS JUNCTION,
UNIVERSITY ROAD,VESU,SURAT-395007
TEL :- 0261-2974111-2974000
Email:- sapient_srt@sapient.net.in

PROJECT: 8 MLD TERTIARY SEWAGE TREATMENT PLANT AT RAIYA DHAR

TITLE: LAY OUT PLAN- (EXISTING + PROPSED)

DRG. NO.:- STC / RMC / TTP / 02

DRAWN: VAP
CHECKED: VNP
APPROVED: SHS
SCALE: NTS
REVISION: R1



FOR TENDER PURPOSE ONLY

EXISTING UNIT	———
PROPOSED UNIT	———

DATE	REV.	DESCRIPTION	DRAWN	CHECKED	APPROVED
04.04.20	R1	REVISED AS PER COMMENTS	VAP	VNP	SHS

CLIENT: RAJKOT MUNICIPAL CORPORATION

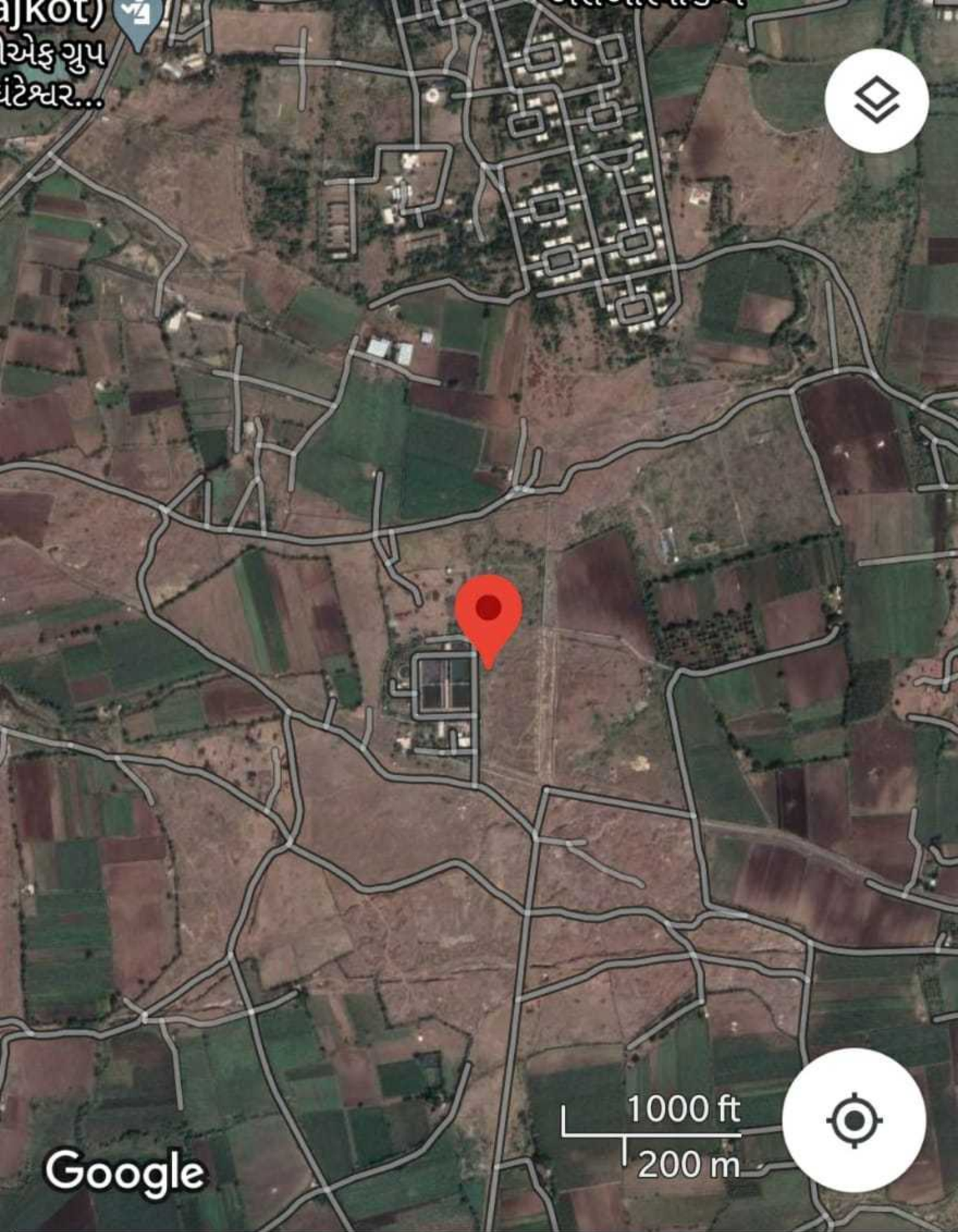
CONSULTANTS: SAPIENT TECHNO CONSULTANT
413, TRINNITY CYGNUS,NR. SOMESHWAR BRTS JUNCTION
UNIVERSITY ROAD,VESU,SURAT-395007
TEL :- 0261-297 4111-297 4000
Email:- sapient_srt@sapient.net.in

PROJECT: 8 MLD TERTIARY SEWAGE TREATMENT PLANT AT RAIYA DHAR

TITLE: HYDRAULIC FLOW DIAGRAM-PROPOSED

DRG. NO.:- STC / RMC / TTP / 04

DRAWN: VAP
CHECKED: VNP
APPROVED: SHS
SCALE: NTS
REVISION: R1



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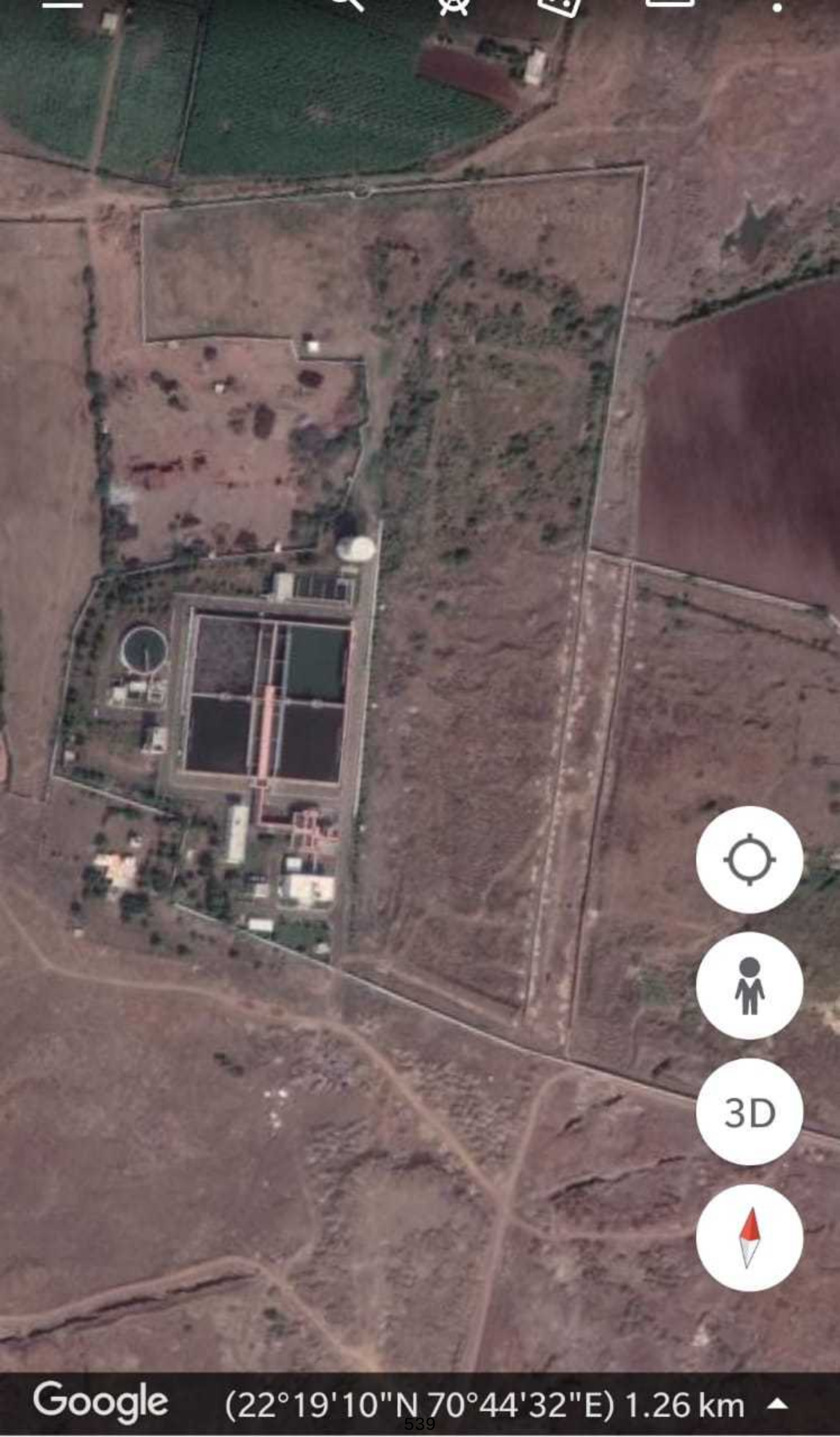
3D
Google
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