

**RAJKOT MUNICIPAL
CORPORATION**

e-TenderNo.:RMC/DRN PROJECT-01/2023-24

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Bid Documents For
**AUGMENTATION OF ELECTRO- MECHANICAL & INSTRUMENTATION
WORKS FOR EXISTING MAIN SEWAGE PUMPING STATION AT RAIYA OF
RMC**

SEPTEMBER-2023-24

Volume-II
Technical Specifications

Milestone dates for e-tendering are as under	
1. Downloading of e-Tender documents	Dt.13.09.2023 to Dt.03.10.2023 up to 17:00 Hrs.
2. Online submission of e –Tender	Dt.03.10.2023 up to 18:00 Hrs.
3 Pre Bid meeting	Dt.22.09.2023 at 11:00 hr At Central Zone, Room no-5 (If bidder have any query mail on hpparmar@rmc.gov.in before 21.09.2023 upto 11:00 Hrs.)
4. Physical submission of EMD, Tender fee and other documents by Speed post or RPAD Only	Dt.06.10.2023 up to 18:00 Hrs.
5. Opening of online tender tech bid	Dt.06.10.2023 at 18:00 Hrs. (If Possible)
6. Verification of submitted documents (EMD, e - Tender fee, etc.)	Dt.07.10.2023 to Dt.10.10.2023 up to 18:00 Hrs. (If Possible)
7. Opening of Price Bid (If possible)	Dt.11.10.2023 at 10:30 Hrs. onwards (If Possible)
8. Bid Validity	180 (One Hundred Eighty) Day's
For further particulars, visit us on " https://rmc.nprocure.com "	

**CITY ENGINEER DRAINAGE PROJECT
DEPARTMENT
RAJKOT MUNICIPAL CORPORATION
SHRI HARISINH JIGOHIL ZONAL OFFICE
WEST ZONE, ROOM NO.3 (G.F.),
150 FEET RING ROAD,
RAJKOT-360005**

SCOPEOFWORK

I. SCOPE OF WORK

The scope of Mechanical, Electrical & Instrumentation equipment works shall include but not be limited to the following for Upgradation of existing Sewage Pumping Station Main at **Raiya MPS** works including Dismantling Existing Electro-Mechanical equipments as per direction of Eng.-in-charge of RMC without interrupting sewage pumping and shifting at location as directed by Eng.-in-charge of RMC in **SPS** compound with Supply, Installation, Testing and Commissioning (SITC) of Pumping Machinery with allied Electro-Mechanical works with Operation & Comprehensive Maintenance, and Defect Liability Period for **2** Years for Sewage Pumping Station (MPS) Main at **Raiya** as mentioned in this tender:

A Mechanical Works:

A.1 Scope for SITC of Mechanical work shall include:

A.1.1 Horizontal Non Clog Centrifugal Pump-Motor Sets with all required accessories like Base plate, Flex. Spacer type coupling, coupling guard, foundation bolts & nuts, spares, etc. with all required accessories and hardware complete as per BOQ.

A.1.2 CIDF manually gear operated rising Spindle Sluice Valves on suction and delivery of each Horizontal non clog pump, delivery of dewatering pumps and on header for drain with all required accessories and hardware as per BOQ.

A.1.3 CIDF swing check type non return valves on delivery of each Horizontal non clog pump and each dewatering pump along with all required accessories and hardware as per BOQ.

A.1.4 CIDF manually gearbox operated double eccentric Horizontal shaft Butterfly valve on header line along with all required accessories and hardware as per BOQ.

A.1.5 Metallic Expansion Bellows on suction and delivery of each Submersible NC pump and on header line of sub. NC pumps with all required accessories and hardware as per BOQ

A.1.6 DI pipes and fittings on suction and delivery line of Horizontal Non Clog pumps as required to connect with the existing header, as required to connect the header to rising main pipe with all required accessories and hardware as per BOQ.

A.1.7 Non clog Self priming/submerged, dewatering pump motor set with all required accessories and hardware, cable with necessary safety features, switch/starter panel, suction strainer, auto stop facility, etc. along with required protections and controls, lifting chain, etc. complete as per BOQ.

A.1.8 Submersible Portable Non clog Dewatering Pump set with necessary accessories and hardware, etc., cable with necessary safety features, panel along with pump monitoring unit for auto stop facilities, cable termination / junction box, PVC flex. Pipe, lifting chain, pump stool, etc. and with all required accessories and hardware as per BOQ.

A.1.9 Bidder to bid considering ownership of bidder of scrap, salvage, old machinery replaced with new one as per tender under buyback condition of this contract and shall quote the prices accordingly. Dismantling of the existing old machinery/ mechanical equipments like Pumps, Motors, dewatering Pump sets, electrical cables, valves, expansion bellows/joints, pipes, fittings, etc. all applicable miscellaneous equipments as directed by Engg.- in-charge of RMC with loading, Unloading & shifting to suitable location as directed by Engg.-in-charge of RMC and transportation to carry the same by bidder outside of RMC premises to bidder's premises within one week from the date of instruction by RMC. However bidder shall retain old machinery with RMC till the commissioning of new SITC work under contract of this SPS as per BOQ is complete.

A.1.10 Dismantling/Removal of RCC/PCC Pipe supports & removal of all the debris, silt / sludge / garbage from sump (Wet Well) & pump house, pumping station compound etc. and cleaning of same as directed by Engg.-in-charge

A.1.11 Constructing / casting of New Pump Foundation works for proposed Pump-Motor Sets as per manufacturer's recommendation & RCC and/or PCC Structure support blocks for Valves, NRV, Pipes, fittings etc. work as required for carrying out casting of foundation including carting & lowering in pump house work, laying of flooring, if required etc. works as required with all required accessories and hardware and as per BOQ / Tender.

A.1.12 To arrange for bypass of raw sewage including dewatering or any suitable arrangement as required to prevent the raw sewage in working area and as required to carry out the installation of electromechanical equipment (screen, pumping machinery, etc. as per tender) within existing SPS or by way of modification / providing new unit for existing SPS or as applicable to complete the work in all respects as per scope of tender.

B Electrical Works:

The Scope for Electrical equipments work shall include dismantling existing Electrical equipments as per direction of Eng.-in-charge of RMC without interrupting sewage pumping and shifting at location as directed by Eng.-in-charge of RMC in SPS compound with Supply, Installation, Testing and Commissioning (SITC) of electrical equipments as per tender but not limited to the following:

- B.1.1 Incoming existing HT power from Power Supply Company Two Pole structure / Metering Panel is feeding to consumer two pole structure and scope of work include but not limited to the following as per BOQ/Tender.
- B.1.2 11kV Two Pole (DP) Structure along with complete all required accessories and hardware etc. as per SLD /BOQ/Tender.
- B.1.3 SITC of 11kV Three Breaker (1I/c&2O/g) HTVCB Panel at HT panel room with terminating of 11kV HT Cable without interrupting sewage pumping as per direction of Eng.-in-charge of client/RMC along with complete all required accessories and hardware etc. as per SLD/BOQ/tender.
- B.1.4 11/0.433kV, ONAN, Dyn-11 Transformers along with Off Circuit Tap Changer with necessary foundation work, transformer yard, fencing, gates etc. as per statutory requirements with statutory approval and with modification /civil rectification work required & with any unforeseen/emergency work required for installation of new transformers along with complete all required accessories and hardware etc. as per BOQ/Tender.
- B.1.5 11kV HT Cables along with required termination kits and cable trench along with complete all required accessories and hardware etc. as per BOQ/ Tender.
- B.1.6 SITC of LT Panels, PMCC, MCC etc. Panels including Star-delta/Soft Starters for sewage pumps as applicable, dewatering pump starters, transformer no load losses fixed capacitors for Power factor correction along with complete all required accessories and hardware etc. as per SLD/BOQ/tender.6

- B.1.7 APFC Panels for power factor correction along with complete all required accessories and hardware etc. as per SLD/BOQ/tender.
- B.1.8 Local Push Button Stations (LCS), Junction Box etc. along with complete all required accessories and hardware etc. as per BOQ/tender.
- B.1.9 LDB, PDB for indoor and outdoor requirements, Power Sockets, Welding Receptacles, etc. as required along with complete all required accessories and hardware etc. as per BOQ/tender.
- B.1.10 LT Power and Control Cables along with required termination works complete with all required accessories and hardware etc. as per SLD/BOQ/ tender.
- B.1.11 Cable Tray, DWCPipes for HT< cables, Cable trench works & Cabling System along with complete all required accessories and hardware etc. as per BOQ/tender.
- B.1.12 Earthing system including Chemical earthing along with complete all required accessories and hardware etc. as per BOQ/tender.
- B.1.13 Internal and External area lighting system with wiring for pump house & compound area along with complete all required accessories and hardware etc. as per BOQ/tender.
- B.1.14 deleted
- B.1.15 deleted
- B.1.16 Safety Equipments/Accessories as per statutory norms/requirements along with complete all required accessories and hardware etc. as per BOQ/ tender.
- B.1.17 Liaisoning works for obtaining N.O. C from Electrical Inspector/Statutory authority for Power obtaining & for all Electrical equipments installation. Liaisoning work shall also include preparing required attested documents & drawing for obtaining NOC on behalf of client.
- B.1.18 All miscellaneous work for installation of electrical equipments with making cut out in panel room/pump house wall/slab for erecting of cables entering/outgoing from room etc. with mini. 100/150mm (as required) GI pipes with fixing, grouting, sealing etc. work and un-forecast /emergency work during dismantling of existing equipments & during installation etc. to complete the work in all respect for all electrical equipments along with complete all required accessories and hardware etc. as per BOQ/ten⁷ de

C Instrumentation&AutomationWorks:

The scope of Instrumentation work may include but not limited to the following:

- C.1.1 Diaphragm type pressure gauge on delivery side along with required accessories, hardware, etc. for each pump and as per BOQ.
- C.1.2 Ultrasonic Level Transmitter at Both Compartment of wet well for local and Remote display at HMI for auto operation of pump as per BOQ.
- C.1.3 Electromagnetic Flowmeter at Pump discharge header as per BOQ and scope of also include on no. existing flowmeter hookup with Proposed PLC/Panel.

Signature of Contractor

CITY ENGINEER
Rajkot Municipal Corporation

SECTION-C1
TECHNICALSPECIFICATIONSFOR
MECHANICALWORK

SECTION:C1
DOCUMENT :
INDEX TECHNICAL SPECIFICATION: MECHANICAL

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A	TECHNICAL SPECIFICATIONS FOR MECHANICAL WORKS
1.0	GENERAL REQUIREMENT
B	DETAILED MECHANICAL SPECIFICATIONS
1.0	HORIZONTAL NON CLOG CENTRIFUGAL PUMP
2.0	VALVES
2.1	SLUICE VALVE
2.2	NON RETURN VALVE
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2.4	ELECTRIC ACTUATOR
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-	OTHER GENERAL REQUIREMENT FOR EQUIPMENT
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-	LIST OF APPROVED VENDORS

SECTION:C1

A. SPECIFICATIONSFORMECHANICALWORKS(GENERAL)

Applicability

The following clauses specify general mechanical requirements and standards of workmanship for equipment and installation and must be read in conjunction with the particular requirements for Contract. These general specification clauses shall apply where appropriate except where redefined in the particular required section of the specification which shall be applicable.

List of Standards

Title of various standards referred to in the specifications is indicated below. This list does not necessarily cover all the standards referred to:

BS5135	Specification for arc welding of carbon manganese steels
BS5316 Part-2	Specification for acceptance test for centrifugal, mixed flow and axial pumps – Test for performance and efficiency
BS6072	Method for magnetic particle flow detection
BS6405	Specification for non-calibrated short link steel chain (Grade 30) for general engineering purposes: Class 1 & 2
BS6443	Method for penetrant flow detection
ASTM A-36	Specification for Structural Steel
ASTM A-216	Specification for Steel Castings, Carbon suitable for fusion welding for high temperature service
ASTM A-276	Specification for stainless steel and heat resisting steel bars and shapes
ASTM A-351	Specification for castings, Austenitic – Ferritic (Duplex), for Pressure containing parts
ASTM A-743	Specification for castings, Iron–Chromium, Iron–Chromium–Nickel and Nickel Base Corrosion Resistant for general Application
ASTM A-744	Specification for castings, Iron–Chromium–Nickel, Corrosion–Resistant
IEC-189 Part 1 & 2	Low frequency cables and wires with PVC insulation and PVC Sheath
AWWA C501	Cast Iron Sluice Gates

IS5	Coloursforreadymixedpaintsandenamels
IS210	GreyIronCastings
IS318	LeadedTinBronzeIngotsand Castings
IS325	ThreePhaseInductionMotors
IS807	CodeofPracticeforDesign,manufacture,erectionandtesting (StructuralPortion)ofcranesandhoists
IS1239	MildSteeltubes,tubularandotherwroughtsteelfittings
IS1536	CentrifugallyCast(Spun)ironpressurepipeforwatergasand sewage
IS1537	Verticallycastironpressurepipesforwater,gasandsewage
IS1538	Specificationforcastironfittingsforpressurepipesforwater, gasandsewage
IS1554	PVC insulated(Heavyduty)electriccables
IS2062	Steelforgeneralstructuralpurposes
IS2147	Degreesofprotectionprovidedbyenclosuresforlowvoltage switchgearandcontrolgear
IS3177	Code of practice of electric overhead traveling cranes and gantrycranesotherthansteelworkcranes
IS3624	VacuumandPressuregauges
IS3815	Pointhookswithshankforgeneralengineeringpurposes
BS2910	Methods for radiographic examination of fusion welded circumferentialbuttjointsinsteelpipes
BS3017	Specificationformildsteelforgedramshornhooks
BS3100	Specificationforsteelcastingsforgeneralengineeringpurposes
BS3923	Methodsforultrasonicexaminationofwelds
BS4360	Specificationforweldablestructuralsteels
BS4772	Specificationforductileironpipesandfittings
BS4870	Specificationforapprovaltestingofweldingprocedures
BS4871	Specification for approval the sting of welders working to approvedweldingprocedures
BS4942	Shortchainlinkforliftingpurposes
IS5120	Technicalrequirements of rotodynamicspecialpurposepumps
IS5600	Horizontal/verticalnonclogtypecentrifugalpumpforsludge handling
IS7090	Guidelinesforrapidmixingdevices
IS7208	Guidelinesforflocculatordevices

IS10261	Requirementsforclarifierequipmentforwastewatertreatment
IS8413	Requirementsforbiologicaltreatmentandequipment
Part-II	Activatedsludgeprocessand itsmodifications
IS10037	Requirementsforsludgedewateringequipment,sludge
Part-I	Dryingbeds,sand,gravelandunderdrains
IS6280	Specificationfor SewageScreens
IS3938	ElectricWireropehoists

Further, following codes and standards unless specified herein shall be referred to for pipelines, pipework & fittings:

IS:210	Specification for grey iron casting
IS:290	Specification for coal tar black paint
IS:456	Code of practice for plain and reinforced concrete
IS:458	Specification for precast concrete pipes (with and without reinforcement)
IS:516	Method of test for strength of concrete
IS:638	Specification for sheet rubber jointing and rubber insertion jointing
IS:783	Code of practice for laying of concrete pipes
IS:816	Code of practice for use of metal arc welding for general construction in mild steel
IS:1367	Technical supply conditions for threaded steel fasteners
IS:1387	General requirements for the supply of metallurgical materials
IS:1500	Method for Brinnell hardness test for metallic materials
IS:1536	Specification for centrifugally cast (spun) iron pressure pipes for water, gas and sewage
IS:1537	Specification for vertically cast iron pressure pipes for water, gas and sewage
IS:1538	Specification for cast iron fittings for pressure pipes for water, gas and sewage
IS:1916	Specification for steel cylinder pipes with concrete lining and coating
IS:2078	Method for tensile testing of grey cast iron
IS:3589	Specification for MSS spirally welded pipes
IS:3597	Method of tests for concrete pipes
IS:3658	Code of practice for liquid penetrant flow detection
IS:5382	Specification for rubber sealing rings for gas mains, 14 water

	mainsandsewers
IS:5504	Specificationforspiralweldedpipes
IS:6587	Specificationforspunhemp yarn
IS:7322	Specificationforspecialsforsteelcylinderreinforcedconcrete pipes
IS:8329	SpecificationforDI pipes
IS:9523	SpecificationsforDI fittings
IS:4984	SpecificationsforHDPEpipeline
IS:14846	Specificationsforvalves
IS:783	Codeofpracticeforlayingofconcretepipes
IS:3114	Codeofpracticeforlayingofcast ironpipes
IS:3764	Excavationwork-Codeof Safety
IS:4127	Codeofpracticeforlayingofglazedstonewarepipes
IS:5822	Codeofpractice forlayingofelectricallyweldedsteelpipesfor watersupply.
IS:6530	Codeofpracticeforlayingofasbestoscementpressurepipes.

Materials

Allmaterialsincorporated intheworksshallbethem**mostsuitablefortheduty concernedandshallbenewandoffirstclasscommercial quality,freefrom imperfectionand selectedforlonglifeandminimummaintenance.**

DesignandConstruction

- a. Theplantdesign,workmanship andgeneralfinishshallbeofsoundqualityin accordance withgoodengineering practice.Designshallberobustandratedfor continuousservice,atthespecifiedduties,undertheprevailingoperational site conditions.
- b. Thegeneraldesignofmechanicalandelectricalplant,particularlythatofwearing parts,shallbegoverned bytheneedforlongperiodsofservice without frequent attentionbutshallaffordreadyaccessforanynecessarymaintenance.
- c. SimilarlyitemsofPlantandtheircomponent partsshallbecompletely interchangeable.Spare parts shallbe manufacturedfrom the samematerial specificationastheoriginals.
- d. Nowelding,fillingorpluggingofdefectiveworkwillbepermittedwithoutthe writtenpermissionoftheEngineer.Allweldingspattershallberemoved.
- e. Itshallbetheresponsibility ofthecontractortoensurethatalltheequipment selectedisfullycompatible,mechanically, electricallyandalsowithrespectto instrumentation,controlandautomation.
- f. Itshallbetheresponsibility ofthecontractortoensurehisequipmentinterfaces withany existingequipmentcorrectly.Anyinterfacesmustnotaffectthe integrity oftheequipment,orinvalidateanywarrantiesorguarantees.
- g. Eachcomponentorassemblyshallhavebeenproveninserviceinasimilar applicationandunderconditionsnolessthanthosespecifiedtherein.

- h. The equipment shall be compatible with the civil structure, when installed, with sufficient space for operator access and maintenance procedures.
- i. All materials shall be of the best commercial quality and free from any flaws, defects or imperfections.
- j. Materials shall be selected to eradicate or reduce corrosion to a minimum.

Tropicalization:

Equipment is to be designed for tropical climates suitable for Indian conditions and the city/location where it is to be installed and the following shall apply:

- i. Tropical grade materials should be used wherever possible. Some relaxation of these provisions may be permitted where equipment is hermetically sealed.
- ii. Iron and steel and in general to be painted or galvanized as appropriate in accordance with the specification. Small iron and steel parts (other than stainless steel) of all instruments and electrical equipment, the cores of electro-magnets and the metal parts of relays and mechanisms are to be treated in an approved manner to prevent rusting. Cores etc. which are built up of lamination or cannot for any other reasons be anti rust treated, are to have all exposed parts thoroughly cleaned and heavily enameled, lacquered or compounded.
- iii. The use of iron and steel is to be avoided in instruments and electrical relays whenever possible. Steel screws, when used, are to be zinc, cadmium or chromium plated or, when plating is not possible owing to tolerance limitations, shall be corrosion resisting steel. Instrument screws (except those forming part of a magnetic circuit) are to be of brass or bronze. Springs are to be of brass, bronze or other non-rusting material. Pivots and other parts for which non-ferrous material is unsuitable are to be of an approved stainless steel.
- iv. Fabrics, cork, paper and similar materials, which are not subsequently to be treated by impregnation, are to be adequately treated with an approved fungicide. Sleaving and fabric treated with linseed oil or linseed oil varnishes are not to be used.

Climate

- i. All parts and materials used shall in all respects be suitable for the climatic conditions of the city/location where it is to be installed. The following maximum conditions shall be used for all design.

Maximum Ambient Temperature	:	47°C
Minimum Ambient Temperature	:	5° C
Yearly Average Ambient Temperature (Max./Min.)	:	43° C/15°C
Maximum Ambient Temperature for Design Purpose	:	50°C
Maximum Relative humidity	:	95%

In damp situations and wherever exposed to the weather, precautions shall be taken against corrosion of metal work, cable armour conduit and the like.

De-rating due to the climatic conditions

- i. All electrical equipment including cables shall be de-rated for continuous operation in an ambient temperature of 50 deg C in accordance with the appropriate regulations unless otherwise specified.
- ii. All materials and equipment which are subject to certification by testing authorities etc., shall be certified as being tested at 50 deg C ambient unless other high temperature specified elsewhere for specific equipment/product.

Packing and Delivery

- a. All parts and equipment as necessary shall be packed in first quality containers or packing; no second hand timber shall be used. All packing must be suitable for several stages of handling via sea or air freight, inland transport and movement on site.
- b. Flanged pipes are to have their open ends protected by adhesive tape or jointing and are then to be covered with a wooden blank flange secured by service bolts.
- c. The sleeves and flanges of flexible couplings shall be bundled by wire ties. Cases containing grub screws, bolts and other small items shall not normally weigh more than 500 Kg gross.
- d. Precaution is to be taken to protect shafts and journals where they rest on wooden or other supports likely to contain moisture. At such points wrappings impregnated with anti-rust composition or vapour phase inhibitors are to be used of sufficient strength to resist chipping and indentation due to movement which is likely to occur in transit. The form of the protective wrappings and impregnation are to be suitable for a minimum period of twelve months.
- e. Lids and internal cross battens of all packing cases are to be fixed by screws and not nails.

Hoop metal bindings of cases are to be sealed where ends meet and if not of rust less material are to be painted. Contents of cases are to be bolted securely or fastened in position with struts or cross battens and not with wood chocks, unless they are fastened firmly in place. All struts or cross battens are preferably to be supported by cleats fixed to the case above and below to form ledges of which the batten may rest. Cases are to be up-ended after packing to prove that there is no movement of contents.

Where parts are required to be bolted to the sides of the case, large washers are to be used to distribute the pressure and the timber is to be strengthened by means of a pad.

Contents of cases are to be bolted securely or fastened in position with struts or cross battens and not with wood chocks, unless they are fastened firmly in place. All struts or cross battens are preferably to be supported by cleats fixed to the case above and below to form ledges on which the batten may rest. Cases are to be up-ended after packing to prove that there is no movement of contents.

Where parts are required to be bolted to the sides of the case, large washers are to be used to distribute the pressure and the timber is to be strengthened by means of a pad.

All stencil marks on the outside of the casings are to be either of a waterproof material or protected by Shellac or varnish to prevent obliteration in transit.

- f. Wood wool is to be avoided as far as possible. Waterproof paper and felt linings are to overlap at seams at least 12mm and these seams secured together in an approved manner, but the enclosure is to be provided with screened openings to obtain ventilation.
- g. Where applicable, indoor items such as electric motors, winch and control gear, instruments and panels, machine components, etc. are to be 'cocooned' or covered in polythene sheeting, selected at the joints and the enclosures provided internally with an approved desiccator.
- h. Bright metal parts are to be covered before shipment with an approved protective compound or coating and protected adequately during transport to site. After erection these parts are to be cleaned by the Contractor.
- i. Each crate or package is to contain a packing list in a waterproof envelope and copies in duplicate are to be forwarded to the Engineer; prior to dispatch. All items of material are to be clearly marked for ready identification against the packing list.

All cases, packages, etc. are to be clearly marked on the outside to indicate the total weight, to show where the weight is bearing and to indicate the correct positions for slings and are to bear an indelible identification mark relating them to the appropriate shipping documents.
- j. Structural steelwork, pipes, valves, encased fittings and metal work shall be similarly marked. In addition, one in every ten repeated articles shall bear the dispatch marks in suitable paint or other approved medium. When in the opinion of the Engineer, the dispatch marks cannot be applied satisfactorily to any item, they shall be stamped on a petal label attached to the item; they shall be stamped on a metal label attached to the item or part by means of a piece of wire passing through holes at either end of the label and secured so that it lies flat with the item.
- k. The Engineer may require to inspect and approve the packing before the items are dispatched but the contractor is to be entirely responsible for ensuring that the packing is suitable for transit and such inspection will not relieve the Contractor for any loss or damage due to faulty packing.

Finish

Workmanship and general finish shall be of first class commercial quality and in accordance with best practice.

All covers, flanges and joints shall be properly faced, bored, fitted, fixed, hollowed, mounted or chamfered as the case may be, according to the best approved practice and all working parts of the plant and other apparatus, shall similarly be well and accurately fitted, finished, fixed and adjusted.

Wrought Steels

When not otherwise specified, wrought steel shall be selected from the appropriate grade of IS: 1570 and be free from blemishes, short or hammer marks. The Contractor shall submit for the approval of the Engineer-in-charge, the grade number selected for each component.

Castings

All castings shall have an homogeneous structure and be free from blow holes, flaws and cracks. Any casting having a thickness in parts in excess of 3 mm to that which it is purported to be shall be rejected. No repairs or patchwork to castings shall be allowed other than that approved by the Engineer-in-charge.

Castings subject to hydraulic pressure shall be tested to 1.5 times the maximum working pressure. Certified copies of Test Reports shall be forwarded to the Engineer as soon as the test is completed.

Steel Castings

When not otherwise specified, steel castings shall be selected from the appropriate grade of BS. 3100.

Grey Iron Castings

All grey iron castings supplied shall be to the appropriate grade of IS: 210. The Contractor shall replace any casting which the Engineer considers is not of first class appearance or is not in any way the best which can be produced, although such a casting may have passed the necessary hydraulic or other tests. No plugging, filling, welding or "burning on" will be acceptable.

Spheroidal Graphite Iron Castings

All spheroidal graphite or modular graphite iron shall be to the appropriate grade of BS- 2789.

Bronze

When not otherwise specified, the bronze used shall be made of a strong and durable zinc free mixture to IS: 318.

Aluminum and Aluminum Alloys

Bars and extruded sections shall be to designation EN 8 or BS. 1474. Aluminum and aluminum alloy shall not be utilized unless alternative materials are considered unacceptable. The use of aluminum requires the approval of the Engineer in all cases.

Aluminum and Aluminum Alloy Castings

Castings shall be manufactured from LM 5 to BS 1490 and subjected to a chill cast to increase tensile strength. Aluminum and aluminum alloy shall not be utilized unless

no other materials is considered suitable. Immersed structures or structures that are periodically immersed shall not be constructed from aluminum or aluminum alloys.

Painting and Metal Protection

All bright metal parts shall be covered before shipment with an approved protective compound and adequately protected during shipment to site. After erection these parts are to be cleaned.

All exposed metal parts of the equipment including piping, structures, etc. wherever applicable, after installation unless otherwise surface protected shall be first painted with at least one coat of suitable Zinc rich epoxy primer which matches the shop primer paint used, after thoroughly cleaning all such parts of all dirt, rust, scales, greases, oils and other foreign materials by wire brushing, scraping or sand blasting and the same being inspected and approved by the Engineer for painting. Afterwards, the above parts shall be finished with two coats of epoxy/coal tar epoxy coating/paint. The quality of the finish paint shall be as per the standards of ISI or equivalent and to be of the colour as approved by the Engineer. The paint shall be suitable for use in industrial corrosive work atmosphere.

All bright metal parts shall be covered before shipment and transportation with approved protective compound and protected adequately during shipment and transportation to the site. After erection, these parts are to be cleaned.

All pipe services wherever applicable are to be painted in accordance with the Owner's standard colour code scheme, by the Contractor.

MS/GI Hand Rail shall be painted with synthetic enamel paint of shade approved by engineer-in-charge.

Chromium Plating

All chromium plating shall comply with IS: 1986.

Galvanizing

Where steel or wrought iron is to be galvanized, it shall be carried out by the hot-dip process and shall conform in all respects with IS: 2629.

Attention shall be paid to the details of members in accordance with BS: 4479. Adequate provision for filling, venting and draining shall be made for assemblies fabricated from hollow section. Vent holes shall be suitably plugged after galvanizing.

All surface defects in the steel including cracks, surface lamination, laps and folds shall be removed in accordance with IS: 6159. All drilling, cutting, welding, forming and final fabrication of unit members and assemblies shall be complete before the structures are galvanized. The surface of the steel work to be galvanized shall be free from welding slag, paint, oil, grease, and similar contaminants. The article shall be pickled in dilute sulfuric or hydrochloric acid, followed by rinsing in water and picking in

phosphoric acid. They shall be thoroughly washed, stoved and dipped in molten zinc and brushed, so that the whole of the metal shall be less than 610 grams per square meter of surface galvanized, except in the case of tube to BS:1387 when it shall be 460 grams per square meter.

On removal from the galvanizing bath the resultant coatings shall be continuous, adherent, as smooth and evenly distributed as possible, and free from gross imperfections such as bare spots, lumps, blisters and inclusions of flux ash or dross, etc. and free from any defect that is detrimental to the stated end use of the coated article. Edges shall be clean and surfaces bright.

Bolts, nuts and washers shall be hot dip galvanized and subsequently centrifuged in accordance with IS:2669. Nuts shall be tapped up to 0.4 mm over size before galvanizing and the threads soiled to permit the nut to be finger turned on the bolt for the full depth of nuts.

During off-loading and erection, the use of nylon slings shall be used. In order to avoid wet storage staining on galvanized work, which is to be stored in works or at site, shall be stacked so as to provide adequate ventilation to all surfaces.

Small areas of the galvanized coat damaged in any way shall be restored by :-

- i. Cleaning the area of any weld slag and thoroughly wire brushing to give a clean surface.
- ii. The application of two coats of zinc-rich paint (not less than 90% zinc, dry film), or the application of a low melting point zinc alloy repair rod or powder to the damaged area, which is heated at 300 deg C.

Where surfaces of galvanized steelwork are to be in contact with aggressive solutions and/or atmosphere the galvanizing shall receive further protection by painting.

Fasteners

Bolts, nuts and studs and fasteners with nominal diameters up to and including 39 mm required to be made in carbon steel shall conform to BS6104 and threaded in accordance with IS:1363+1367. Bright steel washers 3.0 mm in thickness shall conform to BS4320 and shall be provided beneath bolt head and nut.

The above items required to be supplied in stainless steel shall conform to IS:1570. These items together with holding-down bolts and anchor plates required to be supplied in high tensile steel shall conform to BS-970 Ref. Symbol T.

Drilled anchor fixing fasteners for use on concrete structures shall be of an approved type by the Engineer's Representative. The position of all drilled anchors shall be approved by the Engineer's Representative and a Contractor proposing to use such fixings shall be deemed to have undertaken to supply, mark off, drill and fit. All exposed bolt heads and nuts shall be hexagonal and the length of all bolts shall be such, that when fitted and tightened down with a nut and washer, the threaded portion shall fill the nut and not protrude from the face thereof by more than a half diameter of the bolt. Rivets shall conform to BS:641 and tested in accordance with BS:1109.

Forgings

Carbon steel forgings shall be manufactured heat treated forgings and tested in accordance with BS:29.

Foundation and Settings of Machinery

The Contractor shall arrange for the provision of all foundation and plinths required for the plant and shall be responsible and setting for ensuring that all foundations and plinths are constructed and boxed out for Machinery holding down bolts in accordance with the approved drawings.

The Contractor shall provide all necessary templates for suspension of the holding-down bolts during grouting of same.

The Contractor shall visit the site during the course of construction and check the Civil Works to ensure that the foundation and/or plinths are at correct required location and height, for the acceptance of the machinery. When the foundations and/or plinths have been complete and are in a satisfactory condition, the machinery shall be installed as directed by the Engineer's Representative.

The machinery shall be mounted on flat steel packing of a thickness selected to take up variations in the level of the correct foundations. The packing shall be bedded by chipping or grinding of the concrete surface.

Only one packing of selected thickness shall be used at each location, which shall be adjacent to each holding down bolt. The number of shims shall not exceed two at each location and the thickness of each shim shall not exceed 3mm.

The machinery shall be aligned, leveled and pulled down by the nut of the holding down bolts with a spanner of normal length, and no grout shall be applied until the machinery has been run and approved by the Engineer for stability and vibration. The Civil Contractor shall then carry out the grouting and building in of the machinery. However, the Contractor shall take responsibility for the satisfactory nature of this work, and shall have a representative present.

Built In Items

The Contractor shall include in the relevant Schedule of the Specification, details of all the items of equipment to be "Built in" by the Civil Contractor, together with details of the period in which these items could be delivered to site.

The Contractor shall provide to the Civil Contractor full details of the box outs and plant fixing and foundation requirements for incorporating in the Civil Work. The Contractor shall liaise closely with the Civil Work and shall obtain from him a program of the Civil works, clearly showing the dates when box-out and plant foundation details will be required. The Contractor will be responsible for co-ordinating and program his work schedule with the Civil Works so as to ensure an optimum arrangement with the minimum of disturbance to the progress of the Works as a whole. The Contractor

shall deliver all items of equipment that are required to be built in the civil works, as required by the construction program and shall arrange for a representative from the equipment supplier to be in attendance during the progress of such works. The Civil Contractor shall grout up and make good when instructed by the Engineer's Representative.

Location and Alignment

Where individual items of equipment are mechanically located and coupled, such as alignment motors, gearboxes and similar items dependent upon correct alignment for satisfactory operation, each shall be mounted on a common bed plate and when aligned shall be located by means of dowel pins to ensure that correct re-alignment can be easily achieved when re-assembling the items after removal for overhauls.

Coupling

Flexible couplings shall be couplings rated at not less than the stalling torque load of the motor. Couplings liable to impregnation by oil shall be of the all metal flexible type. General service couplings shall be of the flexible multi-pin and resilient bush type, having not less than six bushes and each bush shall have an inner sleeve to allow rotation on the pin (bushes shall not be in direct contact with the pin). All pins shall have shoulders to allow positive location and securing to the half coupling face.

Flexible couplings shall be supplied in matching balanced sets machined, balanced and marked before leaving manufacturer's works. The couplings shall be a tight fit on the shafts and secured with hand fitted keys and fully checked for alignment. All necessary equipment for checking alignments shall be supplied by the Contractor.

Where flexible couplings are used, the Contractor shall fully describe the arrangements proposed for ensuring that the desired freedom of relative movement between the shafts is obtained when transmitting torques corresponding to the continuous maximum rating of the motor.

Solidly bolted couplings shall be subject to accurate alignment and the Contractor's proposed alignment procedure shall be subject to the approval of the Engineer. In particular, the alignment procedures which involve rotating one half coupling only will not be accepted.

Overload release couplings shall not rely on shear pins. Release torque shall be adjustable over a wide range and preferably without the need to change components. The couplings shall be capable of angular alignment of 1 deg. Maximum and 1 mm displacement of shafts.

Hydraulic couplings shall be oil filled with thermal overload protection device. The coupling shall be fully rated to transmit the motor full load power without exceeding normal working temperature and due regard shall be taken to ambient temperatures. An enclosure around the couplings shall be provided to prevent oil spray in the event of operation of the thermal overload device.

Final alignment of all types of couplings shall be checked by the Contractor in the presence of the Engineer's Representative.

Bearings and Lubricators

The size of bearing shall be not less than that calculated for bearings and a minimum L10 basic rating life in accordance with BS:5512 Lubricators Part 1, taking into account all considerations of reliability, material of manufacture and operating conditions. All bearings shall be rated and sized to ensure satisfactory running without vibration under all conditions of operation for a minimum life of 50,000 hours running.

They shall be efficiently lubricated and adequately protected from ingress of moisture, dust and sand and the particular climatic condition prevalent at the site. All bearings shall be to ISO standard SI unit dimensions where practicable.

All ball or roller bearings, except those supplied and "sealed for life" shall be arranged for grease gun lubrication and a suitable high pressure grease gun shall be supplied.

Adequate "Stauffer" screw top pressure grease lubricator with 'tell tale' stems or 'Tat' grease nipples shall be provided for all moving parts. The position of all greasing and oiling points shall be arranged so as to be readily accessible for routine servicing. Wherever necessary, suitable access platforms shall be provided.

The type of lubricant and interval of lubrication, which shall be kept to a minimum (not less than nine days), for each individual item of plant shall be entered on a working schedule, which shall form part of the Operation and Maintenance instructions.

A list of recommended Lubricants and their equivalents Bearings shall be entered in the Operation and Maintenance instructions.

Gearboxes

The Gearboxes shall be totally enclosed dust, water and hose proof. Suitable lifting lugs shall be provided. They shall be robustly constructed and of arduous duty.

The gear cases shall be manufactured from grey cast iron to IS:210 and of a grade to ensure high strength and wear resistance. Inspection covers shall be provided together with protected oil level indication, breather, with oil mist prevented, and drain plugs.

The gearboxes shall be designed for operation at the ambient temperatures specified without the assistance of a cooling fan.

The mechanical service factor shall be not less than 1.5 when applied to the rated motor power or higher as recommended by equipment manufacturer.

The gears shall be manufactured from steel to BS:970 of grade selected by the Contractor and entered in the Schedule of Particulars. The teeth shall be profile ground and lapped to a high standard of accuracy and finish.

Rolling bearings shall be adequately rated to ensure a running life of not less than 50,000 hrs. L10 life.

The input and output shafts shall have oil seals fitted to prevent the ingress of lubricant when the gearbox is mounted in the required orientation. For example, inclined when applied to screw pump installations.

These seals shall also prevent the ingress of dust, sand and moisture.

Lubrication of the gears shall be by splash or forced system.

An anti-run back device shall be supplied and fitted to all gearboxes involved in screw pump installation.

Each gear unit shall be subjected to a full load test at the inclinations specified for a duration of 3.00 hrs during which time temperature, vibration and noise levels together with oil tightness shall be recorded in the presence of the Engineer's Representative.

After satisfactory completion of the tests, each unit shall be drained of lubricant. All internal surfaces shall then be coated with suitable preservative.

A metal label shall be securely wired to the gear case to clearly state that the gear case requires to be coated with suitable preservative.

The gearbox shall be securely wired to the gear case to clearly state that the gear case requires to be filled with lubricant, the type and grade of which shall be clearly identifiable.

A metal label shall be securely wired to the gear case to clearly state that the gear case requires to be filled with lubricant, the type and grade of which shall be clearly identifiable.

Steelwork General

The Contractor shall provide and fix all the steelwork, including stairways, ladders, hand railing, chequered plate and open mesh flooring frames and curbing as detailed in the specification and/or as shown on the contract drawings or as directed by engineer.

All steelwork shall be constructed in mild steel and shall be galvanized after manufacture or shall be provided with finish as specified in the specification of specific equipment/work.

For all pre-fabricated metalwork, including multiple duct covers, external ladders, open mesh flooring, chequered plating, hand railing, staircase, structural steelwork and the like, the Contractor shall submit fabrication drawings for the approval of the Engineer prior to the manufacture of any of these items.

Handrailing and Safety Chains

Handrailing

Handrailings shall be of M.S. ERW Medium Class mild steel of circular hollow section and shall comply with the relevant requirements of BS:1387 BS:6323 Part I or BS:

4360. Mild Steel toe board shall be provided, 100mm high by 3mm thick positioned above the platform level and fixed securely to the standards. All items shall be painted with the epoxy paint & epoxy primer.

Standards shall not be less than 38mm external diameter and rail shall not be less than 32mm external diameter.

Horizontal handrail shall be 1000mm high with an intermediate rail at mid height.

Handrail height shall be measured vertically from finished floor level to the handrail centerline.

Handling and fixings shall be designed to withstand a horizontal force of 740N/m run without permanent distortion or failure of components. When a horizontal force of 360 N/m is applied at handrail level the deflection at any point on the handrail shall not exceed 1/125 of the distance between the center lines of adjacent standards or 10mm, whichever is the least.

All mounting flanges shall be of substantial construction, with horizontal flanges drilled for not less than three bolts with two bolts on a line parallel to and on the walkway side of the line of the handrailing and vertical flanges drilled for less than two bolts and line through the bolts being vertical. Fittings shall be screwed or secured with grub screws. The standards shall be set at not more than 1.5m centers. When provided in sections, handrailings shall be joined together with purpose made fittings secured by screws or grub screws.

All ladder, stairway or other openings shall be guarded on three sides by handrailing conforming to the requirements stated above.

The Contractor shall ensure that unless specified hereinafter to the contrary, all hand railings shall be of uniform appearance and manufacture.

Safety Chain

Mild Steel Safety Chain shall be 8mm nominal size grade (M4) non calibrated Chain Type 1, complying with BS:4942, Part 2. After manufacture, mild steel safety chains shall be hot dipped galvanized in accordance with BS:729.

Stainless Steel safety chains shall be manufactured from grade 316S31 steel complying with ISO:570 Part 1. Chain link shall be welded and have an internal length not exceeding 45mm and an internal width of between 12mm and 18mm. The fins caused by weldings shall be removed and the weld shall be smoothly finished all round. When tested in accordance with Clause 7.3 of BS:4972 Part 2, each chain shall withstand a breaking force of 30kN and a proof force of 15kN.

Open Mesh and Chequer Plate Flooring

Open mesh flooring and gratings shall generally comply with BS:4592 except where otherwise specified hereinafter. Such flooring and gratings shall be of rectangular mesh and non-slip and shall be mild steel galvanized.

Floorings shall be provided to span between the supporting members as shown on the Contract Drawings.

Where necessary intermediate support members shall be provided and fixed.

Mild Steel toe plates 100mm high and not less than 3mm thick shall be provided and fixed at all cut-outs except where otherwise shown on the approved drawings.

Both the load bearing and transverse bars in rectangular flooring panels shall be obtained systemically around the centre lines of the panels in both directions, so that when the panels are fixed in extensive areas or in long runs, the bars of all panels are inline.

Chequer plate floorings shall be MS and of the non-slip type, not less than 6mm thick measured excluding the raised pattern. The flooring shall be secured to its frame by stainless steel countersunk set screws.

All floorings shall be designed to carry a loading of 750 Kg. per Sq. meter and the deflections shall not exceed 1/200 of the span or 10mm whichever is the least.

All floorings shall be removable and set flush in mild steel MS frames. All frames shall be provided with lugs for building in.

Flooring shall be provided in size suitable for lifting and removal by one man and with the appropriate cutouts to permit its removal without disturbing or dismantling spindles, supporting brackets, cables or pipework. Flooring spanning wide openings shall be supported on removable bearers and fixing stops to provide the required rigidity and these shall be supplied and fitted by the Contractor. These members shall be removable to afford clear access to the openings which includes ducts.

Lifting keys shall be supplied for each location and the type of key shall be such that inadvertent release is avoided.

Stairways

Stairways shall be detailed, fabricated and erected to the dimensions shown on the drawings and in accordance with BS:449 Part 2 to carry a load of 750 Kg. Per sq. meter. Treads shall be rectangular open mesh fixed to the stringers, not directly to concrete. Sloping handrailings shall be as specified for horizontal handrailing but with the top rail 850 mm vertically above the line of pitch and standards vertical and spaced at not more than 1500 mm., measured parallel to the line of pitch.

Staircases shall be constructed to the size and position shown on the drawings or as instructed by the Engineer. They shall be steel galvanized at works after manufacture and shall comprise stringers supporting the open mesh stair treads and shall be supplied complete with handrails and stanchions conforming to the above except the height which shall be 900mm above the pitch line.

Ladders

Ladders shall conform to BS: 4211 except where the specified hereafter. They shall be in mild steel as specified in. The stringers shall be flat section not less than 65mm x 10mm spaced 380 mm apart and shall be flanged and drilled for wall fixing at both ends. The stringers shall be radiused over the top where they shall be not less than 600mm apart. Ladders over 3.0m long shall have additional intermediate stays at not more than 2.5m centers.

Rungs shall be 20mm diameter round bar at 250mm c-c distances shouldered at each end and securely riveted into countersunk holes. Rungs shall be not less than 225mm from the wall.

All ladders shall have safety cages which shall be constructed of three flat vertical strips supported by flat hoops, with a diameter of 750mm. The hoops shall be at approximately 70mm centers and the first hoop shall be 2400mm above ground or lower platform level.

Where the rise exceeds 6000mm, an intermediate landing shall be provided.

Multiple Duct Covers and Frames

Multiple Duct Covers and Frames shall be of cast iron, waterproof, non-rocking and recessed for filling with concrete or similar material.

A heavy grease seal is to be formed between the cover and frame to prevent ingress of grit.

General Requirements for Pipework

The Contractor shall supply, deliver and erect all pipework and fittings within the They shall be of the type incorporating integral, removable, intermediate beam stops given there required clear pit opening as shown on the approved drawings.

structures and externally to the limits indicated on the approved drawings and in accordance with each section of specification.

Pipework and fittings shall be suitable for a safe working pressure equivalent to the maximum working pressure of the system. The safe working pressure of the pumping main shall be the closed valve head of the pump plus the maximum suction static head. The maximum surge pressure shall be limited to 125% of the maximum working pressure. All pipework and fittings shall be of adequate strength to accommodate the maximum surge pressure of the system.

The minimum pressure rating of pipe work and fittings shall be 10 Bar, the exception being ductile iron pipework and fitting which shall have a minimum pressure rating of 16 Bar.

There shall be a sufficient number of mechanical joints to enable mechanical plant and valves to be disconnected from built-in pipework. Such joints shall be tied and shall not be allowed to sustain the weight of any pipework.

All pipework and fittings shall be sized for the required capacity at a velocity limits depending on the nature of the fluid or substance to be conveyed.

All pipework shall be adequately supported by purpose made fixings. Support shall not be provided by plant or equipment.

The position of any thrust blocks required shall be indicated on the Contractor's details drawing together with the position of any sleeping required through partition walls in buildings. Puddle flanges shall be provided for building at locations in which pipes 80mm diameter and above pass through structural concrete below ground level.

Where pipework is connected to plant and equipment readily demountable fittings in the form of unions or flanged adapters shall be provided. The flanged adapter on the delivery pipe of pumps shall be located upstream of the reflux valve where appropriate.

Flexible joints shall be provided in all pipework subjected to linear constraint.

All jointing work including the provision of suitable full face gasket not be less than 5mm thick for gravity flow and shall be minimum 3mm thick for pressurised line and galvanized fastenings or fastening gass specified shall be included.

Pump suction bellmouths shall be standard castings in either cast iron or ductile iron.

Unless otherwise specified, the piece shall have a radial branch to enable a more streamlined flow from branch to body. Due allowance shall be made for reinforcement in the vicinity of the branch.

Prior to dispatch, each item of pipework or associated fittings shall be clearly identified in paint with the Plant/Pumping station item number indicated on the Contractor's arrangement drawing.

Puddle flanges shall be provided on all pipes where they pass through pumping station walls. Each puddle flange shall be continuously welded to the pipe on both sides of the flange.

Pipe jointing surfaces and components shall be kept clean and free from extraneous matter until the joints have been made or assembled. Care shall be taken to ensure that there is no ingress of grout or other extraneous material into the joint annulus after the joint has been made.

The dimension of gasket shall comply with BS: 4865 Part I. Gasket shall be manufactured from material complying with BS: 2494 for Type 1 rings.

Pump suction and delivery manifolds shall be provided with a drain valve where a natural drain does not occur.

Hydraulic testing shall not be carried out until all fabrication has been completed when the pressure applied and sustained without further pumping shall be twice the working pressure.

The Contractor shall be responsible for cleaning the internal surface of all pipes prior to erection particularly the removal of weld deposits. Initial capping of the ends for protection during transport and storage shall not be removed until erection takes place.

Grey Iron Pipework and Fittings

Grey Iron flanged pipework shall conform to BS:4622 – not less than Class 3 with flanges to BS:4504 Part 1 – table 16.

Spheroidal Graphite Cast Iron Pipework and Fittings

All spheroidal graphite or modular graphite cast iron pipework and fittings shall be to the appropriate grade of BS:4772.

Carbon Steel Pipework

Carbon Steel Pipework for pressure purposes shall be to BS:3601 and assemblies shall be manufactured from pipe to this specification. The type of pipe shall be hot finished seamless steel. The wall thickness shall be not less than that required in BS:534 – Table – 1.

ABS Pipework

ABS Pipework shall be provided and installed for special purposes where hereinafter specified. The pipework shall conform to BS: 5391 and the fittings to BS:5392.

Fabrication of Carbon Steel Pipework and Fittings

The Contractor shall fabricate the pipeline by butt-welding without utilizing a backing ring in accordance with BS:2971 – Class I metal arc welding of carbon steel pipe work. Branches shall be formed in accordance with BS.2971 (Class I or Class II, depending on operating conditions) and shall be welded before so that at any point along the bend, ovality will not reduce the bore by more than 21%. Radii of hot bends for all pipes shall not be less than five times the outside diameter. Gusseted “Cut and Shut” and wrinkle. All pipe flanges shall be of the wrought steel slip on type conforming to BS4504 PN16, welded on in accordance with BS:2971 (Class I or Class II, depending on operating conditions). No flanged joints shall be located within a backfilled trench. Flexible joints shall be bolted gland or Victaulic coupling as necessary.

Welder Qualification

Before welding work commences on pipework, the Contractor shall satisfy the Engineer's Representative that the welders have previously carried out similar welding work within recent months. When instructed by the Engineer's Representative, the Contractor shall arrange for the welder to produce test welds in accordance with the provisions of BS2971.

Pipework Installation

All pipework, pipe fittings, jointing materials etc., shall be of the best quality free from defects and obtained from a supplier approved by the Engineer. The installation of the pipework shall be carried out using skilled personnel and pipework shall be installed according to the drawing approved by the Engineer. Where valves are incorporated in pipework, the valves shall be provided with their own supports, such that no excess loading is exerted on pipework. All pipework materials shall have no excess

exerted on pipework. All pipework materials shall be off-loaded, stored on site and handled thereafter in such a manner that they are adequately protected from damage or deterioration.

Underground Pipes

Unless otherwise stated, all underground pipes shall be buried in trenches which have been excavated in accordance with the relevant section of the specification.

Examining Pipes

Before being used, each pipe casting or fitting shall be properly examined and should appear defective in any way, it shall be set apart and not used until it has been examined and passed by the Engineer. All metal pipes which shall be buried in the ground shall, prior to their installation, be hung and sounded in an approved manner. Any pipe found to be faulty by this method, shall be set aside for examination by the Engineer.

Cutting Pipework

All pipework shall be cut with proper pipe cutting tools. The use of hammer and chisel for this purpose shall not be permitted. Great care shall be exercised when cutting concrete/bitumen lined spun iron and ductile iron pipes, to ensure that there is no damage to the lining. Should any damage to the lining take place which is to an extent which the Engineer deems to be undesirable, then the pipes shall be rejected. The Contractor shall then prepare another pipe for incorporation into the works. All pipes which have been cut shall have the edges dressed and deburred.

Labels

The Contractor shall arrange for the supply and fitting of engraved identification labels to all valves and items/equipment of plant. The reference numbers of all valves shall be as indicated on the schematic diagram to be supplied under the Contract.

All warning labels shall comply with BS:5378 parts 1, 2 and 3 and screw fixed rigid construction.

Designation labels shall be of 5mm traffic foil with black lettering on white background. Embossed materials and technique shall not be accepted.

The Contractor shall provide 2 nos. enameled iron plates worked "Men Working of Plant". The plates shall be 200mm x 75mm with red lettering on a white background. N.B.: All

identification and warning labels shall be in ("Hindi Language") and English. **Guards**

Adequate guards shall be supplied and installed throughout the installation to cover drive mechanisms. All rotating and reciprocating parts, drive belts, etc. shall be securely shrouded to the satisfaction of the Engineer to ensure the complete safety for both maintenance and operating personnel. However, whilst all such guards shall be of adequate and substantial construction, they shall also be readily removable for gaining access to the plant, without the need for first removing or displacing any major item of

plant. The guard shall be of the open mesh type except where retention of fluid spray is required.

Suppression of Noise

All plant equipment so offered shall be quiet in operation. The noise level within the building shall not be more than 85 dB (+5 percent on this over the audible frequency spectrum measured at mid-band), "A" scale when measured along a contour 3 meters from any single item of plant during starting, running and stopping. The noise level outside the building shall not be more than 60 dB (+5% on this over the audible frequency spectrum measured at mid-band), "A" scales when measured along a contour 3 meters from the external wall. Noise test measurement shall be made on completion of the installation of the plant at site to verify that it complies with this Clause. Plant which fails to comply with the noise level limits when tested which render it liable for rejection unless it is satisfactorily modified at the Contractor's expense by the programmed commissioning date.

Trolley and Chain Pulley Block

The chain pulley block shall be operated on the lower flange of the bridge girder.

The load chain shall be made of alloy steel as per IS:3109. It shall be heat treated to give ductility and toughness so that it will stretch before breaking. It shall be of welded construction with a factor of safety not less than 5.

The hand chains for the hoisting and traverse mechanism shall hang well clear of the hook and both the chains shall be on the same side. The hand chain wheel shall be made from pressed sheet and shall be provided with roller type guarding to prevent snagging and fouling of the chain.

All the gears shall be totally encased. Proper lubricating arrangements shall be provided for bearings and pinions. Gears shall be cut from forged steel blanks. Pinions shall be of heat treated alloy steel. Gears shall be as per BS:436/IS:4460.

- e. The trolley track wheel shall be rim toughened, heat treated carbon steel or low alloy steel or CI and shall be single flanged and shall have anti-friction ball bearings. The wheel shall be machined on their tread to match the flanges of the track joints.
- f. The traveling trolley frame shall be made of rolled steel conforming to IS:2062. The side plate of trolley frame shall extend beyond wheel flanges, thus providing bumper protection for the wheels. The two side plates shall be connected by means of an equalizing pin.
- g. Axles and shafts shall be made of carbon steel and shall be accurately machined and properly supported.
- h. The lifting hook shall be forged, heat treated alloy or carbon steel of rugged construction. They shall be of single hook type provided with a standard depressed type safety latch. They shall swivel and operate on anti-friction bearings with hardened races. Lock stop to prevent hooks from swiveling shall be provided. Hook shall be as per BS:2903 /IS:3815.

- i. The brake for the lifting gear shall be automatic and always in action. It shall be of screw and friction disc type self-actuating load pressure brake. Brakes shall offer no resistance during hoisting.
- j. If the weight of offered pump set/equipment is more than the crane capacity specified, the contractor shall offer the crane capacity 1.5 times higher than the weight of the pump set/equipment.

Pipe and fittings

- a. The cast iron pipe shall generally conform to class BIS:1537/IS1536/IS7181 and pipe fittings shall conform to IS:1538. Ductile Iron pipe shall conform to IS8329/BS:4772.
- b. The material for cast iron pipes and fittings shall be of grey cast iron conforming to IS:210, Gr.FG200.
- c. The pipe shall be of uniform bore and straight in axis. Length of the straight double flanged pipe shall be within a tolerance as specified in IS standard.
- d. The flanges of the straight pipe shall be square to the axis of the pipe. The faces of the flanges shall be parallel. The bolt holes in one flange shall be located in line with those in order.

The faces of the flanges of the fittings shall be square to the directional axes. The holes shall be located symmetrically off the centre line. The intersecting axes of the tees shall be perpendicular to each other.

The bolt holes on flanged pipes and fittings shall be drilled with the help of drilling jig. The blank flanges are to be machined and drilled.

The dismantling joint shall be of cast iron with EPDM sealing.

Ventilation Systems

These specifications are common to all dry well/wet well effluent, sewage and water pumping stations. The scope of ventilation system includes

Supply Air Fans

Exhaust Fans

Associated ducting

Wherever the drawings provided for ventilation system, indicate proposed ventilation fans and the routing of ducting. It is the responsibility of the contractor to study and analyse the adequacy of the system and suggest any improvement at the same time taking into consideration all the requirements of the public authorities including safety orders and Fire Protection Rules & Regulations and IS Code. The necessary permits shall be obtained by the contractor and all payments towards license inspections, etc. paid before starting the work.

Supply Air Fans

Air fans shall be of centrifugal type and fan housings shall be hot-rolled steel of thickness 3/8". End flanged shall be fixed to the casing by continuously welding over the entire circumference. The flanges shall have bolt holes for bolting to inlet bell, companion flanges or ducts as the case may be. Housings shall be continuously welded and shall be expanded by suitable mechanical means to insure concentricity. Motor support shall not be less than 3/9" thick steel plate. Supporting shall be continuously welded to the support plate.

Fan rotor and blades shall be made from cast aluminum with suitable corrosion resistant coating. Belt-driven fans shall have multi V belt on pulleys with suitable guards. V belt shall be 150% of rated HP duty.

The fan rotor shall be whirl-tested to 125% of operating speed and shall be statically and dynamically balanced on fan motor shaft to maximum tolerance in one (1) mil double amplitude at design operating speed.

The fans shall have inlet screen at inlet bell cone and carbon steel bolts for existing discharge cones with flanges on both ends at attachment to fan and to discharge ducting.

Fan motor support shall be of adequate strength, constructed from 1/4" carbon steel angles. All the external fasteners shall be stainless steel.

Motors

Motors selected for the fans shall be of adequate rating with a safety factor of 1.5 or greater. If the fans are belt-driven the motor shall be mounted on slider rails for belt tension and adjustment. The complete assembly shall be mounted on Neoprene Vibration Isolators. The motor shall conform to the relevant latest Indian Standards of British Standards. It shall have permanently lubricated ball bearings. The motor shall be suitable for 415 B, 3 Phase, 50 Hz supply.

The bearing life shall not be less than 20,000 hours at design conditions and motor shall be of class 'F' insulation to allow for operation up to 95° rise over the ambient temperature of 45°C. External copper grease leads for lubrication of motor bearings shall be provided by the manufacturer.

Fan motor shall be standard totally enclosed fan cooled (TEFC) foot mounted squirrel cage induction motor with single speed, single winding, continuous duty variable torque's.

A conduit box shall be mounted on the exterior of fan casing and lead wires from the motor conduit box shall be protected from the airstream by being encased in a tight metal conduit pipe.

The belt drive shall have stainless steel wire cage guards.

Supply air fans in dry well shall have air flow switches and pressure switches fitted in the ducting. The selection of these switches is left to the contractor to suit the fan units being supplied.

ExhaustFans

Exhaustfansshallbeofdirectdrive,impellerpropellertype,havingmax.speedof 1000rpm.

Alltheexposedpartsshallbeofaluminum,withtransparent anodic,anti-saltspray coating,Allexternalfastenersshallbeofstainlesssteel. Hoodshallbehingedfor accessibility andservicing. Fansshallbecompletewithaluminumbirdscreens,Plastic or light weight aluminum back draft compels and electrical disconnectingmeans beneaththehoodandprotectivegridguardbelowfanmotor.

MotorsshallbeofrelevantIndianStandards orBritishstandards andshallhave permanentlylubricatedballbearings. Theratingshallbeadequatewithservicefactor of1.50basedonratedhorsepower. AllmotorshallbeTEFCanbesuitablefor continuousoperationwithoutexceedingatemperatureriseof50° Coverambient.

Themotorshallbeofconstant speedandsquirrel cagetype,operatingon415V,3 phase,50 HzSupply.Roofmountedmotorsshallhaveelectricaldisconnects.

Contractorshallsubmitallcataloguesshowingthesizingandratingoffanswiththe sizeof openingstobeprovidedforapprovalbeforeproceedingwiththework.

Dampers

Alldampersshallbeoflouvertype,robustconstruction, andtightlyfittedsuitablefor thelocationandservice required.

Dampersshallhave suitablelinks,leversandquadrants asrequiredfortheproper operations, controlorsettinginanydesiredposition. Dampersandtheseoperating devicesshallbemaderobust,easilyoperableandaccessiblethroughaccessdoorsin theducts. Everydamper shallhaveanindicatingdeviceclearly showing thedamper positionatall items.

Dampersshallbeplacedinductsandeverybranchsupplyor returnair ductconnection whetherornotindicated onthedrawingsforthepropervolumecontrol andbalancing thesystem.

Grillesand Diffusers

Allgrillesshallhaveverticalandhorizontaladjustablebarsandcontrolledfromthe frontofthegrill.

Installation

The ductfabrication andinstallation shallgenerallyconformtoIS655latest. Itisthe responsibility oftheContractortoprovideandneatlyerectallthesheetmetalworkas shownonthedrawingsorasrequiredatsitetothesatisfactionoftheEngineer.

Allnecessary allowancesandprovisions shallbemadebythecontractor forbeams, pipesorotherobstructionsinthebuilding,whetherornotthesameareshownonthe

drawings. All necessary modifications as required shall be carried out by the Contractor, however maintaining the same area.

All co-ordination with other agencies/contractor works simultaneously at the site to avoid repetition of work shall be the responsibility of the Contractor.

The ducting shall never be hung from the ceiling and only support of beams and columns shall be taken. The ducts shall be rigid and adequately supported and braced with beams or columns. All joints shall be made tight and all interior surfaces smooth. Bends shall be made with radius not less than one-half the width of the duct. All the sheet metal connections, partitions and required to confine the flow of air and through the filters and fans shall be constructed from No. 18 galvanized iron thoroughly stiffened with 25mm x 25mm angle iron braces and fitted with all necessary doors, to give access to all parts of the equipment. Doors shall be set conveniently where required. At the connection of ducting and inlet/outlet of fans, a double-fiber glass reinforced canvas sleeve shall be used.

All fans shall be protected and painted to avoid corrosion.

Lubrication

All blower bearings shall be provided with adequate facilities for lubrication. Exhaust fan unit bearings shall be sealed lubricated type. All oiling devices, grease fittings shall be readily accessible. All bearings shall be lubricated upon completion of the work using lubricants specified by the manufacturer.

Testing

The Contractor shall adjust, test and air balance the ventilating and exhaust systems and shall submit a report after final adjustments to 5% of designed air quantities.

Operating Instruction

Three (3) copies of an Instruction book giving complete service data on all equipment and systems shall be furnished.

B. SPECIFICATIONS FOR MECHANICAL ITEMS (SPECIAL)

1.0 HORIZONTAL NON CLOG CENTRIFUGAL PUMP A.

GENERAL

The Pump shall be Centrifugal, Horizontal shaft, Non Clog, end suction, back pullout, designed and manufactured for pumping contaminated liquid containing suspended solids, like sewage/effluent. Pump shall be directly coupled to motor through coupling, mounted on common base plate with foundation bolts and all other required accessories.

The pump shall be designed to operate satisfactorily without detrimental surges, vibration, noise or dynamic imbalance over the required head range. The head-capacity curve of the pump shall have a continuously rising head characteristic with decreasing capacity over the whole performance range of pump. The shut off head of the pump shall be at least 120% of the total head.

The pump shall be selected in such a way so that operating point shall lie on best efficiency point (BEP) or within 15% of BEP flow on either side meeting NPSH requirement. **Pump selected with duty point lying on right side of BEP beyond 15% limit shall not be accepted.**

The pump shall be selected with intermediate diameter of Impeller. The rated impeller diameter shall be at least 10 mm smaller than the maximum Impeller dia. possible for the offered pump model. **The pump selected for rated performance below minimum Impeller diameters shall not be accepted.**

The manufacturer shall ensure while selecting pump that required Net Positive Suction Head (NPSH) is less than available NPSH to ensure pumps' operation without cavitations under the worst operating condition. The required NPSH at duty point and throughout the range shall be at least 1.0 m and 0.5 m, less than the available NPSH respectively at the lowest water level in the sump.

Each pump must be capable of running satisfactorily in parallel with other sets in the system without throttling and by itself, without cavitations or overload under all operating conditions within the system resistance indicated. All pumps shall have identical performance.

The pump shall be designed to start with delivery valve fully open.

The unit shall be designed to operate safely at the maximum speed attainable in the reversed direction of rotation due to liquid returning through the pump at times when the power supply to the motor is interrupted and the discharge valve fails to close.

Pumps' rotating parts & assembly shall be statically and dynamically balanced as per ISO standards and shall run smooth without undue noise and vibration. The velocity of vibrations shall be within 4.5 mm/sec. Noise level shall be limited to 85 dBA at a distance of 1.0 m.

The power rating of motor to drive pump shall be suitable to meet maximum requirement of power for the rated impeller throughout its performance range.

B. FEATURES OF CONSTRUCTION

PUMP

Pump shall be horizontal shaft centrifugal, single stage, Non Clog, End Suction, back pull out type suitable for dry-pit installation with wearings/plates. The pump shall have side suction and top discharge nozzle. The maximum speed of pump shall be 1500 RPM.

CASING

Pump casing shall be of robust construction self venting type with central/side delivery. Liquid passages shall be designed to allow free passage and finished smooth. The tongue shall be straight across and filed to a smooth rounded edge. Casing shall be provided with wearing rings/wear plates. Casing drain connection with collar and plug shall be provided at lowest part of casing. Tapping shall be provided at side center of suction and discharge nozzles for pressure gauge connection.

Casing shall have inspection hole with cover so as to facilitate removal of clogged material from impeller vanes without dismantling the whole pump.

IMPELLER

Impeller shall be enclosed/semi-open, single suction with smooth and large ways so as to allow free passage to the fluid being pumped. Impeller shall have two/three vanes max. and be capable to handle solids of specified size. It shall be free from sharp corners and projections likely to catch and hold drags and stringy materials. Typical sewage has high content of sand, silt & ash. Hence the pump design shall be of wear resistant type.

Impellers shall be statically and dynamically balanced at rated speed as per applicable standard so as to avoid vibration. Impeller shall have suitable features to balance the resulting axial thrust during operation.

Pump having semi open impeller shall be provided with suitable wear plate fixed in casing with adjusting bolts & nuts.

IMPELLER NUT

Impeller shall be fixed on rotating shaft with the help of SS316 impeller screw or cap to type impeller nut with helicoil insert and washer in such a way that impeller doesn't get loose during rotation of pump in either direction.

SHAFT SLEEVE

Replaceable shaft sleeve shall be provided and shall be securely locked or keyed to the shaft to prevent loosening. Necessary rubber O-ring or CAF/Teflon gasket shall be provided between impeller and shaft sleeve to prevent liquid passage between shaft and sleeve. In no case shall shaft be in contact with liquid. The surface hardness of the shaft sleeve shall be minimum 250 BHN.

STUFFING BOX

Pump shall be provided with **stuffing box arrangement** as mentioned in specific requirement for shaft sealing.

Pump required with gland packed stuffing box shall be of such design that it can be repacked without removal of any part other than gland and lantern ring. Stuffing box drain with pipe connection shall be provided at the lowest point so that no leakage accumulates in it. Lantern rings shall be sandwiched between packing and shall be easily removable. Lantern rings shall be axially split type and shall be sealed with self liquid being pumped or as recommended by manufacturer. Necessary pipe connections and piping for this shall be provided by pump manufacturer. Gland shall be of split type. Gland bolts and nuts shall be of SS.

Pumps required with Mechanical Seal shall be provided with necessary piping for cooling, flushing and lubrication of seal faces as recommended by seal manufacturer. Seal shall be designed and selected for the specified application in order to perform the equipment trouble free and working life not less than 20,000 hours of operation. Seals shall be covered with SS304 mechanical seal cover and shall be tightened with SS fasteners as per the specifications.

Pumps shall be supplied with Rubber liquid deflector to prevent liquid entry to bearings, in case of failure of mechanical seal/leakage through stuffing box.

BEARING HOUSING

The bearing housing shall hold DE/NDE bearings firmly and shall support complete rotating assembly of the pump. It will be designed to provide sufficient span to support rotating assembly so as to reduce the vibration and deflection of rotating assembly. The bearings shall be held in position with necessary fixing arrangement to ensure no axial movement. Bearings shall be covered by bearing covers. Bearing housings shall have suitable arrangement to feed grease to bearings for lubrication. Grease holes shall be plugged to prevent entry of harmful foreign materials.

BEARINGS

Pump shall be supplied with anti-friction grease lubricated bearings. The rotating assembly of pump shall rest on minimum two bearings located at DE/NDE for smooth operation. Bearings shall be easily accessible for inspection and maintenance. Bearings shall be of SKF/FAG make only.

COUPLING

The pump shall be coupled with electric motor mounted on a common base plate. The coupling shall be spacer type flexible jaw coupling with spacer of suitable length (as recommended by pump manufacturer) of KTR/Rathi/Fenner make only. Coupling shall be statically and dynamically balanced at rated speed.

COUPLING GUARD

A stationary coupling guard shall be provided for the coupling conforming to all relevant safety codes and regulations. Coupling guard design shall be such that coupling is covered from both the sides as well as apart from top cover. Guard shall be designed for easy installation and removal, complete with necessary support, accessories and SS fasteners.

BASE PLATE

The pumping unit shall be provided with a common drain rim type base plate with 25 mm dia. drain pipe, terminated to nearest drain pit/trench. The base plates shall be of sufficient size and rigid sufficient to maintain the pump and motor in proper alignment and position. Base plates shall be preferably supplied by pump manufacturer. The base plates shall be grouted on the RCC foundation with the help of "J" type foundation bolts of manufacturer's recommended/approved size.

C. MATERIAL OF CONSTRUCTION

The specific requirements shall be considered as under:

Casing/Casing Cover/Stuffing Box housing	CI IS 210 Gr FG 260 with 1.5 to 2% Ni
Shaft	AISI 410
Shaft sleeve	AISI 410 H
Impeller	SS Gr. CF8M
Casing wearing/Wear plate	CI IS 210 Gr FG 260
Shaft Sealing	Gland Packed
Base Plate (Drain Rim type)	CI Epoxy Coated
Min. Size of Solid handling	100 mm

D. NAME PLATE

Each pump shall be provided with a stainless steel name plate indicating the following details.

- Model
- Manufacturer's special number
- Rated capacity in LPS/M³/HR
- Total head in MWC
- Speed in RPM
- Material of impeller

SUBJECT: DATASHEET OF HORIZONTAL CENTRIFUGAL NON CLOG PUMP

SR. NO.	PARTICULAR	DESCRIPTION	DATA TO FILL BY BIDDER
1.0	LIQUID DATA		
1.1	Liquid handled	Sewage	Sewage
1.2	Specific gravity	1.02	1.02
1.3	Temperature	Ambient temp.	Amb. temp. - 50 Deg. C
1.4	Suc. Pre. @ rated capacity - m	Flooded	Atmospheric
2.0	PUMP DATA		
2.1	Make	Pl furnish Detail	
2.2	Pump type	Horizontal Non Clog CF End Suction - BPO	
2.3	Pump Model	Pl furnish Detail	
2.4	Number of pumps	-	7 nos.
2.5	Type of duty	Continuous	
2.6	Design Capacity in m ³ /hr.	Pl furnish Detail	1100
2.7	Total Rated Head - m	Pl furnish Detail	17
2.8	Guaranteed Pump efficiency at rated capacity - %	w/o - vetolerance	
2.9	Guaranteed Overall efficiency of Pump - Motor set at rated capacity - %	w/o - vetolerance	75
2.10	Pump input at rated duty - KW	Pl furnish Detail	
2.11	Rated Speed of pump - RPM	Pl furnish FLS	
2.12	Max. B KW @ Rated Impeller.	Pl furnish Detail	
2.13	Reco. Drive motor rating - KW	Pl furnish Detail	
2.14	FLS of motor - RPM	Pl furnish Detail	
2.15	NPSH(R) - m	Pl furnish Detail	
2.16	Shutoff head - m	Pl furnish Detail	
2.17	Min. Permi. Solid Size - mm	100mm	
2.18	Location	Indoor	
3.0	CONSTRUCTIONAL FEATURE		
3.1	No. of stage	Single	
3.2	Casing	Volute type	
3.3	Impeller	Non Clog, Encl./Semi Open	
3.4	Impeller dia. - mm	Max./ Rated/Min.	
3.5	Shaft/Drive Transmission	Direct Coupled	
3.6	Shaft sealing	Gland Packed	
3.7	Gland packing Type & Size	Pl. furnish Detail	
3.8	Mounting	Horizontal	41

SR. NO.	PARTICULAR	DESCRIPTION	DATA TO FILL BY BIDDER
3.9	Nozzle orientation & size-mm		
	Suction	Side	
	Discharge	Top/Side	
3.1	Flanged drilling	IS 1538, FF with off center bolt holes	
3.11	Direction of rotation	CW-from DE	
3.12	Type of Starter	Soft starter	
4	MATERIAL OF CONSTRUCTION		
4.1	Pump Casing/Casing Cover/ Stuffing Box Housing (M)	CI ; IS 210 Gr FG 260 with 2 Ni.	
4.2	Impeller (M)	CF 8M	
4.3	Shaft (M)	SS AISI 410	
4.4	Shaft Sleeve (M)	AISI 410H	
4.5	Casing wearing/Wear Plate (M)	CI IS 210 Gr FG 260	
4.6	Lantern Ring	CI/WM/Brass	
4.7	Shaft Sealing	Gland Packed	
4.8	Hardware in contact with liquid/ Non-wetted	In Liq. Contact: SS 304 Non Wetted: G.I.	
4.9	Gland Bolts, Washers & Nuts	SS 316	
4.1	Liquid deflector	Natural Rubber	
4.11	Split Gland	CI ; IS 210 Gr FG 260	
4.12	Base plate	CI epoxy coated	
4.13	Painting	Plfurnish Detail	
5.0	ACCESSORIES & SERVICES REQUIRED		
5.1	Flex. Spacer type Coupling	YES	
5.2	Coupling guard	YES	
5.3	Set off foundation bolts & Nuts	YES	
5.4	Common Base Plate	YES	
5.5	Non standard/special maintenance tools	YES	
5.6	Two years normal working spare parts	Plfurnish list	
6.0	WEIGHT		
6.1	Weight of pump-kg	Plfurnish Detail	
6.2	Weight of motor-kg	Plfurnish Detail	
6.3	Reco. Crane capacity-Ton	Plfurnish Detail	
7.0	DRAWINGS		
7.1	ISO Performance curve	Plfurnish Detail	
7.2	GAD Drg. of Pump set	Plfurnish Detail	
7.3	C/S Drg. of pump with part list	Plfurnish	

SR. NO.	PARTICULAR	DESCRIPTION	DATA TO FILL BY BIDDER
7.4	Catalogue of products	Pl furnish	
7.5	QA Po of products	Pl furnish	
7.6	Speed Torque curve	Pl furnish	
8.0	TESTING		
8.1	Hydrostatic test	Certificate required	
8.2	Performance test	Witness	
8.3	Dynamic balancing test	Certificate required	
8.4	Visual inspection check	Witness	

Note: 01. For components (marked-M) material certificate shall be furnished
02. Bidders shall refer electrical specifications for motor requirement and shall offer accordingly.

2.0 VALVES:

GENERAL

Valves shall be as per relevant IS or internationally recognized standards. Flanges shall be machined on faces and edges to ISO 7005, IS 6392 or BS 4504. Flange drilling should conform to IS 1538, Table-IV & VI.

Valves shall be double flanged type and the faces shall be parallel to each other and flange faces should be at right angles to the valve centerline. Backside of valve flanges shall be machined or spot faced for proper seating of the bolt head and nut.

Valve buried or installed in underground chamber, where access to a hand wheel would be impractical, shall be operated by means of extensions, spindle and/or keys.

Valves shall be suitable for frequent operation as well as operation after long periods of idleness in either open or closed position.

The valve stem, thrust washers, screws, nuts and all other components exposed to the sewage shall be of a corrosion resistant grade of stainless steel.

Valves shall be free from sharp projections.

Valves shall have pressure rating min. PN 1.0 in general.

The Contractor shall provide operating platform for easy open/close operation of valves wherever the valve hand wheel is higher than 1.25 m above floor level.

3.1 SLUICE VALVE:

A. GENERAL:

Cast Iron Sluice Valves shall be manufactured strictly in accordance with and conforming to Indian standard specification IS : 14846 – 2000 or its latest amendment.

The valves are intended to be used in vertical/horizontal position. Valves shall be rising /non rising spindle type as specified having pressure rating PN 1.0 in general or higher as required as per application as specified in these specifications and free from sharp projections which are likely to catch and hold stringy materials. Bolts and nuts shall conform to IS 1363:1967 and IS 4218:1967. Over all dimension like, face to face distance, height of valve etc shall conform to IS 14846.

B. FEATURES OF CONSTRUCTION: BODY & BONNET

Body & Bonnet shall be designed so as to withstand the rated test pressure as specified in IS: 14846. Bodies of the valves shall be fitted with seat rings securely fixed in machined recesses by proper engineering practice.

Reasonable clearance shall be provided behind the rear faces of the flanges on body and bonnet to provide free access to use spanners for assembling & dismantling. Rear side of valve flanges shall be machined or spot faced for proper seating of bolt head, washer and nut.

Valve shall have Gun metal drain plug of required size as per IS to facilitate drain of trapped water from the valve body.

FLANGES

Valve flange faces shall be parallel to each other and shall be at right angle to the valve centerline. The flanges and their dimensions of drillings shall be in accordance with the requirements of IS 1538, Table IV & VI. The rear side of the flanges shall be machined or shall have spot face to provide proper tightening of Nut & Bolts.

STUFFING BOX

The gland and stuffing box which come in contact with spindle shall be provided with bushing of minimum 3mm thickness and of material as specified in IS-14846 or specified in specific requirement of this specification as an anti-frictional device. The minimum inside dimensions of the stuffing box shall be in accordance with IS 14846.

Valve shall be provided with back seat bush to facilitate repacking of valves in pressurised condition without disturbing the pump operation.

WEDGES

The Valve shall be with equal tapered solid CI wedge made in one piece. Valve shall have perfect machined and pressed Wedge seat rings securely fixed into machined recesses. The wedge seat rings shall ride high on the body seat ring to allow for wear, when shut. The minimum wear travel shall be 25% of the face width of these seat rings as specified in IS.

SEATRINGS

The dimensions of the body seat rings and wedge seat rings shall conform to IS 14846. The wedge seat rings & body seat rings shall be securely riveted over and above sufficiently hydraulic press fittings.

GUIDES & LUGS

All valves shall be provided with the guides and lug to guide the wedge through its full travel in body. The channel and shoe arrangements shall be secured by non-protruding rigid rivets of non-ferrous metals. The clearance between lugs and guides for different sizes of sluice valves shall be as specified in IS 14846.

STEM & WEDGE NUT

Valve Stem shall have a machine cut, single start trapezoidal thread of such length that the wedge can be raised to a position so as to ensure full flow passage through the valve's bore. In fully closed position of the valve the stem shall remain in full contact with wedge nut for its entire length with at least 10mm projection. The

length of the stem particularly below the collar shall be kept accordingly. The dimension of stem and wedge nut shall be in accordance with IS: 14846.

The stem of valve shall be so screwed as to close the valves when the cap, hand wheel or crank handle is rotated in clockwise direction. The direction of closing shall be marked on the Cap/ hand wheel.

Wherever extended spindle is provided, the valves shall also be provided with suitable head stock.

Rising Spindle Sluice Valve shall be with the Yoke and Yoke Sleeve (Spindle Nut) placed in the Yoke, in such a way that the axial movement of the Yoke Sleeve is avoided in the yoke along direction of spindle axis and but it cannot rotate. Integrally formed end of the Spindle shall be locked in Wedge and Rotation of the yoke sleeve shall Open/Close the wedge responding to direction of rotation. The design shall offer minimum operating torque to operate the valve.

The ball type thrust bearing may be provided above and below the collar of the yoke sleeve to minimize the operating torque as per manufacturer design. The spindle thread shall be engaged in the operator drive sleeve for the rising spindle sluice valve offered with gearbox and/ or electric actuator.

GEARS

Gears shall be of suitable design (IS 2535: 1978) and workmanship, so as to ensure satisfactory working of sluice valve.

ACCESSORIES:

1. Valves above 300 mm size shall be provided with Repacking arrangement.
2. The Valves 600 mm & above size shall have channel and shoe arrangement.
3. The Valves above 500 mm size shall have bypass arrangement.
4. The Valves 350 mm size & above shall have spur/bevel gear arrangement.
5. All Valves shall have valve's OPEN/CLOSE indicator arrangement as per IS 14846.
6. Valves above 300 mm size shall be provided with Position Indicator indicating extent of opening/closing of gate/wedge.

C. MARKING:

The following information shall be embossed on each valve body:

ISI Certification Mark.

The manufacturer's name or Trade Mark.

Pressure Rating of valve.

The size of valve in mm.

Heat number of cast.

SUBJECT: DATA SHEET FOR CAST IRON SLUICE VALVE

SR. NO.	PARTICULARS		DESCRIPTION	DATA TO FILL BY BIDDER
1.0	Make		Pl. furnish detail	
2.0	Manufacturing Standard		IS: 14846-2000 or latest rev.	
3.0	Size and quantity		As per SOQ	
4.0	Fluid/Specific gravity		Sewage/1.02	
5.0	Pressure Rating		PN: 1.0	
6.0	Stem		Rising Spindle	
7.0	Ends		Flanged, flat faced as per IS-1538 having off center bolt holes	
8.0	Bonnet		Bolted	
9.0	Disc.		Solid wedge	
10.0	Operation		Manually Gear / Actuator operated (as per BOQ)	
11.0	Seat	Body	Renewable	
		Disc	Renewable	
12.0	Direction of Closing		Clockwise	
13.0	Repacking/Back Seat Bush Arrangement		Required (above 300mm size)	
14.0	Channel & Shoe Arrange.		Required (600mm & above size)	
15.0	Gear Box arrangement		Required (350mm & above size)	
16.0	By-pass arrangement		(above 500mm size)	Not Required
17.0	Position Indicator		Required (above 300mm size)	
	Details applicable require for Electrically Operated Valve			
	Actuator make/model		Pl. furnish detail	
	Torque capacity/RPM		Pl. furnish detail	
	Power supply		3 Phase, 415V, AC, 50Hz.	
	Valve opening/closing time		Vendor to specify	
	Electric Actuator Requirements		Fwd. & reverse integral starter for local & remote mode & cable up to actuator motor with all accessories as per	
	Material Of Construction			
18.0	Body/bonnet		C.I. IS 210 GR FG 260	
19.0	Disc			C.I. IS 2
20.0	Stem		S.S. AISI-304 (M)	
21.0	Body seat		S.S. AISI-304 (M)	
22.0	Yoke		C.I. IS 210 GR FG 260	
23.0	Disc seat		S.S. BS 970 Gr 304 (M)	
24.0	Yoke sleeve/Stem nut		Bronze IS 318 GRLTB2	
25.0	Shoe & Channel Linings		S.S. BS 970 Gr 304 S16	
26.0	Stuffing box		C.I. IS 210 GR FG 260	
27.0	Stuffing Box Bush		Bronze IS 318 GRLTB2	
28.0	Gland		C.I. IS 210 GR FG 260	

29.0	GlandPacking	GreasyJutePacking	
30.0	Bolts, studs&nuts	CarbonSteelIS1367Class4.6/4	
31.0	Handwheel/Cap	CI	
32.0	Shelltest	15Kg/Cm ²	
33.0	Seattest	10Kg/Cm ²	

NOTE:01.Manufacturer/suppliersshallsubmitseparatedatasheetforeachduty.

02.Forcomponents(marked-M)materialcertificatesshallbefurnished

03.SeparatedatasheetshallbefilledinforeachPumpingstation.

2.2 SWINGCHECKNONRETURNVALVES

A. GENERAL

Cast Iron double flanged nonreturn valves shall be manufactured as per IS 5312 or its latest amendment for pressure rating PN 1.0 in general or higher as required per application. All the parts of the valves shall be designed so as to withstand the test pressure as specified in the standard. Valves shall be free from sharp projections which are likely to get clogged with stringy materials.

The dimensions and shape of the body, door, cover etc. shall ensure that the area for flow passage at any cross section in the valve is not less than the area of the nominal bore of the valve.

The design of the hinges, hinge pin, door, door suspension, etc shall ensure free swinging of the door. The door faces shall have close face contact with the body ring in close position. Valve shall be designed for horizontal and vertical mounting position. The minimum thickness of metal for body, door & cover shall be as per directives given in the IS 5312 and shall be maintained throughout any section uniform to avoid strains set up by sudden changes in cross section.

Valve shall be quick closing type with non-slam characteristics. The non-slam characteristics shall be achieved by providing suitable combination of door and hydraulic passages without any external lever/damping arrangement.

B. FEATURES OF CONSTRUCTION

BODY & COVER:

Valve body shall be double flanged. Body of the valve shall be fitted with seating securely fixed in machined recesses by proper engineering practice. Rear side of valve flanges shall be machined or spot faced for proper seating of bolt head, washer and nut.

Each reflux valve shall carry an embossed ARROW to indicate the direction of flow.

The internal parts shall be easily accessible for inspection through inspection hole just by removing cover

Valve shall have Gun metal drain plug of required size as per IS to facilitate drain of trapped water from the valve body.

FLANGES:

Valve flange faces shall be parallel to each other and shall be at right angle to the valve centerline. The flanges and their dimensions of drilling shall be in accordance with the requirements of IS 1538, Table IV & VI. The rear side of the flanges shall be machined or shall have spot face to provide proper tightening of Nut & Bolts..

BODYRING:

The inside diameter of the body seat rings shall not be less than the nominal bore of the valves and not more than it by 1.5 mm. The face of the body seat rings shall protrude clear of the surrounding not less than by 1.5 mm. Body seat rings shall be secure riveted over and above sufficient hydraulic press fittings. Seat rings shall be renewable.

DOORS & HINGES:

Doors and hinges shall be designed so as to withstand satisfactorily the repeated impacts likely to occur during service. Doors shall be securely bolted to the hinge/s and the whole assembly shall be fitted with the help of hinge pin and bushes in the body to keep it in swing position.

ACCESSORIES:

1. Valves above 300 mm size shall be provided with by-pass arrangement as per IS 5312
2. Valves above 300 mm size shall be provided with drain plugs as per IS 5312.
3. Valves above 450 mm size shall have support foot as per IS 5312.

C. MARKING:

The following information shall be embossed on each valve body:

The manufacturer's name or Trade Mark.
Pressure Rating of valve.
The size of valve in mm.
Direction of the flow
Heat number of cast.

SUBJECT: DATA SHEET FOR SWING CHECK DOOR NON RETURN VALVE

SR. NO.	PARTICULAR	DESCRIPTION	DATA TO BE FILLED BY VENDOR
1.0	CONSTRUCTIONAL FEATURES		
1.1	Make	Pl. furnish detail	
1.2	Mfg. Standard	IS 5312 PART I	
1.3	Pressure Rating	PN 1.0	
1.4	Size & Quantity	As per SOQ	
1.5	Fluid	Sewage	
1.6	Sp Gravity	1.02	
1.7	Type	Non slam, swing check type	
1.8	Ends	Flanged. Flat faced and confirming to IS 1538 part IV & VI having off center boltholes	
1.9	Seat	Body: Renewable Disc: Renewable	
2.0	MATERIAL OF CONSTRUCTION		
2.1	Body/Cover	C.I. IS 210 GR 260	
2.2	Door	C.I. IS 210 GR 260 (M)	
2.3	Seat rings	S.S AISI 304 (M)	
2.4	Hinge Pin	S.S BS 970 Gr 431 S 29 (M)	
2.5	Bolts, Studs & Nuts	SS 304 (Internal)	
3.0	ACCESSORIES		
3.1	By-Pass Arrangement	Not Required	
3.2	Drain Plug	Required	
3.3	Support foot	Not Required	
4.0	DRAWINGS		
4.1	General outline dimensional drg.	Pl. furnish detail	
4.2	C.S. drawing with parts	Pl. furnish detail	
4.3	QA plan	Pl. furnish detail	
5.0	TESTING		
5.1	Shell test	15 Kg/Cm ²	
5.2	Seat test	10 Kg/Cm ²	

NOTE: 01. Manufacturer/suppliers shall submit separated data sheet for each duty.
02. For components (marked -M) material certificate shall be furnished
03. Separated data sheet shall be filled in for each Pumping station.

2.3 BUTTERFLY VALVE

A. GENERAL

Butterfly valve shall conform to IS 13095-1991 / BS EN 593 and to its latest amendments. The flanges of valves shall conform to IS: 1538-1993. The valve shall be rated to PN 1.0 rating unless and otherwise stated specifically. Face to face dimension of double flanged valves shall be as per the dimensions specified in Table-1 of IS: 13095:1991 or to its latest amendments.

B. FEATURES OF CONSTRUCTION:

BODY

Valve shall be double flanged, short body type, designed to withstand rated pressure and flanges drilled in accordance with the requirement given in ANNEX-B of IS 13095-1991. Flange shall be right angle to the axis of the bore and concentric with the bore. Flanges shall be drilled to IS: 1538:1993 unless & otherwise specified and the bolt hole shall be off centers. Valve 600mm NB and above shall have integral lifting lugs and valves 1200mm NB and above size valves shall have integral duck foot.

DISC AND SHAFT

The disc shall be **DUO ECCENTRIC** and mounted to ensure complete shut-off. Shaft shall be designed to withstand the maximum differential pressure across the valve in either direction of flow. The shaft may be in one or two pieces attached separately to the disc. Proper means of attachment between shaft and disc shall be adopted to preclude components becoming loose in service and leakage from drive end side.

SEATING

The valve body seat shall be replaceable. When the valve is fully closed, the seal shall seat firmly so as to prevent leakage. These seat surfaces shall be machined smooth to provide a long life for the seal.

BEARINGS

The bearings shall be suitable for the maximum load imposed by the shaft during testing and in service. Valves 350mm NB and above shall be provided with bearing to take axial thrust. Suitable sealings shall be provided for the shaft where it passes outside the pressure containing enclosure.

OPERATION

The valve shall be capable of being operated at a differential pressure across the disc as marked on the valve.

The valve up to 150mm NB shall be lever operated with sufficient size to generate required torque to close/open the valve by a single person with normal force. The lever operated valve shall be capable of being locked at three intermediate positions.

The valves above 150mm NB shall be with quarter turn worm gear box and hand wheel. All gear operated valves shall be self locking type and shall have suitable stops to prevent movement of the shaft beyond the disc's fully closed position. The Gearbox shall be packed with grease for lifetime operation and shall be totally enclosed from and whether proof for general operation.

OPENING/ CLOSING DIRECTION:

Hand wheel/lever/gearbox shall be arranged to turn in a clockwise direction to close the valve. The direction of rotation for opening and closing shall be indicated on the hand wheels/lever.

Valves shall be with an indicator showing the % opening/closing from 0 to 100% of valve disc.

PACKING:

All valves shall be supplied with the wedge closed. Valves of small diameter may be packed in wooden case. Parts liable to injury in transit shall be wrapped with wood-wool or similar material as a protection.

C. MARKING:

The following information shall be cast on each valve body in raised letters.

1. The manufacturer's name or Trade Mark.
2. The Pressure Rating of valve.
3. The size of valve in mm.
4. Heat number of cast.
5. Direction of the flow

DOCUMENT: TECHNICAL DATA SHEET FOR CIBUTTERFLY VALVE.

SR. NO.	PARTICULARS	DETAILS	DATA TO BE FILLED BY THE BIDDER
1.0	CONSTRUCTIONAL FEATURES		
1.1	Make	Pl. furnish detail	
1.2	Standard	IS 13095 or BSEN 593	
1.3	Size in mm / Qty	As per SOQ	
1.4	Location	Indoor	
1.5	Fluid	Sewage	
1.6	Sp Gravity	1.02	
1.7	Pressure Rating	PN 1.0	
1.8	Ends	Flanged, as per IS-1538 T-4 & 6	
1.9	Disc.	Double eccentric	
1.9.1	Eccentricity-1 in mm	Pl. furnish detail	
1.9.2	Eccentricity-2 in mm	Pl. furnish detail	
1.10	Operation	Electric actuator operated	
1.11	Other requirements	Valve shall be with HW	
2.0	MATERIAL OF CONSTRUCTION		
2.1	Body	C.I. IS 210 GR 260 (M)	
2.2	Disc	C.I. IS 210 GR 260 (M)	
2.3	Stem	S.S. AISI-410 (M)	
2.4	Body seat (Renewable)	S.S. AISI-410 (M)	
2.5	Disc seal	EPDM Rubber	
2.6	Clamping ring	S.S AISI-304	
2.7	Bolts, studs & nuts	CS, IS: 1367 Class 4.6/4	
3.0	ACCESSORIES		
3.1	Gear Box	Required (150 mm above)	
3.2	By-Pass Arrangement	Not Required (600 mm above)	Not Required
3.3	Support foot	Required (900 mm above)	
4.0	Details applicable requirement for Electrically Operated Valve		
4.1	Actuator make/model	Pl. furnish detail	
4.2	Torque capacity/RPM	Pl. furnish detail	
4.3	Power supply	3 Phase, 415V, AC, 50 Hz.	
4.4	Valve opening/closing time	Vendor to specify	
4.5	Electric Actuator Requirements	Fwd. & reverse integral starter for local & remote mode & cable up to actuator motor with all accessories as per	
5.0	DRAWINGS		
5.1	Gen. outlined dimensional drg.	Pl. furnish detail	63

SR. NO.	PARTICULARS	DETAILS	DATA TO BE FILLED BY THE BIDDER
5.2	C.S.drawing with parts	Pl.furnish detail	
5.3	QA plan	Pl.furnish detail	
6.0	TESTING		
6.1	Body/Shell test	15Kg/Cm ²	
6.2	Seat test	10Kg/Cm ²	

M-denotes material test certificate required

2.4 ELECTRIC ACTUATOR (APPLICABLE FOR VALVES/ GATES)

All local controls shall be protected by a lockable cover.

Each actuator shall be adequately sized to suit the application and be continuously rated to suit the modulating control required. The gearbox shall be oil or grease filled, and capable of installation in any position. All operating spindles, gears and headstocks shall be provided with adequate points for lubrication.

The valve actuator shall be capable of producing not less than $1\frac{1}{2}$ times the required valve torque and shall be suitable for at least 15 minutes continuous operation. The operating speed shall be such as to give valve closing and opening at approximately 10-12 inches per minute.

The actuator starters shall be integrally housed with the actuator in robustly constructed and totally enclosed weatherproof housing. The motor starters shall be capable of starting the motor under the most severe conditions.

The starter housings shall be fitted with contacts and terminals for power supply, remote control and remote positional indication, and shall also be fitted with internal heaters so as to provide protection against damage due to condensation. Heaters shall be suitable for single phase operation. The heaters shall be switched "ON" when the starters are "OFF" and shall be switched "OFF" when the starters are "ON".

Each starter shall be equipped as follows:

- a) A.C. electric motor.
- b) Reduction gear unit.
- c) Torque switch mechanism complete with set of torque switches for "Open" & "Close" position.
- d) Limit switch mechanism complete with set of limit switches for "Open" & "Close" position.
- e) Hand wheel for manual operation.
- f) Hand-auto change over lever with suitable locking arrangement.
- g) Local control switch/push buttons
- h) Forward/Reverse Integral/External starter
- i) 1 No. Set "Open", "close" and "Stop" buttons as applicable
- j) 1 No. Local- Off- Remote switch with pad locking facilities as applicable
- k) Space heater, 220V rated

The actuator shall be suitable for operation in the climate conditions and power supply conditions given in the specification. The actuator shall be capable of producing not less than $1\frac{1}{2}$ times the maximum required torque and shall be suitable for at least 15 minutes continuous operation..

A.C. ELECTRIC MOTOR:

Each motor shall be fully tropicalised and suitable for operation in the prevailing climate conditions. They shall also be suitable for operating satisfactorily under variation of electric supply specified.

MOTORS:

The electric motors shall be of 1 or 3 phase, minimum Class 'F' insulated with temperature limited to Class B, high torque low inertia motor of 15 minutes rating, squirrel cage type with 'O' ring seal to provide complete environmental protection during long period of inactivity. The windings shall be impregnated to render them non-hydroscopic and oil resistant. All internal metal parts shall be painted. Motor shall be capable of at least 60 starts per hour.

MOTOR PROTECTION:

Following motor protections shall be provided:

- a) The motor shall be de-energized in the event of a stall when attempting to unseat a jammed valve.
- b) Motor temperatures shall be sensed by a thermostat to protect against overheating
- c)

Single phasing protection

MOTOR CONTROLS:

The reversing contactor starter and local control shall be integral or external for actuator. The starters shall comprise mechanically and electrically interlocked reversing contactor of appropriate rating fed from a 220V control transformer (120VAC for energization of contactors and 24VDC rectifiers supply for local control for integral starter is also acceptable). The common connection of the contactor coils at the transformer shall be grounded. HRC type primary and secondary fuses shall be provided.

Local control shall comprise push buttons for open, close and stop operations, and a local/remote selector switch lockable in the three positions as below:

Local control only,
Remote control plus local stop only,
Stop locked off - No electrical operation

Vendor should also make a provision for transmitting the mode selected to control panel and control panel will have corresponding indication lamps.

WIRING AND TERMINALS:

Internal wiring shall be of grade PVC insulated stranded cable of 650V and of minimum 1.5mm² copper for control circuits and of minimum 4mm² for the power circuit. Each wire shall be number identified at each end. The terminals shall be of stud type and they shall also be identified by numbers. Cable entries shall be suitable for suitably sized PVC cables.

ENCLOSURE:

The actuator enclosure shall be IP68.

REDUCTION GEAR UNIT:

Reduction gear unit shall be of the totally enclosed oil bath lubricated type. The gear box shall be provided with the first charge of oil lubricants and appropriate filling and drain connections. Gearing shall be adequate to open and close the sluice gates under full indicated maximum operating pressure differential at speeds sufficient to cover the full extent of travel.

The sluice gate operating equipment shall have a hammer-blow device to loosen stuck sluice gate or retrieve jammed sluice gate position.

The gear box shall have suitable stop to prevent movement of shaft beyond fully open / close position. The gear box shall also be designed for 15% more torque than maximum sluice gate / valve torque.

TORQUE & POSITION LIMIT SWITCH MECHANISM:

Each actuator shall be provided with both Open and Close torque limit switches, open and close (end position) limit switches for remote indication and interlocking plus two set of auxiliary limit switches in each direction for intermediate position indication and interlocking. Means shall be provided to prevent the open torque switch tripping during initial hammer blow effect. Torque protection reset shall not allow repeated starting in same direction when the control signal is maintained.

The torque switch mechanism shall function as follows to stop the motor on closing or opening of the sluice gate, upon actuation by the torque when the sluice gate disc is restricted in its attempt to open or close.

The torque switch in the closing direction shall interrupt the control circuit if mechanical overload occurs during the closing cycle or when the sluice gate is fully closed. The torque switch in the opening direction shall interrupt the control circuit if mechanical overload occurs during opening cycle or when the valve is fully open.

The mechanism shall facilitate adjustment of the torque at which the switches are required to operate.

HAND WHEEL:

A hand wheel shall be provided for emergency operation. The hand wheel drive shall be mechanically independent of the motor drive and any gearing should be such as to permit emergency manual operation in a reasonable time.

3.0 DI / CI / MS / GI PIPES & FITTINGS

3.1 DI PIPES, FITTING & SPECIALS:

DI Pipes shall be manufactured as per IS 9523-2000 with latest amendments. The scope shall include manufacture, testing and supply of DI Pipes and Fittings.

The double flanged pipe shall be with integral flanges and of appropriate class rating of pipes. The flanges shall be drilled to IS 1538, T-4 & 6 as a standard unless specified.

DI fittings/specials shall be confirming to IS 8329/2001 with latest amendments.

The fittings shall be stripped with all the precautions necessary to avoid warping or shrinking defects. The fittings shall be free from defects other than any unavoidable surface imperfection which results from the method of manufacture and which do not affect the use of the fittings.

The fittings shall be such that they could be cut, drilled or machined.

The mass of DI Pipes, fittings/specials shall strictly conform to relative IS with latest amendments.

3.2 CI PIPES AND SPECIALS/ FITTINGS

The scope includes manufacture, delivery at site, storage at site, installation, testing and commissioning of double flanged cast iron pipe with fittings, flanges, nuts, bolts and gaskets at suction, delivery & header pipe.

This specification gives the general requirement of pipes/fittings. However, **it is the responsibility of the bidder to take the actual measurement and obtain client's approval prior to the placement of order** to the main supplier/manufacturer as per site conditions during execution of work.

Quantity shall be verified as per actual site condition. Bidders shall be paid only for installed quantity as per actual measurement at site. In case if pipes/fittings are not used or installed, bidder shall not be paid for the same and bidders shall take back the same without any dispute.

In case of tender quantity is less than the actual, bidder has to arrange for the excess quantities and rate for the same shall be as per original tender rate.

All pipes and fittings shall be flanged.

Pipework

The pipework for the plant involves manufacturing, supplying, laying and jointing of suitable size cast iron, ductile iron pipes along with matching special etc as required. All piping/fittings within the pump houses shall be of cast iron/ ductile iron as specified. The specifications for manufacturing, supplying, laying and jointing of pipes shall generally conform to the standard specification.

All pipework and fittings shall be of class rating in excess of the maximum pressure attained in service including any surge pressure.

The pipework installations shall be so arranged to offer ease of dismantling and removal of pumps or other major items of equipments. C.I. dismantling joints which can take radial and axial misalignment of minimum 1 percent of valve nominal size with tie bolt shall be provided. All pipework shall be adequately supported with purpose-made fittings. When passing through walls, pipework shall incorporate a puddle flange. Flange adapters and

union shall be fitted in pipe work runs, wherever necessary, to permit the simple disconnection of flanges, valves and equipment.

The Contractor shall be responsible for ensuring that the internal surface of all pipe work is thoroughly clean before and during erection and before commissioning. Cleanings shall include removal of all dirt, rust, scale and welding slag due to site welding. Before dispatch from the manufacturer's work, the ends of the pipe, branch pipe, etc., shall be suitably removed until immediately prior to connecting adjacent pipes, valves or pumps. All small bore pipes shall be blown through with compressed air before connection is made to instrumental and other equipment. No point of passage of pipe through floors or walls shall be used as a point of support, except with the approval of the Engineer-in-Charge.

CAST IRON PIPING:

Providing and supplying lowering, laying to line, level and slope, cast iron pressure pipes (Class B conforming to IS: 1537/IS: 1536 with latest amendment) and jointing with special ss such as Tees, Bends, Reducers including and others safety provision, cutting the pipes and making joints and hydraulic testing after laying etc. comp.

The Cast Iron pipes shall be Class B conforming to IS: 1537/IS: 1536 with latest amendments bearing ISI Mark.

The pipes shall be free from the defects resulting from raw materials, loading, handling, carting and unloading. The pipes shall be free from load, bends or bulges greater than 3 mm in depth and extending over a length in any directions greater than twice the thickness of barrel.

Each lot of pipes supplied by the contractor must be accompanied by the test certificates as specified in IS 1537/1536 with latest amendments. The contractors shall have to make arrangement for inspection/testing of the pipes at manufacturer's factory at contractor's own risk and cost.

Each pipe shall have cast, stamped or indelibly painted on it the following marks. a)

- Manufacturer's name, initials or identification mark.
- b) The nominal diameter.
- c) Class reference.
- d) The last two digits of the year of the manufacture.
- e) I.S. Certification mark.

The materials shall be carted to the site by the contractor very carefully. The handling, while carting the pipes, specials, valves etc. shall be done carefully. In case of heavy pipes, specials etc. lowering shall be done with the help of the chain pulley block.

Caulking:

After a section of convenient length has been leaded, caulking shall be commenced. The lead shall be free from the leading pipe, outside of the socket of the other pipe with

flatchisel, and then caulked round 3 separate times with the proper caulking tool of increasing thickness and hammer 4 to 5 lbs. in weight in such manner as to make the joints sound and watertight.

Joints under water shall be made with lead wool inserted in strings not less than 6 mm thick and very thoroughly caulked.

New Flanged Joints:

Flanged joints should be made by painting the facing of the flanges with red lead freely and belting up evenly on all sides.

A thin fibre, of lead wool may be very useful in making the joints watertight, where facing of the pipe is not true.

Where packing must be used, it should be of rubber insert cloth three ply and of approved thickness. The packings should be of the full diameter of the flange with proper pipe hole and bolt holes cut and even at both inner and outer edges.

Where the flange is not fully faced, the packing may be of the dimension of the facing strip only. Its proper placing should be tested before another pipe is jointed on.

Testing:

After each section of the pipeline has been completed, it shall be tested for water tightness before being covered in. This can be done by closing each end by means of a reliable guage. When the pipe is laid on any appreciable gradient, the test should be carried out at the lower end of the section. Any leaking joints should be made good, and the above test reapplied until no further leaks are apparent.

Tyton Joints:

After the pipes are examined for line and levels, the C.I. pipes shall be jointed with rubber gaskets (tyton joints) as follows:

The socket and spigot ends shall be cleaned with kerosene oil, then grease has to be applied to the spigot and socket ends, duly after inspection of rubber gasket. Then the rubber gasket shall be jacked and fixed in perfect conditions such that the gasket will fall in groove correctly and the joint become watertight.

Tyton/Lead jointing shall be carried out after the C.I. pipes and specials are properly laid and approved by the Engineer-in-charge.

The lead shall be more than 99%. It shall be soft bluish grey pig lead free from admixtures of tin or other impurities. The lead shall conform to the Indian Standard 3114/1965.

The spun yarn shall be clean hemp and soaked in hot tar or bitumen, cooled and dried before use.

The outside of the spigot and the inside of the socket shall be thoroughly cleaned with a brush. The spigot shall be carefully centered in the socket by spun yarn twisted into ropes of uniform thickness. The ropes shall be well caulked into the back of the socket

to leave as sufficient depth for lead as directed by Engineer-in-charge. The lead shall be used as specified in Table-1 of Indian Standard 3114/1965.

The proper depth of each joint shall be as specified and tested before running the lead by passing completely around it a wooden gauge notched out to the correct depth of lead.

The leading of joints shall be done by means of ropes covered with clay or by using special leading rings. The lead shall be melted rendering it thoroughly fluid and each joint shall be filled in one pouring.

After a section of convenient length has been leading pipe outside of the socket of the other pipe, with a flat chisel and then caulked round three separate times with the proper caulking tools of increasing thickness and hammer 2 to 3 kg. weight in such a manner as to make the joint sound shall be left flush neat and even with the socket.

The item includes all materials tools, tackle etc. required to carry out the work including firewood etc.

After each section of the pipeline has been completed it shall be tested for water tightness. The ends shall be suitably closed with a valve, cap or plug or a blank flange.

The pipeline shall then be filled with water, pressure shall then be supplied with a hand force pump up to 7 kg./sq. cm. (above 100 lbs/sq. inch.) or 15% above. If the pipe is laid on an appreciable gradient, the test shall be carried out at the upper end of the section.

Any leaking joints shall be made good and the test repeated until a perfectly leakproof pipeline is obtained.

Consumption of lead for jointing of pipelines:

The purity of lead must be more than 99% and the contractor shall have to furnish the test certificate and get approval from Engineer-in-charge. The consumption of lead and the depth of jointing shall be as per table listed below:

Sr. No.	Size of pipeline for joint	Consumption of lead in kgs.	Depth of lead joint in cm.
1.	80mm	1.86	5.00
2.	150mm	3.62	6.00
3.	200mm	5.00	6.00
4.	250mm	6.12	7.75
5.	300mm	7.70	8.00
6.	350mm	10.45	8.12
7.	400mm	11.20	8.25
8.	450mm	14.30	8.40
9.	500mm	16.25	8.50
10.	600mm	19.00	9.15
11.	700mm	21.00	10.00
12.	800mm	31.50	10.50
13.	900mm	41.00	10.50

HYDRAULIC TEST:

It shall be incumbent upon the contractor to give a successful hydraulic test to each and every pipeline before filling of the trench. The test shall be carried out in the approved manner by an approved testing machine and pressure gauge to be supplied by the contractor. All the arrangements for such test shall be made by the contractor at his cost including filling the pipe with water etc. and giving a successful hydraulic test.

Testing of the pipeline in the field shall be carried out after the completion of whole length or in parts as directed by Engineer-in-charge. The trench shall be partially refilled except at the joint before starting the test. In each case, the contractor has to plug the both ends of the section of pipeline to be tested either by providing caps or by sluice valves as per direction of Engineer. No extra payment will be made for providing, fixing and removing caps used for testing purpose. If necessary, both the ends shall be properly anchored by providing 1:3:6 c.c. blocks of required dimensions. Contractors shall provide required number of plug points with ferrules of required diameter to serve as injection points, air relief points etc. No payment shall be made for this work. On the completion of the test these points shall be closed by plugs by the contractors without any extra cost.

Testing will be carried out by the contractors under the guidance of Engineer-in-charge. Contractors shall arrange for required machinery, equipments and technical staff for testing the pipeline. Contractor shall also arrange for labour, other materials and tools required to attend the leakage etc. during the test.

The pipeline shall be subjected for following test:

Leakage Test:

The test shall be conducted after satisfactory completion of the pressure test.

There shall not be any leakage in the pipe or at the joint. A seepage allowance of a 2.5 litres per kilometer per hour per centimeter diameter of the pipe shall be permissible and that quantity will not be considered as leakage.

If the retest is delayed for more than 48 hours after any test has proved unsuccessful the Engineer-in-charge, after giving 24 hours notice, shall have every right to get all defects rectified and carry out the necessary works and take hydraulic test/leakage test to the contractor. Any damage done to the pipes, materials, the other labour cost, etc. incurred there under shall be recoverable from the contractor either from his bill or deposit.

The responsibility of the contractor as specified above in case of unsuccessful hydraulic test shall not cease to exist by his pleading that any materials used by him in the pipe line was having cracked or was otherwise defective, as if he has a reason to believe so, he must refuse to accept such materials right at the stores.

If the first test is not found satisfactory, repeated tests will be taken and procedure mentioned above should be followed for testing till a satisfactory test is given. All testings shall be done at the risk of the contractors and they have to attend be done at the risk of the contractors and they have to attend all defects including repairing bursts, leaks at joints, sluice valve ends, caps etc. removing and replacing

pipes etc. These unserviceable articles shall be the property of the contractors and they shall arrange to remove the same from the site as directed by the Engineer.

Any portion of the pipeline that does not stand the specified pressure, shall be rectified by the contractor. Who should make his own arrangement for the water required for the testing.

When this section of the pipeline is tested successfully the contractor shall remove the blank flanges, pump out water from the pipes and backfill the portion as per directions of the Engineer.

C.I. Double Flanged Pipes/Piping within pump houses shall be tested for 150% of maximum system pressure.

The items include all materials and labour required to carry out the work as detailed above.

CAST IRON FITTING & SPECIALS:

Providing and supplying at site of work C.I. fittings/specials conforming to IS 1538/1993 with latest amendments.

The contractor shall have to procure required cast iron specials such as Tees, Bends of required degrees, reducers, collars, caps, plugs, tail pieces, etc. necessary for completion of this item as per site conditions.

The C.I. fittings and specials shall conform to IS 1538/1993 with latest amendments.

The fittings shall be stripped with all the precautions necessary to avoid warping or shrinking defects. The fittings shall be free from defects other than any unavoidable surface imperfection which results from the method of manufacture and which do not affect the use of the fittings.

The fittings shall be such that they could be cut, drilled or machine.

The mass of C.I. fittings/specials shall strictly conform to IS 1538/1993 with latest amendments.

The contractor shall have to procure the required C.I. fittings or specials as per the site conditions and as per direction of Engineer-in-charge.

3.3 M.S. PIPES AND SPECIALS/ FITTINGS

M.S. PIPES

Provide, fabricate, test, paint, supply and installation of M.S. Pipes of specified ID/OD and wall thickness conforming to IS 3589.

Pipes shall be erected on rollers/saddles/supports as required.

All the pipes shall be supplied by the contractor as per actual measurement at site jointly with client's representative.

QUALITY OF STEEL:

PipesshallbefabricatedfromsteelplatesconformingtoIS2062.

MANUFACTURE OF THE PRODUCT:

Pipesshallbemadefromsteelplatesorstripsbybuttweldinglongitudinallyorspirally. Theweldshallbecontinuous.Priortowelding,edgesofplatesorstripsmaybe preparedsuitablywhererequiredbytheprocessofmanufacture.

ORIGINAL CROSS-SECTIONAL AREA OF THE SPECIMEN:

OUTSIDE DIAMETERS:

Theoutsidediametersofthefinishedpipesshallbeasgivenbelow:

Nominal size(in mm)	Outside Diameter(inmm)
200	219.1
400	406.4
500	508.0
600	609.6
700	711.2
900	914.4
1000	1024.0
1200	1224.0
1400	1424.0

Pipesofoutsidediameterotherthanthosecoveredinaboveclauseshallbepermissible asagreedtobetweenthemanufacturerandthe purchaser.

TOLERANCE:

OUTSIDE DIAMETER

- a) Pipe Body- The tolerance on the pipe body shall be as shown below:

<u>Nominal Size</u>	<u>Tolerance</u>
Upto 500mm	0.75 Percent
Over 500mm	1.00 Percent

Note: Measurements may be made by any suitable instrument, such as outside calipers, diameter tapes, micrometers, etc.

- b) Pipes Ends- The tolerance on outside dia. for distance of 100mm from the end of the pipe shall be as follows:

UptoandIncluding250mm +1.6mm - 0.50mm

Above250mm +2.4mm - 0.8mm

- c) Thickness- The tolerance on specified wall thickness shall be as follows: Pipe
+10%

- d) Straightness- Finished pipe shall not deviate from straightness by more than 0.2% of the total length.

Checkings shall be carried out using a taut string or wire from end to end along the side of the pipe to measure the greatest deviation.

- e) Length- Straight pipe shall not vary from the specified overall length by +10 mm or up to 0 mm for length up to and including 6m.

THICKNESS OF PIPES:

The pipe shall have minimum specified wall thickness as per mentioned in Table-3.

TABLE-3

MINIMUM SPECIFIED THICKNESS OF PIPES.

Nominal Size(mm)	Minimum Specified Thickness of pipe mm
Upto 300	4
above 300 to 500	5
above 500 to 600	6
above 600 to 850	7
above 850 to 950	10
above 1000 to 1500	12

HYDRAULIC PRESSURE TEST:

Each pipe shall be hydrostatically tested at the manufacturer's works before the pipe is coated, wrapped or lined at the manufacturer's work.

The Hydraulic test pressure shall be the pressure calculated from the following formula, except that the maximum test pressure shall not exceed 5Mpa.

$$P = \frac{2 \times S \times t}{D}$$

D

P = Test pressure

S = A stress in MPa which shall be taken as 40% of the specified

Minimum tensile strength.

t = Specified thickness in mm and

D = Specified outside diameter in mm.

Test pressure shall be applied and maintained for sufficiently long time for proof and inspection.

Carbon Steel/MS pipe after installation at site with respective joints, piping shall be tested for joint tightness at 150% of Maximum working/ system pressure it is likely to be subjected to.

SPECIFICATION FOR INSIDE/ OUTSIDE COATING:

The pipe internal and external surface shall be coated with Zinc rich epoxy primer and asphaltic bitumen paint of approved quality. No primers shall be applied without prior approval of the owner. The mix of zinc rich epoxy primers shall be prepared at works site not earlier than 15 min. before applying the same on pipes and special surfaces. One coat of zinc rich epoxy primer shall be applied by spray giving a film thickness of approximately 1 ml. No thinner shall be added to ready mix paints without previous approval of the owner and the finishing coats on top of the primer coat shall only be applied after allowing the film to cure for at least 48 hours.

After application of zinc rich epoxy primer, the surface shall be cleaned by duster and inspected. If during inspection any portion is found rusting the same shall be removed by emery paper and coated with zinc rich epoxy primer. When complete section is checked as above, first coat of Inertol 99 equivalent shall be applied, when one coat is applied, the date of application of this coat shall be written on either end of section.

The painting shall be done by cross brushing, i.e. one coat shall be given vertically and another coat shall be given horizontally so as to get required thickness, a good looking surface and also to avoid sagging of paint. Every successive coat of paint shall be given only after 48 hrs. of painting the previous coat. Before applying the next coat, the surface shall be properly cleaned by duster. Each coat of Inertol 99 W thick or equivalent shall give a film thickness of 3-4 mils.

The painting/coating shall be such that it shall not impart any taste or smell to water. Only Food Grade paint shall be used for painting pipes intended for drinking water supply.

LAYING OF PIPELINE:

The laying, jointing and testing of welded steel pipes conform to latest and relevant IS: 5822.

Pedestal shall be constructed by the civil contractor before commencing the pipe laying work in any section.

The welded joint shall be tested as per IS 3600 of 1966.

M.S. SPECIALS:

Scope shall include providing, fabricating, testing and installing M.S. Specials suitable to M.S. pipes, valves and other fittings from steel plates. M.S. Specials shall be

confirming to IS 7322/IS 1538 dimensionally. MS special sand fittings shall be fabricated at site of work tested to specified test pressure and including providing flanges required, painting inside zinc epoxy coating and outside anticorrosive red primer, coated with three coats of anticorrosive waterproof paint including freight, loading, unloading, carting, stacking as directed, and including all taxes, insurance etc. The sizes and types of special shall be as per requirement taking into consideration in tender items like pumps, sluice valves, non return valves, scour valves, expansion joints, dismantling joint etc.

FLANGES:

All MS flanges conforming to IS 6392, PN 0.6 and their dimensions of drilling be in accordance with IS-1538/IS 6392 suitable for pressure 10 kg/cm² (specification for M.S. fittings for pressure pipes for water, gas and sewage) or its latest revision. The flanges shall be flat faced with off centre bolt holes. Prior to manufacturing process, the contractor shall have to obtain approval of Engineer in charge for all sizes and types of flanged drawings.

JOINTING MATERIAL:

Each valve shall be supplied with all necessary joint ring, nuts, bolts and washers for completing the joint on all the flanges of valves supplied under this contract including those flanges which will be jointed to pipe system. The length of bolt shall be assumed to be suitable for jointing M.S. pipes. The cost of all jointing materials supplied under the contract shall be included in rates. Joint rings shall be of flat section at least 3mm. thick. They shall be of rubber in accordance with IS 638-1965.

4.4 G.I. PIPES & FITTINGS

All G.I. piping and Fittings shall conform to IS: 1239.

The screwed end of all GI pipes shall be thoroughly cleaned and painted with a mixture of red and white lead or Teflon before jointing. The joints shall be made by winding a few threads of hemp round the end of tubes and then screwing them into sockets to the full depth of threads. Exposed threads shall be coated with approved anticorrosive paint. No pipes shall be bent/offset to save fittings. The offset in GI pipes shall be made only after the permission of the Engineer-in-charge. If threaded end of pipe is damaged, the contractor shall cut the end with hacksaw and shall prepare new threads confirming to IS 554 to required length.

All fittings shall be malleable galvanized iron approved by the Engineer-in-charge. Fitting in GI lines shall include all couplings, elbows, tees, bends, unions, nipples, reducers, flanges with nuts and rubber insertion and all other fitting to make a complete job.

Flanged joints shall be made by painting the faces of the flanges with red lead and bolting up evenly on all sides with compressed asbestos gasket as per piping material specification.

Flanged or screwed valves shall be installed in locations as directed by engineer-in-charge and/or as shown on the execution drawings after placement of order as per

specification for screwed or flanged joints. All completed G.I. lines shall be hydrostatically tested to a test pressure of 5 Kg/cm²g.

5.0 METALLIC EXPANSION BELLOWS

Expansion bellows shall be designed as per the details furnished in the data sheet and shall be in accordance with the EJMA/ASME standard.

The bellows shall be metallic corrugated design and shall have double flange. The material for bellows shall be SS304. Fatigue life expectancy considered for the Expansion Bellows shall be minimum 7000 cycles.

After satisfactory testing of the Bellows, prior to dispatch, all internal and external unmachined ferrous surfaces of the Bellows shall be thoroughly clean, dry and shall be made free from rust and grease before repainting.

All exposed machined surfaces shall first be given two coats of zinc base primer after completely cleaning the surface and then it shall be coated with three coats of coal tar epoxy paint. The resulting coating shall be uniform and smooth and shall adhere perfectly to the surface. The inside coatings shall not contain any constituents soluble in water or any ingredient which could impart any taste or smell to water.

DOCUMENT: TECHNICAL DATA SHEET FOR METALLIC EXPANSION BELLOWS

SR. NO.	PARTICULARS	DESCRIPTION	DATA TO BE FILLED BY BIDDER
1.0	LIQUID DATA		
1.1	Fluid/Specific gravity	Sewage/1.02	
1.2	Temperature	ambient	
2.0	EXPANSION BELLOWS DATA		
2.1	Make	Pl. furnish detail	
2.2	Manufacturing Standard	EJMA/ASME	
2.3	Size range and quantity	As per SOQ	
2.4	Overall length in mm	As per SOQ	
2.5	Pressure Rating	PN: 1.0	
2.6	Axial adjustment in mm total	30	
2.7	Angular adjustment in degree	3	
2.8	Mode of installation	Horizontal	
2.9	Ends	Flanged, flat faced as per IS-1538 having off center bolt holes	
2.10	No of Convolution	Pl. furnish	
2.11	Thickness of Weld End	Pl. furnish	
2.12	Thickness of internal sleeve	Pl. furnish	
3.0	MATERIAL OF CONSTRUCTION		
3.1	Bellows (M)	SS304	
3.2	Internal Sleeves (M)	SS304	
3.3	Flanges (M)	SS316	
3.4	Lugs	SS316	
3.5	Rods	IS-1367-VI-1994, CI-4.6	
3.6	Hardware	C.S IS1367	
4.0	TESTING		
4.1	Hydrostatic Test pressure	15kg /sq.cm	

Note: 01) M - Denotes material test required

02) Separated data sheet shall be filled in for each Pumping station.

GENERAL REQUIREMENT FOR ALL ABOVE ITEMS: A.

DRAWING SUBMISSION:

All drawings/datasheets/tech.catalogues/documents for various piping & mechanical work/item shall be submitted by bidder as under:

- (a) In Two sets in hard copy along with technical bid for review/evaluation.
- (b) In five sets by successful bidder in hard copy for review & approval including revisions, if any.
- (c) In six sets by successful bidder in hard copy and two sets in soft copy (on two separate CD) of as-built drawings
- (d) In six sets by successful bidder in hard copy and two sets in soft copy (on two separate CD) of O&M manual.

In general, the documents submission for various items shall be as described below:

CENTRIFUGAL PUMP:

The following drawings shall be submitted by the Bidder for review and approval prior to manufacturing:

- 1. Product Technical datasheet.
- 2. Preliminary outlined dimensional drawing (GADrawing) showing the details of pump and motor, Suction, discharge connections and foundation details.
- 3. Performance curves showing capacity v/stotal head, efficiency, NPSH-Required and KW requirements ranging from run out to pump shut off form in., max. and rated impeller dia of offered pump.
- 4. Typical cross sectional drawings showing internal features of pump, parts and their material.
- 5. Torque-Speed curve of the pump.
- 6. Catalogues showing type of construction.
- 7. Quality Assurance Plan.

The following documents shall be submitted along with supply of pumps:

- 1. 3 set of Operation & Maintenance manual.
- 2. 3 set of Tested Curves and records
- 3. 3 set of As built drawings/Documents.

SPARES AND SPECIAL TOOLS

Vendor shall furnish following Lists:

- 1. The list of mandatory spares required for commissioning.
- 2. The list of recommended spares for two years normal operation.
- 3. The list of special tools and tackles required to assemble/dismantle the equipment.

VALVES (SV/ NRV/ BFV)

The following drawings shall be submitted by the Bidder for review and approval prior to manufacturing:

1. Product Technical datasheet.
2. General outlined dimensional drawings.
3. Cross sectional drawings showing constructional details with part list with their qty & MOC confirming relevant standards.
4. QAP of the product.
5. Catalogue showing type of construction.

In addition to above following documents shall be furnished for review and approval when valves are required with Electric Actuator for Operation.

1. Actuator Datasheet.
2. G.A. & wiring Drawing of Electric actuator.
3. Valve Torque Calculations.
4. Product catalogue.

The following documents shall be submitted along with supply of Valves:

1. 3 set of Operation & Maintenance manual.
2. 3 set of Test Certificates

EXPANSION BELLOWS

The manufacturer shall submit the following drawings.

Product Technical datasheet.

Preliminary outlined dimensional drawings.

QAP of the product.

Typical cross sectional drawings showing constructional details with the complete bill of material, MOC and relevant standards.

SLUICE GATE

The manufacturer shall submit following drawings.

Product Technical datasheet.

General outlined dimensional drawings along with part list with their qty & MOC confirming relevant standards.

QAP of the product.

EOT/HOT CRANE/ ECH/CPB/ HOT-MONORAIL

The manufacturer shall submit the following drawings in 5 sets (hard copies) for review and approval prior to manufacturing:

Product Technical datasheet.

Preliminary outlined dimensional drawings.

QAP of the product.

Wiring Diagram of panel

MANUAL/ MECHANICAL COARSE BAR SCREEN:

The manufacturer shall submit the following drawings.

The following drawings shall be submitted by bidder along with the bid.

Data Sheet

Preliminary outlined dimensional drawing

Hydraulic Calculation for head drop across screen for design/peak flow @ 50% clogging.

QA Plan of the product.

B. INSPECTION AND TESTING AT MANUFACTURER'S WORKS:

Inspection & testing of mechanical equipments at manufacture works shall be conducted in presence of engineer-in-charge / client's representative OR third party inspection agency appointed by client.

All the charges for third party inspection shall be included under the scope of contractor. Inspection and testing at manufacturers' works shall be carried out as specified below/applicable IS.

All instrument and equipment required for such tests shall be provided by the Contractor. The instrument shall be calibrated and certified by an approved independent testing authority with valid calibration certificates.

All the tests shall be carried out as per the relevant standard & codes. Brief description of tests to be carried out for various equipments is as follows:

CENTRIFUGAL PUMP:

HYDROSTATIC TEST:

A standard hydrostatic test shall be conducted on the pump casing with water at $1\frac{1}{2}$ times the maximum discharge pressure on the head characteristic curve or 2 times the rated pressure whichever is higher.

Unless otherwise stated in Data Sheet, the hydrostatic test on casings shall be conducted for minimum duration of 30 minutes.

MECHANICAL BALANCING:

Major rotating components of the pumps like impellers, shaft, shaft sleeve etc., shall be individually statically as well as dynamically balanced at rated speed.

Necessary test certificates shall be furnished by vendor for purchaser's approval.

PERFORMANCE TESTING:

Pump shall be tested for its full operating range in accordance with the applicable standard and approved data sheet.

Test shall be carried out with minimum NPSH available at site for rated discharge and maximum discharge. Each pump shall be tested at its rated speed with shop motor for its entire working range.

At least one pump shall be dismantled for internal material and under rubbing marks verification at the time of inspection in the presence of client's representative.

During pump testing, readings to the extent possible shall be taken to correspond to the net effective lift specified in the Data Sheet, and cover its full working range from its closed valve condition to run out condition i.e. when delivery valve is fully opened. Head-flow, Power-flow and efficiency-flow curves shall be drawn based on test readings. The curves produced shall be used to determine the capacity of pump set to meet guaranteed performance at site at rated speed.

MATERIAL TEST CERTIFICATE

Material test certificates for the various pump components shall be furnished for purchaser's review & approval as stated in the Data Sheet.

VISUAL INSPECTION:

Pumps shall be offered for visual inspection by the manufacturer, before dispatch. The components of the pumps shall not be painted before inspection.

WITNESSING OF PERFORMANCE TESTING OF PUMP

Pump Rating	Pump performance Testing to be witnessed for each duty and type (Also see Note below)
upto 15 kW motors	Performance witnessing Not Required. Vendor to submit test cert. For review/approval and dispatch clearance as per Note Given Below prior to dispatch.
> 15 kW upto 75 kW motors	25% Qty. or min. 1 Now whichever is higher per duty/type.
> 75 kW upto 160 kW motors	50% Qty. or min. 1 Now whichever is higher per duty/type.
> 160 kW	100% Qty. to be Witnessed
Note: (1) Manufacturers shall test all the pumps internally and shall provide their Internal test records along with Dynamic balancing, material test certificates for all major parts as per Tender, Hydrostatic test certificate, Dimensional check certificates, etc as per approved QAP & D of each pump for review, record and dispatch clearance prior to dispatch of material. (2) Vendor shall provide Parallel operation curve for pumps where more than two pumps are incorporated in BOQ along with individual pump performance testing witnessing.	

VALVES (SV/ NRV/BFV)

Valves shall be tested at manufacturer works for visual inspection, hydro test, operational test and dimensional check as per relevant standard.

Manufacturers shall offer valves for testing & inspection as per approved QAP and shall furnish all relevant certificates including material test cert. for review and approval.

SLUICEVALVE

Closed End Test of All C.I. sluice valves shall be carried out in presence of Engineer in charge/client's representative at manufacturer works & testing certificate shall be furnished along with each lot of supply.

Valve shall be subjected to hydrostatic tests as described in appendix B of IS: 14846 for 2 minutes duration minimum.

NRV/DPCV

Valve shall be subjected to hydrostatic body and seat tests at appropriate test pressure specified in applicable standard (i.e. IS-5312/API 598-Table-2&3) for minimum 2 minutes duration.

VISUAL INSPECTION:

Valve shall be offered for visual inspection and dimensional check before dispatch. The components of the valve shall not be painted before inspection.

Valve shall be dispatched only after visual inspection and clearing instruction for dispatch.

EXPANSION BELLOWS

Each Bellows shall be subjected to following tests:

Hydrostatic tightness test for 10 kg/cm² pressure for 5 minutes duration minimum.
Compression and expansion test as per data sheet.

VISUAL INSPECTION:

Bellows shall be offered for visual inspection and dimensional check before dispatch. The components of the Bellows shall not be painted before inspection.

WITNESSING OF PERFORMANCE TESTING OF VALVES/EXPANSION BELLOWS

Size of Valves/ Expansion Bellows	Performance Testing to be witnessed for each size/rating and type (Also see Note below)
upto 300 mm dia.	Performance witnessing Not Required. Vendor to submit test certi. For review/approval and dispatch clearance as per Note Given Below prior to dispatch.
> 300 mm dia. upto 600 mm dia.	10% Qty. or min. 1 Nowhichever is higher per size/ rating and type.
> 600 mm dia. upto 900 mm dia.	25% Qty. or min. 1 Nowhichever is higher per size/ rating and type.
> 900 mm dia.	100% Qty. to be Witnessed.
Note: (1) Manufacturers shall test all the valves/Expansion Bellows internally and shall provide their Internal test records for Hydrostatic test along with material test certificates for all major parts as per Tender, Dimensional check certificates, Actuator internal test records for valve, etc as per approved QAP & DS of valve type/expansion bellows for review, record and dispatch clearance prior to dispatch of material. ¹⁰⁰	

SLUICEGATE

HYDROSTATIC TEST:

Each Gate shall be subjected to hydraulic tests as per IS/AWWA for 5 minutes duration minimum.

VISUAL INSPECTION:

Gates shall be offered for visual inspection and dimensional check before dispatch. The components of the valve shall not be painted before inspection.

Gates shall be dispatched only after visual inspection and clearing instruction for dispatch.

WITNESSING OF PERFORMANCE TESTING OF SLUICEGATE:

Size, Class & Type of Sluice Gate	Witnessing for each size, type & class of Sluice Gate (Also see Note below)
upto 800 mm dia./Square	Performance witnessing Not Required. Vendor to submit test cert. for review/approval and dispatch clearance as per Note Given Below prior to dispatch.
> 800 mm dia./square	25% Qty. or min. 1 Now whichever is higher per size/class and type.
Note: (1) Manufacturers shall test all the sluice gates internally and shall provide their Internal test records for Hydrostatic test along with material test certificates for all major parts as per Tender, clearance check test, leakage test, movement test, Dimensional check certificates, Actuator internal test records for gates, etc as per approved QAP & DS of Sluice Gate for review, record and dispatch clearance prior to dispatch of material.	

EOT/HOT CRANE/ CPB/ ECH/ HOIST/ HOT-MONORAIL

EOT/HOT Crane/CPB/ECH/HOIST/HOT monorail shall be tested for overload tests at 125% of the rated load, speed of lifting and deflection check at manufacturer works. All required test certificates shall be furnished for hook, wire rope, brake. etc. and complete crane/hoist/CPB/monorail.

WITNESSING OF PERFORMANCE CPB/HOIST/HOT-MONORAIL

TESTING OF EOT/HOT CRANE/ECH/

Type of Material Handling Equipment	Witnessing for each type & capacity
(Ele./Manual) CPB/HOIST/HOT/- monorail/Elec.Chain Hoist	Performance witnessing Not Required. Manufacturer shall test all the CPB/Hoist & HOT internally and shall provide their Internal test records along with material test certificates for all major parts as per Tender, Dimensional check certificates, etc as per approved QAP & DS of CPB/Hoist & HOT for review, record and dispatch clearance prior to dispatch of material.
EOT/HOT Crane	100% EOT/HOT Cranes shall be witnessed at manufacturer works for performance test as per approved documents/QAP

MANUAL/ MECHANICAL COARSE BAR SCREEN:

The barscreens shall be factory assembled and subjected to following tests at manufacturer's premises.

Dimensional Check: The overall dimension of the screens shall be confirming to the approved drawings & QAP.

Operational Test: The complete Mech. screen including its carriage, rake, drive system and

(for Mech. Screen) brake motor, etc. shall be mechanically operated and tested to verify interference free movement and satisfactory operation with its control panel.

Any other testings shall be as per manufacturing standard & as per approved QAP.

WITNESSING OF PERFORMANCE TESTING OF SCREEN:

Type of Screen	witnessing for each type & size
Manual Removable/Fix coarse bars screen	Performance witnessing Not Required. Manufacturers shall check all the Manual screen internally and shall provide their Internal test records for Dimensional check certificates along with material test certificates for all major parts as per Tender and approved QAP & DS for review, record and dispatch clearance, prior to dispatch of material.
Mechanical Coarse Bar Screen	100% Mechanical screens shall be witnessed for performance test at manufacturer works as per approved QAP & related documents and tender specs.

CI/DI/ MS/GIPIPES & FITTINGS

CI/DI Pipes and fittings shall be offered for inspection and testing as per applicable standards. Pipes and fittings shall be subjected to Hydrostatic test, Mass/weight check and dimensional check as per approved QAP & Bill of Material.

WITNESSING OF PERFORMANCE TESTING OF CI/DI/MS/GIPIPE & FITTING:

Size, Class & Type of Pipes/Fittings	Performance Testing to be witnessed for each size/Class and type of pipe & Fittings (Also see Note below)
upto 300 mm dia.	Performance witnessing Not Required.
> 300 mm dia. upto 600 mm dia.	10% Qty. or min. 1 Now whichever is higher per type size/class/length and type.
> 600 mm dia. upto 900 mm dia.	25% Qty. or min. 1 Now whichever is higher per type size/class/length and type.
> 900 mm dia.	100% Qty. to be Witnessed.
Note: (1) Manufacturers shall test all the pipes & Fittings internally and shall provide their Internal test records for Hydrostatic test along with material test certificates, Mass/weight check statement, Dimensional check certificates, etc as per BOM and as per approved QAP for review, record and dispatch clearance, prior to dispatch of material.	

C. PAINTING REQUIREMENT

PUMPS

All pumps shall be provided with following painting specification.

Surface preparation : Blast clean to near white metal finish.

Priming : 1 coat of red oxide primer before and after shop testing.

Finish painting : 2 coat of epoxy grey paint, minimum 200 micron DFT inclusive of priming.

Colour Code : RAL 7030 or equivalent IS

SV / NRV

COATING:

After satisfactory testing of the valves, prior to dispatch, all internal and external unmachined ferrous surfaces of the valves shall be thoroughly cleaned, dried and shall be made free from rust and grease before repainting.

All exposed machined surfaces shall be painted with one coat of aluminum oxide primer confirming to IS 5660 followed by two coats of black Japan confirming to Type B of IS 3410 paint confirming to IS 9862/IS 2932 shall be applied by brush/spray for exterior application. The coatings shall be such that it shall not impart any taste or smell to water.

The painting shall be such that it shall not impart any taste or smell to water when the valve is offered for potable water.

EXPANSION BELLOWS:

PAINTING:

All Expansion Bellows shall be painted following requirement/specification.

Surface preparation : Blast clean to near white metal finish.

Priming : 1 coat of red oxide primer before and after shop testing.

Finish painting : 2 coat of epoxy paint, minimum 200 micron DFT inclusive of priming.

Colour Code : RAL 5009 or equivalent IS-AZURE BLUE shed

SLUICE GATE:

PAINTING:

After satisfactory testing of the gates, prior to dispatch, all surfaces of the gates shall be cleaned by shot blasted or by wire brush and grinding to base metal, bed dry and shall be made free from rust and grease before painting. After cleaning, following painting procedures shall be adopted for the gates:

A) Priming : 1 coat of red oxide primer before and after shop testing. B)

Finish Painting – Gate: Black bituminous paint for gate assembly. Min. DFT 200 microns.

C) Fin. Painting - : Epoxy red oxide primer and epoxy grey paint. Min. DFT 150 microns. (Yoke & Headstock)

The coatings shall be such that it shall not impart any taste or smell to water when the gate is offered for potable water.

EOT/HOT CRANE/ ECH/CPB/ HOT-MONORAIL

PAINTING:

Steel materials of all structural parts of Crane shall be shot blasted to SA 2_{1/2} finish to remove rust, mill scale and grease prior to fabrication and painted as follows:

1

Prior to Fabrication	: One coat of epoxy paint (primer).
After partial assembly and inspection at the supplier's works	: Two coats of enamel paint.
After erection at site	: One coat of enamel paint.
Colour Code	: RAL 1017 or equivalent IS

The final coat shall be Saffron yellow Colour with black zebra marking wherever applicable. All machined parts shall be coated with grease, varnish or other approved protective coats before dispatching from the supplier's works. Interior of the gear casings shall be painted with one coat of oil resisting paint.

MANUAL BARS SCREEN:

After satisfactory testing of the Manual MS Bars screen, prior to dispatch, all machined / exposed surfaces shall be thoroughly clean, dry and shall be made free from rust and grease before repainting.

All exposed surfaces shall first be given two coats of zinc base primer after completely cleaning the surface and then it shall be coated with three coats of coal tar epoxy paint. The resulting coatings shall be uniform and smooth and shall adhere perfectly to the surface.

TESTING, ERECTION, AND COMMISSIONING

TESTING - GENERAL

Tests of the plant at the manufacturer's premises will be required in accordance with the conditions of contract. All inspection, examination and testing shall be carried out in accordance with appropriate standards.

Testing & inspection at manufacture work of all major items viz. : pumps, motors, valves, sluice gate, grit mechanism, EOT crane, power panels, VCB's, DG Set etc. shall be conducted at manufacturer's work in presence of third party inspection agency appointed by client / and engineer-in-charge representatives of Client.

All the charges for third party inspection shall be included under the scope of contractor. All instruments used for such tests shall be calibrated and certified by an approved independent testing authority not more than 3 months prior to the test in which they are used. The engineer's representative reserves the right to impound any instrument immediately after test for independent testing. A certificate shall be produced by the contractor prior to carrying out every test showing the readings obtained, calculations and full details of the calibration certificates referred to.

If the engineer's representative witnesses the test, he shall be given a copy of the test results and certificates immediately. Whether he witnesses the test or not, copies of test certificates shall be sent to the engineer's representative. No item of the plant shall be forwarded to the site until its test certificate has been approved in writing by the engineer's representative. Six copies of the test certificates shall be supplied in suitable folders with proper index.

Certificates shall be clearly identified by serial or reference number where possible to the material being certified and shall include information required by the relevant reference standard or specification clause.

INSPECTION AT MANUFACTURER'S PREMISES

The inspection of all equipment required to be supplied to complete the work shall be done as detailed in this specification. Only defect free and sound material meeting the technical requirements of this specification and in accordance with a high standard of engineering would be acceptable to the engineer's representative.

For meeting these requirements of inspection, testing (including testing for chemical analysis and physical properties) shall be carried out by the contractor and certificates submitted to the engineer's representative who will have the right to witness or inspect the above mentioned testing/inspection at any stage desired by him. Calibration certificates or test instruments shall be produced for the engineer's consent in advance of testing and if necessary instruments shall be recalibrated or substituted before the commencement of the test. Items of plant or control systems not covered by standards shall be tested in accordance with the details and program agreed between the engineer and contractor.

If during or after testing, any item of the plant fails to achieve its intended duty or otherwise proved defective it shall be modified or altered as necessary, retested and re-inspected as required by the engineer.

At least 21 days notice shall be given to the engineer before the specified tests are carried out.

No material is to be delivered to site without the above described inspection having been carried out or officially waived in writing by the engineer's representative.

One pump of each rating shall be tested with shop motor at rated speed in the presence of client's representative. Shop motor efficiency and ratings shall be submitted to client for approval prior to inspection call.

TESTS AT MANUFACTURER'S PREMISES

SEWAGE/ WATER PUMP SET:

Pump testing and inspections shall conform to the latest standard

(a) Hydrostatic testing

A standard hydrostatic test shall be conducted on all the pressure parts of the pumps at 1.5 times the shut-off head of the pump or twice the rated head whichever is higher. The hydrostatic test shall be conducted for a minimum duration of 30 minutes.

(b) Balancing Test

Impeller and pump rotating assembly shall be dynamically balanced.

(c) Performance Test

Each pump shall be tested for full operating range individually to BS:5316:Part 2. Tests shall be carried out for performance at rated speed with minimum NPSH as available at site.

MOTORS

Motors shall be offered for routine and type tests in accordance with IS:996-1979 and IS:325-1978 at the manufacturer's works. Test certificates shall be endorsed to the effect that the motors are properly balanced and free from vibration. In addition, a test shall be required to establish the maximum transient starting current.

PIPEWORK

Testing of pipes/fittings shall be carried out in accordance with relevant standard.

VALVES

(a) All valves shall be hydrostatically tested close ended. Body, seat/door and back seat test pressures shall be 15 bar, 10 bar and 6 respectively.

(b) Valves shall be tested with associated actuators for general performance.

HOISTS/CPB

(a) The hoist shall be completely assembled in the contractor's or sub-contractor's works and shall be subjected to the tests as specified in IS:807/IS:3177. The contractor shall provide the test weights.

(b) In addition a vertical deflection test shall be carried out with the 'Safe Working Load' suspended from the hook with the crab in the centre of the span. The ratio of deflection to span shall not exceed that specified in IS807. Manufacturer's test certificates for mechanical items shall be furnished.

GATES

(a) Seat Clearance Check

With the gate fully closed, the clearance between seating faces when checked with thickness gauge, shall not exceed 0.1 mm.

(b) Movement Test

Each gate shall be shop operated three times from the fully open position to the fully closed position and return to fully open, under no flow conditions to demonstrate that the assembly is workable.

(c) Leakage Tests

With the gate in the closed position design pressure shall be applied for a period not less than 10 minutes to the unseating side of the sluice gate and the leakage shall not exceed the maximum leakage permissible as per AWWAC-501, for the head applied on the unseating side.

(d) Hydrostatic Tests

Finally a differential of one and half times the design pressure shall be applied to the unseating side of the gate. Under these tests no part shall show any deflection of deformation.

ERECTION-GENERAL

The contractor's staff shall include at least one competent erection engineer with proven suitable, previous experience on similar contract to supervise the erection of the works and sufficient skilled, semi-skilled and unskilled labour to ensure completion of the works in time. The contractor shall not remove any representative, erector or skilled labour from the site without the prior approval of the engineer's representative.

One erection engineer who shall be deemed to be the contractor's representative shall be conversant with the erection and commissioning of the complete works. Should there be more than one erector, one shall be in charge and the contractor shall inform the engineer's representative in writing which erector is designated as his representative and is in charge. Erection engineer is to report to Project Manager.

The contractor's erection staff shall arrive on the site on date to be agreed by the engineer's representative before they proceed to the site, however, the contractor shall first satisfy himself, as necessary, that sufficient plant of his (or his sub-contractor's) supply has arrived on site so that there will be no delay on this account.

The contractor shall be responsible for setting up and erecting the plant to the line and levels of reference given by the engineer in writing, and for the correctness (subject as above mentioned) of the positions, levels, dimensions and alignment of all parts of the works and for provision of all necessary instruments, appliances and labour in connection therewith. The checking of setting out of any line or level by the engineer or engineer's representatives shall in any way relieve the contractor of his responsibility for the correctness thereof.

Erection of plants shall be phased in such a manner so as to obstruct the work being done by other contractors or operating staff whom may be present at the time. Before commencing any erection work, the contractor shall check the dimensions of structures where the various items of plant are to be installed and shall bring any deviations from the required positions, lines or dimensions to the notice of the engineer. Plants shall be erected in an neat and workmanlike manner on the foundations and at the locations shown on the approved drawings. Unless otherwise directed by the engineer, the contractor shall adhere strictly to the aforesaid approved drawings. If any damage is caused by the contractor during the course of erection to new or existing plant or buildings or any part thereof, the contractor shall, at no additional cost to the employer, make good, repair or replace the damage, promptly and effectively as directed by the engineer and to the engineer's satisfaction.

During erection of the plant the engineer will inspect the installation from time to time in the presence of the contractor's site representative to establish conformity with the requirements of the specification. Any deviations and deficiencies found or evidence of unsatisfactory workmanship shall be corrected as instructed by the engineer.

RECORD, PROCEDURES AND REPORTS

The contractor shall maintain records pertaining to the quality of installation/erection work and inspection, testing, compliance with all technical requirements in respect of all his works as described in the previous paragraphs. The reporting format shall be in the approved formats. The contractor shall submit such records to the engineer after the completion of any particular work before submitting the bill of supply/progress of work. Such report shall comprise of shop inspection reports, shop testing reports, material test reports, based on which dispatch clearances are provided, all the quality control reports of welding, erection and alignment records.

All the above mentioned records shall be submitted in the final form duly countersigned by the engineer's representative attesting conformity to specifications and disapproval of installation and duly incorporating all the additions, alternations and information as required by the engineer, on the basis of preliminary reports giving the progress of the work. Such records notwithstanding any records submitted earlier with bill of supply/progress etc. shall be duly bound and submitted to the engineer in six copies by the contractor on his notification of the mechanical completion of erection.

COMPLETION OF ERECTION

The completion of plant under erection by the contractor shall be deemed to occur, if all the units of the plant are structurally and mechanically complete and will include among others such responsibilities the following:

- (a) Plant in the scope of the contractor has been erected, installed and grouted as per specifications.
- (b) Installation checks are completed and approved by the engineer.
- (c) The erected plant are totally ready for commissioning checks.

At the stage of completion of erection, the contractor shall ensure that all the physical, aesthetic and workmanship aspects are totally complete and the plant is fit and bound to undergo commissioning checks/test on completion.

Upon achieving the completion as described above, the contractor shall notify the engineer by a written notice intimating such mechanical completion of units and notify the engineer for inspection and acceptance of mechanical completion. The engineer/engineer's representatives shall proceed with the inspection of such units within 14 days of such a notice.

Thereafter:

- (a) The engineers shall certify completion when there are no defaults in the works and the plant is acceptable or
- (b) The engineer shall inform the contractor list of deficiencies for rectification hereinafter referred as Punch List and the contractor shall complete the rectification work within a jointly agreed period before tests on or approval of the same before proceeding with the Test on Completion or
- (c) The engineer may inform the contractor that the works are accepted with the 'punch' list (Items which do not hamper operability, safety or maintainability) and allow the contractor to proceed with the pre-commissioning checks followed by Test on Completion when the contractor undertakes to complete such outstanding works within an agreed duration of Defects Liability Period.

Taking over shall be based on rectification of all deficiencies as advised by punch lists.

The erection period indicated by the contractor would be deemed to cover all the activities up to completion as stipulated in previous paragraphs, notice of completion by the contractor, inspection by the engineer for completion, and contractor rectification of all deficiencies as noticed by the deficiency/punch list, and acceptance by the engineer of such rectification, prior to Test on Completion.

Minor defects, which in the opinion of engineer which do not hamper operability and maintainability will not be taken into account for deciding mechanical completion. Such defects shall be rectified concurrent to commissioning checks before Test on Completion. However, the engineer's decision in this regard is final.

The commissioning period as notified by the contractor shall be deemed to occur beyond the date of completion and shall include all period of pre-commissioning, trials and Test on Completion.

It is in the contractor's interest to offer the sections/units/systems, progressively under identified milestones within overall erection period, duly completed for inspection by the engineer's representative, obtain his 'punch' list, for rectification of any deficiencies pointed out by the engineer and to achieve mechanical completion before undertaking the Test on Completion within the specified erection period. The engineer also reserves a right to withhold the cost as estimated to be equivalent to the rectification of deficiencies pointed out to the contractor until such a time such deficiencies are rectified to the satisfaction of the engineer.

SETTING TO WORK

On completion of erection the contractor shall request the engineer's representative to carry out the installation inspection.

After the plant has been set to work the contractor shall continue to operate the plant for a period of one week.

INSTALLATION INSPECTION

In addition to the progressive supervision and inspection by the purchaser the contractor shall offer for inspection to the engineer, the completely erected plant/part of plant on which tests are to be carried out. After such inspection by the engineer, each equipment/sub-system shall be tested by the contractor in accordance with the applicable standards in the presence of the engineer. Such tests shall include but not be limited to the tests specified in the following clauses.

PUMPS, PIPING AND VALVES

- (a) The erected pipework shall be subjected to a hydraulic test at 1.5 times the maximum pressure or twice the working pressure whichever is higher to test the soundness of the joints. Provision of the necessary pumps, gauges, blank flanges, tapping etc. for carrying out these tests shall be included in the contract.
- (b) Leakage tests shall be carried out on all erected pipework, pumps and valves immediately after erection and where possible before being built in.
- (c) Operating tests shall be conducted on valves.
- (d) The pump set shall be tested for satisfactory operation. The vibration and noise level shall be checked to be within the specified limits.

PUMP MOTORS

Condition of winding insulation to be tested and insulation values shall be restored to required level by suitable heating arrangements locally.

HOISTS

The hoist and lifting tackle shall be tested to 125% of the safe working load. The contractor shall arrange the test load.

SCREEN Deleted

SLUICE GATE

- (a) Leakage tests shall be performed by the contractor after installation of the sluice gates.
- (b) Under the design seating head and unseating head the leakage shall not exceed the limits specified in AWWAC 501/IS:13349, class 1 for shop testing.

INSTRUMENTATION

Performance of the instrumentation shall be checked as per the design requirements.

COMMISSIONING

SCOPE

At the time of commissioning, the engineer will appoint his representative as commissioning engineer. The contractor shall carry out commissioning tests in the presence of the commissioning engineer. Though the mechanical completion may have been checked and clarified by the site engineers, the commissioning engineer may verify any mechanical completion check to satisfy himself that the plant is fit and sound, if such check had not been witnessed by him. It will be the responsibility of the contractor to make all arrangements for carrying out these tests. The evaluation of test results and decision passed by the commissioning engineer regarding the test results will be final and binding on the contractor. Any additional tests or repetition of tests to establish satisfactory operation of any equipment shall be carried out by the contractor at no extra cost.

MISCELLANEOUS

Completion checks and commissioning tests on items not covered under above, shall be carried out by the contractor as per the instructions of the engineer's representative.

TAKING OVER

No item of plant will be certified for taking over by the purchaser unless it has successfully passed all the tests called for under the contract. If nevertheless the employer uses any part of the works, that part which is used shall be deemed to have been taken over at the date of such use.

Taking Over Certificate for plants shall not be issued unless the following

documentation are duly compiled and submitted in final format in duly bound volumes.

- (a) A compilation of all shop inspection results/reports of the plant/machinery with due attestation that the plants have been manufactured to specified standards (5 copies).
- (b) All erection/construction quality control checks in appropriate approved formats for all installation works with attestation that installation has been carried out as per acceptable/stipulated standards (6 copies).

TENDER/ CONTRACTDRAWINGS-MECHANICAL

SR. NO.	DESCRIPTION	Docs./ DRGSTOBE SUBMITTED	
		WITH BID	AFTER AWARD OF WORK
1.0	Datasheet & Outlinedimensional drawing		
(a)	Pump-motor Set	*	*
(b)	Non Rising spindle Sluice		*
(c)	Non-return valve		*
(d)	Butterfly Valve		*
(e)	Expansion Bellows		*
2.0	Cross Sectional Drawing with Materials of Construction		
(a)	Pump-motor Set		*
(b)	Non Rising spindle Sluice		*
(c)	Non-return valve		*
(d)	Expansion Bellows		*
3.0	Pump performance Curves		
(a)	ISO efficiency curve of Pump (for Q vs H, P & NPSH-R)	*	*
4.0	Motor Curves		
(a)	Starting Current V s time		*
(b)	Characteristic under cold and hot conditions		*
5.0	Non return valves		
(a)	Velocity vs pressure drop		*
6.0	GA drawing of the pumping plants with all dimensions		*
7.0	'As built' GA drawing		*
8.0	Instrumentation Diagrams		
(a)	Dimensional drgs. & installation Drgs. of instru.		*
9.0	Quality Assurance Plans (QAP) for		
(a)	Pumps		*

(b)	NonRisingspindleSluice		*
(c)	Non-returnvalve		*
(d)	ButterflyValve		*
(e)	ExpansionBellows		*
(f)	ElectricHoist&EOT		*
(g)	DI/MS/GI/CIPipes&Fittings		*
(h)	Screens		*
(i)	SluiceGate		*

Note: * Indicatesthe documentrequiredtobesubmitted.

LIST OF APPROVED VENDORS FOR MECHANICAL EQUIPMENT

End Suction Centrifugal Non-Clog Pumps	Beacon Weir/Jyoti/Kirloskar/KSB/M&P(Wilo)/WPIL
Drain/Dewatering/De-silting Pumps (Submersible / Horizontal)	Aqua/ABS/ITT-Flygt/Kirloskar/Kishor/ KSB/MBH/M&P(Wilo)/JASCO
Sluice Valves	Kirloskar/IVC/IVI/Fouress
Non Return Valves (Single/ Multidoor)/Dual Plate Check Valves	Kirloskar/IVC/IVI/Fouress
Butterfly Valves	Kirloskar/IVC/IVI/Audco/Fouress
Ball Valves	Audco/Intervalve/Kirloskar/Saunders/Saturn/Virgo
Electric Actuator	Auma/Rotork
Gear Boxes	Greaves/ Elecon/CPEC/PEPL/Bonfiglioli
C.I. Pipes & fittings.	ElectroSteel/Kejriwal/Upadhaya Valves/NJMW/Eskay(Howrah)/Oriental Castings/BIC
D.I. Pipes	Electrosteel/Kejriwal/Lanco(Kalahasthi)/ Kiswok /Jindal/ Electrotherm/ Trueform Techno Pro.Ltd
D.I. Double flanged pipes & fittings.	Electrosteel/ Kejriwal/Lanco(Kalahasthi)/Kiswok /Jindal/ Electrotherm/ Trueform Techno Pro.Ltd
HDPE Pipes	Astral/Dutron/Duraline/Narmada/RIL(PIL)/ Penwalt/Aniney/Jain Irrigation/Sangir
PVC/uPVC/CPVC Pipes	Astral/Supreme/Prince/Dutron
M.S./C.S./G.I. Pipes	Jindal/Zenith/Tata/Welspun/Samshi/Asian/SAIL
Bearing for all equipment	SKF/FAG/NBCOR OEM Standard
Fasteners	Precision/Darukhanawala/Echjay/Tata/Sundaram OROEM Standard
Mechanical Seals	Eagle Seals(Sealol)/Durametallic/Burgman OROEM Standard
MS/GI Plates & Sheets	Essar/Tata/Jindal/SAIL/Zenith/Asian
Expansion Bellows	Dhruv/Beloflex(B.D.Engineers)/D.Wren/Precision/Precise Engg./SurInd./Athulya

SECTION:C2

**TECHNICALSPECIFICATIONSFOR
ELECTRICALWORK**

DOCUMENT: INDEX

SECTION-C2:ELECTRICALWORK

DOCUMENT: INDEX SECTION-

E:ELECTRICAL

SR. No.	TITLE
A	GENERALREQUIREMENTS
B	DETAILEDTECHNICALSPECIFICATIONS
1.0	11KVSWITCHYARD/TWOPOLE STRUCTURE
2.0	11kVH.T. SWITCHGEAR(VCBPANEL)
3.0	DISTRIBUTIONTRANSFORMER
4.0	SWITCHYARD,TRANSFORMERYARDWITHFENCING&GATE
5.0	LTBUSDUCT
6.0	LT SWITCHBOARD(LTPANELS)
7.0	APFCPANEL
8.0	SOFTSTARTER
9.0	LTMOTORS(INDUCTIONMOTOR)
10.0	H.T.XLPECABLES
11.0	LTPOWER& CONTROLCABLES
12.0	LOCALPUSHBUTTONSTATION(LCS)
13.0	JUNCTIONBOX
14.0	EARTHINGSYSTEM
15.0	INTERNALANDEXTERNALLIGHTINGSYSTEM
16.0	SAFETYEQUIPMENTS
17.0	OTHEREQUIPMENT&ACCESSORIES
18.0	Deleted
C	INSPECTION&TESTING
D	ERECTION,TESTING&COMMISSIONINGOFELECTRICALINSTALLATIONS
E	LISTOFAPPROVEDVENDORS

SPECIFICATIONS FOR ELECTRICAL WORKS

A GENERAL REQUIREMENTS

General Requirements

All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian and International Standard except where modified and/or supplemented by this specification. Only in absence of Indian standards International standards shall be followed.

The equipment shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Codes of Practice. In addition, other rules and regulations as applicable to the work shall be followed. In case of any discrepancy, the more restrictive rules shall be binding.

Completeness of Supply

It is not the intent to specify completely here in all details of the equipment. Nevertheless, the equipment shall be complete and operative in all aspects and shall conform to highest standard of engineering, design and workmanship. The following shall be considered in the scope of work as a minimum.

Any material or accessory which may not have been specifically mentioned but which is necessary or usual for satisfactory and trouble free operation and maintenance of the equipment shall be furnished without any extra charge.

SIT Co of Electrical Equipment with all necessary erection accessories and materials, all steel members (angle, channel, plate, steel sheet, etc.) for installation of electrical equipment, GI pipes, GI conduits, bends, clamps, nut, bolts, hot dipped GI ladder type cable trays, tray installation materials & accessories, cables supporting structures, flexible metal hoses, sealing materials for openings/conduits, single/double compression cable glands, cable lugs, cable tags, cable fasteners, insulating tapes, ferrules, RCC slabs/checker plates, GI/RCC pipes for protection of cables at road crossings and other places, cable markers, cable jointing & termination kits and materials, earthing strips of different sizes, junction boxes, pull boxes, Epoxy paints and all consumable materials for complete laying & termination of cables, earthing system and erection of electrical equipment etc.

Obtaining license/ certificates/ clearances etc. from appropriate Govt. statutory authority/body for installation and energizing the complete electrical system and necessary Liaisoning work for the same (Necessary statutory fees only shall be paid by client).

The quantity/ no. of items, weight and length of cables/ earthing strips, etc. mentioned in tender document are expected use but the payment will be given as per actual items installed, works done and actual length of cable/ earthing strips, etc. actually used and installed.

Submission of all engineering documents, drawings, datasheets, earthing system, layout, etc. for review and approval. All manuals, catalogues, characteristic curves, etc. for various electrical equipment/components shall be submitted.

Contractor shall verify the quantity of cable or such material required as per site condition against quantity specified in BOQ/SOQ and to procurement and place order as per actual site requirement.

All Drawings / Datasheets / Tech. Catalogues / Documents for various electro-mechanical work/ items shall be submitted by bidder as under:

No. of copies for Submission for various Drawings/ Documents shall be as under:

- a) In Two sets in hard copy along with technical bid for review/evaluation.
- b) In five sets by successful bidder in hard copy for review & approval including revisions, if any. (The approved drawings for execution purpose shall be retained in Two Sets by Client, One Set by Client's Consultant and Two Sets shall be returned to Contractor as office and site copy).
- c) In five sets by successful bidder in hard copy and two sets in soft copy (on two separate CD) of as-built drawings
- d) In three sets by successful bidder in hard copy and two sets in soft copy (on two separate CD) of Operation & Maintenance (O&M) manual including manufacturer's O&M and preventive maintenance schedule, recommended spares list, etc.

All above final documents and drawings incorporating modifications, if any, done during erection/commissioning shall be furnished.

SITE/ AMBIENT CONDITIONS

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

Maximum ambient temperature:	50°C
Minimum ambient temperature	: 5°C
Design Ambient temperature:	50°C (Unless otherwise specified for Specific Components/equipment in the Tender)
Relative humidity	: 95%
Climate	: Tropical, Dusty, Corrosive

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

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

CODES & STANDARDS

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

The complete system shall conform to the latest revision 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

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 bidder however, shall have to substantiate equivalence or superiority.

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
IS5621	Hollow insulators for use in electrical equipment
IS:398 (Part-I&II) 1996	ACSR conductor
IS:9920 : Part 1 to 4 :2002	Specification for High Voltage Switches for rated voltage above 1kV and less than 52kV (First Revision)
IS9921	Alternating current disconnectors (isolators) and earthing switches for voltages above 1000V
IS:9385- 1983	Governing spec. for GOAB switch
IS3070	Lightning arresters for alternating current systems
IS15086	Surge arresters
IS8828	Electrical Accessories - Circuit Breakers for Over Current Protection for Household and Similar Installations
IEC60529	Enclosure degree of protection IP-5X

IS3231	Electricalrelaysforpowersystemprotection
IS-4047, IEC-408	Air BreakSwitches
IS-2208, IEC-259-1	Fuses
IS1248	Directactingindicatinganalogueelectricalmeasuringinstrumentsandtheir accessories
IS2419	Dimensionsforpanelmountedindicatingandrecordingelectrical instruments
IS2705	Currenttransformers
IS3156	Voltage transformers
IS2026, IEC60076	Powertransformers
IS11171	SpecificationforDry-TypePowerTransformers.
IS335	Newinsulatingoils
IS1180 (Part-1) 2014	OutdoorTypeOilImmersedDistributionTransformersUptoandincluding 2500kVA,33kVSpecification
IS8468	On-loadtapchangers
IS2099	Bushingsforalternatingvoltagesabove1000Volts
IS6600	Guidefor loadingoilimmersedtransformers
IS-4237	SwitchgearGeneralRequirements
IS13947 IEC60947- 1andIEC 60947-2	Low-voltageswitchgearandcontrolgear
IS-375	PanelWiring
IS3427	A.C.MetalEnclosedSwitchgearandControlgearfor RatedVoltagesAbove 1kVandUptoandIncluding52 kV
IS-2516	MouldedCaseCircuitBreakers
IS3842	Applicationguideforelectricalrelaysforacsystems
IS13925	Shuntcapacitorsforacpowersystemshavingaratedvoltageabove1000 V
IEC61921	Powercapacitors-Low-voltagepowerfactorcorrectionbanks
IS-2959, IEC-158-1	Contactors
IS-1822, IEC-292	Starters
EN50081- 1,50082-2& 60204-1	MicroprocessorSoftStarter
IEC61800 and/orIEEE	HarmonicsControl&ReactiveCompensationOf StaticPowerConverters

519-1992	
IEC721-3-3,class 3C1	Max.CorrosionLevelofthe CoolingAir
IEC721-3-3Class3C2	Max.CorrosionLevelofthe ChemicalGases
UL508C	SolidstatethermalprotectionofACDrive
IS722	Specificationfor ACElectricityMeters
IS12615: 2011	Energyefficientinductionmotors-threephasesquirrelcage.
IS325	Threephaseinductionmotors
IS12065	Permissiblelimitsofnoiselevelforrotatingelectricalmachines
IS2253	Designationtypesofconstructionandmountingarrangementofrotating electricalmachines
IS8789	Valuesofperformancecharacteristicsforthreephaseinductionmotors
IS9283	Motorsfor submersible pump sets
IS9334	Electric motor operated actuators.
IS8130	Conductors for insulated electric cables and flexible cords
IEC:228	Conductorsof Insulated Cables.
IEC:230	Impulse testson cables and their accessories
IEC:502	Extruded solid dielectric-insulated power cables for rated voltage from 1kV upto 30kV.
IEC:540	Test methods for insulations and sheaths of electric cables and chords
IEC:229	Test on cable oversheaths which have special protective functions and are applied by extrusion.
IEC:287	Calculations of continuous current rating of cables (100% load factor).
IEC60751	Industrial platinum resistance thermometers and platinum temperature sensors
IEC61537	Cable management-Cable trays systems and cable ladder systems
IS : 7098 (Part II)	Cross-linked polyethylene insulated PVC sheathed cable for voltage from 3.3kV upto 33kV.
IS : 5831-1984	PVC insulation & sheath of electrical cables.
IS694	PVC Insulated cables for working voltage upto and including 1100 V.
IS1255	Code of practice for installation and maintenance of power cables upto 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 materialsof electric

	cables.
IEC:230	Impulsetestoncables&otheraccessories.
IEC:859	Cableterminationforgas insulatedswitchgear.
IS: 7098 PartI	XLPEInsulatedelectriccables(heavyduty)
IS:3961	Recommendedcurrentratingsforcables.
IS1554	PVC insulated(heavyduty)electriccables
IS3043	Codeofpracticeforearthing
IS2629	RecommendedPracticeforHot-DipGalvanizingofIronandSteel
IS2633	Methodsfortestinguniformityofcoatingofzinccoatedarticles
IS1897	Copperstripforelectricalpurposes–Specification
IS2309	Codeofpracticeforprotectionofbuildingsandalliedstructuresagainst lightning
IS732	Codeofpracticeforelectricalwiringinstallations
IS:1646	Codeofpracticeforfiresafetyofbuildings(General)Electricalinstallation.
IS:2509	Rigidnon-metallicconduitsforelectricalwiring.
IS:6946	Flexible(Pliable)non-metallicconduitsforelectricalinstallation.
IS9537	Conduitsforelectricalinstallations
IS:3854	Switchesfordomesticpurpose.
IS:3415	Fittingsforrigidnon-metallicconduits.
IS3837	Accessoriesforrigidsteelconduitsforelectricalwiring
IS14927	Cabletrunkingandductingsystemsforelectricalinstallation
IS:4648	GuideforelectricalayoutinresidentialbuildingIndianelectricityactand rules.
IS:1293	3pinplugsandsockets.
IS4795	HoldersforIndicatorLampsforElectronicandTelecommunication Equipment
IS3646	Codeofpracticeforinteriorillumination
IS1913	1969GeneralandSafetyrequirementsforElectriclightingfittings
IS:1239, IS:2713	GI LightingPoles
IS1944	Codeofpracticeforlightingofpublicthoroughfare
IS374	Electricceilingtypefans andregulators
IS1293	Plugsandsocket-outletsofratedvoltageuptoandincluding250voltsand ratedcurrentupto16amperes–Specification
IS6665	Codeofpracticeforindustrialighting
IS8224	Electriclightingfittingsfordivision2areas
IS9583	Emergencylightingunits

IS9974	High pressuresodiumvapour lamps
IEC62305	Protection against lightning-Part4:Electrical and electronicsystems within structures
IS1271	Thermal evaluation and classification of electrical insulation
IS1544	Cotton calico
IS1868	Anodic Coatings on Aluminium and its Alloys–Specification
IS2190	Selection, Installation and Maintenance of First-aid Fire Extinguishers—code of practice
IS2546	Specification for galvanized mild steel fire bucket
IS5572	Classification of hazardous areas (other than mines) having flammable gases and vapours for electrical installation
IS9677	Guide for limits of temperature-rise of the windings of electrical equipment when tested by different methods
IS9678	Methods of measuring temperature rise of electrical equipment
IS10118	Code of practice for selection, installation and maintenance of switchgear and control gear
IS15652	Insulating mats for electrical purposes–Specification.
IS5424	Rubber mat
IS4770	Rubber Gloves -Electrical Purposes–Specification
IS2551	Danger notice plates
ISO3046	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 (Part2)	LED modules for General lighting-Performance Requirement
16107 (Part-10)	Luminaires Performance-General Requirement
16108	Photobiological safety of lamps and lamp systems

DESIGN BASIS

The Electrical equipment systems shall be in accordance with project specifications and shall ensure continuity/reliability of supply, flexibility of operation and safety.

The Basic Design Data to be considered as follows:

IncomingSupplyConditions	11kV $\pm$ 10%
Frequency	50Hz $\pm$ 5%
Voltage and Frequency Combinedvariation	$\pm$ 10%
FaultLevelat11kV	350MVAAsymmetrical(1sec)orhigherasper Statutoryrequirement
SystemGrounding	SolidlyEarthed
Fault Level at 415V (Design)	50kASymmetrical(1sec)
Controlcircuitvoltage	230VACviacontroltransformerforLTpanels and110VDCforHTPanelviapowerpack
HVCabbling	3CXLPE,11kV(UE)
LV Cabbling	Alu.ConductorXLPE/PVC
Earthing	Earth Pit: Cu Plate/ G.I. Pipe electrode(ChemicalType) as per IS: 3043 / Specification/Drg.
InductionMotor	EnergyEfficientDesignofIE2/IE3asper IS:12615-2011
Softstarter	DOLstarting,SoftstarterDe-ratedcurrentfor 50° C operating conditions $\geq$ min.110% of ratedmotor current,with in-builtorexternal bypasscontactor,within-line contactor&semi-conductor(fastacting)fuseprotection,required protectionparameters,etc.

Existing HTPowerisin11kVGODstructure fromPowerSupplyCo.11IVTwo pole structure cumMeteringPanelfrompowersupplycompanyandthescopeofworkshall commence fromAugmentation /enhancementofpowerfromthispoint&thescopeof workshall alsoinclude providingclientendGODstructure/s andnecessaryACSR conductorsforevacuationofpowerandonwardtransmission. 11kVHTPowerthan transmitted throughHTcablesburiedunderground/laidincabletrenchandfrom proposedtwopole structuretoproposed11kV HTPanel &thanterminatedtoexisting/proposedTransformers,asapplicable,locatedin existing/proposedsubstation.

Theproposed transformersLTsideshallbeconnected byproposedbusducts&DGset shall beconnected byLTcablestoproposedPMCCpanel.Existing transformer LTside shallbeconnected tooneno.I/cofMCCPanel&anotherincomerofMCCpanelfrom PMCCpanelbyLTCables.PMCC&MCCPanelsshallbefeeddowntstreamAPFCand LDB,PDBetc.forfeedingvariousloads.

Motorsshallbestartedandstoppedbypush buttonsatLocalControl Stationslocated nearrespective motors,asperspecification/SLD/BOQ.Startersshallbehousedin MCCswithSTOP/ START(whereverLCSisnotapplicable)/RESETPushButton.

Inoutdoorareascables shallbemostly burieddirectlyunderground withmechanical protectionwhereverapplicable.In indoorareas,cables shallbelaid intrenchesthrough hotdippedG.I.Cabletray/MSfabricatedcabletraysasindicatedinBOQ/SOQ.

Earthing system design and installation shall be generally 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 resistance shall not exceed one ohm at any point.

Notwithstanding anything mentioned in this tender's specifications & Schedule of Quantities (SOQ)/Bill of Materials (BOM), contractor shall be responsible to provide all equipment and material to complete the electrical installation in all respects at no extra cost. Bidder is responsible to study the technical specifications/SOQ in entirety and understand the requirements prior to bid submission and shall bid/quote accordingly.

General Instructions to tenderers for all the Items of work:

Unit Rate: The unit rate of all the Item work as per BOQ shall include the following job as a minimum:

Delivery of the Equipment at site.

Unloading at site store/proposed area.

Storage and security of supplied material and equipment till installation at site and handing over to client.

Power and Control cabling work between equipments.

Assembling various items as per requirement.

Checking of operation & wiring before commissioning.

Testing & commissioning of equipments.

Supply of necessary spares required for commissioning.

DRAWINGS/ DOCUMENTS

Successful bidders shall submit documents, data sheets, etc., all manuals, catalogues, characteristic curves, etc. for various electrical equipment/components for review & approval.

Detailed documents to be prepared in line with recommended specifications / details and submitted to client in a timely manner to allow for review and approval.

The bidder shall furnish following required drawings/**documents** for each Item for review and approval as a minimum:

- a) List of Drives/Loads with Qty./Rating/Specifications along with power load statement
- b) Transformer, D.G. Set and Capacitor Sizing Calculations
- c) SLD and control diagram of complete electrical system
- d) Wiring/Schematic Drawings for complete electrical system (HT Panels, LT Panels, Lighting Panels, PDBs, etc.)
- e) Overall Cable Layout & Unit Wise Cable Tray layout
- f) Earthing Layout with Earthing Calculations
- g) Internal Lighting Layout with Calculations
- h) External Lighting Layout
- i) Cable Schedule with voltage drop calculation/sizing calculations
- j) Interconnection Schedule

- k) G.A. Drawings for all equipment including sectional drawing wherever necessary, and specifying recommended installation, weight, clearances requirements, etc.
- l) Filled in Data Sheets
- m) Schedule of quantities along with brief specifications
- n) Design/sizing calculations for equipment as applicable
- o) O&M manual for all equipment

VENDOR DATA REQUIREMENT

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

VENDOR DATA REQUIREMENT FOR ELECTRICAL WORK				
Sr. No.	Description	With Bid / offer	For Review / Approval	As-Built
1	Technical details for major equipment	*	*	*
2	List of Recommended Spares	*	*	*
3	Data sheet & B.O.M. for 11kV HT VCB Panel/Motor/Busduct		*	*
4	GA Drawings/B.O.M./SLD/Wiring & Schematic diagram for Power & Control circuit for Transformer / LT Panel /		*	*
5	GA drawing/B.O.M/Technical details for LCS/indoor & outdoor light fixtures /LDB/switchboard/safety equipment		*	*
6	Data sheet & BOM for cable tray.		*	*
7	Cable Schedule/Data sheet/BOM for HT/LT Power & Control Cables.		*	*
8	RCC foundation details for various electric equipment.		*	*
9	Inspection Schedule & QA/Pf for major equipment		*	
10	Test Certificates		*	*
11	O&M Manual (If applicable)		*	*

B DETAILED TECHNICAL SPECIFICATIONS FOR ELECTRICAL WORKS

1.0 11kV SWITCHYARD/ TWO POLE STRUCTURE

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

- a) 11kV 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 cables support.
- c) Chain links fencing shall be as specified in this tender elsewhere.

Generally the HT pole structures 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 sites shall be provided.

Sr.No.	Particulars	Qty.
1	11kV Porcelain glazed Disc Insulator with hardware	3 Nos.
2	11kV, 10kA Single pole Gapless Lightning Arrestor (LA) with all required fitting accessories/ hardware.	3 Nos.
3	11kV, 9kV LA clamp with nut-bolt	3 Set
4	11kV, 10kV LA jumper wire	3 Nos.
5	11kV, 400A, 3-Pole Gang Operated Air Break (GOAB) switch with gang operated mechanism & earth switch and all required fitting accessories/ hardware.	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 porcelain Insulator for 11kV GOAB switch, D.O. fuse, etc.	15 Nos.
8	Fiber operating insulated rod with mechanism & handles suitable for 11kV GOAB switch	1 Set
9	ACSR Mink/Dog/Panther Conductor with required clamps, connectors, hardware etc.	30 Mtrs. 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 Aluminium 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 nut & bolts, washer etc. used shall be hot dip galvanized.

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. 11kV pole structure/ switch gear shall meet all statutory equipment & I.E. rules.

STRUCTURE

A pole structure shall be of rolled steel of minimum ISMB 150mm X 75mm size and min. 9 meters 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 channel of required length & Nos. shall be provided with cross bracing angles ISA of 50mm X 50mm X 6mm size of required length & clamps, cleat etc. shall be fabricated from minimum 50mm X 6mm size MS flats as per actual requirements. All bolts, nuts, washers, etc. shall be of minimum 15mm dia.

All MS parts shall be painted with one coat of red oxide and two coats of aluminium paint. All MS parts shall be galvanized as per IS 2629.

11KV GOAB SWITCH

The GOAB switch shall be triple pole construction and shall be suitable for vertical/horizontal mounting. Each pole consists 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.

Disconnectors and earthing switches, including their operating mechanisms 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.

Insulators 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 and shall be of appropriate voltage rating, suitable for atmospheric conditions specified. 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 handles shall also be provided with an "equalizing braid" earth connection to prevent unequal potential between structure and rod during faults.

11kV DROPOUT FUSE

The D.O. Fuse assembly set has single pole construction suitable for 11kV supply and shall be suitable for vertical mounting. Each pole consists of galvanized steel base, insulators, copper alloy D.O. 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 GOA SWITCH & D.O. FUSE SET.

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

LIGHTNING ARRESTOR FOR 11kV RATING

Lightning arrestor shall be furnished complete with insulating base, anchoring hardware for mounting on steel structure. The arrestor shall be metal oxide gapless type comprising of a stack of zinc oxide valve elements as per IS 3070.

The arrestor 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. Insulator shall be wet process porcelain, brown glazed and free from imperfection. All metal parts and hardware shall be hot dip galvanized.

TECHNICAL REQUIREMENT FOR LIGHTNING ARRESTOR

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

ACSR CONDUCTOR

Aluminium conductor steel reinforced shall be hard drawn from 99.5% pure electrolytical aluminium rods with 60% IACS conductivity. The vendor shall specify the conductivity. The aluminium shall have resistivity of $0.028264 \Omega \text{mm}^2/\text{m}$ at 20°C.

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.

TEST & TEST CERTIFICATE

1) Routine/ Acceptance Test

The inspection may be carried out by the Purchaser at any stage of manufacture.

The following routine tests shall have to be conducted on each set. a)

Power frequency voltage dry test.

b) Measurement of resistance of main circuit.

c) Test to prove satisfactory operation and mechanical strength d)

Dimension check.

e) Millivolt Drop Test

2) Type Test

Certificate for all the type tests conducted on a prototype set of A.B. Switch as per

IS, in a NABL approved test house/CPRI shall have to be submitted.

2.0 11kV H.T. SWITCH GEAR PANEL/ VCB PANEL

Design Criteria

The Switch gear system shall be capable of continuous operation at specified rating under the design conditions specified herein.

The switch gears will be located indoor/outdoor area as per BOQ.

The de-rating of the complete panel include Busbar sections 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 ratings shall not exceed 85 deg C considering reference ambient temperatures as 50°C.

Specific Requirements

The switch gear shall be metal-clad, floor mounted, draw-out type. Enclosures shall conform to the degree of protection IP-4X as per IEC 60529, however, metering sections shall be suitable for IP-5X.

The minimum thickness of sheet steel used shall be 2mm CRCA steel & 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 a padlocking 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 switch gear panel shall be of arc proof version and shall be as per DIN VDE 0670 part 601, IEC-694/IEC-298.

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 breakers 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 breakers shall be provided with 4 ways, 2 positions, lockable in any position, angular movement, lever type handle Local-Remote selector switch.

Each switch gear cubicle shall be provided with a thermostat controlled space heater and single phase 3 pin 15 Amp plug point & light point operated at 230 VAC. 50Hz.

Bus connection from bus compartment to breaker compartment & breaker compartment to cable compartment and bus compartment to adjacent panel 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 4NO & 4NC contacts. The swing of the door shall be more than 90 degree.

Bus and Bus Taps

Busbars 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, electrolytic aluminium (E91-E). **The current density for sizing purpose of aluminium bus bar shall not exceed 0.8A/mm².**

Copper bus bar shall be sized for maximum 1.4A/mm² current density only.

All Busbars, Jumpers connections 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. Busbars, links, live parts, etc. shall have non-flammable Epoxycast-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, Busbar seal-off bushing plate, support insulator etc. shall be non-flammable high tracking fibreglass/epoxy insulation system.

All buses and connections shall be supported and braced to withstand dynamic electromagnetic stresses due to maximum short circuit current and also to take care of any thermal expansion.

CIRCUIT BREAKER

Circuit breakers shall be triple pole, single throw, Vacuum type/SF6 type as per BOQ, 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 breakers shall have manual spring charge as well as motor wound charging facility with Mechanical & Electrical anti-pumping features and shunt trip. Motor wound mechanisms 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 racked 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 devices 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 6NO+6NC contacts, mounted on the draw-out portion of the switch gear.
 - b) Position/cell switch with minimum 3NO+1NC contacts, one each for TEST and SERVICE position.
 - c) Auxiliary switch, with 4NO+4NC contacts, mounted on the stationary portion of the switch gear 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 contacts shall be rated 10AA.C. and 2AD.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 cubicles shall be provided with an earthing facility. Earthing facilities shall be fully interlocked to prevent faulty operation e.g. earthing of live parts. 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 - 6 Nos. (if applicable for motor feeder)

DO

Breaker On
 Breaker OFF

RTD Input

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

PROTECTION & MEASUREMENT

Protective Scheme Requirement

All the main protective relay shall be microprocessor based numerical relays.

Auxiliary relays, timers switches etc. required to make the scheme complete shall be considered as part of the scope of work.

All CT-PT wire shall be brought to test terminal blocks before connecting to circuits.

The circuit of various protection shall be connected to master trip relay though aux. relays (flag indicated).

Aux. relay shall be provided for each transformer fault. Connection of the relay shall be through link to facilitate maintenance.

Contact arrangement, number of poles/ways in control/selectors switch shall be as per the approved drawing/scheme/ requirement.

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 panel shall be provided by the supplier.

IDMT relay shall be numerical type with communication facility.

All relay shall be self/hand-reset type with digital/flag indication. NO/NC contacts for relay shall be as per the requirement of approved protection, annunciation & interlock schemes. Wherever required, supplier shall provide aux. relays for contact multiplication.

Annunciation face shall be mounted on the switch gear panels and detail shall be finalized during drawing approval stage.

Emergency stay-put type off push button/mechanism to be considered.

DC supply fails alarm indication to be considered.

Draw-out type line PT's shall be provided on all incomers with suitable 110 VDC secondary two winding transformer.

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

Sr. No.	Relay	Indication and Monitoring	Digital Type Meter
1	PT fuse failure relay	Breaker On	Ammeter
2	Trip circuit supervision relay	Breaker Off	Voltmeter + VSS
3	IDMT & Instantaneous O/C relay	Breaker trip	MFM with communication Port Equivalent to Schneider (Conzerv) EM 6400
4	IDMT & Instantaneous E/F relay	Spring charge	P.F.
5	Undervoltage relay with timer	Test & Service position, DC supply on	
6	Overvoltage relay	Trip circuit healthy	
7	Anti pumping relay	Phase indication	
8	Master trip relay with hand reset contact (2 NO & 2 NC Contact)	12 window Annunciation panel	

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

Sr. No.	Relay	Indicationand Monitoring	Digitaltype Meter
1	Tripcircuitsupervisionrelay	BreakerOn	Ammeter
2	IDMT &Instantaneous O/C relay	BreakerOff	MFM with communication Port Equivalent to Schneider (Conzerv) EM-6436
3	IDMT &Instantaneous E/F relay	Breakertrip	
4	Antipumpingrelay	Springcharge	
5	Master trip relay with hand resetcontact	Test&Serviceposition,DC supplyon	
6	Lockoutrelay	Tripcircuithealthy	
7	Aux. relayforBuchholzalarm indication&Trip	12 window Annunciation panel	
8	Aux. relay for winding &oil temp.alarmindication&trip		
9	Differential relay(For transformer rating2MVA& aboveonly)		

OutgoingH.T.BreakerOtherthanX'merFeeder

Sr. No.	Relay	Indicationand Monitoring	Meter
1	Tripcircuitsupervisionrelay	BreakerOn	Ammeter
2	IDMT &Instantaneous O/C relay	BreakerOff	MFM with communication Port equivalent to Schneider (Conzerv) EM-6436
3	IDMT &Instantaneous E/F relay	Breakertrip	
4	Antipumpingrelay	Springcharge	
5	Master triprelay withhand reset contact (2NO&2NC Contact)	Test&Serviceposition,DC supplyon	
6	Lockoutrelay	Tripcircuithealthy	
7	Annunciation	12 window Annunciation panel	

Relays&Meters

MFM shall be Microprocessor based numerical and communicable type with RS-485 Port. Communication link shall be provided between MFM and numerical relay to further communication to PLC/SCADA.

All instantaneous current protection relay shall be of 3 pole type.

Relay shall be rated for operation on 110 VDC secondary voltage and 1 A secondary current. Number and rating of relay contacts shall suit the job requirements.

All relay shall furnish, install & co-ordinate to suit the protection and interlock requirement of VCB Panel.

Relay shall be Low burden, provided with RS485 Computer communication Port for monitoring & operation from Remote location/PLC with suitable Software.

Overcurrent protection relay with below minimum Specification or better as per manufacturer STD:

Pickup setting:	5% to 200% in step of 5%
High set:	50% to 1600% in step of 1%
Time setting:	Min 0.05 to 1.0 Sec. in step of 0.05 Sec.

Earth fault current protection relay with below minimum Specification or better as per manufacturer STD:

Pickup setting:	5% to 200% in step of 5%
High set:	50% to 1600% in step of 1%
Time setting:	Min 0.05 to 1.0 Sec. in step of 0.05 Sec.

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 meter 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 0.5 for MFM and ISF < 5 for metering.

The current transformers 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 requirements 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 transformers shall be provided in separate cubicle.

PTs, connection, Insulation level shall be similar to rating of associated breaker.

VABurden shall be selected based on requirement for meters, closing, tripping & indicating circuit.

Voltage Transformers shall be cast-resin, draw-out type and shall have an accuracy class 0.5/3P. Voltage Transformer mounted on breaker carriage is not acceptable.

The PT 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 transformers shall be protected by current limiting fuses. The voltage transformer and fuses shall be completely disconnected and visibly grounded in fully draw-out position.

Low voltage fuses, sized to prevent overload, shall be installed in all ungrounded secondary leads. Fuses shall be suitably located to permit easy replacement while the switch gear is energized.

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 underground 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

Indicating Lamp shall be 20 ϕ 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. 96 sq. mm dial flush mounted digital type with accuracy class 0.5 minimum.

Digital type Multi-function Meters shall be of Accuracy Class: 0.5S (for Active) - IEC-687/CBIP-88 and suitable for measuring and digitally displaying the following parameters: kVA, kW, kWh, kVAR, A, V, P.F., frequency.

Each meter will be provided with at least two output signals of 4-20 mA 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 contact to prevent open circuit of CT secondary.

Annunciation

Shall be static types 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 indications shall be provided on DC failure. Audio alarm with reset facility shall be provided. Visual indications shall be panel-wise.

Spare annunciation points shall be wired up to terminal blocks. 20% spare facilities shall be provided

Sequences 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, i.e. feeder, bus coupler, incomer, etc.). Remote and annunciation face 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 indication 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.

Fuse and link 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; FRLSPVC insulated wires with stranded copper conductors of 1.5mm^2 for control current circuits and voltage circuits. All power wiring like space heaters 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. Wire 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 wire 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 cutouts or openings they shall be protected by providing suitable grommet or gasket around the openings. Interpanel wiring at shipping section 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 10mm² marking strips.

Terminal for P.T. Secondary lead shall be disconnecting link type. Power wiring circuits and PT secondary wiring circuit 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 terminal equal in number to 20% active terminal 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 wires 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.

Cable Termination

Switch gear 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 knockout plates for specified HT Cable connection.

The design of the cable box shall be such that any type of jointing method such as heat shrinkable/push on type/cold shrinkable type termination can be adopted.

Ground Bus

A ground bus shall be 40x6mm tinned copper, shall extend full length of the switch gear in all compartments including cable compartment 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 neutral 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, 6pin plug socket, panel illumination lamp. Cubicle heater, Plug/socket circuit shall have individual MCBs.

230VA. C Supply to the HT panel will be made provided by client.

Auxiliary Power & Control Supply

a) Control Voltages shall be for

- Closing, Tripping Coil : 110VDC
- Indication Circuit : 110VAC

- Spring Charging Motor,
Panel space Heater, 3 pin socket &: 230 VA.C.
Panel illumination
- b) Bus-wires of adequate (minimum 4 sq. mm copper) capacity shall be provided to distribute the incoming supplies to different cubicles.
- c) Isolating MCB shall be provided at the switch gear for the incoming supplies 230 VA.C. supply.
- 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.

Tropical Protection

All equipment, accessories and wirings 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 HTP panel shall be treated with seven tank process with cleaning of scale, greaserust 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 surface shall be given 2 coats of epoxy primer.
After seven tank process and primer coating the HTP panel paint shall be powder coated with **RAL-7035** for inside and outside of the entire HTP panel.

Inspection & Tests

The switch gear 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 be limited to the following for switch gear:

- 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 parts shall be given appropriate High Voltage test. c) Primary current and voltages shall be applied to all instrument transformers.
- d) Routine tests shall be carried out on all equipments such as circuit breakers, instrument transformers, meters etc.
- e) Power frequency withstand insulation HV test for main circuits, auxiliary & control circuits 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/Specs., one 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 work shall be furnished in Four (4) copies for approval of the Owner.
- b) The equipments shall be dispatched from work only after receipt of Owner's written approval of the test reports.
- c) The test reports shall furnish complete identification of the equipments such as serial no., rating, equipment designation as per schematic etc. & date of test.

List of Recommended Spares

Manufacturers shall submit a list of recommended spare parts for two (2) years satisfactory and trouble free operation. Necessary consumable spares shall be also indicated specifically.

DOCUMENT: TECHNICAL DATA SHEET FOR H. T. VCB

Sr. No.	Particular	Details	Confirm be filled bidder	/Data to by the
1.0	General:			
1.1	Make	As per Approved vendor list		
1.2	Model & Type no.	Pl. furnish		
1.3	Design Ambient temperature	50°C		
1.4	Atmosphere	Corrosive, Humid, Dusty		
1.5	Location	Indoor/Outdoor		
1.6	Degree of Protection	IP-4X and IP-5X for Metering section		
2.0	Electrical Data:			
2.1	Type of breaker	Vacuum Circuit Breaker		
2.2	Service	Continuous		
2.3	Voltage	11kV $\pm$ 10%		
2.4	System earthing	Solidly earthed		
2.5	Frequency	50Hz. +5% to -5%		
2.6	No. of phase	3		
2.7	System fault level	350 MVA or higher as per Statutory requirements		
2.8	Rated short time current	18.37kA (1sec.) or higher as per Statutory requirements		
2.9	Max. system voltage	12kV		
2.10	Auxiliary supply: (Power Pack required)	110V D.C derived from Power Pack connected on 110V AC P.T. supply.		
2.11	Making capacity	46KA (peak)		
2.12	Busbar material & current rating	Copper & 630A & 400A as per BOQ.		
2.13	Cable entry	Bottom		
2.14	Cable termination space required for:	For 3C x 240 sq.mm, XLPE armoured cable (UE)		
2.15	Breaker particulars:			
	(a) Operating duty	Pl. furnish/show catalogue/IS		
	(b) Operating mechanism	Motor charged spring/manual trip & close		
	(c) Spring charging motor	230VAC, 200W		
	(d) Trip/Closing coil	110VDC, 180W		
	(e) Anti pumping feature/relay	Required.		
	(f) Latching requirement	Trip free		
	(g) Emergency trip push button	Required.		

Sr. No.	Particular	Details	Confirm befilled bidder	/Datato bythe
	(h) Space heater and cubicle lamp	Required.		
2.16	Constructional requirements			
	(a) Thickness of sheet steel for frame, enclosure, doors, covers and partitions	CRCA sheet-2mm, hinge type door with neoprene rubber gasket		
	(b) Colour	Epoxy powder coating RAL7032 or Two coats epoxy primer & two coats of epoxy paint Shade		
	(c) Earth bus size	40x6mm tinned Copper		
	(d) Foundation frame	ISMC-100, Suitable for three breakers or as per BOQ, with necessary bed plate and foundations bolt.		
	(e) Overall dimension	Provided dimensions		
	(f) Over load of equipment	Provide as per tender		
	(g) Minimum clear space required (i) front side as well as (ii) rear side	Provided dimensions		
2.17	Annunciation Provided	To be Provided as per tender		
2.18	Relays	As per Specifications		
	(a) Relay no. & detail	Shall be as per tender		
	(b) Type of relay	Shall be as per tender		
	(c) Make of relay	Shall be as per tender		
	(d) Model no of relay	Provided details		
2.19	Current Transformer			
	(a) Type of CT	Cast Resin		
	(b) Accuracy class	Provided details as per tender		
	(c) VA burden	Provided details as per tender		
	(d) CT ratio	Provided details as per tender		
2.20	Potential Transformer			
	(a) Type of PT	Cast Resin		
	(b) Accuracy class	Provided details as per tender		
	(c) VA burden	Provided details as per tender		
	(d) PT ratio	Provided details as per tender		
2.21	Panel Accessories			
	Toggle switch for space heater and socket	230VA.C, 6A		
	(b) Socket	6pin 5/15A with DP MCB		

Sr. No.	Particular	Details	Confirm filled bidder	/Data by the
	(c) MCB for spring charging motor circuit	6A, DPMCB		
	(d) MCB for ON/OFF	Double pole, 16A, 110V D.C for D.Cckt. Double pole, 16A, 230V A.C for A.Cckt.		
	Local / Remote selector switch	4 ways, 2 positions, lockable in any position, angular movement, stay put, lever type handle.		
	Trip-Neutral-Close (TNC) Switch.	6 ways, 3 position, spring return to neutral, angular movement, lockable pistol grip type handle.		
	Space Heater	230V A.C, 100W (LT supply from LT Panel)		
	Limit switch for test and service position.	Required		

3.0 DISTRIBUTION TRANSFORMER

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 minor civil works i.e. foundation required for the erection of the transformer are also included in the scope of this contract.

Standards & Compliances:

The transformers shall comply with IS: 2026 (Part I to V) and as per IS: 1180 (Part I)

2014 or latest edition and shall be suitable for service under voltage and frequency fluctuation condition as permissible under Indian Electricity Act 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 $\pm 10\%$ voltage and $\pm 3\%$ frequency or $\pm 10\%$ combined voltage and frequency unless otherwise specified.

The transformers 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.

Transformers shall be designed for frequent direct on-line starting of motor having an equivalent rating in kVA upto CMR of the transformer and shall be capable of withstanding the forces arising from the starting currents of these motors.

Transformers 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 above 2000 kVA shall be considered with OLTC and RTCC.

For transformer rated above 2500 kVA, neutral CTs for stand-by earth fault and REF protection shall be provided. Neutral CT shall be provided before bifurcation of neutral.

For transformers rated higher than 5000 kVA, differential Protection shall be provided.

Creepage distances shall be 31 kV/mm to be considered.

All hardware and radiator shall be hot dipped GI.

The Maximum Total Loss & % Impedance without any tolerance for transformer rating upto 2500 kVA shall be as per **Energy Efficiency Level 2** as per IS: 1180 (Part I): 2014. For transformer rating above 2500 kVA the permissible losses shall be as under:

Transformer Rating	Max. Permissible Load Losses with IS Tol.	Max. Permissible No Load Losses with IS Tol.	Max. Permissible % Impedance Voltage with IS Tol.
3000 kVA	32.0 kW	3.20 kW	6.25%
3150 kVA	33.5 kW	3.40 kW	6.25%
3500 kVA	37.5 kW	3.80 kW	7.15%
4000 kVA	42.0 kW	4.40 kW	7.15%

Tap 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 devices shall normally be off circuit type (OCTC) or on load (OLTC) type if specified in SOQ.

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 indicator shall be positive and there shall not be any ambiguity resulting in incomplete tap change with respect to the mechanical tap position indication.

The operating handle of tap exchangers 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 tank 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.

Fittings

All standard & optional fittings shall be provided as per IS: 1180 (Part-1): 2014. Additional fittings shall also be provided as stipulated in the specification of equipment schedule/datasheet.

Accommodation for Auxiliary Apparatus:

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

Rating Plates & terminal Plates:

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

- a) Rating Plate & Terminal marking plates 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 400 kVA and above.

The design of the relay mounting arrangements, the associated pipework shall be such that mal-operation of the relays shall not take place under normal service. The pipework 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 form 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 pipework shall be avoided.

All wiring connections, terminal boards, fuses and link sets 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 bare 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 with required 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 same percentage impedance, same voltage ratio, same vector group, phase sequence etc.

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, temperature rise tests shall be in variably 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. Bushing 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 busbar 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) Dielectric strength Test on oil.
- d) Buchholz relay operation by simulation test when fitted.

All test results to be recorded and reports should be submitted to the department.

Installation and Commissioning

The transformers 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 transformers 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 transformers shall be dried out 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.

All tests specified in these specifications shall be carried out by the contractor in the presence of inspecting officer/consignee free of cost.

DOCUMENT: TECHNICAL DATA SHEET FOR TRANSFORMER

SR. NO.	PARTICULAR	DETAILS	Confirm/DATA TO BE FILLED BY BIDDER
1.0	GENERAL FEATURES		
1.1	Make	As per Tender	
1.2	Rating in kVA	As per SOQ	
1.3	Installation	Outdoor	
1.4	Service	Continuous	
1.5	Climate	Corrosive	
1.6	Type of cooling	ONAN (Oil natural Air Natural)	
1.7	Ambient temperature	Max. 50° C Avg. 35°C	
1.8	Allowable temperature rise	As per IS:1180 (Part-1):2014	
1.9	Painting	Epoxy, shade no. 631 as per IS :5	
1.10	Oil type	Mineral oil	
1.11	Position	Plinth mounted	
2.0	ELECTRICAL DATA:		
2.1	Earthing: L.V. side	Solid	
2.2	No. of windings	Two	
2.3	Phase	3	
2.4	Frequency	50 Hz.	
2.5	Voltage ratio	11/0.433 kV	
2.6	Phase connection	Delta-Star	
2.7	Vector group	Dyn-11	
2.8	Winding insulation class	"A"	
2.9	Termination suitable for: a) H.V. side b) L.V. side	11 kV (UE), 3CX240 Sqmm Al. XLPE Cable, as per SLD /BOQ	
3.0	TAP CHANGER:		
3.1	Tapping	H.V.	
3.2	Tap changer	Off Circuit ≤ 2000 KVA OLTC (above 2000 kVA) or as per BOQ	
3.3	Tapping range	as per IS-1180 (Part 1):2014	
3.4	No. of steps	as per IS-1180 (Part 1):2014	
4.0	Limit for transformer operation under overload condition as per IS	Pl. furnish	
5.0	ACCESSORIES AS UNDER:	Required	150

SR. NO.	PARTICULAR	DETAILS	Confirm/DATA TO BE FILLED BY BIDDER
6.1. a)	Guaranteed Maximum Total losses without Positive tolerance (no-load + load losses at 75°C) at 100% of rated load.	IS:1180(Part-1):2014/as per specifications	
b)	Guaranteed Maximum Total losses without Positive tolerance (no-load + load losses at 75°C) at 50% of rated load.	IS:1180(Part-1):2014/as per specifications	
c)	Impedance (Percent) on principal tap	IS:1180(Part-1):2014/as per specifications	
6.2 a) b)	Rated current No load current at 100% voltage No load current at 112.5% voltage	As per IS-1180(Part 1):2014 2% of Full load Current 5% of Full load Current	
6.3	Rated efficiency at 0.8 P.F.	As per IS-1180 (Part 1):2014	
a) b) c)	At full load At 100% load At 50% load	Pl. furnish.	
6.4 a) b) c)	Rated regulation At 0.9 P.F. lag At 0.8 P.F. lag At unity P.F.	Pl. furnish	
6.5	Load at which max. efficiency occurs	Pl. furnish	
6.6	Maximum efficiency	Pl. furnish	
6.7	Permissible flux density & Overfluxing	As per IS-1180 (Part 1):2014 Pl. furnish	
6.8	Current density	Pl. furnish	
7.0	MECHANICAL DATA:	Pl. furnish	
7.1	Total Quantity of oil.	Pl. furnish	
7.2 a) b) c) d)	Total Trans. Weight (with oil) Trans. Weight without oil Copper weight core weight	Pl. furnish Pl. furnish Pl. furnish Pl. furnish	
7.3	Dimensions (mm.) including all accessories:	Pl. furnish	152

4.0 SWITCHYARD&TRANSFORMERYARDWITHFENCING&GATE

Fencing around the outdoor transformers substation/11 kV switchyard.

The fencing shall be at a distance of not less than 1.525m on all sides of the substation (pole structure and transformer plinths, as applicable) to ensure free movement all round.

Fencing shall be with Chain links with proper MS Channel supports for better look.

The post shall be installed at 2.5m. centre to centre and of 2.75m. height. The MS Channel shall be 2.375m. above finish ground level (FGL) and 0.6m. below FGL, fixed in cement concrete foundation in 1:3:6 with 40mm size stone jelly. In case of MS angles ISA 75X50mm MS Channel having 6mm thickness shall be used as a minimum. The foundations shall be of suitable size to be finalized during detailed engineering.

To include sand filling of 15cm height. The fences shall be of chain link 75mm size, 10 gauge. The height of fence is 2m after leaving 75mm gap from ground level including fixing the fence with the posts using GI binding wire etc. complete. A gate of minimum 2.5 metres or higher suitable width as required shall be provided on one side of the fencing with necessary access (road/pathway) for ease of mobility of each transformer / vehicular movement and for ease of O&M of switchyard/transformer yard.

Fencing & Gate shall be installed as per site condition/requirement & shall be painted with two coats of primer & one coat of epoxy paint. Paint shade as approved by Engg. - in-charge.

Fencing shall be earthed properly covering all rows on all sides. 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 and spread with 35mm black gravel to a depth of 15cm over a layer of sand.

5.0 LT BUS DUCT

The proposed bus duct will serve as interconnection between MV terminals of outdoor transformers to their respective MV Switchgears and also connection between Switchgears and generator.

Bus duct shall conform to IS 8084; with latest amendments.

Busbars, 3-Ph, 4W, 415V shall be electrolytic aluminium grade E91 - E and of non-phases segregated type. The fault level of complete bus duct shall be as per specified system fault level.

Maximum operating temperature at any point of the bus shall not exceed 85 deg C with the limiting ambient condition specified 50 deg C. Eddy current heating shall be taken into account while designing the enclosure.

Enclosure

All the three phases shall be enclosed in a weather proof, dust tight enclosure.

Outdoor section of the bus duct shall be water proof. Enclosure shall be of CRCA sheet steel fabricated. Degree of protection of bus duct enclosure shall be IP-55. Rain hood/Canopy shall be provided for outdoor portion of the bus duct and shall be designed to offer complete protection from rain. All joints and covers shall be provided with gaskets.

Bus duct enclosure sheet steel shall be CRCA mini. 2.0mm for load bearing members & 1.6mm for non-load bearing members. Gland plates shall be CRCA sheet min. 3.0mm thick. Make of the Bus duct enclosure/ Panel CRCA/MS/GI Plates & sheet shall be "Essar/Tata/Jindal/ Sail/Zenith/ Asian" only.

Weather resistant type circumferential gasket shall be provided for making the joints with adjacent enclosure to meet the IP protection specified.

The connection flanges shall be sufficiently stiffened so as not to bend while tightening the bolts. The outdoor flanges shall be provided with suitable rain protection hood to prevent water entry.

Suitable inspection opening with gasket shall be provided for access to support insulator, bus joint etc. The opening shall not be exposed to rain.

When the bus duct passes through building wall from indoors to outdoors, a wall frame assembly with seal off bushing shall be provided to prevent interchange of air between two sections. These seal off bushing shall be flanged type.

A space heater circuit comprising of MCB/switch, fuses, thermostat and a heater suitable for 240V single phase supply shall be provided in the Indoor and Outdoor section of bus duct. The space heaters shall be located at a suitable location to maintain temperature of air 5°C above ambient throughout the length of the bus duct.

Suitable drain holes with proper plug shall be provided for natural draining of any water collecting within enclosure due to moisture condensation. Necessary slope shall be provided for water drainage so that water does not fall on the switch gear/transformer.

Bus Conductor

The current density for sizing purpose of aluminium bus bar shall not exceed 0.8 A/mm^2 .

Joints made at the factory shall be welded type and the joints to be made at site shall be bolted type preferably.

For bolted rigid/ expansion joints, necessary bolts, nuts, (cadmium plated) washers and other hardware shall be supplied.

Bus bars shall be with R, Y, B & Black (N) - colour coded heat shrinkable PVC sleeves for easy identification and insulation.

Tinned copper flexible connection shall be provided at the end terminations, both at transformer end and switch gear end and min. 1 no. at intermediate places depending upon length and configuration of the bus-duct. The connector shall preferably be laminated to cater for linear expansion of bus bars. The material of flexible shall be same as bus bars. If different material is used, care shall be taken to prevent bimetallic corrosion.

For each shipping section, the bus conductor shall be adequately supported.

Shipping markings shall be adopted for easy identification of shipping section at site.

Matching faces of shipping section shall be clearly identified.

Removable bolted disconnect link shall be provided as per the requirement. The bus on either side of disconnecting link shall be suitably supported. The clearance between the disconnecting pieces shall be such that necessary working clearances are available after removal of the link. Necessary mandatory clearances shall be maintained for this purpose by the Bidder.

Bus bars shall be air insulated. The clearances between phase and neutral shall be as per BS: 162.

BusBarSupportInsulators

All buses and connections shall be supported and braced to withstand stresses due to maximum short circuit current.

Busbar supports shall be made of high quality insulating materials such as DMC, SMC, Araldite, etc.

The bus conductors supporting insulators shall be high strength tracting resistant type with high Creepage surface. Busbar support insulators can be either epoxy based or glazed porcelain type. Fixing arrangement of bus bars to the insulator shall be as per manufacturer's standard, however suitable precautions shall be taken to allow the expansion of the conductor while the busbar is carrying the rated current.

The insulators shall be so located they can be easily removed and replaced without dismantling the bus duct installation.

All buses shall be adequately supported and braced to successfully withstand normal operation, vibration, thermal expansion, dynamic short circuit forces as per fault level and design loads as calculated during detailed engineering stage.

Supporting Structures

All supporting structures required for hanging and/or supporting the complete bus duct shall be included in the scope. This includes all members, indoor/outdoor posts, bolts, shims, base plates, beams, hangers, brackets, bracings and hardware.

All steel members shall be hot dip galvanized after fabrication. All hardware shall be of high strength steel with suitable treatment against corrosion.

The enclosure supporting arrangements shall be such that the bus duct load is not transmitted onto the terminations.

The insert plate required to be embedded in concrete will be provided by contractor and further anchor bolts, plates, members required to support the bus duct shall be included by the Bidder as part of the structural material. Alternatively anchor bolts can be used in which case the bolts shall be shipped in advance for grouting in civil foundation.

Connections and Terminations

All matching flanges, seal-off bushings, gaskets, fittings, hardware, and supports required for termination of the bus duct to MV switchgear and transformer/generator, and any other equipments shall be supplied.

Tinned copper flexible connection for both conductor and enclosure shall be provided for the following:

a) At all equipment terminations (Generator/transformer/MV switchgears/reactors / other equipment)

b) On either side of seal off bushings.

Expansion joints shall be provided on bus conductor and enclosure to take care of thermal expansion as required.

Seal off bushing with wall frame assembly shall be provided wherever the bus duct penetrates the building wall from outdoor to indoor.

Equipment terminal connection shall be readily accessible and shall provide sufficient air gap for isolation of equipment during testing.

If the material of bus conductor and that of the equipment terminal connectors are different, suitable bi-metallic connector shall be provided.

Phase sequence of Bus-bar shall be matched according to the transformer phase sequence.

Earth Bus

2 nos. 50x12mm Aluminium earth bus rated to carry maximum fault current shall be provided. The earth bus shall run the entire length of the bus duct, grounding all parts of the supporting structure and each enclosure section. The earth bus shall be provided with two bolt drilling with GI bolts and nuts at each end to receive 75x10mm GI flat (size as per bus duct fault level) for connecting to the station earth mat.

Wiring

The internal wiring for CT/PT and space heater requirements shall be carried out with minimum 2.5 Sq. mm 1100/650V FRLS insulated stranded copper conductor. For all external connection the same shall be brought to a terminal box and terminal box shall be provided with suitable terminal block of 600V grade. Necessary spare terminal shall be provided for looping the connection.

Finish

Except for supporting steel structures which shall be galvanized, all other material shall be finished with a undercoat of high quality primer surface treatment including phosphating, followed by two coats of synthetic enamel finish paint. The interior surface finish shall be as per manufacturer's standard. The shade of exterior surface finish shall be as approved by engineer-in-charge. Pre-treatment consisting of degreasing, de-rusting, etching, etc. shall be done on all fabricated parts before painting or galvanizing.

6.0 LTPANEL- PCC/ PMCC/ MCC/ APFC/ OTHER LT SWITCHBOARDS

Construction

The MV switchboard panels shall be floor mounting, free standing, compartmentalized, Modular type suitable for indoor installation. The panel shall be totally enclosed and dust, damp & vermin proof. Enclosures 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 units shall be additionally provided with canopy or weather shed for protection.

Overall height of Panel shall not exceed 2375mm (For VFD, Soft Starter panel height up to Max. 2500mm can be accepted) including min. 75mm ISMC base frame. Minimum 175mm height cable alley shall be provided at bottom of each vertical compartment as a part of panel in total height of 2300mm. 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.:

Operational height of starters and control switch gear shall not exceed 1800/1900mm above FFL (irrespective of overall height of panel) for ease of operation of starters.

VFD, Soft Starter cubical compartment rated 75KW and above shall be provided with Min. **750mm width and Mini. 800mm depth & 1800mm Height.**

Busbar chamber compartment shall be provided with Min. 300mm or higher as required.

All type of meters shall be digital type.

MFM shall be considered with communication facility.

CT on Y phase with Ammeter to be considered for 7.5KW and above rating. 3 Nos.

CT with Ammeter and AS to be considered for 30KW and above rated feeder.

MV switchboard sheet steel shall be CRCA mini. 2.0mm for load bearing members & 1.6mm for non-load bearing members. Gland plates shall be CRCA sheet min. 3.0mm thick. All the doors and other 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.

LTPanel shall be of fixed type (except air circuit breaker feeder, air circuit breaker feeders shall be draw-out type), single/double front execution. LTPanel shall be single tier for all incomers & bus couplers and multi-tier for all outgoing feeders. Vacant space on incomer and bus coupler panel shall not be used for mounting the starter and switch gear modules.

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 relay shall be mounted on the front side of respective compartment, for easy operation without opening the door.

Minimum width of Cable alley shall be 350mm and Bus-bar alley shall be 300mm to be provided.

Circuit Breakers for capacitors shall have a current rating of at least 160% of the capacitor rated current. Circuit breakers capability to interrupt applicable capacitive currents shall be specifically verified/supported by manufacturer recommendation.

The switchboard components, Busbar etc. shall be designed to withstand the maximum Designed short circuit level for minimum 1 sec.

Incomer MCCB shall be considered with micro-processor based release with in-built O/C, S/C and E/F protection and all outgoing MCCB for power feeders shall be considered with thermal magnetic release. MCCB shall be suitable for ICS = ICU. The rated service short-circuit breaking capacity (Ics) of MCCB shall be more than or equal to the specified fault level.

The outgoing Motor Feeders should comply with Type-2 Coordination as per IS: 13947.

Panel shall have main horizontal and riser busbars air insulated, housed in a separate compartment, segregated from all other compartments, with sheet steel barriers.

The LTPanel 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. Minimum size of the earth bus shall be 50x12mm Aluminium.

All control wiring except C.T. secondary wirings shall be carried out with minimum 1.5 sq. mm copper conductors. C.T. secondary wirings shall be carried out with 2.5 sq. mm copper conductor.

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 240VAC auxiliary bus for space heater. These space heaters 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 multifunction meters, VFD and soft starters, where provided shall have RS485 port to communicate with PLC/SCADA.

240VAC control supply shall be fed from 415/240V control transformer. Control transformers shall be provided on incoming bus.

All CTs, PTs and Control transformers shall be cast resin type.

2 Nos. auxiliary contactors to be considered for PLC interface.

All capacitors shall be with dielectric losses $\leq 0.2 \text{ W/kVAR}$.

Following DI and DO to be considered for various type of feeder for PLC interface:

Breaker Feeder

DI

- Breaker on
- Breaker trip
- Local/Remote selection
- Breaker test position
- Breaker service position

DO

- Breaker On
- Breaker Off

Motor feeder (All Types including VFD & Soft Starter)

DI

- Motor Run
- Motor Trip
- A/M selection
- VFD Ready (applicable for VFD only)

DO

- Start/Stop latched type

AI

- Speed Feedback (applicable for VFD only)

AO

Speedreference(applicablefor VFDonly)

MOVFeeder(applicablefor non-integralMOVstarteronly)

DI

ValveOpen
ValveClose
OverloadTrip
Local/Remote

DO

ValveOpen
ValveClose

AI

Valvepositionfeedback(applicableasperactuatorspecifications/BOQ)

AO

Valvepositionreference(applicableforModulatedcontrolValve)

BusBar

Busbarsshallbeofhighconductivity,electrolyticaluminium(E91-E)suitablefor carryingtheratedandshorttimecurrentwithoutoverheating supportedon insulatorsmade ofnon-hygroscopic,non-flammablematerialtoensurefreethermal expansion.Withtrackingindexequalto ormorethanthatdefinedinIS.

Aluminiumbusbarsshallbesizedformaximum0.8A/mm²currentdensity only.

Copperbusbarsshallbesizedformaximum1.4A/mm²currentdensity only.

Busbarsforrisersshallberatedtocarry125%oftheratedcurrentofallfeeders connectedtotherisers.

Thecurrentratingofneutralshallbemin. halfthatofphasebusbars.

BothhorizontalandverticalTP&N,busbars,busjointsandsupportsshallbe capableofwithstanding dynamicandthermal stressesofthespecifiedshortcircuit currentsfor1second.

Onlyzincpassivatedorcadmiumplatedhightensilesteelbolts,nutsandwashers shallbe usedforallbusbarsjointsandsupports.

Thehotspottemperatureofbusbarsincludingjointsatdesigntemperatureshall not exceed85 degCfor normaloperatingconditions.

AllbusbarsshallbeinsulatedwithheatshrunkPVCsleevesof1100Vgrade.

AuxiliaryBusbars

Auxiliarypowerbus bars ofsuitableratedsizesshallbeprovidedforall SoftStarters, VFD&allStartersabove30kWrating.Cables/Wiresshallnotbeacceptable.

Auxiliary bus bars of suitable size in copper shall be provided for following application.Exactnumberofbusbarsshalldependonvariouscontrols,metering andauxiliarypowerdistributionrequirement.

Panel space heaters supply and motors space heaters supply.

Control supply for breaker tripping, closing and indication circuits.

Control supply for breakers spring charging motors, motor starter control and indication circuits.

AC potential supply for energy meters, voltage operated relays, etc.

Wiring and Terminal Blocks

All wirings shall be done with IS approved FRLS insulated copper conductors. The insulation grade for these wires shall be 660V grade. The control wirings shall preferably be enclosed in plastic channels or neatly bunched together.

Control/CT circuit wirings shall be FRLS insulated, copper conductor of 2.5 sq. mm size.

Each wire shall be identified at both ends by PVC ferrules.

Interpanel wirings shall be done through PVC sleeves or 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 terminals of panel mounted equipment and devices shall be wired to terminal blocks.

Earthing

All vertical panels shall be connected to a Aluminium earth bus bar running throughout the length of the switchboard. The minimum earth bus size shall be 50x12 sq. mm aluminium shall be considered..

All doors and movable parts shall be earthed using flexible copper connections to the fixed frame of the switchboard. Provisions 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., 10 mm dia hole shall be provided on the earth bus for termination of earth strip/wire.

Name Plate

Name plates shall be provided as per standard.

LTPanel 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 descending order letters size on top of front side of panel.

LTPanel 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 LTPanel shall be treated with seven tank process with cleaning of scale, greaserust 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 surface shall be given 2 coats of epoxy primer.

After seven tank process and primer coating the external paint shall be powder coated with RAL-7032 or paint shade shall be 631 of IS-5 for indoor and outside of LTPanel.

Motor Starter

DOL starter to be considered up to and including 15 KW rating, Star-delta starter to be considered above 15 KW and up to less than 55 KW. Soft starter to be considered for 55 KW and above rating.

MPCB, contactor and Overload relay to be considered for motor feed errated up to and including 15 KW.

MCCB, contactor and Overload relay to be considered for motor feed errated above 15 KW. MPR shall be considered for 30 KW and above rated feeder including for soft starter and VFD feeders (for SS and VFD feeders MPR settings shall be lower than SS/VFD settings). Thermister relay shall be considered 90 KW and above rated feeder.

Switchgear Modules

Minimum 1kVA control transformers shall be provided for each bus section for motor control circuit voltage and each transformer shall be sized for the entire switchboard, with Auto/Manual changeover switch.

Incomer supply to control transformers shall be tapped from incoming side of the Incomer.

Air Circuit Breakers

Circuit breakers shall be air break, motorised, draw out type for feeders rated above 630A.

The ACB shall have 50kA (1Sec.) S/C withstands rating and having I_{CW} for 1Sec. = I_{CS} = I_{CU} = I_{CW} . The breaker shall be electrical draw-out type and electrically operated motor spring charging type in open execution

All ACB shall be of Schneider Masterpack-NW or Siemens 3WL or L&TU power or equivalent from approved list

All ACB shall comply and tested as per IS-13947/IEC 60947-1 and IEC 60947-2 standards.

ACB for all Incoming, Bus coupler and PCC Feeder outgoing should be Four Pole Type.

ACB shall be with communication facility.

ACB Trip Releases 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

Trip Indications

Ammeter Display

ACB shall be fitted with following

Heavy duty switches having not less than 4 NO + NC contacts

Built in resin cast current transformer

Auxiliary contacts

Shunt and undervoltage tripping device

The ACB shall be suitable for locking the breaker in various positions. Provision for door locking ACB shall be provided with the requisite end termination lugs/sockets. Terminal bars for connecting more than one terminal.

Switches/Fuses

The switches or fuses switch 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 contactor shall be air break type, equipped with three main contacts and minimum (2NO+2NC) auxiliary contacts. The main contacts of a particular contactor for motor starter modules shall have AC-3 rating.

Unless otherwise specified, the coil of the contactor shall be suitable for operation on 240V, 1Ph., AC supply and shall work satisfactorily between 65 to 110% of the rated value.

Bimetal Relay

All bimetal overload relays shall be of manually reset type with at least 1NO and 1NC contact with reset type push buttons, mounted on doors such that it shall be possible to reset the O/L relay without opening the compartment door.

Moulded Case Circuit Breakers (MCCB)

All MCCBs shall comply and be tested as per IS-2516 / IEC 60947-1 & IEC 60947-2 standards. MCCB shall be provided with short circuit delay & instantaneous protection, overload protection and Earth fault protection as in built-in protection along with time delays. Position of the knob shall be clearly indicated ON, OFF and TRIP conditions as a minimum in front and 1NO+1NC Aux. Contacts. All MCCBs shall be considered with operating handle with padlocking facility.

All MCCBs shall be of min. 50kA (1sec.) rated ultimate short circuit breaking circuit current rating as a min. or of higher short circuit current rating capacity as per fault level. MCCB as part of motor starter modules shall be current limiting type and type tested for Type-2 co-ordination as per IS: 13947/IS/IEC: 60947.

Protective Relays

All relays (Except Lock-out and Auxiliary relays) shall be numerical type with communication facility.

Relays shall be rectangular in shape, flush mounting type, having dust tight covers, removable from front, and shall be equipped with externally reset, positive action operations indicators. The relay shall have auxiliary units of either series connected or shunt connected type. All auxiliary relays shall be non-drawout type and protection relays shall be draw-out type with test facilities.

Test plug shall be supplied loose. All relays shall conform to the requirements of IS-3231 or relevant IEC in general and IS-3231 in specific.

Relays shall be provided with adequate number of potential free self-reset/hand reset output contacts as required. Provision shall be made for easy isolation of trip circuit of each relay for the purpose of testing and maintenance.

Motor Protection Relay (MPR)

Motor Protection Relay (MPR) shall be provided above 30 KW motors/ starters & except soft starters.

Relay (MPR) shall be electronic type with having Overload, Earth fault; Phase current out of balance, Over Voltage & under Voltage, Phase loss/reversal, No load running, Negative sequence & Single Phasing Preventer protection.

Ten channels Temperature scanners shall be provided to detect high winding, and bearing temperature in order to generate tripping signals. The input signal to temperature scanners 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°C
3	Alarm Contacts	Adjustable 4 Nos. (High temperature and very high temperature) for motor winding and bearing temperature high, very high and bearing temperature high and very high.
4	Type of Relay contacts	One Single Pole Double Throw per set point (Relay)
5	Input Signal	From RTDs for each Motor
6	No. of channels	10 Nos. (6 Nos. for Winding, 2 nos. Bearing, 2 Nos. Spare).
7	Accuracy	1°C
8	Communication	RS-485 for Instrumentation panel interface

Instrument Transformers (CTs/PTs)

Current transformer & potential transformers 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.

Current transformers for instruments & protection shall have an accuracy class as per SLD.

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 generally of square pattern type of 96x96 mm suitable for flush mounting. Instruments shall generally conform to IS: 1248 & shall have accuracy class of 1.0 or better.

Digital meters shall have 3½ Digit, LED/LCD display as a minimum

All auxiliary equipments such as shunt transducers, CT's, PT's etc., as required shall be included in the supply of switchboard. The current coil of ammeters and potential coil of voltmeters shall continuously withstand 120% of rated current and voltage, respectively, without the loss of accuracy.

Digital type Multi-function Meters shall be of Accuracy Class: 0.5S (for Active) - IEC-687/CBIP-88 and suitable for measuring and digitally mini. three lined displaying the following parameters: kVA, kW, kWh, kVAR, A, V, P.F., frequency & with RS485 communication port.

Danger Notice Plates:

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

Push Buttons

Push buttons shall be of tight type with 2NO + 2NC contacts; each contact shall have rated operational current of not less than 4A (AC-11)

Push buttons for START, OPEN, CLOSE, LEFT, RIGHT, FORWARD, REVERSE etc. shall be of flush type with spring aided self-reset contacts.

Push buttons 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 button shall be in compliance with IEC 60947-5-5

Push button colour 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

SHOP DRAWINGS

Prior to fabrication of the Panels the supplier / contractor shall submit for consultant's approval the shop / vendor drawing consisting of G.A. drawing, sectional elevation, single line diagram, bill of material etc. and design calculations indicating type, size, short circuiting rating of all the electrical components used, bus bar size and calculation, internal wiring size, Panels dimension, colour, mounting detail etc. in 6 sets..

The contractor shall also submit manufacturer's catalogues of the electrical components installed in the Panels along with the drawing.

INSPECTION

At all reasonable times during production and prior to transport of the Panel to site, the supplier/contractor shall arrange and provide all the facilities at their plant for inspection.

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 types of test certificates and routine test certificate for the test carried out at factory and bought out material and at sites shall be submitted in duplicate to the consultant for approval.

DOCUMENT: TECHNICAL DATA SHEET FOR MEDIUM VOLTAGE PANEL BOARD

SR. NO.	PARTICULAR	DETAILS	CONFIRM/ DATA TO BE FILLED BY THE BIDDER
1.0	SITE CONDITION		
1.1	Type/Make	Indoor/As per tender	
1.2	Mounting	Floor	
1.3	Ambient Temperature	50° C	
1.4	Atmosphere	Corrosive, Humid and Dusty	
2.0	CONSTRUCTION		
2.1	Housing	2.0mm thick CRCASheet for body and all partitions	
2.2	Protection Class	IP-5X	
2.3	Doors	1.6mm thick CRCASheet with Hinges	
2.4	Base channel	75x40mm CC channel	
3.0	OPERATIVE CONDITION		
3.1	Voltage	415V±10%	
3.2	No. of phase	3	
3.3	System	3 phase, 4 wire	
3.4	Frequency	50Hz, +5%/-5%	
3.5	Fault Current	50kA as per SLD	
3.6	Neutral Grounding	Solid	
4.0	CONTROL SYSTEM		
4.1	Voltage		
	For Indication	230VA.C.	
	For Metering	230VA.C.	
	For Protection	230VA.C.	
4.2	Control Supply Through Control Transformer	230VA.C. for MCC & APF Only	
4.3	Control Wiring	1.5 / 2.5mm ² FRLSCu. Wire	
5.0	BUSBAR		
5.2	Neutral Busbar Material	Same as Phase Busbar.	

5.3	EarthBusbarMaterial	AsperSLD	
6.0	PLCBasedSystem	Asper SLD /BOQ.	
7.0	ElectronicMotor ProtectionRelay(withRS-485port)	Microprocessorbased	
7.1	Type	Aspertender	
7.2	Make	Aspertender	
7.3	Protection	Pl.furnish	
	1)overcurrent 2)singlephasing 3)phasereverse 4)Currentunbalance 5)undercurrent(dryrun) 6)stall(bearingbroken) lockedrotor 7)RestartInhibition 8)Ground/Earthfault(CBCT)		
8.0	PAINTING		
8.1	Sheetshouldbe7tankprocess ed,OvenBakedat310°C withpowdercoating.	Required	
8.2	Colour	RAL 7032/7035 asper RMC Req.	
8.4	Shade: Exterior&Interior	RAL 7032/7035 asper RMC Req.	
9.0	PANELTEMPERATURE RISE		
9.1	Max.temperaturerise insidethepanel(°C)	35°Caboveambient	
10.0	ControlWiring		
10.1	WireSize	1CX2.5Mm ² /1CX1.5Mm ² Cu.	
11.0	Hardware(ZincPlated)	YES	
12.0	SpaceHeater	230VA.C.withthermostat	
13.0	PocketForDrawingsat door	YES	

14.0	Annunciator Window (Free standing to be mounted at convenient location with required cabling, required contacts should have separate terminal block in cable alley)	Indication for each Pump: a. Pump Trip (Red) - Through starter b. High level in sump c. Low and very low level in sump d. High and low discharge pressure e. Valve Motor Trip	
15.0	Instrumentation compartment	Separate compartment for energymeter, Hrmeter, level controller, etc. with necessary internal wiring	
16.0	Panel Internal Lighting	Auto NO contact/switch with Panel door and CFL 18W for Panel Internal Lighting	

Note: Other specifications not mentioned in data sheet shall be considered as per tender specifications

7.0 AUTOMATIC PFIC PANEL & CAPACITOR BANK

The control equipment including capacitor shall be mounted in a panel made of 2 mm cold rolled sheet steel for all load-bearing members and 1.6 mm for doors and covers. The panel shall be of indoor type for internal part of LT panel as a cubical compartment as per SLD/BOQ.

The housing of the capacitor banks shall be of open construction with free ventilation for capacitor units (IP5X). The connections from the capacitor units to the control panel shall be carried in totally enclosed, dust-proof, vermin-proof bus-ways or wire-ways.

All capacitor shall be with dielectric losses $\leq 0.2 \text{ w/kVAR}$.

Except for the specific requirements of PFIC/APFC panels specified herein, rest all specifications shall be as per LT Panel/MV Switchboard specifications specified above. APFC Panel ratings shall be at 415V & APFC Panel shall be as per IS-16636:2017

The automatic control panel shall comprise of the following:-

MCCB for Protection of Each Capacitor Bank (MCCB should be suitable for Capacitor Switching)

Microprocessor based APFC Relay for sensing and correction the power factor of the system with required no. of steps to achieve the specified improvement in power factor.

'ON' and 'OFF' push buttons for manual control of each capacitor unit with indication lamp.

'ON' indication lamps with LED type lamps for each capacitor unit.

Auto/manual Selector switch and On delay timers shall be considered for each capacitor feeder.

Capacitor Duty Contactor with series Reactor.

Any other components required for satisfactory and safe operation.

Capacitor Banks shall comprise identical delta connected three phase units.

Capacitor Banks shall be non-flammable, non-toxic, all polypropylene type with extended foil design. Capacitors should be of APP Double Layer Type only.

Capacitors shall be compact in size and hermetically sealed. In built fuses & surge suppressors shall be provided for protection of each capacitor element.

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.

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

Fully dimensioned general arrangement drawing of capacitor and capacitor control panel with elevations side view, sectional view and foundation details.

Complete schematic and wiring diagrams for capacitor control panel.

8.0 SOFTSTARTER (FORMING PART OF FLT 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 starters shall consist of built-in MODBUS RTU for monitoring & control.

Soft starters should be built for continuous operation without need of bypass 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.

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 Starters shall be min. 110% of rated current of motor.

Soft Starters shall be rated for DOL starting and shall have **In-built/External Bypass** Contactor of **AC3** rating as per SLD/BOQ.

Soft starters shall be provided with breaker (MCCB/ACB) along with F.A. Semi-conductor fuse protection and with series contactor or frating as recommended by vendor and meeting Type-2 co-ordination requirement (soft starters 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 closes 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 high nos. as required. The enclosure cooling fans & temperature sensing device (RTD / Thermistors) with tripping arrangements 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 starters shall be tripped/shall not turn ON. Vent shall be provided with washable filter.

Soft Starters shall be provided with conformal coating to protection level 3C2 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

a) 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 controllers 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 settings shall be adjustable from 0 to 200% of motor torque.

The end torque settings 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

Protection of Controllers shall meet applicable standards.

Protective Features: Motor Thermal Overload – selectable for starting class 10A, 15A, 25A underload protection (to avoid dry run), Soft Start thermal overload, PTC input, Phase imbalance, Phase reversal, Overvoltage, Undervoltage, 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 Protection should be available in bypass mode also.

When fault conditions are detected, the controllers shall inhibit starting or shut down SCR pulse firing.

Fault Indications: Controllers shall indicate latest fault indications/occurrence for Line failure, Phase imbalance, Overtemperature – motor, Overtemperature – Soft Starter, Shorted Thyristor, Open Thyristor, Locked Rotor, Motor output loss, Overload & Underload – Shaft Torque, Overvoltage, Undervoltage, 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 & Runtime in hour etc.

9.0 INDUCTION MOTOR

SCOPE:

This specification covers the design, manufacture, inspection, testing at works, supply, delivery to site, installation, testing at 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 conform to the IS 325 and IS 12615-2011 or latest applicable standards.

GENERAL DESIGN AND CONSTRUCTION REQUIREMENTS:

Motors shall be continuous maximum rated as per IS: 12615-2011, IS: 325, 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 armored PVC/XLPE insulated Aluminium conductor of appropriate size/ ratings. Motors shall be of energy efficient design of IE2/IE3 as per IS: 12615-2011.

All motor 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 ratings for motor 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 motor 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	:	10%
Design Temperature	:	50°C

2) STARTING

- Unless otherwise specified, motor shall be designed for direct-on-line starting.
- Motor shall be designed for re-acceleration under full load after momentary loss of voltage with the residual voltage being 100% and in phase opposition to the applied voltage.
- 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.
- The motor shall be suitable for starting under specified load conditions with 75% of rated voltage at the motor terminals.
- Motor shall be designed to allow the minimum number of consecutive starts indicated in Table-I below:

TABLE-I

Starts	Min.no.ofConsecutiveStarts
No.ofconsecutivestart-upswithinitial temp.oftheMotoratambientlevel(cold)	3
No.ofconsecutivestart-upswithinitial temp.oftheMotoratfullloadoperating level(hot)	2

3) **DirectionofRotation**

Motorsshall besuitable foreither direction ofrotation.Incaseunidirectionalfan isprovidedfor motors,directionofrotationforwhichthe motor isdesignedshall bepermanentlyindicated bymeansofanarrow. Whenamotorisprovidedwith bi-directionalfans,a doubleheadedarrowsshouldbeprovided.

Normallyclockwiserotationisdesiredasobservedfromdriving(coupling)end.

Ample space shall be provided in terminal box for interchangingany two externalleadsforobtainingreversephasesequenece.

PERFORMANCE

- 1) Motorsshallbe ratedforcontinuousduty(S_1)unlessotherwisepecified.
- 2) Unlessotherwisepecified,thestartingcurrent(as%ofratedcurrent)shallnot exceed600%subjecttotolerance.
- 3) Inparticular cases,whenthestartingcurrentistobelimitedorwhenstarting withreducedvoltage, caeshallbetakensuchthatthedesignvalueoftorque meetstheloadrequirement whileatthesametimecomplyingofabove mentionedclausefor"starting"requirementofmotor.
- 4) Startingtorqueandminimumtorqueofthemotorshallbecompatible withthe speedtorquecurveofthedrivenequipment underspecified starting and operatingcondition.
- 5) Forheavydutydrivessuchasblowers,etc.highstartingtorque motorsshallbe provided.
- 6) In case where characteristics of driven equipment are not available while selectingthemotor,minimun startingtorqueshallbe110% ofratedvalue for motorsupto75 KWandshallbe90%of ratedvalueformotorsabove75KW.
- 7) Thepullouttorqueatthe rated voltageshallbenotlessthan175%ofthe rated loadtorque withnonegative tolerance.Unlessotherwise agreed, thepullout torqueshallnot exceed300%of ratedloadtorque.
- 8) Incaseofmotorsdrivingequipment withpulsatingloads(e.g.reciprocating compressors)theminimumvalueofpullouttorqueat75%ofratedvoltage shallbemorethanthepeakvalueofpulsating torque andthecurrentpulsation shallbelimitedto40%.

CONSTRUCTIONALDETAILS

MotorCasingandTypeof Enclosure

Motorsforuseinsafeareashallbeofindustrial typemeetingthespecifiedambient conditions,startingandoperatingrequirements.Motorsforuseinhazardousareas shallhavetypeofprotectionEx-dorotherasperareaclassification andtomeet requirementofapplicableIndianStandards.

ThemotorenclosureincludingterminalboxesandbearinghousingshallhaveIP:55 degreeofprotection.

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

All vertical motor 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.

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

Motors installed in outdoor area shall be provided with FRP type canopies/covers.

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

Windings

Insulation and bracing

Unless otherwise specified, motor 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.

Overhang of windings shall be DOUBLE coated with epoxy gel.

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

Windings shall be double insulated, vacuum impregnated

Windings shall have Class H insulation.

Motors rated 11 KW and above shall have forced cooling arrangement and for motors rated less than 11 KW, frame sizes shall be suitably selected for effective heat dissipation.

Motor 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 considered at the side of the motor.

Bearing and Lubrication

Motor 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 nipple 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 motor shall be self-ventilated, fan cooled. VFD operated motor shall be VFDDuty.

Rotor

The motor shall be squirrel cage type, dynamically balanced to provide low vibration level and long service life of the bearings.

Shaft Extension

Motor shall be provided with 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 30kg 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 240V, Single Phase, shall be provided for motors as per SLD/rated 30KW 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.

Thermistors/RTD, one for each phase, 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 thermistors.

Name plate shall be provided on each motor as per IS.

Noise level and Motor Vibration shall be within the limits as laid down in IS.

MOTOR TESTING

Testing of motor shall comply with the requirements of IS: 4029. Motor shall be subjected to all routine tests as per IS 12615-2011/ applicable standard, shall be carried on the motors in OEM factory, in witness of client/TPI agency. All type test certificates shall be furnished during factory test. Generated values of efficiency and power factors at full load and $\frac{3}{4}$ load shall be furnished by the tenderer.

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

GAD & Preliminary outlined dimensional drawings showing other details of motor, terminal boxes etc.

Typical cross sectional drawings showing constructional details with the complete bill of material and relevant standards.
Performance curves.
Data Sheets

DOCUMENT: TECHNICAL DATA SHEET FOR INDUCTION MOTOR

SR. NO.	PARTICULAR	DESCRIPTION	CONFIRM / DATA TO BE FILED BY BIDDER
1.0	Make	Pl. Furnish	
2.0	Application	Pl. furnish as per applicable	
3.0	Type of motor	Squirrel cage induction	
4.0	Motor Ratings in KW	Please Furnish Detail	
5.0	No. of units / Qty. - nos	As per BOQ / Tender	
6.0	Supply neutral	Solidly earthed	
7.0	Rated voltage	415V	
8.0	No. of Phase & frequency	3 Phase & 50 Hz.	
9.0	Full load Amp. - A	Pl. Furnish	
10.0	Supply condition	±10% voltage variation ±5% frequency variation ±10% combined variation	
11.0	Synchronous Speed	As per BOQ / Tender	
12.0	Duty condition as per IS 325/12615 or equivalent	S1 suitable for continuous operations	
13.0	Method of starting	DOL / Star delta / Soft Starter / VFD etc. as applicable	
14.0	Guaranteed Motor Efficiency @ full load @ 3/4 load @ 1/2 load	Motor shall be IE2 / IE3 as per IS: 12615-2011. Pl. furnish	
15.0	Power Factor @ full load @ 3/4 load @ 1/2 load	As per IE2 / IE3 as per IS: 12615-2011. Pl. furnish.	
16.0	Starting torque % of full load torque	Sufficient starting torque to start the maximum full load of driven equipment. Pl. furnish.	
17.0	Pull out torque % of full load torque	Sufficient to bring the motor to normal speed in minimum time. Pl. furnish.	
18.0	Starting time at specified minimum starting voltage Sec.	Pl. furnish (As per Tender)	
19.0	Permissible running time at full load at minimum allowable voltage Min.	Pl. furnish (As per Tender)	
20.0	Locked rotor current withstand time (safestall	Pl. furnish (As per Tender)	

SR. NO.	PARTICULAR	DESCRIPTION	CONFIRM/DATA TO BE FILED BY BIDDER
	time)at110%rated voltage		
20.1	At ratedtemp.(Hot)	Pl.furnish(AsperTender)	
20.2	Whencold	Pl.furnish(AsperTender)	
21.0	Classofinsulation&temp.riseby thermometer	Pl.furnish(AsperTender)	
22.0	Design temperature	50°C	
23.0	Location	AsperTender	
24.0	Hazardousareadivision	AsperTender	
25.0	Atmosphere	AsperTender	
26.0	a) TypeofCooling b)Typeofenclosure c)Degreeofprotection	Pl.furnish. Pl.furnish. ForMotor&TB:min.IP55:	
27.0	Terminalbox	AsperMfg.Standard	
28.0	EarthingTerminals	Requiredasper IS.Min.2no.	
29.0	Externalcabledetails.	Asperthe SLD/Tender	
30.0	Shaft-Hollow/Solid	Pl.furnish(AsperTender)	
31.0	TypeofCouplings	Pl.furnish(asperTender)	
32.0	Typeofbearings	Pl.furnish(AsperTender)	
33.0	Colourshadeofpaint	EpoxyGreyscale632asper IS:5	
34.0	Spaceheaterformotors	ConfirmasperSLD /SOQ/ Tender	
35.0	RTD/Thermistors	ConfirmasperSLD /SOQ/ Tender	
36.0	Windingconnections	6Terminals	
37.0	Standardtobefollowed	IS12615,325,8225,4889, 4772,4029,4691andother relevantIndianStandardor equivalentStandards.	

Note:1)Manufacturer/ suppliershallsubmitseparatedatasheetforeach duty/rating.

2)Otherspecificationsnotmentionedindatasheet,shallbeconsidered aspertenderspecification/ IS.

10.0H.T.XLPECABLES

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 and PVC overall sheathed. 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-circuit temperature of 250°C.

Operating Conditions:

Electric system

System Voltage : 11kV
Frequency : 50Hz.

Environment

Ground temperature : 35C.
Ambient air temperature : 50C.
Atmospheric conditions : Humid and dusty

Construction

11kV grade cross-linked polyethylene (XLPE) insulated, PVC outer sheathed GI strip armoured, Aluminium conductor UEH 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 11000VOLT", cable size, IS specification No., identification of manufacturer and year of manufacture etc. at each m length. Cables 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:

Routine tests and acceptance tests shall be carried out in accordance with the relevant IEC standards / IS. The copies of type test results shall be submitted along with each drum length or part thereof.

11.0LT 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 Cables (Medium Voltage)

1.1kV grade PVC/XLPE insulated, Aluminium conductor GI strip/wire armoured LT cable as per IS 7098 (part I) (for XLPE) with latest amendment.

RTD/ BTD/ SignalCables:

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 BOQ/Price bid. 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 cables shall be tested at room temperature at 3kVA 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:

Cables 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.

12.0 LOCAL PUSH BUTTON STATION (LCS)

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 & as per BOQ.

The local push button station/local control station (LCS) shall have die-cast aluminium enclosure with minimum IP-5X protection & canopy made of at least 14 SWG (2mm) galvanized sheet steel or FRP suitable for outdoor application. The enclosures painted with two coats of epoxy paint with final colour shade (both internal and external) of Light grey shade 631 of IS:5

All control stations shall be suitable for 10A 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 6Amps at 415Volts (10A at 240VAC)

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 ammeters shall be 72mm x 72mm or minimum 65mm dia. The ammeter front glass shall be toughened.

20% spare or minimum 2 nos. 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 & Decrement & Ammeter (ammeter for above 30KW)
Type-C	Motor above 30KW	Start, Stop PB & Ammeter
Type-D	MOV	Open, Close and Stop PB

13.0 JUNCTION BOX:

Junction Box (JB) material shall be Cast Aluminium (LM-6) as per BOQ, and shall be weather proof to IP-55/65. Outdoor JB shall be provided with canopy made of at least 14 SWG (2mm) galvanized sheet steel or FRP suitable for providing protection against rain from top and two sides for IP-5X protection JB's. JB shall be as per electricity regulations & BS 7671.

The box shall have terminals suitable for Power cables and/or control cables termination as per BOQ, mounted on ISMC/Steel structure. The size of terminal and busbar connection shall be suitable for termination of Submersible pump motor flat cable / PVC/XLPE cables as per SLD and BOQ. Minimum 20% or minimum 2 Nos. (whichever is higher) of spare terminals shall be supplied in junction boxes for each size of terminals.

Each junction box shall be provided with 10% or minimum 1 No. of spare entry for each power & control cable with plugs.

Fault level of Junction box shall be 20 MVA as per BOQ.

JB shall be with Wall/Stand mounting with Zinc passivated Bolts & nuts and earth terminals as per IS and name plate as required.

JB shall be as per approved drawings and test certificates shall be submitted.

14.0 EARTHING SYSTEM

Standards

The following standards and rules shall be applicable:

1. IS: 3043-1987 Code of practice for Earthing.
2. IS: 2309-1989 Code of practice for the protection of buildings and allied structures against lightning.
3. Indian Electricity Act and Rules / Electrical Inspector / statutory norms

All codes and standards mean the latest. The installation shall generally follow the Indian Standard Code of Practice or the British Standard Code of Practice in absence of Indian standard.

General

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 earth resistance shall be maintained with suitable soil treatment, (If required).

The main earth loop shall be laid at a depth of 500 mm below ground level.

All medium (LT) and high voltage (HT) equipment (above 230V) shall be earthed by two separate and distinct connections with earth.

All metallic non-current carrying parts of Electrical & Instrumentation equipment, current and potential transformer secondary, towers, storage tanks, cable tray etc. shall be earthed at least by two distinct separate earth conductors from the earth plate connected to main earthing loop.

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

Joints and tapings 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 epoxy paint.

All hardware used for earthing installations shall be hot dip galvanized. 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 IS/tender specification/drg.

Lightening protection shall be provided 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.

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

The main earth electrode after being driven into the ground shall be protected at the top by constructing brick masonry chamber of size 400mm x 400mm x height 300mm shall be provided with 6mm thick chequered plate cover/CI cover hinged with CI frame for housing of funnel & pipe.

The earth electrode shall be situated at a distance not less than 3.0m from the building fencing structure and equipment foundations.

The distance between two electrodes shall not be less than 3 meter.

The surrounding the electrodes, soil shall be treated up with salt, coke and charcoal.

Copper plate type (600x600x3.15mm size) electrodes shall be used for Transformer & DG neutral earthing and also for the PLC/specialized earthing.

Chemical Type Earthing/ Earth Pit:

Chemical type earthing electrodes 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, 17mm diameter with 99.9% pure electrolyte copper coating of minimum 250 microns & ANSI/UL467 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 80,000 PSI and straightness tolerance 0.01" per linear foot and shall meet the requirement of ANSI/UL467, 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.

Backfilling compound used shall have resistivity less than 20 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 absorb sand and retain moisture for long

time and shall reduce soil resistivity, Dissipate fault current very fast, Eliminate need 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 IEC 62561-7 from a 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 electrodes so that a minimum 150 mm of the electrodes shall be inserted in the natural soil.
 Earth Enhancing material (min 20 KG) shall be filled into 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, 40X5 mm thick copper clamp shall be provided.

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 electrodes shall be 600x600x3.15 mm copper plate for neutral earthing.
 The earthing conductor 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 plates 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 treated as unit length.
 The earth system connections 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 of work

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

Plate (600x600x3.15mm Copper plate)/Pipe type (Chemical type) Earthing station with G.I Pipe/Copper plate of size as per BOQ/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 BOQ.

Galvanising thickness shall be 86 micron & 610g/m² as a minimum.

15.0 INTERNAL AND EXTERNAL LIGHTING SYSTEM:

Section covers supply, installation, connection, testing and commissioning of internal & external lighting system, definition of point wiring, system of wiring, point wiring for light points, ceiling fan points, exhaust fan points, convenience socket outlet points, power socket outlet points etc. including fixing of light fixtures, ceiling fan, exhaust fan, wall fan etc.

Lighting system shall conform to the latest Indian Standards.

Point Wiring

The point wiring shall be complete with the branch wiring from the distribution board to the outlet point, through switchboard, conduit with accessories, junction, pull, inspection boxes, control switch, socket, outlet boxes, ceiling roses, batten/swan holder, earth wire DB to SB & point etc.

System of Wiring

The system of wiring shall consist of ISI marked, single core, stranded copper conductor PVC insulated, 650/1100 volt grade, FRLS wires laid through exposed (surface mounted) PVC conduits as directed.

In places where ceiling fans are provided, lighting fixtures shall be installed suspended/wall mounted below fan level with the help of conduits/chains to avoid shadows on the floor.

Conduit Wiring-PVC Conduit

All non-metallic PVC conduits shall conform to IS: 9537 and shall be used with the corresponding accessories.

PVC conduits pipes of approved minimum 1.6mm wall thickness shall be used. The minimum PVC conduit diameters shall not be less than 20 mm.

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

To facilitate drawing of wire in the conduit, GI mesh wire of 16 SWG shall be provided while laying of recessed conduit.

Conduit pipes shall be fixed by heavy gauge clamps, secured to suitable wood plugs or other approved plugs with screws in an approved manner at an interval of not more than 60 cm but on either side of the couplers, bends, or similar fittings, saddle shall be fixed at a distance of 30 cm from the centre of such fittings.

The saddle should not be less than 24 gauge for conduits up to 25 mm dia and not less than 20 gauge for larger diameter.

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 clips 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.

Boxes:

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, up to a size of 20 cm x 30 cm and above this M.S. boxes having minimum sheet thickness of 1.6 mm shall be used.

Inside each switch box, one bolt shall be welded to receive earthing wire.

Switch boxes shall be galvanized after fabrication. Except where otherwise stated 3 mm thick phenolic laminated sheets like Bakelite, hylam/sun micashall 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 in flush pattern.

Cables:

The size of the cables used for internal wiring shall be as per BOQ/IS:

Switches & Sockets:

Switches & Sockets shall conform to IS: 3854, IS: 1293 and IS: 4615.

Joints

The wiring shall be by looping back system, and hence all joints shall be made at main switches, distribution boards, socket outlets, lighting outlets and switch boxes only.

No joint shall be made inside conduits and junction boxes.

Joints where unavoidable, due to any specified reasons, prior permission in writing shall be obtained from the client before making such connections. Joints by twisting conductors are prohibited.

Testing of Installation

Before a completed installation is put into service, the following tests shall be complied with

Insulation Resistance

1. The insulation resistance shall be measured by 500 volt Megger with all fuses in places, circuit breaker and all switches closed
2. The insulation resistance of an installation, measured shall not be less than 50 mega-ohms divided by the number of points on the circuit.
3. The insulation resistance shall be measured between Earth to phase, Earth to neutral, Phase to neutral And Phase to phase.
4. Polarity test on single pole switches.

Completion Certificates:

All the above tests shall be carried out in presence of client and the results shall be recorded in prescribed forms.

Any default during the testing shall be immediately rectified and that section of the installation shall be retested. The completed test result forms shall be submitted to the client for approval.

On completion of an electric installation a certificate shall be furnished by the contractor, countersigned by the certified supervisor under whose direct supervision the installation was carried out. This certificate shall be in a prescribed form as required by the local electric supply authority.

Light Fixtures

Scope:

The scope of work shall cover the supply, assembling, installation, testing and commissioning of various types of light fixtures as per specification and latest standards, including wiring from ceiling rose/point to the fixture with 3 core flexible copper conductor wire.

All codes and standards mean the latest. Where not specified otherwise the installations shall generally follow the Indian Standard Code of Practice or the relevant British Standard Code of Practice in the absence of Indian Standard.

The light fixtures shall be of standard make from list of vendors as per tender.

General Requirements:

All fixtures shall be complete with ballast, igniters, starter, capacitor, lamp, accessories and prewired at manufacture work.

Fixtures shall be completely wired with FRLS wires and constructed to comply with the regulations and shall conform to relevant IS standards for Electric Lighting Fixtures, unless otherwise specified.

All the fixtures are as per the IP-2X/4X protection for indoor application whereas IP-6X protection for outdoor application.

The lighting fixtures shall comply with the following requirements.

- a) Luminaires shall have high efficiency Lumen Output/Watts
- b) Enclosures shall be with corrosion resistance paints.
- c) For all the fluorescent fittings the ballast shall be High Frequency Electronic Ballast only (less than 10% Total Harmonic Distortion). Fittings shall preferably have integral ballasts and shall conform to relevant IS.
- d) Fluorescent/LED fittings shall be provided for indoor areas as specified in SOQ. HPSV/LED or other fittings as specified in SOQ shall be provided for outdoor and yard areas.
- e) All high bay/mid bay/low bay type and well glass/street/flood light fixtures shall be of extruded cast aluminium body.
- f) All LED type fixtures shall be considered with integral driver.
- g) Constant current and constant voltage protections shall be considered in LED type fixtures.
- h) All hardware shall be of SS302 grade.
- i) All LED fixtures shall be considered with SMD type LEDs.

Lamps:

Lamps used for temporary lighting service shall not be used in the final lamping of fixture units.

Lamps shall be of wattage and type as given in the drawings and schedules. Where not given, the details shall be ascertained from the client before procurement.

Lamps for permanent installation shall not be placed in the fixtures until so directed by the Client's representative, and this shall be accomplished directly before the respective portions are ready for occupation.

LED Light Fixtures/ Lightings:

LED fixtures shall be generally having

LED luminous efficacy lumens/watt: - 100% min.

Efficiency of Electronic system: - 80%-85% min.

LED Lamp/Light efficiency :- 85%-90% min.

Total Harmonic Distortion :- For Outdoor Fittings - $\leq 10\%$
For Indoor Fittings - $\leq 10\%$

Power Factor :- ≥ 0.85

Colour Rendering Index (CRI) :- ≥ 70

Colour temperature/apparent: $\geq 5700\text{K}$ (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 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 Light shall be of Class-I.

Luminaires must be clearly marked with manufacturer name, model number, electrical rating and agency approval (If applicable-CSA, UL, etc.).

Lighting Poles

Lighting 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 (6/4.5/3.0 m x 1.5 m x 1.5 m) 139.7 mm, 114.3 mm, 88.9 mm dia respectively, 4.85 mm, 3.65 mm, 3.25 mm thick respectively, with M.S. base plate, pipe cap, single/double arm of 1/0.5 m height & over hung 1/1.5 m long GI pipe having dia. to suit the socket of 250/150/70 W etc, 240V, HPSV/LED/MH/HPMV lighting fixture as applicable. Street light poles shall be conforming to IS 2713: 1980. and with

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

TEST:

The routine tests shall be conducted as per the relevant Indian Standards

16.0 SAFETY EQUIPMENTS

The contractor shall provide safety equipment as per IERules/ as specified in BOQ, on the HV panels, Generator panels, Control panels and main MV panel rooms. Generally following shall be provided:

Rubber mat 1000 mm wide, conforming to IS: 15652 Class-A for 1.1 kV LV voltage & IS: 15652 Class-B for 33/11 kV HT voltage in front of all the LT & HT panel for their entire length.

Pair of electrically tested 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 numbers shall also be kept.

First aid box containing medicines for treatment of electrical burns in the main switch room.

ABC powder type 'Cease fire' 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 to comply with the requirement of IERules.

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 HT substation.

3 Mtr & 6 Mtr. long folding aluminium ladders for safe maintenance of lighting system, etc.

17.0 OTHER EQUIPMENT AND ACCESSORIES SPECIFICATIONS:

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 hereunder. The equipments 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 vendor list of tender.

Cable Trays:

These shall be channel type, fabricated from structural steel, hot dip galvanized, 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 trays 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, solderless, crimping type. These shall be suitable for the cable being connected and type of function (such as power, control or connection to instrument etc.).

Cable Indicators

All cables shall be identified by cable tag of 2mm. thick, 15mm 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. Pipes shall be laid at an angle of max. 45 deg. to trench wall. Both ends of pipes shall be sealed with approved W.P. Sealing plastic compound after cabling work. Size of pipes 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 pipes shall be free after drawing of cable.

18.0 DIESEL GENERATOR SET (ALONG WITH AMF/AMFCUM SYNCHRONISING PANEL, AS APPLICABLE)

Supply, Installation, Testing and Commissioning of D.G. Set KVA as per SOQ rating at 0.8 PF 415V $\pm 1\%$ and 50 $\pm 1\%$ Hz or better, 3 Phase, 4 Wire Diesel

Generating Set complete with AMF or AMFCum synchronizing control panel, as applicable, and necessary controls and safety devices in panel conforming to relevant IS specification. The set must be continuous operating with a speed regulation of $\pm 1\%$ or better. Diesel engines shall be conforming to relevant ISS/BSS/ISO with latest amendments and as per latest CPCB norms.

DG set ratings shall be for prime rating power (PRP) in accordance with BS-5514/IS

/ISO-3046.

DG set engines shall be as per CPCB-II/ Present norms. DG set shall comply latest emission norm 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.

GENERATING SET:

The generating set shall comprise diesel engine of adequate capacity directly coupled to an alternator mounted on a common base frame and with floor mounted AMFCum Synchronizing control panel as per details given below.

DG set is required to function at place situated at an altitude up to 1000M, 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 by manufacturer on the entire DG Set including Battery and Rubber Parts

The controller of DG panel shall be with RS-485 port (Modbus protocol) for remote data monitoring and logging.

A. ENGINE:

Diesel Engines shall have constant speed, water cooled, suitable for generating set application 1500 RPM, powered by multi cylinder, turbocharged after cooled, cold starting, heavy duty type rated in accordance with ISO 3046/IS with latest amendments

Engines should be preferably from the engine manufacturers whom maintain quality – assurance to international standard of ISO 9001.

The noise level should not be more than 75 db at 1m. distance and engine exhaust smoke emission level shall comply latest emission norms of MOEF, GOI.

Diesel Engine below 140 kVA ratings shall have mechanical governing system and 140 kVA and above ratings shall be with Electronic governing system.

The engines should have automatic belt tensioning arrangement for battery charging alternator system.

The engines should have facility for the indication of oil level in oil sump during running of the engine.

The engine water circulation pump should be directly driven by engine gear system. V-belt driven system will not be adopted/accepted.

The engines should have equipped with the following accessories:

1. Flywheel to suit flexible coupling with guard
2. Dry type air cleaner
3. Corrosion inhibitor liquid
4. Fan blowertype with guard
5. Radiator with guard
6. Water pump, centrifugal type, engine mounted
7. Fuel pump PT type, Fuel filter
8. Governor–Mechanical/Electronic type to meet test requirements as per ISO 8528
9. Fuel injection equipment
10. Exhaust silencer, Hospital Grade type with spark arrester. Height of exhaust pipe above DG room height shall be as per pollution control regulation and supported with MS angle iron supports and stay wires. The exhaust pipe to be wrapped with asbestos rope till the end point.
11. Electric starting equipment comprising starting motor on 12/24 VDC supply.
12. Lub oil cooler, Lub oil pump, Lub oil filter
13. Turbo charger
14. 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)
15. Any other as required.

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 manufacturer's premises: Tests of major items like HT panel, LT panel (rated above 630A), Transformers (rated 500kVA & Above), HT Cable (Length 50Mtr and above) & LT cables (For Cable Size < 120 Sqmm: in case of length 1000m & above for each size; For Cable Size 120 Sqmm & above: in case of length 500m & above for each size) and Motors (Except Pump/Equipment tested with Job motors) 55kW & above shall be conducted at manufacturer's working presence of third party inspection agency (TPIA) and client's 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/material 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 representatives shall be performed on the electrical system

/equipment before it is being put into service. All test equipments 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.

D ERECTION, TESTING & COMMISSIONING OF ELECTRICAL INSTALLATIONS

Scope

The intent of this specification is to define the requirements for the installation, testing and commissioning of the electrical system like HT Equipment, HT Panel, transformer, M.V. panels, Cables, earthing system, Internal and External lighting, Light fixtures etc. Requirement of this project shall be as specified in bill of quantities/approved drawings/general specifications or as per the battery limits fixed by the owner/consultant.

Standards

The work shall be carried out in the best workmanlike manner in conformity with this specification, the relevant specification/codes of practice of the Indian Standards Institution, approved drawings and the instructions issued by the authorized representative, from time to time.

Some of the relevant Indian Standards are listed elsewhere in this tender document.

In addition to the standards mentioned in the tender, all work shall also conform to the requirement of the following:

1. Indian Electricity Act and Rules framed thereunder
2. Fire Insurance Regulations.
3. Regulations laid down by the Chief Electrical Inspector of the State / State Electricity Board/Union Territory.
4. Regulations laid down by the Factory Inspector of the State/Union Territory.
5. Any other regulations laid down by the local authorities.
6. Installation & operation manual of original manufacturers of equipment.

ERECTION & TESTING:

The contractor shall make his own arrangement for safe transportation of all the items to the erection site and also carry out complete loading/unloading during transportation. Equipments shall not be removed from packing cases unless the floor has been made ready for installing them. The cases shall be opened in presence of the client/consultant or his authorized representative. Any document if found with the equipments shall be handed over to the client's representative.

ONAN Type Transformer

Erection

Before erection of transformer, the level of rail on foundations shall be checked and minor corrections if necessary shall be carried out.

After the completion of erection, necessary stoppers shall be provided at the wheels.
 All loosely supplied fittings/accessories shall be cleaned and mounted on the transformer and connections made.
 After completely assembling & installation, the transformer shall be cleaned and touched up with a paint supplied by the manufacturer applied wherever necessary.
 All cover bolts shall be checked for proper tightness. All the civil foundation work required shall be in the scope of contractor.

Testing

Winding insulation resistance shall be measured from primary and secondary to ground and between primary and secondary.
 Check the polarity of terminals and the phase sequence.
 Insulation resistance test with 1000V megger.
 Between primary to earth
 Between secondary to earth
 Between primary and secondary
 Polarity marking and phase sequence.
 Earth resistance : Body as well as Neutral link.

MOTOR CONTROL CENTER, DISTRIBUTION BOARDS:

Erection

Electrical panel is own arrangement for safe transportation of all the items to the erection site and also carry out complete loading/unloading during transportation.
 The contractor shall be responsible for final assembly and interconnection of bus bars/wiring.
 Foundation channel shall be delivered in convenient shipping section by the manufacturer.
 Switchgear shall be aligned and levelled on their base channels and bolted to them as per the instructions of the client/consultant.
 The earth bus shall be made continuous throughout the length. Loosely supplied relays and instruments shall be mounted and connected on the switchgear. The contacts of the draw out circuit breakers shall be checked for proper alignment and interchangeability.
 After erection, the switchboard shall be inspected for dust and vermin proof. Any hole which might allow dust or vermin etc. to enter the panel shall be plugged suitably at no extra cost. If the instrument transformers are supplied separately, they shall be erected as per the direction of the client/consultant.
 The contractor shall fix the cable glands after drilling the bottom/top plates of all switchboards with suitable holes at no extra cost.
 Range of overload relays/timers etc. shall be checked with requirement of motor actually to be connected at site and if the same is undersized/oversized, it shall be brought to the notice of the client/consultant, who shall arrange procurement of corrected components.
 However, the contractor shall not charge anything extra for labour for such replacements.

Testing

Before electrical panel is energised, the insulation resistance of each bus shall be measured from phase to ground. Measurements shall be repeated with circuit breakers in operating positions and contacts open.

Before switch gear is energised, the insulation resistance of all control circuits shall be measured from line to ground.

Each circuit breaker shall be drawn out of its cubicles, closed manually and its insulation resistance measured from phase to phase and phase to ground.

All adjustable direct acting trip devices shall be set using values given by the manufacturer.

The dielectric strength of insulating oil wherever applicable shall be checked. Before switch gear is energised,

The following tests shall be performed on each circuit breaker in its test position.

1. Close and trip the circuit breaker from its local control switch push button or operating handle. Switch gear control bus may be energised to permit test operation of circuit breaker with A.C. closing with prior permission of the client/consultant.
2. Test tripping of the electrically operated circuit breaker by operating mechanical trip device.
3. Test proper operation of circuit breaker latch, check carriage limit switch if provided. Test proper operation of lockout device in the closing circuit. Wherever provided by simulating conditions which would cause a lockout to occur.
4. Trip breaker either manually or by applying current or voltage to each of its associated protective release.

Before switch gear is energised, the tests covered above shall be repeated with each breaker in its normal operating position.

Capacitor bank shall be tested as per manufacturer's instructions.

All electrical equipment alarm shall be tested for proper operation by causing alarm to sound under simulated abnormal conditions.

Insulation resistance test (contacts open, breaker racked in position)

Between each phase of bus	:	Megaohm
Between each phase and earth	:	Megaohm
DC and AC control and auxiliary circuits	:	Megaohm
Between each phase of CT/PT		
Between CT & PT circuit if any	:	Megaohm

Installation of Cable Network:

Cable network shall include power, control and lighting cables which shall be laid in underground trenches, cable trays, G.I. pipes, or on building structures as per drawings/site condition as per cable schedules or as per the client/consultant's instructions.

Supply & installation of cable trays, G.I. pipes/conduits, cable glands and sockets of end isolators, junction boxes, remote push button stations, etc. shall be in the scope of the contractor.

General Requirements for Handling Cables:

- a) Before laying cables, this shall be tested for physical damage, continuity, absence of cross phasing, insulation resistance to earth and between conductors. Insulation resistance tests shall be carried out with 500/1000V megger.

- b) The cables shall be supplied at site, wound on wood end drums as far as possible. For smaller lengths and sizes, cables in properly coiled form can be accepted. The cables shall be laid by mounting the drum of the cable on drum carriage. Cables shall be handled and laid as per IS 1255.
- c) While drawing cable through G.I. pipes, conduits, RCC pipes, ensure that size of pipe is such that, after drawing cables, 40% area is free. After drawing cables, the end of pipes shall be sealed with approved WP sealing plastic compound.
- d) Armoured cables shall never be concealed in walls/floors/roads without G.I. pipes, conduits or RCC pipes.
- e) A minimum loop of 3m shall be provided on both ends of the cable, and on both ends of straight through cable joint if any.
- f) Cable shall be neatly arranged in the trenches/trays in such manner so that criss-crossing is avoided and final take off to the motor/switchgear is facilitated. Arrangement of cable within the trenches/trays shall be the responsibility of the contractor.
- g) All cable routes shall be carefully measured and cable cut to the required lengths and undue wastage of cable to be avoided. The cable routes indicated are indicative only and these may be rechecked with the client/consultant before cutting of cables.
- h) All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of all PVC insulated cables shall be taped with an approved PVC or rubber insulating tapes. Use of friction type or other fabric type tape is not permitted.
- i) Wherever cable rises from underground/concrete/masonry trenches to motors/switchgears /push buttons, these shall be taken in G.I. pipes of suitable size, for mechanical protection up to 300mm. distance of concerned cable gland or as instructed by the client/consultant.
- j) The cable passing through foundation/walls of other underground structures, the necessary ducts for opening will be provided in advance for the same. However, should it become necessary to cut holes in existing foundation of structures the electrical contractor shall determine the location and obtain approval of the client/consultant before cutting is done.
- k) Cable trays, racks and trenches shall be installed to allow for 20% future cables. Cable installations shall provide minimum cable bending radius recommended by cable manufacturer.

Laying of Cables (Underground System)

Cables shall be so laid in trench that this will not interfere with other underground structure. All water pipes, sewage lines or other structures which become exposed by excavations shall be properly supported and protected from injury until the filling has been rammed solidly in places under and around them. Any telephone or other cables coming in the way are to be properly shielded/diverted as directed by the owner/consultant.

The cables shall be laid and protected by filling trench bottom with a layer of sand. This sand shall be levelled 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. This laying work shall comply with **IS 1255** with latest amendments and enclosed tender drawings

Cable shall be laid at minimum depth of 750 mm. in case of L.T. and 1000 mm. in case of H.T. from ground level. Excavation will be generally in ordinary soil. The width of trench shall be sufficient for laying of required no. of cables.

The surface of the ground after back filling the earth shall be made good so as to conform in all respects to the surrounding ground and to the entire satisfaction of the client/consultant.

For all underground cables, route markers should be installed at every 30 Mt.

Interval and at every route change along the cable route. Separate route markers should be used for LT, HT and Instrumentation cables.

Route markers should be grounded in ground with 1:2:4 cement concrete.

RC Humepipe for crossing road in cable laying shall be provided by employer. No deduction shall be made for cable laying in Humepipe for not providing bricks, sand and excavation.

RC Humppipe & pipesleeve shall be sealed at both ends by bituminous compound / WP sealing after laying and testing of cables by electrical contractor without any extra charge.

Laying of Cable in Masonry Trenches

Masonry/concrete trenches for laying of cables shall be provided by employer.

However, steel members such as M.S. angles/flat etc. shall be provided and grouted by electrical contractor to support the cables without any extra charge.

Cables shall be clamped to these supports with minimum saddles/clamps. More than one tier of cables can be provided in the same trench if the no. of cables are more.

Entry of cables in trenches shall be sealed with approved WP sealing plastic compound to stop entry of water in trenches.

Laying of Cables in Cable Trays

Cable trays and steel members such as M.S. angle/channel/flat etc. shall be provided and fixed by the contractor.

Cables shall be fixed in cable trays. Cables shall be clamped with flat clamps and galvanised bolts/nuts in cable trays.

Earthing flat/wire can also be laid in cable tray along with cables.

After laying of cables, minimum 20% area shall be spare.

Termination and Jointing of Cables:

For HT cables suitable size of heat shrinkable type termination kit shall be used as per BOQ/SLD. For HT cable manufacturer's recommendations should be followed.

For LT cables:

1. All PVC/XLPE cables up to 1.1 KV grade, armoured or Unarmoured shall be terminated at the equipment/junction box/isolators/push buttons/control accessories, etc. by means of suitable sized double compression type cable glands, crimped type solderless lugs/connectors for termination of cable.
2. Armour of cables shall be connected to earth point.
3. In case of termination of cables at the bottom of the panel over a cable trench having no access from the bottom, a close fit hole should be drilled 205 the

bottom plate for all the cables in one line, and then the bottom plate should be split into two parts along the centre line of holes. After installation of bottom plate and cables with glands, it shall be sealed with cold sealing compound.

Dressing of Cable inside the Equipment:

After fixing of cable glands, the individual cores of cables shall be dressed and taken along the cable ways (if provided) or shall be fixed to the panels with polyethylene straps. Cables shall be dressed in such a manner that a small loop of each core is available inside the panel.

For motors of 20 HP and above, terminal box if found not suitable for proper dressing of aluminium cables, the erector shall modify the same without any additional cost.

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.

All tests shall be carried out in accordance with relevant Indian Standard Code of practice and Indian Electricity Rules. The Vendor shall provide necessary instruments, equipment and labour for conducting the above test and shall bear all expenses in connection with such tests. All tests shall be carried out in the presence of the client and results shall be recorded in the prescribed forms.

EARTHING SYSTEM:

The plate/pipe electrodes shall be installed as per IS: 3043/tender specification / BOQ.

Construction of the earthing stations shall in general be as shown in the drawing and shall conform to the requirement of earth electrodes mentioned in the latest edition of Indian Standard IS: 3043, Code of Practice for Earthing Installation.

The earth conductors (Strips/Wires copper/hot dip G.I.) inside the building shall properly be clamped/supported on the wall with galvanised Iron clamps and Mild Steel Zinc Passivated screws/bolts. The conductors outside the building shall be laid at least 600 mm below the finished ground level.

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

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.

Continuity test for earth continuity conductors with ELV tester.

The complete earthing system shall be mechanically and electrically bonded to provide an independent return path to the earth source.

Test:

The entire earthing installations shall be tested as per requirements of Indian Standard Specification IS:3043.

The following earth resistance values shall be measured with an approved earth Megger and recorded.

1. Each earthing station
2. earthing system as a whole
3. Earth continuity conductors
4. Earth conductor resistance for each earthed equipment shall be measured which shall not exceed 5 ohm in each case.

Measurements of earth resistance shall be carried out before earth connections are made between the earth and the object to be earthed.

All tests shall be carried out in presence of the client's or PMC.

Erection:**Ceiling/ Wall Outlet Boxes for Lights/Fans:**

Outlet boxes shall be of steel with cover and so installed as to maintain continuity throughout. In beams conduit socket shall be provided in place of outlet boxes. The same shall be used for installation of luminaries.

For fixing light fixtures/brackets, outlet boxes complete with knockout for holding conduit shall be used. For lighting fixtures suitable for 40/20 watts fluorescent tubes /incandescent lamps/ mercury vapour lamps, only one outlet box is required.

For fixing ceiling fans, circular outlet boxes, 100 mm diameter, complete with 12 mm dia. Mild Steel rod 300 mm long, for holding 12 mm dia. Mild Steel cover 125 mm dia. at bottom shall be used.

Switch and Socket:

Switches shall be installed at 1200 mm above finished floor level unless otherwise indicated on the drawings. In office areas switch box installed at 900 mm from FFL can be accepted.

Installation of Lighting Fixtures:

Scope of work under this item shall start from light point, with 3 nos. 1.5 mm.² PVC insulated wires from connector to the connector inside the lighting fixture, connections, fixing of lighting fixture complete with all accessories, lamp on wall/ roof/ steel truss etc. testing the lighting fixture and commissioning.

Installation of Exhaust Fans:

Scope of work under this system shall start from exhaust fan point, with a ceiling rose, 2 core 2.5 mm.² PVC insulated wire from ceiling rose to connector of exhaust fan, connections, making fan opening in walls including repair/finishing fixing of exhaust fan complete with accessories and louver on walls with hold-fasts, testing the exhaust fans and commissioning.

COMPLETION TESTS of INSTALLATION:

After supply and installation of complete project or a particular building / area, following tests shall be carried out by the contractor before switching on the power to installation and the results shall be recorded and submitted to the Site-Engineer. If results are not satisfactory as per standards set herewith, the contractor shall identify the defects/shortcoming and shall rectify the same. Nothing extra shall be paid for carrying out these tests and contractor has to arrange all necessary instruments.

Insulation Resistance

The insulation resistance shall be measured by 500 volt Megger with all fuses in places, circuit breaker and all switches closed.
The insulation resistance of an installation, measured shall not be less than 50 mega-ohms divided by the number of points on the circuit.
The insulation resistance shall be measured between
Earth to phase
Earth to neutral
Phase to neutral
Phase to phase
Earth continuity test for all points, fixtures, fans etc.
Polarity test all single phase switches.

Completion Certificates:

All the above tests shall be carried out in presence of client and the results shall be recorded in prescribed forms.
Any default during the testing shall be immediately rectified and that section of the installation shall be retested. The completed test result forms shall be submitted to the client for approval.
On completion of an electric installation a certificate shall be furnished by the contractor, countersigned by the certified supervisor under whose direct supervision the installation was carried out. This certificate shall be in a prescribed form as required by the local electric supply authority.

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, drawings & documents shall be submitted by him to the electrical inspector. This will be an integral part of the contract and shall not be paid for separately. **The contractor shall liaise 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.**

HANDING OVER/ TAKING OVER:

After completion of works and tests specified above, the various installations of equipment can be taken over by the employer as and when these are ready in all respects. The defect liability period shall start from the date, when all the installations of the equipment have been executed, tested as described above, successfully commissioned and handed over after trial run.

(E) APPROVED VENDOR LIST FOR ELECTRICAL EQUIPMENT/ COMPONENT

ITEM DESCRIPTION	APPROVED MAKE
COMPACT SUBSTATIONS	ABB/CGL/SCHNEIDER/ SIEMENS
DISTRIBUTION TRANSFORMERS	ABB/ AREVA/BBL/BHEL/CGL/ EMCO/GEC /KEC/RAYCHEMRPGLTD./SCHNEIDER/ TRANSFORMERS&RECTIFIERS INDIA LIMITED /VOLTAMP
315KVA&BELOW 315KVA DISTRIBUTION TRANSFORMERS	SKP TRANSFORMERS/ ATLANTA ELECTRICAL/ GUJARAT TRANSFORMERS/ EMCO /
TRANSFORMER LIGHTING-DRY TYPE (CAST RESIN)	ABB/AUTOMATIC ELECTRIC LTD./CGL/ INDCOIL/KOTSONS/ VOLTAMP
SWITCHBOARD MV-11/33KV-INDOOR/OUTDOOR TYPE (VCB/SF6)	ABB/ AREVA/BHEL/CGL/GEC/JYOTI/L & T/ SCHNEIDER/ SIEMENS/HIGH VOLT (ABB)
PROTECTIVE RELAYS (NUMERICAL TYPE)	ABB/ALSTOM/CGL/GE/L&T/SCHNEIDER / SIEMENS
PROTECTIVE/AUXILIARY RELAYS (ELECTROMECHANICAL TYPE)	ABB/ALSTOM/CSPC/EASUNREYROLLE/GE /GECL& T/ SCHNEIDER/ SIEMENS
ELECTRONIC CIRCUIT RELAY	ALLEN BRADLEY/OEN/OMRON/PLA
CONTROL AND RELAY PANEL	ABB/ALSTOM/EASUNREYROLLE/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
L.V. SWITCHBOARD-DRAW OUT/ FIXED TYPE (PCC/PMCC/MCC/ MLDB/MPDB/MOVB/ APFC)	ABB/ALPHANIPPON/C&S/CGL/ ELEMBICA/ ELEMECH/HORIZON/ INDUSTRIAL CONTROLS/L&T/PATEL BROTHERS/POSITRONICS/POWER&INSTRUMENTATION (O) LTD./SCHNEIDER/ SIEMENS/ SUNAUTOMAT/SWATISWITCH-GEAR/HIGH VOLT

Note No.-1:

Any 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. Shall have In-house panel fabrication facility.
4. The company should be in existence for mini. 5 years and shall have GST Registration Certificate.

5. Shall be ISO 9001:2015 or latest amended up to date certified
6. 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 letterhead (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). AMC reserves to inspect the work facility of such panel vendor at any stage of bid/execution to assess the facility and verify the requirements as specified above (The cost of such visit by AMC 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, AMC reserves right to initiate action against such bidder/vendor including keeping their registration at AMC in abeyance for up to 3 years or as decided by the concerned authority of AMC.

AIR CIRCUIT BREAKERS	ABB/ AREVA/L&T/SCHNEIDER/ SIEMENS/LEGRAND/C&S
MCCB'S	ABB/C&S/GEC/L&T/ SCHNEIDER/ SIEMENS/LEGRAND/C&S
SWITCH DISCONNECTOR FUSE UNIT (SDF) AND SWITCH DISCONNECTOR ISOLATOR	ABB/C&S/GEC/L&T/ SCHNEIDER/ SIEMENS
CHANGE-OVER SWITCH	BCH/C&S/GEPOWER/HAVELLS/HPL/ KRAUS&NAIMER/L&T/SCHNEIDER/ SIEMENS
SOFT STARTER (MICROPROCESSOR BASED)	ABB/CGPOWER(EMOTRON)/DANFOSS/ L&T/ROCKWELL/ SCHNEIDER/ SIEMENS
VVVF DRIVES (VFD)	ABB/CGPOWER(EMOTRON)/DANFOSS/ L&T/ROCKWELL/ SCHNEIDER/ SIEMENS
MV CAPACITORS	ABB/EPCOS/ SHREEM/UNIVERSAL
LV CAPACITORS/POWER CAPACITOR	ABB/ ASIAN/BHEL/CGL/ EPCOS/GEC/ HAVELLS/ KHATAUJUNKER/MADHAV/ MALDE/NEPTUNE/SCHNEIDER/ UNIVERSAL/SHREEM/PRABODHAN/POWER MATRIX
SERIES REACTORS FOR CAPACITORS	EPCOS/WHEPL/YESHA
APFC PANEL	ABB/ ASIAN/CGL/DATAR/EPCOS/L&T/ NEPTUNE/SCHNEIDER/ALL APPROVED VENDORS FOR LT PANEL/EASUN/ALSTOM/ CSPC
APFC RELAY/CONTROLLER	ABB/CUMMINS/DATAR/ ENERCON/EPCOS /L& T/SCHNEIDER/SIEMENS/SYNTTEL/ TRINITY
AC/DC POWER & AUXILIARY CONTACTOR	ABB/BCH/C& S/GE/L&T/SCHNEIDER/ SIEMENS

BI-METAL/ ELECTRONIC/ MICROPROCESSORBASED OVERLOADRELAY	ABB/C&S/GE/L&T/SCHNEIDER/ SIEMENS/CSPC/ALSTOM
THERMISTERRELAY	ALSTOM/INSTACONTROLS/MINILEC
SINGLEPHASINGPREVENTER	ABB/C&S/GE/L&T/MINILEC/SCHNEIDER / SIEMENS
TIMESWITCH	GIC/LEGRAND/ SCHNEIDER/ SIEMENS/ THEBEN
TIMERS/TIMEDELAYRELAY	BCH/EAPL/L&T/LEGRAND/MINILEC/ OMRON/PLA/SCHNEIDER/ SIEMENS/ TEKNIC/THEBEN/ELICO
MOTORS	ABB/BBL/BHEL/CGL/JYOTI/KEC/ MARATHON/ SIEMENS
BATTERYCHARGER&DCDB	AMARARAJA/AMCOPOWER/ AUTOMATIC ELECTRIC/CALDYNEAUTOMATICS/CHHABI ELECTRICALS/EXIDE/HBLPOWERSYSTEMS /HIREL-HITACHI/MASS-TECHCONTROLS/ UNIVERSALINSTRUMENTS
LIGHTFIXTURES	BAJAJ/C&S/CGL/GE/HAVELLS/PHILIPS / SURYA/WIPRO
CABLESH.V.- XLPEINSULATED	ASIANCABLE/CCI /FORTGLOSTER/ HAVELLS/KEI/NICCO/POLYCAB/ PRIMECAB/ RPGCABLES/TORRENTCABLES/ UNIVERSAL
LTPOWER&CONTROLCABLES/ EARTHINGCABLES	ASIANCABLE/AVOCAB/CCI /FINOLEX/ FORTGLOSTER/HAVELLS/ KEI/LAPP / NICCO/POLYCAB/PRIMECAB/ RPGCABLES /RRKABEL/TORRENT/UNIVERSALCABLES
WIRES-FLEXIBLES(ALLTYPES)	AVOCAB/FINOLEX/ KEI/L&T/LAPP/ POLYCAB/RRKABEL/ UNIVERSAL/ANCHOR/HAVELLS/ATLAS
LIGHTING/SMALLPOWER DISTRIBUTIONBOARDS/ ENCLOSURES	ABB/BCH/C&S/ ELDON/ ENCLOTEK/ HENSEL/INDOASIAN/L&T/LEGRAND/ RITTAL/ SCHNEIDER/SIEMENS/HAVELLS/ STANDARDELECTRIC/ALLVPANELVENDORS
MCB,RCCB,RCBO/MCBISOLATORS	ABB/C&S/INDOASIAN/L&T/LEGRAND/ MOELLER/SCHNEIDER/ SIEMENS/GEC/ HAVELLS/C&S
MPCB	ABB/C&S/L&T/ SCHNEIDER/ SIEMENS/ AREVA
ALARMANNUNCIATORS(SOLID STATETYPEWITHLED ILLUMINATION)/FACIA ANNUNCIATOR	ALSTOM/DIGICONT/ICA/IICP/MINILEC/ PROCONINST.(P)LTD/PROTON ELECTRONICS/APLAB
DECORATIVE/MODULARSWITCH&S OCKET	ABB/ANCHOR/CLIPSAL/CRABTREE/L&T/ LEGRAND/MK-HONEYWELL/ SIEMENS/SCHNEIDER
CEILING/WALLMOUNTING/	ALMONARD/BAJAJ/CGL/HAVELLS/211

EXHAUSTFANS	KHAITAN/ORIENT/USHA
CABLETERMINATION/ JOINTING KITS	3M/ ABBKABELDON/M SEAL/ RAYCHEM/XICOM/CCI
CONTROL/SELECTORSWITCH	ABB/ALSTOM/BCH/GEPOWERCONTROLS/ HAVELLS/KAYCEE/L&T/ SCHNEIDER/ SIEMENS/RECOM/SULZER/EE/JYOTI
INDICATINGLAMPS	BCH/L& T/ SCHNEIDER/ SIEMENS/TEKNIC CONTROLS/VAISHNO/IEC/EE
TERMINALBLOCK/CONNECTORS	CONNECTWELL/ ELMEX/PHEONIX/ TELEMECHANIQUE/WAGO
CONTROLTRANSFORMER	AE/ASHMORE/G&M/INDCOIL/NEC/ PRAGATI/PRECISE/ SILKAANS
SEMICONDUCTORFUSE	BUSSMANN/FERRAZ/GE/SIEMENS
HRCFUSE(POWER&CONTROL)	ABB/C&S/GE/L& T/SCHNEIDER/ SIEMENS/TECHNOELECTRIC
PUSHBUTTONS	BCH/L& T/ RASS/SCHNEIDER/ SIEMENS/ TEKNIC/VAISHNO
PUSHBUTTONSTATIONS/ JUNCTION BOX (CASTALUMINIUM)	BALIGA/BCH/CEAG/EXPROTECTA/FCG/ FLEXPOR/HANSU/HENSEL/PUSTRON/ SCHNEIDER/ SIEMENS/ SUDHIR/EXCEL
NONMETALLICENCLOSURES (INCLUDINGINDUSTRIAL RECEPTACLES)	BCH/HENSEL/LEGRAND/PUSTRON/ RITTAL / SCHNEIDER/ SIEMENS/SINTEX
DIGITALMETER(EXCEPTKWH/ LOADMANAGER/MULTIFUNCTION METERS)	AE/ ALSTOM/KRYKARD/L&T/MASIBUS/ NIPPEN/ RISHABH/SCHNEIDER/SECURE/ SIEMENS/IMP/MECO/ASIAN
ELECTROMECHANICALMETERS- AMMETER&VOLTMETER	AE/IMP/MECO/ RISHABH
KWH/LOADMANAGER/MULTI FUNCTIONMETER	ABB/KRYKARD/L&T/ SCHNEIDER/SECURE
CABLELUGS	3D/COMET/CONNECTWELL/DOWELLS/ JAINSON/3M
CABLEGLANDS(SINGLE/DOUBLE COMPRESSION,NI-PLATTEDBRASS)	BALIGA/BRACO/COMET/ELECTROMECH/ EX- PROTECTA/FCG/HMI/JAINSON/ SIEMENS/ SUDHIR
CABLEGLANDS-POLYAMIDE	FIBOX/GEWISS/HENSEL/LAPP
LIGHTNINGARRESTORS	CGL/ELPRO/JAYSHREE/OBLUM/WS
SURGESUPPRESSORS	ABB/EMERSON/ERICO/MTL/OBLUM/ PEPPERL+FUCHS/PHOENIX/ SCHNEIDER/ SIEMENS/WEIDMULLER
UNINTERRUPTEDPOWERSUPPLY (UPS)	ABB/ EMERSON/FUJI /HITACHI/INVENSYS /SCHNEIDER/SOCOMECH
GI CABLETRAYS	GLOBE/INDIANA/JACINTH/LEGRAND/ M.M.ENGINEERING/SHARDA/ SILVERLINE POWER/VATCO/SUPERELECTRO
UPVCCONDUIT&ACCESSORIES	AKG/CLIPSAL/L&T/POLYCAB/PRECISION/ SALZER
MS/GICONDUIT& PIPES	BECINDUSTRIES/ JINDAL/JKTUBE/SAL/

	TATASTEEL/ZENITH
SMF/VRLA/Ni-CD/LEADACID (PLANTE/TUBULAR)BATTERY	AMARARAJABATTERIESLTD./ AMCO/EXIDE /HBLPOWERSYSTEMSLTD./AUTOMATIC ELECTRIC
MS/GI LIGHTINGPOLES& BRACKETRS	AMBICAENGINEERING/BAJAJ/BOMBAY TUBESANDPOLES/GAYATRIELECTRICALS/ INDIAELECTRICPOLES/ RIDDHIPOLES/ SHAKTIPOLES/ SURYA
USDUCT	ABB/C&S/L&T/ SCHNEIDER/ SIEMENS/ STARDRIVE/ALLLT PANELVENDORS
HANDHELDDIGITALMULTIMETER/ CLIP-ONMETER/MEGGER	FLUKE/IMP/MECO/MOTWANE/ RISHABH
CAPACITOR DUTY CONTACTOR	EPCOS/ABB/SIEMENS/L&T/SCHNEIDER/C&S
BATTERY BACKED POWERPACK	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&BACKFILL COMPOUND	ASHLOK/CURSP/ECOTECHNOLOGY& PROJECTS/ENNOVINFR/ERICO/ISGGLOBAL /PRAGATIELECTROCOM/SAARAEARTHING/ EQUI.REPUTEDMAKESUBJECTTO CLIENT APPROVAL

SECTION:C3

**TECHNICALSPECIFICATIONSFOR
INSTRUMENTIONWORK**

SECTION-3C:INSTRUMENTATIONWORK

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SPECIFICATIONS FOR INSTRUMENTATION WORKS

INTENT OF SPECIFICATIONS

This specification along with specific job requirements (if any) is intended to cover the design, engineering, supply, installation, testing and commissioning of entire instrumentation equipment and items and accessories including consumable against price quoted for instrumentation works as indicated herein and elsewhere covered in the scope of this tender.

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 SPS.

APPLICABLE NATIONAL/INTERNATIONAL STANDARDS

AGA	American Gas Association, Gas Measurement Committee	
ANSI/ASME	American National Standards Institute/American Society of Mech. Engineers	
	B1.20.1	Pipe Threads
	B16.5	Steel Pipe Flanges and Flanged Fittings
	B16.20	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	
	RP520	Sizing, selection and installation of pressure relieving systems in refineries.
		Part-I- Sizing and selection
		Part-II- Installation
	RP521	Guide for pressure relieving and depressurising systems
	RP526	Flanged steel safety relief valves
	RP527	Seat tightness of pressure relief valves
	MPMS	Manual of Petroleum measurement standards
	RP551	Process measurement instrumentation
		Part-I Process Control and Instrumentation
	RP552	Transmission Systems

	S2000	Ventingatmosphericandlowpressurestorage tanks	
	S670	Vibration,Axial-PositionandBearingTemperature MonitoringSystems	
ASTM	AmericanSocietyforTestsandMaterials		
BS	BritishStandards		
	BS-1042	MeasurementofFluidFlowinClosedConduits	
	BS-5308Part-II	SpecificationforPVCinsulatedcables	
	BS-7244	BreatherValves	
DIN-43760	TemperatureVs.ResistancecurvesforRTDs		
DIN-19234	ElectricalDistanceSensors;DCinterfacefordistancesensorsandsignal Converter		
DIN-50049	DocumentonMaterialTesting		
IEC	InternationalElectrotechnicalCommission		
	IEC79	ElectricalapparatusforExplosiveGasatmosphere	
	IEC85	Thermalevaluationandclassificationforelectrical insulation	
	IEC332	Testonbunchedwiresorcables	
		PartIIICat.A	
	IEC529	Classificationofdegreeofprotectionprovidedby enclosures	
	IEC534-2	IndustrialProcessControlValves-Flowcapacity	
	IEC584-2	Thermocouples-Tolerances	
	IEC751	IndustrialPlatinumResistanceThermometerSensors	
	IEC801	Electromagneticcompatibilityforindustrialprocess measurementandcontrolequipment	
IS	IndianStandard		
	IS-5	Coloursforreadymixedpaints	
	IS-319	Specificationforfreecuttingbrassbars,rodsandsections	IS-
	1239	MildSteeltubes,tubularsandotherwroughtsteelfittings	IS-1271
	SpecificationofThermalEvaluationandClassificationof ElectricalInsulation		

	IS-1554	Part-IPVCinsulated(heavyduty)electricalcables –working Voltageuptoandincluding1100V
	IS-2074	Readymixedpaints,airdrying,red oxide-zincchrome
	IS-2147	Degreeofprotectionprovidedby enclosuresfor low Voltageswitchgearandcontrolgear
	IS-2148	Flameproofenclosuresforelectricalapparatus IS-
	3624	SpecificationforPressureandVacuumgauges IS-
	5831	PVC insulationandsheathofelectriccables
	IS-7358	SpecificationforThermocouples
	IS-8784	Thermocouplecompensatingcables
ISA		InstrumentSocietyofAmerica
	S-5.2	Binarylogicdiagramsforprocessoperations
	S-7.3	Qualitystandardforinstrumentair
	S-75.01	Flowequationsforsizingcontrolvalves
ISO5167		Measurementoffluidflowbymeansoforificeplates,nozzlesandventur tubes insertedincircularcross-sectionconduits
NACE		NationalAssociationofCorrosionEngineers -MR-01-75
NEC		NationalElectricCode
NEMA		NationalElectricalManufacturer’sAssociation
	ICS-6	Enclosuresforindustrialcontrolandsystems
NFPA		NationalFireProtectionAssociation
	NFPA-496	Purgedandpressurisedenclosuresforelectrical equipment
OSHA		OccupationalSafetyandHealthAuthority

1. GENERAL:

TheContractorshallobtainallinstrumentsfrommanufacturers ofinternational standing.

The designandqualityofallinstruments shallbefullysuitedtotheconditions which willbemetinservice.The design ofelectronicinstruments shallbein compliancewiththeelectromagneticcompatibilityrequirementsasperIEC-801.

Theinstrumentation andcontrolsystemshallbedesigned,manufacturedand installedtoensurehigheststandardofoperational reliability.Major instrumentationshallbeelectronic type.Panelmountedreceivinginstruments

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

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

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.

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 (zone) 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 otherwise stated.

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

Instrumentation System shall be designed as per good engineering practice.

POWER SUPPLY TO PACKAGE:

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

For Instruments, Control Systems, Analysers : 230V AC $\pm 10\%$, 50Hz ± 3 Hz

Solenoid Valves, Relays, Lamps : 24VDC

Input Interrogation Voltage : 24VDC

Panel/Cabinets Lighting

: 230VAC $\pm$ 10%

Clients shall provide for a separate feeder in the Plant MCC of suitable current rating and at suitable location to provide 230VAC $\pm$ 10%, 50Hz $\pm$ 3Hz supply to Instrument Panel(s). Necessary cabling work shall be carried out by successful bidder for required power distribution.

24VDC required for Input Interrogation, relays and lamp setc., same shall be generated by the bidder using SMPS. Power shall be suitably conditioned by providing UPS/Isolation Transformer-Voltage Stabilizer-CVT to prevent damage to instruments against power fluctuation/disturbances.

Instrument power circuit shall be individually protected from fault with the help of MCBs of adequate rating with overload protection. MCBs shall be two pole type.

EARTHING:

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

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

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

ENCLOSURE:

All instrument enclosure mounted in the field shall be weatherproof to IP-65/NEMA 4 as a minimum.

For Hazardous Areas:

All electrical instrument 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 NEMA 7. Contacts shall be gold plated rated for 30V, 1Amp.

INTERLOCKS/ LOOPS:

All plant interlocks shall be carried out using PLC/electromagnetic relay 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 relay shall be low power continuously rated type and shall have LED for status indication.
- b) The relay 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 minimum two numbers of 'NO' and two numbers of 'NC' contacts as a minimum. Out of these, one 'NO' and one 'NC' contact 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 health status.

INTRINSIC SAFETY BARRIERS:

Intrinsic safe barriers shall be provided for all analog signals coming from hazardous area. The following points must be taken into consideration while selecting I.S. barriers:

- a.) Safety barriers must be based on entity concept.
- b.) Each instrument in the loop must be certified intrinsically safe by a statutory authority.
- c.) Each input/output in the loop shall have a separate I.S. barrier. No barrier shall be shared between two loops/inputs/outputs.
- d.) All safety barriers shall be isolating type, as far as possible.
- e.) All safety barriers shall be of MTL make or equivalent. The following barriers may be selected, unless otherwise necessary because of technical reasons:

Analog inputs: MTL3041 or equivalent (Repeater Power Supply for Transmitters)

Analog outputs: MTL3042 or equivalent (4-20mA Repeater)

Contact inputs: MTL3011/2210B or equivalent

Contact outputs: MTL2241/3021 or equivalent (Solenoid Valves)

2. CONTROL PANEL:

Control Panel shall be CNC machine prefabricated out of CRCA sheet steel of thickness not less than 1.5mm, modular in construction, properly reinforced,

powder coated and having rigid frame structure. Internal mounting plate including the gland plate shall be 3mm thick. The instrument panel shall have dimensions as per system requirement. However, the Control panel height shall not exceed 2100mm.

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

Lifting lug 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 IP52 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 entry to the panel shall be from the bottom with fire retardant spray compound sealing. Instrument panel shall be provided with louvers along with washable micron filters AIR IN – AIR OUT 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 230V shall not enter the 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 panel shall be housed in covered non-flammable plastic raceways arranged to permit easy accessibility to various instruments for maintenance, adjustment, repair and removal. No raceways shall be more than 70% full.
- b.) Separate wiring raceways shall be used for power supply wiring, DC signal wiring.
- c.) Distance between terminal strips and side of the panel parallel to the strips up to 50 terminals: Min. 50mm.
- d.) Distance between terminal strip and top and bottom of cabinet: Min. 75mm.
- e.) Distance between two adjacent terminal strips: Min. 100mm.
- f.) Distance between cable gland plate and the bottom of strips: Min. 300mm.
- g.) 20% spare terminals shall be provided as a minimum.

Overall height of Control Panel shall not exceed 2100mm. Panel mounted instruments and controls shall be such mounted that they are accommodated between 800mm and 1300mm 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 change to limit temperature rise within panel to 5 deg C over ambient temperature.

Contractor shall consider necessary power conditioning unit (UPS) to prevent power fluctuation and surge to damage the instruments as well as other electronic components.

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

Mounting

All equipment 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 Station to be provided each for Instruments / Panel Earthing and for Signal (Electronic) earthing. The earth stations shall be of cuplating type electrode or 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 panel to prevent moisture condensation on the wiring and panel mounted equipment when the panel is not in operation. The heaters shall operate on 230 VAC. Heaters inside the panel 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 CFL lighting fixture rated for 11 watt, 230V, 1 phase, 50Hz 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, 50Hz, combined 5amps and 15amps, 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 door then maintenance socket shall be provided at both locations.

Labels

All the equipment mounted on the front face of Instrument panel as well as equipment mounted inside the panel 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-circuit shall be separately provided with DP Miniature Circuit Breakers (MCBs). Potential circuits for relaying and metering also shall be protected by MCBs.

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 wire shall be shielded, where necessary.

Panel 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

adoptsingle tube printed arrangement
line always & hence easily readable

so that all the characters remain on one

Terminal Blocks

Terminal blocks for power connections shall be 600V grade, 20 amp 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 strip shall correspond to wire numbers on the wiring diagrams. All control output terminals will be fused type.

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

Panel internal wirings 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 steel work shall be painted using seven tank process in accordance with the following procedure:

- i. The pretreatments 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 scales shall be removed by trickling with clean water followed by final rinsing with diluted dichromate solution.
- iv. The control panel shall be powder coated. Thickness of coatings shall be around 60 microns. QA test certificates shall be furnished for thickness adhesion and hardening of powder coating.

ALARM ANNUNCIATOR:

- (i) Microprocessor based alarm annunciator shall be provided, **if specified**, for generating audio-visual alarms for each abnormal condition. Alarm shall be initiated by the opening and closing of volt-free contacts which shall remain unchanged throughout the periods in which the alarm condition exists. Alarm circuit 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. These sequence of alarms 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.	topline	:	location
ii,	middleline	:	parameter
iii.	bottomline	:	status

e.g. WETWELL
 LEVEL
 HIGH

The annunciator will be split/integral architecture type and the face will have SuperBright 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 : 60mm X 26mm
- 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	Powersupply	:	24VDC/240VAC
xi.	Powersupplystatus	:	Required indication
xii	Weatherprotection	:	IP-52 of IS13947
xiii	No.ofWindows	:	as per requirement+20% spare windows

In case if hardwired annunciator is not specified in detailed specifications for instruments, then visual alarm shall be provided at HMI and audio alarm through panel mounted hooter along with reset push button shall be provided for all the required alarms as per specifications/approved P&ID/ process requirement.

Annunciator, in general, shall be solid state type with plug-in modules, in a cabinet with backlighted engraved windows and integral power supply.

Alarm logic module shall be single channel type. In case multi-input alarm module are selected, only one channel shall be used.

Intrinsically safe annunciator circuit, when used, shall have power supply unit in a safe area.

Annunciator alarm sequences shall be Automatic Reset Type/Automatic Reset First Out with First Out flashing and Reset Push Button as a minimum.

The design of alarm annunciator system shall be such that transient alarms of less than 330 milliseconds duration shall be automatically rejected.

ANALOG SIGNAL MULTIPLIERS:

The flow, level signals shall be provided with back of panel mounted signal multipliers. They'll provide loop power with option to select measurement with power and without. The multiplier will provide 2 outputs of 4-20mA one for the panel mounted indicator and other for PLC i/p. There will be total galvanic isolation between field I/O's and also between the 2 outputs.

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 per 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.

FIELD MOUNTED INSTRUMENTS

Field mounted instruments shall, where possible, be hermetically sealed. If this is not possible, they shall be of weather proof construction with heavy cases. Transmitters and similar equipments shall be further enclosed in purpose made weather proof, 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.

PUSH BUTTONS AND SWITCHES

Push buttons 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 push buttons 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 push buttons 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.

INSTRUMENT CONNECTIONS:

Electrical cable entry shall be ½" NPT (F). Suitable cable gland shall be used.

End connections shall meet the following unless otherwise specified:

Threaded end connections shall be NPT as per ANSI/ASME B.1.20.1

Flanged end connections shall be as per ANSI/ASME B16.5

3. 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 in this section or as required for proper operation of the plant as described elsewhere 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 ports suitable for process/diagnostic data transfer with PLC/HMI need not consider analog signal and alarm contacts in input to PLC.

All instruments, gauges and control equipments shall be strictly procured as per the list of approved vendors enclosed herewith as part of the tender documents

a) 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. Range shall be so specified that the gauge normally operates in the middle third of the scale and shall conform to IS-3624 standard dials, wherever possible.

Diaphragm seals, filled type or mechanical types 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 cleanout type with flushing connection.

Pressure Gauge Dial Size shall be of minimum 150mm and of white with black engraving, shall be provided with blow out disc, toughened/safety glass window, bayonet type bezel ring, case material of SS304, Bourdon Element/Socket of SS316, movement part of SS, weatherproof 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 Part shall be of SS316, Upper Chamber of SS304/SS316, with silicon oil sealing fluid, 2" ANSI B16.5 flanged process connection

Following accessories shall be supplied as a standard with all pressure gauges:

Isolation Valve : Required, Gate/Ball Valve, SS316
Manifold Valve : Required, SS316, 3Way 2Valve type

b) ULTRASONIC TYPE LEVEL TRANSMITTER:

Ultrasonic transmitter shall be provided to measure liquid level of two compartment of Wet well. The purpose is to monitor sum levels and for start/stop of pumps in auto mode through suitable logic to be decided during detailed engineering, low/high level alarm notification on control panel at control room, etc. These specifications shall be as under:

Type :
Ultrasonic, Fully User Programmable
Type of Tx. (controller):
Integral/Remote Type
Mode of Operation :
Level
Repeatability :
 $\pm 0.25\%$ of range
Outputs : 4-20 mA DC HART analog output proportional to level
Programming Device: In-Built in controller or Hand-held
Local Digital Display : Level in Engg. Units
Power : 2/4-Wire (24VDC or 230VAC, 50Hz)
Control Unit Protection: IP-65 as a minimum
Proc. Temp. Compensation: Required, Built-in temp. sensor in transducer
Meas. Range : As per SOQ
Transducer Protection : IP-67/68
Blanking Dist. : 0-3-0.4m max.
Transducer Cable Length: NA
Process Connection : 2" or 3" Flanged as per mfr. Std.. Matching flange with required pipe/support structures shall also be provided.

Level readings shall be continuously displayed locally as well as in remote at Panel mounted Process Indicator and at PLC/HMI. Low-Low & High-High level alarms shall be announced at HMI and audio-visual alarms shall be provided at panel mounted hooter. The raw sewage pumps shall operate in level based auto mode i.e. start at set high level and stop at set low level. The working and standby pumps shall be selected by operator at HMI or shall be determined by operating hours of pumps such that pump with minimum operating hours shall start first & soon and in case of pump trip, pump with maximum operating hours shall stop first and soon. Also in case of power failure, the same shall be sensed by PLC and in such an event, the pump shall operate on programmed timer basis for start cycle till such time that all pumps turn off and after that it

shall resume operation on level basis. Operating hours of pump shall be logged in PLC

4. INSTALLATION MATERIALS:

Vendor shall supply all erection hardware 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, airline pipes and fittings, filter regulator, insulation material, cable duct and trays, conduits, identification tags, structural material required for instrument supports and tray setc.

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 1.5 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 multi-pair cable, Pair identification as per BS 5308 Part-II marking pair no. for each pair shall be provided at maximum 50 mm between two consecutive numbers.

Cables For Digital Signals:

Cables of 660V/1100V grade, multi-core cables, multi-stranded high conductivity annealed 1.5 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 50 mm between two consecutive numbers. Colour coding for cables 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. Sequential marking 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, lug sets 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 glands wherever 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 SS 316 as a minimum. Packing material in general shall be PTFE. Valves and Manifolds shall be of forged type only.

D) PIPE AND TUBE FITTINGS:

Tubefittings shall be flareless compression type and of three piece construction of Swagelok/Parker Hannifan make.

Ferrules shall be as per general.

Socket Weld type forged pipe fitting of suitable material and ratings shall be supplied for pipe fittings. The minimum rating 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 B68/B68M shall be used. It shall be manufactured from Bar Stock or equivalent and shall be nickel plated.

E) CABLE TRAYS:

All branch cables/tubes, cables on various civil units/structures shall run on cable tray only.

Cable tray shall be made out of galvanized mild steel sheet of 1.5mm thickness with required accessories. All material shall be hot dip galvanized (610 g/m²) as per IS 2629. The width shall be so selected that 40-50% 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 4mm² cable termination mounted on rails. 20% spare terminals shall be supplied in junction boxes.

Each junction box shall have 10% or minimum 2 nos., whichever is higher, spare entries of each size. Spare entries shall be provided with plugs.

7. INSPECTION:

Test/Calibration Certificates shall be reviewed and approved prior to dispatch 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.

8. VENDOR DATA REQUIREMENT(INSTRUMENTATION)

Sr. No .	Description	With Bid	Info./ Review	As-Built
1	Piping&InstrumentDiagram		*	*
2	Instrumentindex		*	*
3	VendorListforInstruments& accessories		*	
4	SizingCalculations		*	
5	Utilityrequirements		*	
6	InstrumentSpecificationsanddata sheets		*	*
7	Detailedloopdrawings		*	*
8	Panelfrontarrangement		*	*
9	Wiringdiagramforpanels		*	*
10	CableSchedule		*	*
11	InstrumentInstallationdrawings		*	*
12	BillofMaterialforinstallationitems		*	*
13	InspectionandTestprocedures		*	
14	Test Certificatesandcertific.from statutorybodies		*	*
15	Completecatalogueswithpartlistfor allvendorsuppliedinstruments, controlsetc.	*	*	
16	Installation,Operationand maintenancemanuals			*

LIST OF APPROVED VENDORS FOR INSTRUMENTATION SYSTEM

Ultrasonic Transmitter Level/Diff. Level/flow	Endress+Hauser, Siemens, Krohne, Vega, Emerson, ABB
Pressure Gauge	Wika, General Instruments Consortium Manometer (India) P.Ltd., Baumer, Pricol
Panel mounted Process Indicator & Flow Integrator	ABB, Yokogawa, Nishko, Nivam, Masibus

SECTION:D

***SPECIFICATIONFOROPERATION&M
AINTENANCEWORK***

SPECIFICATIONS FOR OPERATION & MAINTENANCE WORK
SECTION: D

1.0 ADMINISTRATIVE PROVISIONS

The following additional clauses shall apply only during the Five year of Operation and Maintenance period for entire system of sewage pumping station.

1.1 DEFINITIONS

1.1.1 In this Agreement, the following words and expressions shall have the meanings hereby assigned to them, except where the context otherwise requires:

1. **"Contract"** shall mean the agreement between the Client and the Contractor along with all documents incorporated therein by reference and all documents incorporated by these Conditions of Contract.
2. **"Contractor's Equipment"** shall mean all equipment, instruments, tools, machinery and other appliances and things of whatsoever nature required for the fulfillment of the Contract or of the Contractor's Obligations, but not including those items which are intended to form, or which form part of the Facility.
3. **"Contractor's Obligations"** shall mean the obligation to execute the Project in its entirety and shall, without limitation, include the Contractor's Operation and Maintenance.
4. **"Taking Over Certificate"** shall mean the certificate to be issued when the whole of the Works or any sections or parts of the Permanent works have been substantially completed and satisfactorily passed the test on completion in accordance with the provisions of the Contract.
5. **"Date of Taking Over"** shall mean the date of issue of the "Taking Over Certificate" under the construction phase.
6. **"Defects Liability Period"** shall mean the Defects Liability Period of 5 (Five) years for all works commencing on and from Date of Taking Over during which the Contractor shall undertake the responsibilities, and have the liability for the facility (including Civil Works, mechanical and electrical installations including all allied works at sewage pumping station(s)).
7. **"Facility"** shall mean the entire system to be designed and constructed in accordance with the provisions hereof, including the buildings, structures, ramps, pits, pipes, fencing, lighting, testing and analysis equipment, tools, mechanical, electrical as well as safety equipment, Sewage pumping machinery, supplies, instruments and **ventory**.

incorporated therein, as well as all open areas within the site, and including any additions, modifications, alterations, replacement and repairs as may be made thereto from time to time.

8. **"Authority"** shall mean any municipal corporation, authority or body exercising executive, legislative, judicial, regulatory or administrative functions, including, without limitation, any government/semi-government authority, agency, department, board, commissioner or instrumentality of Indian or any political subdivision thereof, court, tribunal, arbitrator or self-regulatory organisation.
9. **"Law"** shall mean and include all the provisions of all Indian statutes, regulations, ordinances, codes, official or other standards, administrative or other rules, zoning and other plans and restrictions, building and other permits, judgements awards and decrees of, or agreements with any Governmental, semi-Governmental or quasi-Governmental Authority, municipal corporation etc. as currently in effect or as may be in effect from time to time and/or as may be amended or supplemented from time to time.
10. **"Maintenance Standard"** shall mean the requirements for maintaining, repairing, and renewing the Facility:
 - a) Asset forth in the O&M Manual;
 - b) Required pursuant to applicable Law;
 - c) As may be necessary for keeping the facility in a satisfactory condition such that the Facility will continuously, comply with the Operation Standard; and
 - d) As may be necessary to ensure that the Facility shall continuously be in an optimum condition and state in relation with the lifetime of the Facility.
11. **"O&M Manual"** shall mean the final Manual for the Operation and Maintenance of the Facility to be prepared by the Contractor in accordance with the Bid Documents.
12. **"Operation and Maintenance Obligations"** shall mean the obligation of the Contractor pursuant to the Agreement to operate and maintain the Facility on and from the Date of Taking Over until the date of completion of this Agreement.
13. **"Operation and Maintenance Period"** shall mean the period starting on the Date of Taking Over and continuing for the term of the Agreement.
14. **"Operation and Maintenance Price"** shall mean the amount payable by the Client to the Contractor, for the fulfillment of the Contractor's Operation and Maintenance Obligations.

15. **"OperationStandard"**shallmean:

- a) ThePerformanceGuarantees;
- b) AllapplicableLaws;
- c) Alloftherequirements,policiesandproceduresetforthinthe O& MManual
- d) AllotheroperationalrequirementssetforthinthisAgreement.

16. **"Performance Guarantees"**shallmeantheListofGuarantees offered/provided bytheContractorinitsBidderSubmissionpursuantof the BidDocuments.

17. "Site"shallmeanthatspecificareaspecifiedintheBidDocuments andshallincludeanyotherplacesasmaybespecificallydesignated bytheClientfromtimetotimeasformingpartoftheSite.

1.2 OBJECTOFCONTRACT

1.2.1 RISKSANDOBLIGATIONOFTHECONTRACTOR

1.2.1.1

ForthedurationofCOMPREHENSIVEO&Mperiod,Contractorshallrenderandmakeavailabletothe Clientthefollowingservices:-

- a) Duringtesting&commissioningwork,requiredSewageandpowerwillbe thescopeofContractor.
- b) Drawlofsewagefromtheinletchamberofsewagepumpingstationand passingthroughscreens andcollectedintowetwellandfromthe wetwell to sewagepumpingand thentransferofsewageuptoproposedpointof locationtojointhesewageintolargesizesewerthroughrisingmain.
- c) Control andOperation of Sewage pumping Station with supply of all necessaryspares,tools,consumables,lubricants,etc.
- d) RoutineMaintenanceofall Buildings,mechanical&electricalinstallationsand equipmentandareas;atthesiteofsewagepumpingstation
- e) Managementofthesewagepumpingstationinadministrativeandfinancial operationsconnectedtoSewagepumpingmanagement;
- f) Trainingof O& MstaffoftheClient.

1.2.1.2 TheContractorshalltakefullresponsibilityforthecareoftheFacilityandmaterials andSewage pumpingfromthedateofissueoftheTaking-Over CertificateforthewholeoftheWorks,untilthedateofcompletion ofthe OperationandMaintenanceperiod,whenthe responsibilityforthecareshall passtotheClient.

1.2.1.3

IfanylossordamagehappenstotheFacility,oranypartthereof,ormaterialsorSewage pumpingforincorporation therein,duringtheperiodforwhichthe Contractorisresponsibleforthe carethereof,fromany cause whatsoever,other thantherisksdefinedinSub-Clause 1.2,theContractorshall,athisowncost, rectifysuchlossordamagesothattheFacilityconformineveryrespectwiththe provisions oftheContracttothesatisfactionoftheClient.TheContractor shall alsobeliableforanylossordamagetotheWorksoccasionedbyhiminthe

course of any operations carried out by him for the purpose of complying with his obligation.

- 1.2.1.4 In the case of a combination of risks causing loss or damage any such determinations shall take into account the proportional responsibility of the Contractor and the Client.

1.2.2 RISKS AND OBLIGATION OF THE CLIENT

- 1.2.2.1 For the duration of COMPREHENSIVE O&M Contract, Client will supply power only.

- 1.2.2.2 Provide free access to the site and the Sewage pumping and all its components free of charge.

- 1.2.2.3 Make payments to the Contractor according to the terms of this Contract as specified hereinafter.

- 1.2.2.4 If the Client shall carry out work on the Site with his own workmen he shall, in respect of such work:
- a) Have full regard to the safety of all entitled to be upon the Site, and
 - b) Keep the Site in an orderly state appropriate to the avoidance of danger to such persons.

- 1.2.2.5 If the Client shall employ other contractors in the Site, he shall require them to have the same regard for and avoidance of danger.

1.3 COMMENCEMENT AND DURATION OF COMPREHENSIVE O&M CONTRACT.

- 1.3.1 The O&M Period shall commence upon issuing of Taking Over Certificate under the construction phase of the project and shall continue for a period of **Two (2) year, including defect liability period** as mentioned in the Conditions of Contract.

In event of any electrical and mechanical fault, the contractor has to attend the same immediately. For Major Faults like Rewinding of Motors, Transformer, Soft Starter, Pump overhauling should be done at manufacturer's works.

1.4 LIABILITY

- 1.4.1 The Contractor will not under any circumstances be liable for costs or loss of profit that the Client may incur as a result of the unavailability of the Sewage pumping on account of force major.

1.5 INSURANCE

- 1.5.1 The Contractor shall, without limiting his or the Client's obligations and responsibilities, insure:

- a) The Works, together with materials and Sewage pumping for incorporation therein, to the full replacement cost (term "cost" in this context shall include profit).

b) The Contractor's Equipment and other things brought onto the Site by the Contractor, for as much as sufficient to provide for their replacement at the Site.

1.5.2 The insured detailed above shall be in the joint names of the Contractor and the Client at the Contractor's cost and shall cover the Client and the Contractor against all loss or damage from whatsoever cause arising, other than as provided from the start of the operation and maintenance until the date of completion of operation and maintenance in respect of the Facility or any Section or part thereof as the case may be.

1.5.3 Any amounts not insured or not recovered from the insurers shall be borne by the Contractor in accordance with their responsibilities.

1.5.4 The Contractor shall, except if and so far as the Contract provides otherwise, indemnify the Client against all losses and claims in respect of:

- a) Death of or injury to any person, or,
- b) Loss of or damage to any property (other than the Works),

Which may arise out of or in consequence of the Operation and Maintenance of the Facility and the remedying of any defects therein, and against all claims, proceedings, damages, costs, charges and expenses whatsoever in respect thereof in relation thereto, subject to the exceptions defined above.

1.5.5 The "exceptions" referred to are:

- a) The permanent use or occupation of land by the Works, or any part thereof.
- b) The right of the Client to execute the Works, or any part thereof, on, over, under, in or through any land,
- c) Damage to property which is the unavoidable result of the execution and completion of the Works, or the remedying of any defects therein, in accordance with the contract, and
- d) Death of or injury to persons or loss of or damage to property resulting from any act or neglect of the Client, his agents, servants, or other contractors, not being employed by the Contractor or in respect of any claims, proceedings, damages, costs, charges and expenses in respect thereof or in relation thereto or, where the injury or damage was contributed to by the Contractor, his servants or agents, such part of the said injury or damage as may be just and equitable having regard to the extent of the responsibility of the Client, his servants or agents or other contractors for the injury or damage.

1.5.6 The Client shall indemnify the Contractor against all claims, proceedings, damages, costs, charges, and expenses in respect of the matters referred to in the exceptions defined above.

- 1.5.7 The Contractor shall, without limiting his or the Client's obligations and responsibilities as above, issue in the joint names of the Contractor and the Client, against liabilities for death or injury to any person or loss of or damage to any property (other than the Facility) arising out of the Operation and Maintenance of the project other than the exceptions defined.
- 1.5.8 The insurance policy shall include a cross liability clause such that the insurance shall apply to the Contractor and to the Client as separate insurers.
- 1.5.9 The Client shall not be liable for or in respect of any damages or compensation payable to any workman or other person in the employment of the Contractor or any Subcontractor, other than death or injury resulting from any act or default of the Client, his agents or servants. The Contractor shall indemnify and keep indemnified the Client against all such damages and compensation, other than those for which the Client is liable as aforesaid, and against all claims, proceedings, damages, costs, charges, and expenses whatsoever in respect thereof in relation thereto.
- 1.5.10 The Contractor shall insure against such liability and shall continue such insurance during the whole of the time that any persons are employed by him on the Facility. Provided that, in respect of any person employed by any Subcontractor, the Contractor's obligation to insure as aforesaid under this Sub-Clause shall be satisfied if the Subcontractor shall have insured against the liability in respect of such persons in such manner that the Client is indemnified under the policy, but the Contractor shall require such Subcontractor to produce to the Client, when required, such policy of insurance and receipt for the payment of the current premium.
- 1.5.11 In the event that the Contractor or the Client fail to comply with conditions imposed by the insurance policies effected pursuant to the Contract, each will indemnify the other against all losses and claims arising from such failure according to the Contract Conditions.

1.6 STAFF

- 1.6.1 All Contractor's staff employed at the Sewage pumping at any time during the period covered by the present Contract will be provided by him. The Client is not liable for staff in any way and cannot be held responsible in the event of litigation of any sort between the Contractor and members of Sewage pumping staff or their representatives.
- 1.6.2 All decisions related to staff numbers and qualifications should be approved by the Client.
- 1.6.3 The Contractor undertakes to comply with applicable legislation and the code of labour law on matters of health, hygiene and safety, and shall assume responsibility for works required in the event of any change in applicable regulations.

1.6.4 The Contractor shall provide the following staff for the operation & maintenance

:

(1) Pump Operator -1 no. per shift (XIIth Pass, with min. 2 Years Exp.)

(2) Helper cum Operator -1 no. per shift (Xth Pass, with min. 2 Years Exp.)

(3) Security/mali/sweeper-1 no. for general shift (8th Std. Pass)

During COMPREHENSIVE O&M period of 24 hours a day & 7 days a week, minimum one person must be present on sewage pumping station. Person must be ITI Fitter/Electrician/Wireman trade passed for operation work of electro-mechanical equipment of sewage pumping station & This person must be for work of security also during night shift.

1.7 PENALTY

Failing the execution of the operation, maintenance, servicing & comprehensive repairing work as per the tender document, the penalty will be applicable as per the mention in the tender. If the penalty occurs three times in the month, then the contract shall be liable to terminate, security deposit shall be forfeited and party shall be blacklisted in the RMC.

1.7.1 Due to negligence, forgetfulness, irresponsibility of contractor's staff, Pump sets and Machinery remains in non usable condition/idle for more than Two days then in such a case penalty as mention below shall be recoverable from contractor's O&M bill. If such incidents occur three or more times in one month, then RMC can terminate the O&M Service and Comprehensive repairing work contract.

Idleness up to 7 days : Rs.300/- per day per pump

Idleness for 8 days & above: Rs.700/- per day per pump

Maximum ceiling of penalty shall be Rs.10000/- per month subject to 20% of monthly O&M charges, whichever is higher.

1.7.2 Spare pump set shall also be kept ready for operation. If spare pump is not ready for operation for work more than five days RMC will deduct Rs.500/- per day per pump as penalty from their bill.

1.7.4 If fault occurs in transformer, H.T. breaker or any electrical machinery that should be rectified or faulty parts should be replaced within 48 hours. Otherwise penalty of Rs.5000/- Per day will be deducted from the contractor's bill.

1.7.5 (a) If the Contractor does not recruit/deploy the 'Personnel' identified as per the schedule or remain absent then penalty/ Liquidated Damages will be deducted as follows:

For Pump attendant : Rs.500/- per person per day.

For Helper : Rs.400/- per person per day.

(b) Force majeure means an event beyond the control of the contractor and not involving the contractor's fault or negligence and not forceable. Such events

may include but are not restricted to, acts of the contractor either in its sovereign or contractual capacity, wars or revolutions, fires, floods, epidemics, quarantine restrictions and freight embargoes.

1.8 TERMINATION

1.8.1 Termination by the Client

The relevant clause of the General Conditions of Contract shall be applicable in this case.

1.8.2 Termination by the Contractor

The relevant clause of the General Conditions of Contract shall be applicable in this case.

1.9 FORCE MAJEURE

The relevant clause of the General Conditions of Contract shall be applicable in this case.

1.10 CONTRACT INTERPRETATION AND DISPUTES SETTLEMENT

1.10.1 The relevant clause for Amicable Settlement of Disputes of the General Conditions of Contract (Part I) shall apply.

1.11 ASSIGNMENT

1.11.1 The Contractor will not be entitled to sub-contract any part of his obligation to any third party without prior approval of the Client.

1.12 COMPLETION OF THE CONTRACT

1.12.1 On the date of Contract Completion or if the Contract is terminated, all the installations, works and equipment placed under the Contractor's responsibility shall be handed over to the Client, at no cost, in good working order, except for normal wear and tear. The Client may perform many inspections, tests or expert appraisals he shall consider necessary with a view to checking that the property is in good working order.

1.12.2 At the end of O&M period, the Contractor shall be entitled to receive an Operation and Maintenance Completion Certificate within twenty-one (21) days, of the completion of the Contract.

1.12.3 The delivery of such Completion Certificate will relieve the Contractor from his responsibility as regards to the Operation and Maintenance and confirm that the Contractor has fulfilled all of his obligations under the contract.

2.0: TECHNICAL PROVISIONS

2.1 NOT USED

2.2 MAINTENANCE

2.2.1 The Contractor shall be responsible for routine as well as corrective (preventive) maintenance of hydraulic, mechanical, electrical equipment as well as miscellaneous equipment and instruments as described in Conditions of Contract for O&M.

2.2.2 The Contractor shall be responsible for carrying out regular servicing and lubrication of machines, complying with maintenance instructions as defined in the Operation and Maintenance manual, and ensuring that electromechanical equipment and motors operate correctly at all times.

2.2.3 The Contractor shall ensure that measurement systems operate correctly at all times.

2.2.4 The Contractor is responsible for the maintenance of the landscaped areas inside the client's Sewage pumping fences.

2.2.5 The Contractor shall be responsible for maintenance of civil structures including inlet and screen chambers as well as wet and dry well, sewage pumping machineries as well as mechanical & electrical installations/equipments.

Performance Standards

The Contractor will operate and maintain in a state of continuous operational readiness all Sewage pumping and systems to meet the incoming flow. It shall remain the Contractor's responsibility to ensure that sewage pumping systems are at all times able to operate to the maximum capacity of the installed duty Sewage pumping.

All Sewage pumping installation shall be operated within their designed limits. The Contractor shall operate the Sewage pumping strictly within these operating ranges and shall manage the operation of these sewage pumping to achieve optimum performance as far as possible.

2.3 CONSUMABLES AND UTILITIES SERVICES- SPARE PARTS- STORES

2.3.1 CONSUMABLES AND UTILITIES SERVICES

2.3.1.1 Unless stipulated otherwise elsewhere in the document, for the duration of the COMPREHENSIVE O&M period, the Contractor will be responsible for the supply and control of lubricants, spare parts, tools and consumable materials excluding electrical power, necessary for the continuous operation of the works.

2.3.1.2 The Contractor will manage the consumables and utilities services to ensure their most economic consumption and to minimize wastage.

2.3.1.3 Power required for COMPREHENSIVE O&M for 5 (Five) years will be supplied free of cost by the client from Power Supply Company. Only Diesel for the power generator set (DG Set) shall be provided by Client/RMC. Any other serviceable parts & lubricants Oil, Grease etc for the DG Set shall be supplied by contractor at his own cost. For the usage of diesel proper records shall be maintained by contractor. If any other energy required for COMPREHENSIVE O&M will have to be borne by contractor.

2.4 SPARE PARTS AND STORES

2.4.1 The stores inventory, the issuing and recording of spare parts will be the responsibility of the Contractor.

2.4.2 The Contractor is also responsible for providing required spare parts, tools and any other material required during year of operation and maintenance period by **free of cost**, and also bare the cost of storing and safeguarding also.

2.4.3 The Contractor will make all necessary arrangements to ensure the continuous supply of spare parts and material for the works as would ensure uninterrupted operation and shall be supplied free of cost.

2.4.4 Spare parts shall be supplied by the Contractor and the same will be used during Five year operation and maintenance period free of cost. Any spare parts not used during the O&M period shall be handed over to the Client at no cost.

2.4.5 The quality of spare parts, lubricant etc. required for COMPREHENSIVE O&M activities will be checked frequently by the Engineer-in-charge or his representative and the quality/brand of each will be approved. The material without approval shall not be allowed to be used and such material shall be immediately removed from the site in presence of the Client with a letter, addressed to the Engineer-in-charge as a confirmation.

2.5 MISCELLANEOUS EQUIPMENT

2.5.1 OFFICE

All the furniture and administrative office equipment etc. required shall be furnished by the Contractor. Costs of operating Administrative office and supplies shall be borne by the Contractor.

The Contractor shall take out subscriptions for standard telephone lines. Running cost for the telephone will be borne by the Contractor.

2.5.2 SEWAGE PUMPING STATION COMPLEX

Cost of operation and maintenance and housekeeping of sewage pumping station complex including domestic water supply and drainage, roads, gardens, electrical installations, etc. will be borne by the contractor.

2.6 INSPECTION

2.6.1 GENERAL PROVISIONS

2.6.1.1 The Client shall check the operation of the Sewage pumping or designate an organisation of his choice to carry out inspections regularly. The Client 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 the Client requires to complete these inspections.

2.6.1.2 Before any inspection, the Employer shall give prior written notice of one day to the Contractor, indicating the name(s) of the person(s) empowered to carry out such inspection in the name of the Client.

2.6.2 MEASUREMENT AND ANALYSIS

The Client has the right to perform any analysis or inspection he deems necessary. Before any inspection, the Client shall give a prior written notice of one day to the Contractor and shall cover the cost of such action.

2.7 SEWAGE PUMPING STATION COMPLEX VISITS

2.7.1 At the end of each month, or at the initiative of the Client, a visit shall be organised so that both parties can check the condition of the installations at the Sewage pumping complexes.

2.7.2 A report shall be drawn up to record the opinion of both parties. The Client reserves the right to call line equipment manufacturers or specialised technicians for these visits.

2.7.3 These visits shall provide an opportunity for examining maintenance programs and operating procedures and improvements requiring additional investments.

2.8 DOCUMENTS TO BE PROVIDED BY THE CONTRACTOR

2.8.1 OPERATION LOGBOOK

2.8.1.1 The Contractor shall keep a permanent record of Sewage pumping station operation (logbook). This logbook shall be kept at the site and shall be presented on request to agents approved by the Client.

2.8.1.2 On a daily basis, the following information shall be recorded in the log book:

- a) Reading from the different meters, indicators and recorders (including but not limited to consumption of energy, volume of sewage lifted, operating times of the different electro-mechanical & instrumentation equipments), voltage etc. as required.
- b) Report of visits by persons other than those of the Client and the Contractor to the Facility.

2.8.1.3 The Contractor shall also indicate any significant modification to the set-up characteristics of the installation, shut-downs, anomalies or incidents that have occurred with respect to operation.

2.8.2 MONTHLYREPORT

2.8.2.1 The monthly reports shall include but not be limited to:

- a) Daily Volume of sewage actually received, pumped or conveyed to the off-take point (flow measurement per house and per day, sewage pumping total quality of sewage per day/month/year etc.).
- b) All the problem areas in the facility.
- c) The status and progress of the training programs.
- d) Electricity consumed totally.
- e) List of the parts replaced and quality of other different consumable items consumed during the month.
- f) List of major defects/breakdown during the month.
- g) Detail of rectification works during the month.

2.8.3 ANNUAL REPORT OF OPERATION

2.8.3.1 The Contractor shall provide the Client by March 31 of the current year (n) with an annual report for the preceding year (n-1). This report shall include:

- a) All technical statistics related to Sewage pumping operation as supplied by the operation;
- b) A statement of work carried out during the preceding year - 1 in connection with the Contractor's maintenance obligation;

3.0:FINANCIALPROVISIONS

3.1 FINANCIALPROVISIONS

3.1.1 METHODOFPAYMENT

- 3.1.1.1 TheClientwillpaytheContractorfortheO&MPriceonaquarterlybasis subjectedtosatisfactory performance oftheentiresystem.Thepaymentfor comprehensiveoperationandmaintenanceshallbein**asperPriceSchedule oftenderdocument.**

3.1.2 INVOICING

- 3.1.2.1TheContractorshallprepareandsubmittotheClientaninvoiceeachmonth withalldocuments(CopyofAttendanceregister,Subscription copyofP.F,ESI, workreportetc)supportingitsclaim.Theinvoiceshallbesubmittedbetween thefirstandfifthdayofthemonth.

3.1.3 FLUCTUATIONFACTORS

- 3.1.3.1Deleted...

3.2 LIQUIDATEDDAMAGES

- 3.2.1 Thesystem shallbe capable to deliver the designed capacity of sewage pumping.Howeverintheinitialstagethesewage flowmaynotgetdeveloped fully,duetolesspopulation coverage.However,thebiddershallkeepallthe installationsandsysteminworkingconditionthroughouttheCOMPREHENSIVE O& Mperiod.

3.2.2 Forthenoncomplianceofemploymentofkeystaff

- 3.2.2.1 Ifthesuccessfulbidderdoesnotrecruit/deputeorinabsenceofthekeystaff identifiedasperschedule, thenliquidated damageswillbedeductedat**1½ times**oftheratequoted(perday).

3.3 TAXES,LICENSES,PERMITSANDFEES

- 3.3.1 Noextrapaymentsshallbemadetothecontractor againstanytaxes,licenses, permitsandfeeswhichever isinforceormaybeimposed infutureby Central/StateGovt.whichaffectsthiscontract.

3.4 TRAINING

- 3.4.1 Beforeendofthecontract,suitabletrainingshallbegiventotheclient'sstaff.

Asst. Engineer
RMC

Dy.Executive Engineer
RMC

City Engineer (Drainage Project)
RMC

