



::GUJARAT HIRA BOURSE::

Gem & Jewellery Park, Ichchhapore, Surat.

VOLUME - II

TENDER DOCUMENT FOR

**DETAIL TECHNICAL SPECIFICATIONS & DETAIL SCOPE OF
WORKS FOR 5 MLD SEWAGE TREATMENT PLANT**

Contents:

Chapter-I	INTRODUCTION & TREATMENT PHYLOSOPHY
Chapter-II	DETAIL SCOPE OF WORKS
Chapter-III	SPECIFICATIONS FOR CIVIL WORKS
Chapter-IV	SPECIFICATIONS FOR MECHANICAL & ELECTRICAL/ INSTRUMENTATION WORKS
Chapter-V	LIST OF APPROVED MAKES FOR MAJOR ITEMS
Chapter-VI	OPERATION & MAINTENANCE WORKS

Chapter-I

INTRODUCTION & TREATMENT PHYLOSOPHY

1.1 Introduction

1.1.1 The Gujarat Hira Bourse has taken up to construct STP at Gem & Jewellery Park at Ichchhapore village, Surat. The present Tender deals with Design and Construction of Sewage Treatment Plant (STP) for 5 MLD Capacity including cost of Civil, Mechanical & Electrical/Instrumentation works on Turnkey basis and all other works contingent thereto at Ichchhapore, Surat including Operation and Maintenance for 60 months.

1.1.2 Site Information

1. Location of Site : Ichchhapore, Surat city
2. Soil report for proposed STP site is attached with tender
3. Natural Ground Level (NGL)= 49.127 at Site
4. Invert Level of Incoming Sewer Line : approximately 4.0 m below ground level
5. Consider water table shall be 3.0m below from existing ground level for uplift design for water retaining structure.
6. The plot area available at site is 5312.00 sq.m.

1.1.3 Raw Sewage Characteristics

The proposed Sewage Treatment Plant shall be designed to treat the average flow of 5 MLD and peak flow of 10.0 MLD considering a peak factor of 2.0.

The plant shall be designed to treat the wastewater of following characteristics:

Sr. No	Parameter	Value	Unit
1.	pH	6.5 -8.5	
2.	BOD ₅	150-200	mg/l
3.	COD	400	mg/l
4.	Suspended Solids	150-200	mg/l
5.	Fecal Coliform Count	1 x 10 ⁷	MPN/100 ml
6.	Total Kjeldahl Nitrogen (as N)	30-35	Mg/l
7	Ammonia Nitrogen (as N)	10	Mg/l
8	Total Phosphorous	5	Mg/l

1.1.4 Treated Sewage Quality

The final treated sewage quality to be guaranteed by the Contractor is as below at the outlet after Chlorination System.

Sr. No.	Parameter	Value	Unit
1.	pH	6.5 to 8.5	
2.	BOD ₅	≤ 5	mg/l
3.	COD	≤ 60	mg/l
4.	Suspended Solids	≤ 5	mg/l
5.	Fecal Coli form Count	≤ 1000	MPN/100 ml
6.	TKN	≤ 10	Mg/l

(a) 1.1.5 Scope of Work

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

Planning, designing and construction of civil engineering works for all the units and all the ancillary structures.

Planning, designing and supply, erection, testing & commissioning of all the mechanical equipment.

Planning, designing and supply, erection, testing & commissioning of all the electrical & instrumentation equipment.

Planning, designing and supply, erection, testing & commissioning of all the piping, valves and specials etc.

Hydraulic testing of all the water retaining structures

Operation & Maintenance of the plant for a period of sixty (60) months.

During Operation & Maintenance period Electricity Charges, Diesel Charges (if any) shall be borne by the Department. All other consumable material and required staff for shall be provided by the Bidder.

Defect liability for a period of Twelve (12) months.

Supply of as-built drawings after completion.

Manufacturer's Manual for Operation & Maintenance of the Equipment supplied.

1.1.6 DRAWINGS

1.1.6.1 Layout and Hydraulic Flow Diagram shall be submitted by the Bidder. **Preliminary drawings and design showing sizes and levels of various units shall be submitted by Bidder along with filled up Tender.**

- 1.1.6.2 Detailed working drawings and design shall be submitted by the successful Bidder to developer for approval before execution of work. If changes in the submitted design/drawings are required, Engineer in Charge may either himself do so prior to approval or may request the Contractor to resubmit the design/drawings after making the required amendments.

The agency shall submit Layout, Hydraulic Flow Diagram and P & I Diagram within 15 days of issuance of letter of Award. The first set of working drawings/structural drawings along with design shall be submitted within 15 days of approval regarding Layout, Hydraulic Flow Diagram and P & I Diagram. The remaining working drawings/structural drawings and design shall be submitted by the firm to Engineer in Charge within two months of approval of Layout, Hydraulic Flow Diagram and P&I Drawing.

The components of the Sewage Treatment Plant (STP) for the Contractor/Bidder are as under:

1. Main Pumping Station with submersible sewage transfer pumps
2. Stilling Chamber (Inlet Chamber)
3. Fine Screen Channel (1 No. Working: Mechanical)
4. Grit Channel (1 No.-Working: Manual)
5. SBR Reactors (2 Nos.)
6. Chlorination Tank (1 No.)
7. Sludge Sump (1 No.)
8. SBR Air Blower cum MCC & Control House
9. Process Piping & Drain Piping

1.2 TREATMENT PHILOSOPHY FOR SBR TECHNOLOGY

1.2.1 Stilling Chamber

Raw Sewage shall be received into the Stilling Chamber from the Raw Sewage Pumping Station which is located at the nearest of the STP site.

1.2.2 Mechanical Fine Screen Channel

Mechanical Fine Screen Channel shall be provided upstream of Grit Removal System. The Fine Screen shall be capable to screen out most of the small floating material above 6 mm size.

1.2.3 Mechanical Grit Chamber

Screened sewage shall gravitate to mechanical grit chamber for removal of grit and small inorganic particulate matter of specific gravity above 2.65 and particle size above 150 microns. The grit chamber shall be of RCC construction. The grit separated shall be properly collected and be transferred for disposal.

1.2.4 Cyclic Activated Sludge /SBR Reactors

Screened and de-gritted sewage shall be fed into the Cyclic Activated Sludge / SBR Process Basins for biological treatment to remove BOD, COD, Suspended Solids, Biological Nitrogen and Phosphorous.

SBR / Cyclic Activated Sludge Process shall work in Cyclic / Batch mode in single step. It shall perform biological organic removal, Nitrification, De-nitrification and Biological Phosphorous removal. It shall be capable of simultaneous sludge stabilization. The oxygen required shall be supplied through fixed type Fine Bubble Diffused Aeration System with auto control of oxygen level in Basins. The system shall have a SVI < 120 for higher settling rates and shall be designed in such a way that growth of filamentous bacteria is restricted. The complete operation of SBR / Cyclic Activated Sludge Process including decanting rate, sludge recirculation and wasting of excess sludge shall be controlled by PLC. Treated Sewage from SBR / Cyclic Activated Sludge Process Units shall be collected in Chlorination Tank for its disinfection.

1.2.5 Chlorination System

Treated Sewage from SBR / Cyclic Activated Sludge Process Units shall be collected in a Chlorination Tank where disinfectant shall be added for disinfection at suitable dosing rate. Baffle walls shall be provided in the Chlorination Tank to facilitate hydraulic mixing of treated sewage. Adequate reaction time shall be considered for while selecting volume of the Chlorination Tank to ensure proper disinfection of treated sewage.

The treated sewage shall be pumped to UF system for further tertiary treatment.

1.2.6 Sludge Handling System

The sludge from the SBR / Cyclic Activated Sludge Process Basins shall be withdrawn through RAS Pumps and collected in the Sludge Sump. The sludge shall be then pumped to Centrifuges for dewatering. Centrifuge Feed Pumps shall be of positive displacement type Screw Pumps. The sludge in form of wet cake from Centrifuges shall be collected and disposed off.

1.2.7 SBR Air Blower cum MCC & Control House

Air Blowers for SBR Basins as well as MCC & Control Panel shall be housed in SBR Air Blower cum MCC & Control House.

1.2.8 Process Piping & Drain Piping

This shall include the interconnecting pipelines between different units of STP.

1.2.9 Site Development including storm water drain, road, fencing and External Water Supply shall be taken care by the developer & is not in the scope of the Contractor.

Unless otherwise specified, the entire RCC structures are to be constructed in M-30 or higher grade of concrete as per IS: 456 – Latest Edition.

RCC Staircase/Access Platform/Walkway and Railing along Staircases/Access Platforms/Walkways shall be provided to Primary Treatment Units & SBR Reactors.

The detailed technical specifications for all the items are covered in this part of the Tender documents. In case any item is not covered or missing, relevant IS Codes shall have to be followed upon approval of Engineer in Charge.

In case of any discrepancy between specifications laid down in this document and relevant IS Codes, the decision of the Engineer in Charge will be final & applicable.

Wherever reference is made to Indian Standard Specifications, the latest specifications are applied.

Chapter-II

DETAILED SCOPE OF WORKS

1.3. DETAILED SCOPE OF WORK FOR MAIN PUMPING STATION (MPS)

1.3.1 CIVIL WORKS OF MPS

- i. Sewer connection
- ii. Inlet Chamber
- iii. Screening Chamber
- iv. Valve Chamber
- v. Piping and specials

1.3.1.1. Sewer Connection

Raw sewage is being conveyed to the STP site by developer. The depth of this line is approximately 4.0 metres below ground level. The scope of work of the bidder is to connect sewer line to inlet chamber of proposed MPS along with provision of intermediate manholes. **The tenderer will lay HDPE pipes from GHB's end laid pipes including jointing upto inlet chamber of the MPS unit. Developer shall supply adequate size pipes.**

1.3.1.2. Inlet Chamber

The inlet chamber is proposed to act as a receiving structure for the sewage flow from the gravity sewer to the MPS. The sewage from the inlet chamber overflows into screen chamber where it undergoes screening.

No. of Unit	=	1
Average flow (MLD)	=	20
Peak factor	=	2.0
Peak flow (MLD)	=	40
Free Board (m)	=	0.50
Hydraulic Retention time at peak flow	=	30 seconds (minimum)

1.3.1.3. Screen Chamber

Three number screen channels with one number mechanical bar screen (working) and one number manual bar screen (standby) shall be provided. CI sluice gates shall be proposed on upstream and downstream of the two channels to regulate the flow. RCC Platforms shall be provided at suitable level to enable operation and maintenance of the unit.

No. of Unit	=	1 No. Mechanical Working +1 No. Manual Standby
Approach Velocity at Average Flow (m/sec.)	=	0.3
Velocity through Screen at Average Flow (m/sec.)	=	0.6 maximum
Velocity through Screen at Peak Flow (m/sec.)	=	1.2 maximum
Free board u/s of screen (m)	=	0.5
Average flow for each screen (MLD)	=	20
Peak flow for each screen (MLD)	=	40

1.3.1.4. Main Collection Sump

Main collection sump is rectangular RCC Structure for receiving and collection of sewage from screening chamber. Hydraulic retention time shall be minimum 5.0 minutes at peak flow. The working depth of sump shall be considered below bed level of screening chamber / weir level at the downstream end of screening chamber. Additional depth of sump to take care of minimum submergence of pumps shall be provided. Civil structure for pump lifting with Mono rail mounted Electric Hoist shall be provided. The wet sump shall have RCC staircase.

The supply and installation of 4 No. submersible raw sewage pumps, non clog type, shall be provided in the main collection sump. However, the bidder must have consider the space for installation of other 2nos of pumps of 5 MLD capacity each for future provision in Main Collection Sump during detailed engineering. The scopes of supply of these 2 nos. of 5 MLD pumps are not in the scope of bidder and also not considered for technical evaluation purpose.

Complete piping, valves, cabling, earthing etc. shall be included in the scope of work of the contractor. Based on incoming flow conditions, adequate no. of pumps shall start / stop automatically to cater the pumping requirements. Suitable arrangement shall be made for emptying sump portion for maintenance.

1.3.1.5. Valve Chamber

Valve chamber is a rectangular enclosure of suitable size. Valve chamber shall house all the valves, fittings, and common header rising main. All the specials of delivery line i.e. non return valves, sluice valves, tees, bends, dismantling joints etc. shall be housed in this chamber. CI D/F puddle collars of sufficient length for individual pump deliveries and one for common header shall be fixed in RCC Walls.

1.3.1.6. Delivery Piping and specials

This shall include providing, laying, cutting, jointing, testing etc. complete of following pipes along with specials:

- Delivery line for individual pump up to common header : DI K-9/CI
 - Non return valve, sluice valve, dismantling joint, pressure gauge on each pump delivery line.
 - Common header up to inlet of STP : DI K-9/CI
 - Sluice valve in the common header
 - All other required specials such as bends, tees etc.
- The common header pipe shall be minimum 350 mm dia DI K-9/ CI pipe.

1.3.2. ELECTRICAL & MECHANICAL WORKS OF MPS

- i) Mechanical & Manual Coarse Screen
- ii) Main Electrical Panel
- iii) Submersible Sewage Pumps
- iv) Cabling & Earthing
- v) Instrumentation
- vi) Control Gates
- vii) Electrical Hoist Mechanism
- viii) PLC/SCADA

1.3.2.1. Mechanical & Manual Coarse Screens

Design Criteria:

Avg. flow through each screen	=	10 MLD
Peak flow through each screen	=	20 MLD
Mechanical Bar Screen	=	2 Nos. (Working)
Manual Bar Screen	=	1 No. (Standby)
Approach Velocity at Average Flow (m/sec.)	=	0.3
Velocity through Screen at Average Flow(m/sec.)	=	0.6 maximum
Velocity through Screen at Peak Flow (m/sec.)	=	1.2 maximum

1.3.2.2. Main Electricity Panels

Substation facilities including transformer yard along with cabling etc., is not in the scope of contractor. The power shall be supplied up to MEP panel of MPS/STP by the developer.

The following panels would be provided in the Panel Room in Operation Building For feeding and controlling the electrical loads.

(a) Main Electrical Panel for receiving power supply (LT Panel)

This includes supply, installation and commissioning of Electricity Panel complete for MPS and STP units.

(b) APFC capacitor Panel

Bidder shall provide an automatic power factor control panel of reputed brand of adequate capacity. Bidder shall get approve the APFC Panel with GHB Authority.

1.3.2.3. Submersible Sewage Pumps

It is proposed to install 4 submersible sewage pumps along with motors in the main collection sump. The capacity of 2nos. of working pumps shall be 2.5 MLD each. Remaining 2 Pump shall act as standby having capacity of 5 MLD. The bidder must have consider the space for installation of other 2nos of pumps of 10 MLD capacity each for future provision in Main Collection Sump during detailed engineering. The scopes of supply of these 2 nos. of 5 MLD pumps are not in the scope of bidder and also not considered for technical evaluation purpose. **The power cost evaluation shall be based on 5 MLD average flows only.**

The automated working of the main pumping station shall be governed by the level of sewage in the Main Collection Chamber. It will have following features:

1. There shall be provision of the pumps turning ON depending upon the level of sewage in the collection chamber. The ultrasonic Level Indication Mechanism shall be fitted on the top of the Collection sump which shall transmit signal for starting or stopping of specific number of pumps as per level of sewage in the collection sump.
2. Sequence change of the pumps should ensure so that standby pumps are also brought to use regularly.
3. The pump operating at lowest level is changed on daily basis.
4. Raw Sewage Pumps operation shall be in auto. Capacitance Type Level Transmitter shall be provided for "High-High", "High", "Medium", "Low" and "Low-Low" levels for auto start/stop of pumps. The arrangement shall be such that under no condition, dry run of pump occurs. Also adequate number of pumps shall start/stop based on levels in the sump. The pumps shall be PLC controlled.

Type	:	Non-clog, submersible
Quantity	:	2 W + 2 SB
Capacity of Working Pump	:	104.17 m ³ /hr each
Capacity of Standby Pump	:	208.33 m ³ /hr each
Discharge Head	:	15m (min.)
Solid size handling	:	Minimum 80 mm
Minimum efficiency	:	65%

1.3.2.4. Cabling & Earthing

 Signature of the Contractor

 Signature of the secretary

Cabling: This includes supply, erection, testing & commissioning of Power & Control Cables required for various electrical loads and their controls such as water level control, dry run control, moisture seal control, ON-OFF control (Push button stations) to their respective sources and loads. The cable with cable trays & junction boxes and bus-bars of suitable capacity, wherever required should be complete in all respect. Civil works like construction of cable trenches with angles, chequered plate etc. are also included in the scope.

Power & Control Cables : LOT
Junction Boxes : LOT
Cable Trays : LOT

Note: Power will be made available inside the STP premises by the developer.

Earthing: This includes the earthing arrangement of all ground-exposed non-current carrying metal components of electrical equipment, cable grounding conductors' armour or shielding and enclosures. Continuity of system and equipment grounds throughout the electrical installation shall be maintained. Grounds, bushings and jumpers shall be provided where normal metallic ground paths are interrupted. The work should be done accordingly as mentioned in the specifications.

Earthing Works : LOT

1.3.2.5. Instrumentation

This includes supply, erection, testing and commissioning of various instruments used. The details of the instruments are as follows:

Sr. No.	Instrument	Location	Quantity
1	Differential Level Transmitter (Ultrasonic)	On each Mechanical Screen	1
2	Pressure Gauges	On each Pump delivery line	3
3	Ultrasonic Flow Transmitter (non contact type)	Common discharge header of raw sewage transfer pumps	1
4	Ultrasonic Level Transmitter (non contact type)	Collection Tank	1
5	Actuators for valves & gates	Valves / Gates	As per requirement

1.3.2.6. Control Gates

CI Gates shall be provided at following location for flow control

- Upstream of Coarse Screens of MPS

1.3.2.7. Electrical Hoist Mechanism

Monorail Mounted Electric Hoist shall be provided over the main collection sump for lifting of submersible pumps. Minimum capacity of the hoist shall be 2.0 tonnes.

1.3.2.8. PLC / SCADA

PLC based automation system along with SCADA to control all pumps shall be provided.

1.4.0. DETAILED SCOPE OF WORK FOR SEWAGE TREATMENT PLANT .

The inlet units as well as chlorination system shall be designed for total 10MLD average flow with 2.0 peak factor considering future provision.

1.4.1. Stilling Chamber

Stilling Chamber shall receive raw sewage from the Raw Sewage Pumping Station. Stilling Chamber shall be designed for average flow of **10 MLD** with a peak factor of 2.0. The entire construction shall be in M30 grade concrete and as per IS 3370. Adequate RCC Platform, minimum 1000 mm wide, with railing as per specifications shall be provided. RCC Staircase, 900 mm wide shall be provided for access from ground level to the top of the Unit & to the operating platform.

Total Average flow	:	10 MLD
Peak factor	:	2.0
Design Flow	:	20 MLD
Number of Units	:	One
Detention period	:	60 sec.
Min Free board	:	0.5 m

1.4.2. Mechanical Fine Screen Channel

One Mechanical Screen shall be provided in the Fine Screen Channel. Fine Screen Channel shall be designed for peak flow. The clear opening for Screen shall be 6 mm. Manual operated Aluminium Sluice Gates shall be provided at the upstream and downstream ends to regulate the flow.

Adequate RCC Platform shall be provided at the upper level to enable operation. Railings shall be provided around the entire periphery of the platform. The entire structure shall be in M30 grade concrete and as per IS 3370.

Average Flow	: 10 MLD
Peak Factor	: 2.0
Peak Flow	: 20 MLD
Number of Units	: 1no. of Peak Flow capacity
Approach Velocity at Average Flow	: 0.3 m/s
Velocity through Screen at Average Flow	: 0.6 m/s maximum
Velocity through Screen at Peak Flow	: 1.2 m/s maximum
Min Freeboard	: 0.5 m

1.4.3. Mechanical Grit Chamber

One Mechanical Grit chamber of peak flow capacity shall be provided after Fine Screen Channel. Aluminium Sluice Gate shall be provided at the entrance of the Grit Chamber. To enable easy operation of the Gates, RCC Platform with GI Railing shall be provided at the upper level. The entire construction shall be in M30 grade concrete and as per IS 3370.

Average Flow	: 10 MLD
Peak Factor	: 2.0
Peak Flow	: 20 MLD
No of Unit	: 1 no. of Peak Flow capacity
Size of grit particle	: 0.15 mm
Specific gravity of grit	: 2.65
Maximum Surface Overflow Rate	: 960 m ³ /m ² /day
Freeboard	: 0.5 m
Side Water Depth	: 0.8 m
:	

1.4.4. Cyclic Activated Sludge Process / SBR Process

1.4.4.1 Process Design

- The biological treatment section comprising Cyclic Activated Sludge / SBR Process shall be installed and equipped for average flow of 5 MLD.
- The complete system shall be designed for handling peak flow.
- Two Basins with adequate volume shall be provided. In addition, 0.5 m free board shall be provided to each Basin. Maximum Liquid Depth shall be restricted to 6 m.
- Cyclic Activated Sludge / SBR Process Basins shall be constructed in M30 grade concrete and as per IS 3370. RCC Staircase of 1000 mm wide shall be provided to each Basin for access from the ground level to the operating platforms. All platforms and walkways shall be provided with Hand Railings.
- The system shall work on a continuous gravity influent condition. No Influent / Effluent Equalization Tank or Flash Filling shall be accepted.
- The system shall be designed for maximum F/M ratio up to 0.18 kg BOD/kg MLSS day.
- MLSS maintained in the basin shall range from 2500 to 5000 mg/l.

- The cycle Time of Cyclic Activated Sludge / SBR Process shall be selected adequately considering min. 12 hrs/day/basin of aeration with preferred cycle times containing max. 50% not aerated portion.
- The excess sludge produced shall be fully digested. Sludge production (including percipients) rate shall be about 0.5 – 1.2 kg / kg of BOD removed.
- No filling during settling or decanting shall be acceptable.

The expected outlet quality of treated sewage from SBR unit shall be as under:

Sr. No.	Parameter	Value	Unit
1.	pH	7 – 8	
2.	BOD ₅	≤ 5	mg/l
3.	COD	≤ 100	mg/l
4.	Suspended Solids	≤ 10	mg/l
5.	TKN	≤ 10	mg/l
6.	Total Phosphorus	≤ 2	mg/l

1.4.4.2 Decanting Device

- The Decanting Device shall be Moving Weir Arm Device of Stainless Steel 304 with top mounted Gear Box, Drive, Scum Guard, Down Comers, Collection Pipe and Bearings.

The following type of Decanter assemblies is not acceptable:

- Rope Driven Decanters.
- Floating Decanters.
- GRP Products.
- Valve Arrangement.
- The maximum design travel rate shall be 60 mm/min with proven hydraulic discharge capacity of the decanter proportional to the selected basin area.
- There shall be Maximum one Decanter per Basin.
- The hydraulic design based on design flow rate as given above shall not exceed flow speed of 1.3 m/s.
- Flexible Rubber Hose kind of sealing shall not be acceptable.
- Each Decanter shall be inclusive of local Control Box with manual operation selection and function buttons and communication to main PLC by DH 485 or Ethernet.

1.4.4.3 Aeration System

- The Aeration facility shall be installed for 5 MLD average flow.
- Only Fine Bubble PU Membrane Diffusers shall be acceptable with minimum Diffuser to Floor coverage area of 5%. Diffusers shall be submerged fine bubble / fine pore, high transfer efficiency, low tow maintenance, non-buoyant type. Diffusers shall be tubular (membrane) type. Material of construction for entire Under Water System including Accessories shall be of non corrosive. Complete Diffuser as a unit shall be assembled at the Manufacturing Factory. The grid supports shall of adjustable type made of SS 304 / UPVC.

- The Air Blower arrangement shall be capable of handling Total Water Level and Bottom Water Level operation conditions controlled by process sensors such as DO, Temperature and Level.
- Each set of Blowers shall have dedicated standby. Minimum one working Air Blower in each set shall operate via VFD while others may be operating at a fixed constant speed on Soft Starter configuration.
- The Blowers shall be positive displacement (Roots) type and head for Blowers shall be decided on the basis of S.O.R. of Diffusers and maximum Liquid Depth in Basins duly considering the losses governing point of delivery (Diffusers) and the Blowers. Blowers shall be complete with motor and accessories like Base Frame, Anti Vibratory Pads, Silencer, Non Return Valve, Air Filter etc. as per requirements. Further, Blowers shall have Acoustic Enclosure to ensure that the noise level at 1 m from Blowers is below 80 db. The Blower Room shall have sufficient ventilation, lighting and working space. The Room shall be equipped with suitable Electric Hoist with Trolley (1.5 times the weight of single Blower) to facilitate removal of Blower/Motor etc. for repairs. The Room shall also have Rolling Shutter.
- The operation of Aeration System shall include PLC based control. The operation and speed of Blowers shall be automatically adjusted using parameters like Oxygen Uptake Rate, Dissolved Oxygen, Temperature and Liquid Level in the Basin such that the DO is supplied as per demand and power utilisation for operation of Blowers is optimised.
- The main Air Header shall be in MS as per relevant IS painted outside with corrosion resistant paint as per Manufacture's recommendations. The Air Header shall be supported on saddles at suitable intervals or shall be protected against external corrosion in case they are laid below ground. The Air Header shall have auto valves to facilitate switch over Aeration Cycle from one Basin to other by PLC operation. The Air Header shall supply air to Diffusers at various locations through air supply pipes. Air Supply Pipes above water shall be in MS and shall be in Imported PVC as per relevant standards below water. All under water Lateral Pipes shall be of Imported PVC. Junction between Air Header and Air Supply Pipes shall be suitably protected against corrosion due to dissimilar materials.

1.4.4.4 Return Activated Sludge (RAS) & Surplus Activated Sludge (SAS) Pumps

Dedicated RAS and SAS Pumps shall be provided for each Basin. The Pumps shall be of submersible / horizontal centrifugal type suitable for handling biological sludge of 1 – 2% solids consistency. Capacity and head shall be decided based on Cyclic Activated Sludge / SBR Process requirements. Each Cyclic Activated Sludge / SBR Process Basin shall be provided with suitable lifting arrangements to facilitate lifting of Pump, if required for maintenance.

RAS Pumps

Capacity and Head	: As per Process requirements
Type	: Submersible / Horizontal Centrifugal
Liquid	: Bio-sludge of 1 – 2% solids consistency

Specific Gravity	: 1.05
Solid Size	: 100mm (Maximum)
Temperature	: Min. 20° C
Efficiency	: more than 40%
Installation	: Fixed.
Quantity	: 1 No. per Basin +1 no. stored standby

SAS Pumps

Capacity and Head	: As per Process requirements
Type	: Submersible / Horizontal Centrifugal
Liquid	: Bio-sludge of 1 – 2% solids consistency
Specific Gravity	: 1.05
Solid Size	: 100mm (Maximum)
Temperature	: Min. 20° C
Efficiency	: more than 40%
Installation	: Fixed.
Quantity	: 1 No. per Basin + 1 no. stored standby

1.4.4.5 Automation and Control

PLC based Automation System to control **SBR/MBR System** including all Pumps, Blowers, VFDs, Valves, Gates, Decanters, Limit Switches and Probes including I/ Os with 20 % spares and UPS shall be provided.

1.4.5. Chlorination System

1.4.5.1 Chlorination Tank

Treated sewage from Cyclic Activated Sludge Process / SBR Process Basins shall be taken to Chlorination Tank by RCC channel/pipe. The tank shall be constructed in M30 grade concrete and as per IS 3370. Baffle Walls shall be provided to achieve proper disinfection.

Design Flow	: 10 MLD
No. of Units	: 1 No.
Detention Time	: 30 minutes
Freeboard	: 0.5 m

1.4.5.2 Chlorinators

Chlorine Dosing System shall comprise of tonner mounted vaccume type chlorinators (2 No.(1W+1S)) with 2nos chlorine tonners, booster pumps , etc. complete.

Design Flow	: 10 MLD
Number of Units	: 1 W+ 1S
Capacity	: 2 kg/hr
Chlorine Dosing	: 5 ppm max

1.4.6. Ultrafiltration (UF) system

The UF system shall be designed for **net permeate flow of 2 MLD capacity** and final effluent shall be pumped to the treated sewage collection sump to blend with 3 MLD sewage from SBR unit. The UF system shall be consisted of feed inlet pumps, membrane modules, Backwash pumps, Permeate pumps, Air blowers and Clean- In-Place (CIP) system and Periodic Flux Enhancement (PFE) system with Chlorine injection system, Caustic/ Acid injection system including piping ,valves and instrumentation works etc.,completely. Necessary standby arrangement of mechanical items shall be provided as per requirement .The instrumentation work shall be included following items:

<u>Parameter</u>	<u>Min. Qty</u>	<u>Remarks</u>
• pH Sensor/Transmitter (feed & CIP)	4	1-14 pH range
• Feed Flow Sensor/Transmitter	2	
• Air Flow Sensor/Transmitter	2	
• Permeate Flow Sensor/Transmitter	2	
• Backwash Flow Sensor/Transmitter	2	
• Temperature Sensor	2	0-35.0 °C
• Feed Turbidimeter	2	0-1,000 NTU
• Permeate Turbidimeter	2	0.0-1.0 NTU
• Dual Pressure Sensor/Transmitter	2	-0.7 to 1.0 bar
• Membrane Tank Level Sensor/Transmitter	2	0-150 cm H ₂ O
• Permeate Tank Level Sensor/Transmitter	2	0-150 cm H ₂ O
• Pressure Gauge	2	0.07-0.7 bar
• Pressure Gauge	2	0-10.0 bar

The effluent from the UF system shall be guaranteed as under:

<u>Parameter</u>	<u>Effluent</u>
pH	6-8
TSS	<1.0 mg/l
Turbidity	<0.1 NTU
SDI	<3.0

UF Membrane Specifications shall be strictly as under:

1. The UF membrane configuration shall be spiral wound, submerged (negative pressure) with backwashing and air scouring capabilities.
2. The UF membrane shall be rated at a pore size of 0.03 micron.
3. UF membrane shall be of flat-sheet configuration.
4. Membrane shall have a clean water permeability of 30 gfd/psi.
5. UF membrane shall be of PES.
6. Minimum design flux rate shall be 25 gfd with a maximum of 35 gfd.
7. UF membranes shall have the ability to be drained after every backwash.
8. Minimum recovery should be 90%.
9. Operating pH range shall be 4-11.
10. Cleaning pH range shall be 2-12.
11. UF system shall be skid mounted.

1.4.7 Treated sewage collection sump

Treated sewage from chlorine contact tank as well as from UF system shall be taken to Treated sewage collection sump by RCC channel/pipe. The tank shall be constructed in M30 grade concrete and as per IS 3370.

No. of Units : 1 No. (with 2 compartments)
Volume of sump : 400 cu.m.
Freeboard : 0.5 m

1.4.8. Sludge Handling System

1.4.8.1 Sludge Sump

Sludge Sump shall be provided to collect the excess sludge from Cyclic Activated Sludge Process/SBR Process Basins. There shall be one common Sludge Sump for all Basins.

Sludge Sump shall be constructed in M30 grade concrete and as per IS 3370.

Number of Units : 1 No.
Freeboard : 0.5 m
Detention Time : 8 hrs

1.4.8.2 Sludge Transfer Pumps

Sludge Transfer Pumps shall be provided in Sludge Pump House to feed sludge to Mechanical Dewatering Device. The Pump shall be of screw type suitable for handling biological sludge of 1 – 4% solids consistency.

Type : Screw Type
Liquid : Biological sludge of 1 – 4% solids consistency
Specific gravity : 1.05
Temperature : Min. 20° C
Efficiency : More than 30%
Installation : Fixed
Quantity : 2 Nos. (1W + 1S)

1.4.8.3 Mechanical Dewatering Unit

The Mechanical Dewatering Unit shall be Centrifuge designed so as to give a 100% trouble free operation at all times. The dewatered sludge shall have minimum solid concentration of 20% or more (measured as dry solids w/w basis).

Number of Centrifuges : 2 No. (1 Working +1 standby)
Capacity : 5 m³ /hr (min.)
Operating Hours : 20 hrs per day maximum:

1.4.9. SBR/MBR Air Blower cum MCC & Control House and other works

The SBR Air Blower cum MCC & Control Building shall be RCC Frame Brick Masonry structure with adequate area. However, the operation buildings shall be RCC framed structure with minimum clear height of 4 meters consisting of following:

1. Admin room : Minimum area = 40 sqm
2. MCC room : Minimum area = 100 sqm
3. PLC room : Minimum area = 40 sqm
4. Laboratory : Minimum area = 30 sqm
5. Toilet Block for officers : Minimum area = 10 sqm
6. Air Blower room : Minimum area = 80 sqm
7. UF system House : As per requirement

The MCC room shall have panels for all the electric units of MPS and STP. A HDPE/ RCC storage tank of minimum 500 litres capacity shall be provided on roof for conveying water to toilet and laboratory. PLC room shall be provided with air conditioner (split type) of minimum 2 ton capacity.

Substation facilities including transformer yard along with cabling etc., is not in the scope of contractor. The power shall be supplied up to MCC panel of STP by the developer.

1.4.10. Process Piping & Drain Piping

This shall include the interconnecting pipeline between different units of STP as given below:

SL NO	FROM	TO	MOC
1	SBR Reactors	Chlorination Tank	RCC NP3
2	Chlorination Tank	Disposal Point	RCC NP3
3	SBR Air Blowers: Discharge	Main Discharge Headers	MS EPOXY PAINTED
4	SBR Reactors: Main Air Headers	SBR Reactors	MS EPOXY PAINTED
5	SBR Reactors: Down comers		HDPE
6	Selectors: Main Air Headers		MS EPOXY PAINTED
7	Selectors: Down comers		HDPE
8	RAS Pumps: Discharge	Selectors	CI "class LA"
9	SAS Pumps: Discharge	Sludge Sump	CI "classLA"
10	Sludge Sump	Centrifuge Feed Pumps: Suction	CI "class LA"
11	Centrifuge Feed Pumps: Discharge	Centrifuge	CI "class LA"
12	Centrate from Centrifuge	Raw Sewage Sump	RCC NP3

Note: Combination of pipes and channels can be used for conveyance of waste water as per requirement of site conditions.

1.4.11. Other Non-Technological Works

1.4.11.1 Stairs

RCC / MS Staircase (minimum 1.2 m wide) shall be provided to access all the Platforms provided/required for all the Units above ground level. The treads shall be 250 mm and risers shall be 175 mm. The width of the Staircase and type shall be as approved by Engineer in Charge before execution of the work.

1.4.11.2 Railings

Railing shall be provided along all the Platforms above the ground level and Staircases. The railings shall consist of two horizontal rows of 32 mm NB GI Pipe, Class 'B' supported on RCC Pedestals 1 m high fixed at interval of 1.5 m c/c.

1.4.11.3 Whitewashing, Painting and Allied Works

Buildings

Buildings shall be painted/coated wherever required. All the internal surfaces shall be painted with Plastic Emulsion Paint and all the external surfaces shall be painted with Snowcem.

Water Retaining Structures

The inner concrete surfaces of all the Water Retaining Structures shall be painted with two coats of Bitumen Paint of approved make and outer wall shall be of 20mm thk plaster.

1.4.11.4 Effluent Channel / Pipe

An RCC Effluent Channel / RCC NP3 Pipe of sufficient size from Chlorination Tank to the Final Disposal Point shall be provided up to 5 RM.

1.4.11. Electrical & Instrumentation Works

1.4.11.1 Motor Control Centre

This includes supply, installation, testing and commissioning of Motor control Centre (MCC) accommodating individual starter panels for various loads complete in all respects with suitable switchgear. It shall be provided with Metering, ACBs with S/C & O/L Relays, Switch-Fuse Units, Lamps, Bus Bars etc. The accessories used shall conform to the latest IS codes.

1.4.11.2 Cables, Cable Trays and Junction Boxes

This includes supply, erection, testing and commissioning of Power & Control Cables. The cabling shall be complete in all respects. Civil works like construction of Cable Trenches with Angles, Chequered Plates etc. are also included in the

scope. Cable Trays & Junction Boxes shall be installed to accommodate the Cables wherever required.

1.4.11.3 Instruments

This includes supply, erection, testing and commissioning of various Instruments used. The details of the Instruments are as follows:

Sr. No.	Instrument	Location	Quantity
1	Pressure Gauges: Bourdon Type	Discharge of SBR Air Blowers	As per requirement
2	Pressure Gauges: Diaphragm Type	Discharge of Sludge Transfer Pumps	As per requirement
3	Level Transmitters: Hydrostatic Type	SBR Reactors	As per requirement
4	DO Meters: Immersion Type	SBR Reactors	As per requirement
5	Level Switch: Capacitance Type	Sludge Sump	As per requirement
6	Variable Frequency Drives	SBR Air Blowers	As per requirement
7	Variable Frequency Drives	Decaners	As per requirement
8	Electrical Actuators for Valves/ Gates	Valves / Gates	As per requirement
9	Ultrasonic Flow Meter	Rising Main to Stilling Chamber	As per requirement

Tenderer's opting to quote for alternate offer than above can quote as under:-**2.1. TREATMENT PHILOSOPHY MBR Technology with External/Submerged Membranes.****2.1.1. SCOPE OF WORK**

The Bidder shall furnish and commission one submerged or external membrane bioreactor (MBR) treatment system as per the Raw Sewage and Treated Sewage criteria and Scope of Works and terms and conditions as per Base Offer.

In general the MBR proposed shall include, but not be limited to the following components:

1. Membrane Filtration Cartridges/Modules
2. Membrane Cartridge Cassettes/Modules
3. All necessary Piping
4. Mixers/Pumps/Air Blowers as required
5. Internal Recycle Pumping Equipments
6. CIP Equipment and Instrumentation
7. Automated Valves
8. Process Instrumentation
9. SCADA System
10. Automatic On-Line Turbidity Measurement
11. Process Tankage (as applicable)

The scope of work of common units like Raw Sewage Transfer Pump House, Stilling Chamber, Screen Channel, Grit Channel, Chlorine Tank, Air Blower cum MCC Room and Control Room shall remain same as Base Offer.

2.1.2. Treatment Scheme

Raw waste water after coarse screening, grit removal shall be pumped to the MBR which shall include fine screening to remove any solids that might damage the membranes. The fine screen shall be the bar type, automatically cleaned with multiple rakes that engage the screen from the downstream side. Screenings shall be carried up the screen and discharged into a collection box for disposal. All materials of construction for the fine screen are corrosion resistant. The fine screen shall be nominally rated to remove 1 mm particles and larger. To minimize the amount of organics removed as screenings, finer screens shall not be accepted.

Screened influent from fine screen shall enter into the pre-aeration tank(s), designed for nitrification. Pre-aeration basin shall be equipped with suitable fine bubble aeration system with PU membrane as the MOC. In the pre-aeration basin air (with fine bubble diffused aeration system) is supplied to provide oxygen for carbonaceous BOD removal and nitrification (ammonia conversion to nitrates).

The partially stabilized mixed liquor then shall be pumped to the MBR basins by recycle pumps. The MBRs shall employ flat sheet micro filtration membranes. Membrane system shall be able to ensure reduced fouling, reduced cleaning cycles, flexibility in operating at higher flow to meet the peak demand and gravity operation capability whenever required. The scouring air supplied in these zones, to avoid premature fouling of membranes, shall supplement the oxygen supplied in the pre-aeration basin for biological treatment. From the MBR basis the mixed liquor should flow back to the pre-aeration basin to complete the loop.

Biological system should be designed based on the following design criteria.

DESIGN CRITERIA	
BOD Removal Efficiency	To meet outlet characteristics
Plant F/M (Kg BOD5 applied/Kg MLSS.day)	0.08 Max
Total Ø (Sludge Age) (days)	15 Days Minimum
MBR MLSS Concentration (mg/l)	10000 mg/L (minimum)
Detention Period (hrs.)	5 Hrs (Minimum)
Recycle Ration for De-nitrification	4Q (Minimum)
Operating DO to be maintained in the tank (mg/l)	1 (Minimum)

The Bidder shall follow the other design criteria as under:

- (i) The MBR shall be designed to operate at or below a trans-membrane pressure (TMP) of 5 psig.
- (ii) The MBR shall utilize self-priming centrifugal pumps to filter water. No additional components such as vacuum pumps and air separators shall be required for filtration purposes.
- (iii) Membrane flux must not exceed $0.75 \text{ m}^3/\text{m}^2\text{-day}$ during average day (design) flow conditions or $1.50 \text{ m}^3/\text{m}^2\text{-day}$ during peak daily loading conditions when all trains are on-line.
- (iv) Once a month (maximum) in-situ chemical cleanings (maintenance or recovery cleaning) shall be sufficient to maintain the submerged membrane TMP.
- (v) Each in-situ cleaning shall not require the MBR to be drained.
- (vi) Each in-situ cleaning shall not require the MBR to be taken out of service for more than 6 hours.
- (vii) Aside from air scouring, relaxation and diffuser cleaning, no daily cleaning of any other kind shall be employed to maintain the submerged membranes.
- (viii) Integral air diffuser assemblies shall provide continuous cleaning air to ensure stable operating conditions and minimize membrane fouling. Cleaning air shall not be cycled in anyway.
- (ix) COMPONENTS

The Membrane units shall be of flat-plate or hollow fiber type. Micro-filtration membranes will be preferred as they are considered better suited for wastewater treatment. Each membrane cartridge shall be comprised of a solid ABS support plate with a spacer layer between it and an ultrasonically welded flat-sheet membrane on both sides. Membrane cartridges should be of the following specifications:

DETAILS OF MEMBRANE FILTRATION	
Type of Membrane	Flat sheet/Hollow Fiber
Membrane type	MF/UF
Mean Pore Size (um)	0.4 (minimum)
Material of construction of membrane	PE/PES
Material of Module Frame	ABS
Normal Operating Suction Pressure	<= 5 psig
CIP Frequency (Maintenance/ Recovery Cleaning)	12 Times in a Year (MAXIMUM)
Recovery of permeate through MBR System (%)	95% (DESIGN)
Flow Direction	Outside in
Average Net Flux (Rate) (m3/m2/day)	0.75 m3/m2/day (Maximum) – (See Note 1)
Peak flow factor	2Q (See Note 2)
Guaranteed Mechanical Warranty for Membranes (Original Certificate from Membrane Manufacturer/ Supplier)	2 Years
Submerged MBR Supplier	GE, Siemens, Ovivo/GLV (Kubota)
MOC of in-basin Piping	CPVC
MOC of Frames	SS304

- (x) Net flux is defined as gross flux less any loss due to backwash/back pulse with permeate for membrane cleaning.
- (xi) The membrane should be proven to sustain a peak flux/ filtration rate of 2Q. Documentary evidence regarding peak flux shall be provided from reputed International Testing Agency.
- (xii) Each membrane unit will be comprised of three components. The upper components shall store the membrane cartridges and the lower component shall house a diffused air system specifically designed to ensure that membrane fouling is minimized.

2.1.3. WARRANTY

The MBR SUPPLIER shall guarantee that the MBR system will meet the effluent parameters specified. This guarantee shall be valid for one (1) year from commissioning. The SYSTEM SUPPLIER shall guarantee the MBR system and all appurtenances against defects in material, work, and workmanship for a period of one (1) year. The MBR MANUFACTURER shall further provide mechanical workmanship guarantee for the membrane filtration cartridges/cassettes for a period of two (2) years.

2.1.4. GENERAL MATERIALS & EQUIPEMNT REQUIREMENTS

- A. Each unit containing 50-400 membrane cartridges, integral diffuser assemblies and permeate manifolds shall be provided.
- B. All necessary anchor bolts, plates, nuts, washers and other hardware shall be Type 304 or 316 Stainless Steel unless otherwise noted.
- C. Nameplates shall be securely attached to all equipment and motors.
- D. Aeration blowers shall supply air to meet process requirement and to provide cleaning air for the membranes.

The blowers shall be complete with motors, base plates, intake air filter, inlet silencers, discharge silencers, check valves, pressure relief valves, butterfly valves, flexible connections, pressure and temperature gauges, vibration isolation pads, inlet filter restriction indicator and spare parts.

- E. Each piece of equipment, its motor(s) and drive unit(s) shall be designed and constructed to operate at any point between no-load and full load without overloading the motor or drive or decreasing any service factor; causing noise or vibration that exceeds the specified limits or government regulations, whichever is less. Pumps and drives shall not exceed the vibration limits of the Hydraulic Institute, when measured at the top of the motor.
- F. Membrane Cassettes shall be primarily constructed of Type 304 stainless steel and designed to support the membranes inside the bioreactor. The cartridges will connect to a manifold with quick connections for easy removal/installation of membrane cartridges. Cassettes are to be installed directly into the bioreactor. Membrane cassettes shall be furnished with stainless steel guide bars to allow easy installation and removal of the cassettes.
- G. Air Scouring Diffusers

At the base of the membranes will be coarse bubble air diffusers for inducing turbulent air flow across the membranes. This coarse bubble system forms an integral part of the Membrane cassette.

- I. Clean In-place System

The Membrane Cartridges shall be designed to be cleaned in-situ preferably no more than four times per year or when the transmembrane pressure exceeds the design parameters.

The cleaning system shall consist of a chemical feed pump to allow back flushing of the membranes with 0.25-0.5% sodium hypochlorite or 1% oxalic acid. Cleaning will be carried out by taking one unit off line and back flushing it with sodium hypochlorite or oxalic acid.

J. Control Panel

1. One control panel and control system shall be furnished for controlling the MBR. The MBR shall be controlled via a programmable logic controller.
2. The SYSTEM SUPPLIER shall supply all equipment and custom software programming required for a fully automatic and operational system, and shall provide the necessary hardware/software to allow for remote monitoring of the MBR System.

K. MBR Controls

Furnish a fully automatic control system to automatically establish control of the MBR system. The system shall integrate all functions required.

CHAPTER-III

SPECIFICATION FOR CIVIL WORKS FOR 5 MLD SEWAGE TREATMENT PLANT

1. Earthwork, PCC, RCC, Brick Work and Plastering

General

All the works pertaining to Earthwork, Plain Cement Concrete, Reinforced Cement Concrete, Brick Masonry & Plastering shall be carried out strictly as per Gujarat R & B/GWSSB- GUJARAT Specifications, latest relevant ISI Codes, Manual of Sewerage & Sewage Treatment & Manual of Water Supply & Treatment Published by Central Public Health & Environmental Engineering Organization (CPHEEO), all of latest editions and specifications contained in the tender document & also those based on good engineering practices. In case of any doubt / clarification, the decision of Engineer in Charge shall be final.

- 1.1 All surplus soil/earth shall be transported and disposed off as directed by the Engineer in Charge within 5 kms. In case the excavated material falls short of requirement, the backfill soil/earth shall be taken from borrow pits approved by the Engineer in Charge. The rates quoted by the contractor shall be deemed to be inclusive of all such works
- 1.2 A permanent baseline, cross lines & bench marks shall be established to serve as reference.
- 1.3 All excavated materials obtained from excavation shall be Departments property.
- 1.4 The cement used shall be ISI marked O.P.C. – 43 grade conforming to IS 8112 or PPC – 53 MPA conforming to IS 1489.
- 1.5 The reinforcement / steel shall be TMT high strength deformed steel bars Fe-415 ISI marked (IS 1786).

WHEREVER, REFERENCE TO VARIOUS ISI CODES HAS BEEN MADE IN THE TECHNICAL SPECIFICATIONS, IT SHALL MEAN THE LATEST EDITION OF THE RELEVANT CODE.

2. Piping

2.1 General

The specifications given under this clause shall cover guide lines for providing all types of pipes for water supply, sewerage, rising mains, plumbing, interconnecting pipes in water, wastewater treatment units etc.

The diameters and types of pipes shall be as described in the approved drawings. The pipes shall include all types of pipes. All the materials shall be as per relevant Indian Standards. The specials and fittings like SV, FH etc. shall be installed in locations as per approved drawings or as directed by Engineer in Charge.

The work includes supply of all types of pipes at the site of work, road cutting and remaking, excavation of trenches in all types of soil, lowering of pipes into the trenches, concrete bedding where specified, aligning to line and grade, jointing, testing, back filling of trenches to meet the requirements of Indian Standards codes of practices in a best workmanlike manner.

The R & B/GWSSB -Gujarat Specifications / IS Codes should be followed for work of pipe laying.

2.2 Puddle Collars

CI D/F Puddle Collars shall be provided wherever CI / DI pipe has to pass through RCC work. Puddle Collars shall be provided of sufficient length and puddle height.

The quality and thickness of puddle collar shall be equivalent to CI DF specials (as per IS: 1538)

2.3 HDPE pipes

The HDPE pipes shall be jointed properly with HDPE socketted specials to get smooth inner side surface without any extrusion to avoid any obstruction to flow of wastewater. If in any particular case butt welding has to be done, smooth inner surface of pipe without intrusion inside shall be ensured.

2.4 Glazed Stone Ware Pipes

The drain pipes and filtrate pipes shall be of GSW. The GSW pipes to be provided should be ISI marked as per IS 651. They should be laid to proper gradient and as per R & B/GWSSB- GUJARAT specification as approved by Engineer in Charge.

2.5 RCC Pipes

The RCC pipes to be provided shall be NP-3 S&S ISI marked with rubber rings as ISI 458 (Latest edition) and these shall be laid to proper gradient and as per R & B/GWSSB- GUJARAT specification as approved by Engineer in Charge.

2.6 Pipes and Specials

2.6.1 DI S&S Pipes

All DI pipes / fittings used for different units as described in the scope of work shall be Class K-9 as per IS 8329 and IS 9523 with up to date amendments. The pipes shall be cement mortar lined on inner face suitable for sewage and painted with bituminous paint on outer surface.

2.6.2 DI Double Flanged Pipes

The DI welded D/F pipes shall be conforming to IS 8329 with up to date amendments Class K-9 barrel. The pipes shall be cement mortar lined on inner face suitable for sewage and painted with bituminous paint on outer surface. The flange rating shall be PN 1.6 with working pressure of 10 kg/m².

2.6.3 CI Double Flanged Pipes

The pipes shall be Double flanged horizontally cast iron pressure pipes ISI marked as per IS 7181 – latest edition Class LA in standard length of 2.75 m.

2.6.4 CI Specials

Cast iron standard socketted and / or flanged fittings shall be ISI marked as per IS 1538 – latest edition suitable for CI / DI pressure pipes. The metal used for manufacturing shall be of a quality not less than specified for grade 15 of IS 210.

2.6.5 CI D/F Sluice Valves

ISI marked non rising stem type sluice valves PN 1.6 having double flanged ends for connections as per IS 14846. The components / parts of sluice valves shall be manufactured from preferred material mentioned in table 1 of IS 14846 except for Stem, Body Seat Ring, Wedge Facing Ring, which shall be made of stainless steel and wedge nut of high tensile brass of relevant grade specified in IS specifications. The body length over flanges shall be as given under column 3 i.e. PD in table of IS 14846. Each valve shall be hydrostatically tested as per clause 10 of IS 14846 for closed end test as well as open end test. The valves shall be suitable for application in horizontal position as well as for use in pipe lines in unsupported and terminal position. The valves shall be either with cap or with hand wheel.

Valves shall be flanged type. For sluice / gate valves, back seat arrangement shall be provided. Valves buried or installed in underground chambers, where access to a hand wheel would be impracticable, shall be operated by means of an extension spindle and / or keys. Valves shall be suitable for frequent operation as well as operation after long periods of idleness in either the open or closed position. The valve stem, thrust washers, screws, nuts and all other components exposed to the water shall be of a corrosion resistant grade of stainless steel. All valves parts shall be in general of the material of construction best suited for the proposed application.

(a) Sluice Valves

The gate face rings shall be securely pegged over their full circumference. Valves of 450 mm and above shall be provided with a thrust bearing arrangement for ease of operation. They shall also have renewable channel and shoe linings. The gap between the shoe and channel shall be limited to 1.5mm. Alternatively, valve of diameter 450 mm and above may be provided with a gear arrangement for ease of operation. The operation gear of all valves shall be such that they can be opened and closed by one man against an unbalanced head 15% in excess of the maximum specified rating. Valve and gearing shall be such as to permit manual operation in a reasonable time and not to exceed a required rim pull of 80 N. All hand wheels shall be arranged to turn in a clockwise direction for opening and counter clockwise for closing. These directions shall be indicated on the hand wheels. All valves shall be rated for not less than PN 1.6.

All valve doors when fully closed, will ensure door faces are riding on body seat ring by at least 50% of width of seat ring providing sufficient allowance for wear. Valves of diameter 450 mm and above shall be provided with a drain and air plug.

Tests: Acceptance tests as per IS 14846**(b) Knife Gate Valves**

Knife gate valves shall be suitable for use at suction and delivery side of pumps in a sewage pumping station as well as for sludge application. The valve should be provided with gate made of stainless steel and the gate should have bevelled knife edge at the bottom to cut through and easily enter in the solids settled in the bottom and ensure positive shut-off / closure in sewage environment. The valve should be bonnet-less and suitable for face to face flange connections in between pipelines. It should be suitable for uni-directional application.

The valve body should be of Cast Iron Gr. FG 260. The body shall be designed to withstand 6 bar pressure.

The valve shall be provided with replaceable type flexible sealing seals to offer drop tight shut off. The seals should be made of EPDM rubber and should be held in place by an easily removable type seal retainer ring. The seal retainer ring should be designed in a manner so that the flow of the fluid should be away from the sealing perimeter and towards the center of the valve.

The valve housing should have integral as cast tapered lugs provided for pushing the gate towards the flexible rubber seal only at the verge of closure with a view to avoid seal wear and achieve drop tight shut off. The surface of the gate coming in contact with the seal should be polished & buffed.

The valve shall be provided with sufficient ply of stuffing seals in the in built stuffing box to seal the rear opening. The stuffing box should have internal tappers for pushing the seals on to the gate. The seals should be of non-asbestos PTFE to reduce the friction and offer higher life. Provision shall be made to enable tighten the stuffing seals by means of a pusher arrangement to minimize the leakage through the back of the valve. Replacement of stuffing seals should be done in installed condition of the valve.

The spindle should be double start threaded and non-rising type for compact & safe operation. The gate movement area should be covered by protection shields. Gate opening indicating arrangement should be provided to find out the extent of gate opening /closing.

Acceptable Makes.

Flange drilling suitable to mount between flanges as per IS 1538 -1993.

Body	: Cast Iron FG 260 as per IS 210
Knife gate	: AISI 304 Gr. ASTM A240
Retainer ring	: SS 304 ASTM A351 Gr. CF8
Inlet Seal	: EPDM
Spindle	: AISI 410 Gr. ASTM A276
Spindle Nut	: Cast Iron Gr. FG 200 as per IS 210
Stuffing plate	: Cast Steel ASTM A216 Gr. WCB
Stuffing seal	: Synthetic yarn with PTFE

Factory Tests

Body test: The valves shall be hydrostatically pressure tested at specified pressure without any visible leakage.

Seat test: The valve shall be hydrostatically pressure tested for seat leakage at 2.8 bar for no visible leakage.

(c) Reflux Valves

Reflux valve shall possess high speed closing characteristics and be designed for minimum slam conditions while closing. External counterweights are not acceptable. Check valves shall conform to API 594 and API 598. They shall have metal to metal sealing. The pressure drop in the valve at design flow shall be limited to 0.4 mWC.

Material of construction

Body	CI conforming IS 210 Gr FG 220
Plate	SS AISI 316
Spring	SS AISI 316
Seal	SS AISI 304

Parameters

Type	Single Plate.
Nominal pressure	Twice the pressure in pipeline
Nature of operation	Automatic
Closure characteristic	Non slamming
Applicable code	API 594
Tests	Acceptance tests as per API 598

Tests

Acceptance tests as per IS 5312

2.7 Reference Codes

The pipes and specials shall conform to the Indian Standard Specifications (latest issue/revision). Commonly used IS codes are listed below:

I.S. 458	Concrete pipes with or without reinforcement
I.S. 651	Salt glazed stone ware pipes and fittings
I.S. 780	Sluice valves (50 to 300 mm size)
I.S. 784	Pre stressed concrete pipes
I.S. 1239	Mild steel tubes, tubular and other wrought steel fittings (parts I and II)
I.S. 1536	Centrifugally cast (spun) iron pressure pipes for gas, water and sewage
I.S. 1537	Vertically cast iron pressure pipes for water gas and sewage
I.S. 7181	Horizontally cast Double Flange Pipes
I.S. 1538	Cast iron fittings for pressure pipes for water, gas and sewage
I.S. 1592	Asbestos cement pressure pipes
I.S. 2906	Sluice valves for water works purposes (350 to 1200 mm size)
I.S. 3006	Chemical resistant salt glazed stone ware pipes and fittings
I.S. 3076	Low density polyethylene pipes for potable water supply
I.S. 4984	High density polyethylene pipes for potable water supply
I.S. 4985	Unplasticised PVC pipes for potable water supplies
I.S. 8329	Centrifugally cast (spun) Ductile Iron Pressure pipes for water, gas and sewerage – specifications
I.S. 9523	Ductile Iron fittings for pressure pipes for water, gas and sewerage – specifications
I.S. 14333	High Density Polyethylene pipes for Sewerage – specifications
I.S. 13592	Specification for UPVC pipes for soil and waste discharge systems inside buildings including ventilation and rainwater system
I.S. 14735	Unplasticised Polyvinyl Chloride (UPVC) Injection Moulded Fittings for Soil and Waste Discharge System for Inside and Outside Buildings Including Ventilation and Rain Water System Specification

2.8 Construction

2.8.1 Transportation of pipes

The transportation of pipes to the site of works has to be done in such a way that pipes are not damaged while handling.

Light pipes and pipes of smaller diameter shall be handled manually. Heavy pipes shall be loaded and unloaded using lifting tackles like chain pulley blocks and shear legs. The pipes shall be protected against impact, shocks etc. Pipes shall not be allowed to fall freely on to the ground and hard surfaces so as to cause cracks in pipes.

Transportation of pipes and stacking by the side of the trenches shall also be done in such a way that it causes minimum inconvenience to the traffic.

Lowering of the pipes into the trenches shall be done equally carefully so that the pipes are not damaged and also the trenches and bedding for pipes are not disturbed and damaged. Smaller and lighter pipes can be lowered using rope slings and shall not be dropped on to the trench bottom.

2.8.2 Transfer of levels to trench bottom

Permanent bench marks shall be established at convenient and frequent intervals all along the pipe alignment for carrying the levels to the place of laying of the pipes. The levels shall be transferred by using boning rods and sight rails. The lowering of pipes shall not be commenced until the Engineer has checked levels and permits the lowering of pipes.

Heavy pipes shall be lowered into the trenches by means of shear legs, chain pulley blocks and tackle. Care shall be taken while lowering the pipe into the trench. Each pipe which is laid in the trench is examined for damage. Cracked, broken or damaged pipes shall not be allowed to be used in the works.

2.8.3 Cleaning of pipes

The pipes shall be checked for absence of cracks and damaged parts of pipe ends. The pipes shall also be cleaned to remove all dirt and soil and other foreign materials before lowering into the trenches. After jointing it shall be ensured that the extra jointing materials are removed. It shall also be ensured that no foreign material enters the pipes after they are laid by covering the pipe ends suitably.

The specified jointing materials shall be used and methods of jointing the pipes of different materials shall be followed as per relevant IS specifications/directions of the Engineer in Charge. For flanged joints necessary gaskets/packing material, bolts and nuts shall be provided without any extra cost. The gaskets/packing materials shall be of full diameter and of approved quality.

The bedding of the pipes where specified shall be as detailed in the approved drawings/ direction of the Engineer in Charge. The locations of the bedding, the thickness of the bedding, the width of the bedding, material specifications and proportion of mix shall all be as indicated in the approved drawings/ direction of the Engineer in Charge.

For laying and jointing of pipes the following codes of practices (latest edition) shall be followed unless otherwise stated.

- I.S. 783 Code of practice for laying concrete pipes
- I.S. 2685 Code of practice for selection, installation and maintenance of sluice valves
- I.S. 3114 Code of practice for laying cast of iron pipes
- I.S. 4111 Code of practice for ancillary structures in sewerage system-manholes etc (part I to IV)
- I.S. 4127 Code of practice for laying of glazed stone ware pipes
- I.S. 5822 Code of practice for laying of welded steel pipes for water supplies
- I.S. 6530 Code of practice for laying asbestos cement pressure pipes
- I.S. 7634 Code of practice for plastic pipe work for potable water supplies (part I to III)
- I.S. 12288 Code of practice for use and laying of Ductile Iron Pipes

2.8.4 Manholes

The manholes on the gravity sewers shall be provided at appropriate locations. Normally they are located at the junctions of sewers, where the diameters of pipes, direction of pipes, grades of pipes change and also on straight lengths at specified intervals to facilitate cleaning operations. The sizes of the manholes depend upon the diameters of pipes, depths of pipes, number of junctions etc. A drawing showing all the above details shall be approved by the Engineer in Charge before execution of the work.

The material specifications viz., brick masonry or concrete, the proportion of the concrete, mortar for masonry and plastering shall be as indicated in the approved drawings of manholes. The dimensions and thicknesses of masonry, concrete, plaster etc., shall be as specified in the drawings to be got approved by bidder for manhole chambers as well as access shafts in case of deep man holes.

RCC manhole covers of specified weight and thicknesses and type as specified in the approved drawing for manholes, shall be provided and fixed as directed by the Engineer in Charge and as per relevant Indian Standards.

2.8.5 Thrust blocks

In case of rising mains/pressure pipes, at changes of directions of pipes thrust blocks to resist unbalanced forces shall be provided. The dimensions, material specifications shall be as approved by Engineer in Charge / I.S specifications.

2.8.6 Valve chambers

Chambers/masonry pits to protect the valves or other special fittings on the pipe lines shall be constructed as per site requirements. The dimensions and material specifications, covers shall be as approved by EIC.

2.8.7 Back Filling

Back filling of the trenches shall not be commenced till the pipes are tested for I.S. specified hydraulic pressure and till approval for filling of the trenches is given by the Engineer. Back filling of the trenches shall be done with approved back fill material free from boulders, sharp objects, rubbish. The filling shall be carried out in layers not more than **150** mm thick. The filled up material shall be well watered and consolidated, taking proper care to see that the pipes are not disturbed.

3. Joints

Movement joints such as expansion joints, complete contraction joints, partial contraction joints and sliding joints shall be designed to suit the structure. However, contraction joints shall be provided at specified locations spaced not more than 7.5 m in both right angle directions for walls and rafts. Expansion joints of suitable gap at intervals not more than 30 m shall be provided in walls, floors and roof slabs of water retaining structures. Construction joints shall be provided at right angles to the general direction of the member. The locations of construction joints shall be decided on convenience of construction. To avoid segregation of concrete in walls, horizontal construction joints are normally to be provided at every 2 m height. PVC water stops of suitable type and 230 mm width, shall be used for walls and base slabs.

Joints are to be provided in the structures as per approved drawing / I.S specification. The item of providing expansion joints and construction joints in concrete includes all the labour, tools and plants necessary for completing the item in best workman like manner. Either RCC key joints or PVC water bar joints shall be provided as per directions of Engineer in Charge.

The material for the PVC water stops shall be a plastic compound with the basic resin of polyvinyl chloride and additional resins, plasticizers, inhibitors, which satisfies the performance characteristics specified below as per IS:12200.

Construction joints will be as shown on the drawing or as approved by the Employer. Concrete shall be placed without interruption until completion of work between construction joints. If stopping of concreting becomes unavoidable anywhere, a properly formed construction joint shall be made with the approval of the Employer.

Dowels for concrete work which are not likely to be taken up in the near future shall be coated with cement slurry and encased in lean concrete as indicated on the drawings or as approved by the Employer.

As soon as the exposed concrete has sufficiently hardened, the surface of the joint shall be water jetted or brushed with a stiff brush to expose the larger aggregate without being disturbed. Alternatively, if the preparation is not satisfactory, or proper joint preparation is not possible due to inclement weather, the Contractor shall thoroughly remove the laitance of hardened concrete by mechanical chipping after seven days of concrete work at his own cost. Before placing fresh concrete against a construction joint all loose material shall be removed and the surface sluiced with water until it is perfectly clean, thereafter all ponded water should be removed. When concreting is to be resumed on a surface which has not fully hardened, all laitance shall be removed by wire brushing, the surface wetted, free water removed and a coat of cement slurry applied. On this, a layer of concrete not exceeding 150 mm thickness shall be placed and well rammed against the old work. Thereafter work shall proceed in the normal way

4. Floor Finishes and Allied Works

General

This specification covers furnishing, installation, finishing, curing, testing, protection, maintenance till handing over, various types of floor finishes and allied items of work.

4.1 Base

The base to receive the finish is covered under other relevant specifications.

4.2 Installation

4.2.1 Special Materials

In general, all materials shall be as per Gujarat, R & B/GWSSB- GUJARAT specification or relevant IS Codes. In all cases these materials shall be of the best quality available indigenously unless specified otherwise.

The materials for finishing items must be procured from well-reputed specialized manufacturers and on the basis of approval of samples by Engineer in Charge. The materials shall be as per the following:

White cement shall be white Portland cement in accordance with **IS: 8042** (Latest edition).

Sand shall be coarse screened, washed sand, free of organic materials, in accordance with **IS: 2116** (latest edition).

Colour pigments, as selected shall be pure mineral pigments, lime proof and non-fading.

4.3 Preparation of the Base Surface

The surface to be treated shall be thoroughly examined by the Contractor. Any rectification necessary shall be brought to the notice of the Engineer in Charge and his approval shall be taken regarding method and extent of such rectification work.

For all type of flooring, skirting, dado and similar location, the base to receive the finish shall be adequately roughened by chipping, raking out joints and cleaning thoroughly all dirt, grease etc with water and hard brush and detergent if required, unless otherwise directed by the manufacturer of any special finishing materials, or specifically indicated in this Specification under individual items.

To prevent absorption of water from the finishing treatment the base shall be thoroughly soaked with water and all excess water mopped up.

The surface shall be done dry where adhesives are used for fixing the finishes.

Prior to commencement of actual finishing work the approval of the Engineer in Charge shall be taken as to the acceptability of the surface.

4.4 Ceramic Tile Finish

This finish shall be composed of glazed earthen coarse tiles with an underbed laid over a concrete or masonry base.

4.4.1 Tile: Ceramic

The tiles shall be of earthenware, covered with glaze, white or coloured, plain or with designs, or sizes as indicated on approved drawings and directed by Engineer in Charge and 5 mm thick unless otherwise specified. The tolerance shall be + or - 1.5 mm for length and breadth and + or -0.5 mm for thickness. Specials like internal and external angles, beads, covers, cornices, corner pieces etc. shall match. The top surface of the tiles shall be glazed with a gloss or matt unfading stable finish as desired by the Engineer in Charge. The tiles shall be strong, fine grained in texture, dense and homogeneous and free from faults such as cracks, chips, crazing, specks, crawling etc. and other imperfections. The edges and the undersides of the tiles shall be completely free from glaze and the undersides shall have ribs or indentations for better anchorage with the fixing mortar. The coloured tiles, when supplied shall preferably come from one batch to avoid difference in colour.

4.4.2 Mix: Under-bed

The mix for the under-bed shall consist of 1 part cement and 3 parts coarse sand by weight mixed with sufficient water or any other mix, if specified.

4.4.3 Laying

The under-bed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. The surface shall be roughened for better bond. Before the underbed has time to set and while it is still fairly moist but firm, cement shall be hand dusted over it or a cement slurry applied and the tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the under-bed until it achieve the desired level. The tiles shall be kept soaked for about 10 minutes just before laying. The joints in tiles shall be as closed as possible and not more than 1.5 mm wide.

Special care shall be taken to check the level of the surface and the lines of the joints frequently so that they are perfect. When tiles are required to be cut to match the dimensions these shall be sawn and edges rubbed smooth.

At the junction of horizontal surface with vertical surface the tiles or the former shall enter at least 12 mm under the latter. After fixing, the floor shall be kept moist and allowed to mature undisturbed for 7 days. Heavy traffic shall not be allowed for a further period of 14 days.

4.4.4 Finishing

The joints shall be cleaned and flush pointed with white cement or cement mixed with pigment for coloured tiles and cured for 7 days by keeping in wet. The surface shall be cleaned with soap or suitable detergent, washed fully and wiped with soft cloth to prevent scratching before handing over.

4.5 Stone Slab Finish: Marble Flooring.

This shall include natural stone slabs of regular shape and dimensions and capable of taking a good polish and under-bed over a concrete or masonry surface.

4.5.1 Thickness

The total thickness of the floor shall be as given in the approved drawing including the underbed.

4.5.2 Stone Slab

The stone slab shall be hard, sound, homogeneous, dense and white in texture and free from flaws. Angles and edges shall be true, squatter, free from chipping and surface shall be plane. The slabs shall be machine cut to the required dimensions. Tolerance of + or -5 mm in dimensions and + or -2 mm in thickness will be allowed. Unless otherwise specified the slabs shall not be smaller than 450 mm X 450 mm.

Stone slabs will come from specific regions and in specified quality with top surface fine chisel dressed. All sides shall also be fine chisel dressed to the full depth to allow for the finest possible joints.

Stone slabs shall be delivered to the site well protected against damage and stored in a dry place under cover.

4.5.3 Mix: Under-bed

The mix for the under-bed shall consist of 1 part cement and 3 parts coarse sand by weight mixed with sufficient water or any other mixed as specified.

4.5.4 Laying

The sides and top surface of the slabs shall be machine polished and washed clean before laying.

The under bed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. The surface shall be roughened for better bond. Before the under-bed has time to set and while it is still fairly moist but firm, cement shall be hand dusted over it or a cement slurry applied and the slab shall immediately be placed upon and firmly pressed by wooden mallet on to the under bed until it achieve the desired level. The slab shall be kept soaked for about 10 minutes just before laying. The joints in slab shall be as closed as possible and not more than 1.5 mm wide.

Special care shall be taken to check the level of the surface and the lines of the joints frequently so that they are perfect. When slab are required to be cut to match the dimensions these shall be sawn and edges rubbed smooth.

After fixing the floor shall be kept moist and allowed to mature undisturbed for 7 days. Heavy traffic shall not be allowed for a further period of 14 days.

4.5 Ironite Flooring (IPS Flooring)

12 mm IPS (metallic hardener) over 50 mm PCC M-20 concrete shall be provided. The sub base shall consist of 100 mm thick brick ballast 1:6:12 (1 cement, 6 sand, 12 brick ballast) laid over 100 mm well compacted sand layer. The floor should be casted in panels not more than 900 mm x 900 mm. Aluminium strips should be provided at the junction of two panels.

5. Painting, Whitewashing and Allied Works

General

This specification covers painting, white washing, distempering, wall finishing etc. of both interior surfaces of masonry, concrete, plaster, structural and other miscellaneous steel items, floor and roof drains, waste and service water pipes, and other ferrous and non-ferrous metal items as shown on approved drawings or as directed by the Engineer in Charge.

If surface to be finished cannot be put in suitable condition for painting by customary preparatory methods, the contractor shall notify the Engineer in Charge in writing or assume responsibility for and rectify any unsatisfactory finishing that results.

5.1 Materials

- 5.1.1** Materials shall be highest grade products of well known approved manufacturer and shall be delivered to the site in original sealed containers, bearing brand name, manufacturer's name, and colour shade, with labels intact and seal unbroken. All materials shall be subject to inspection & approval by the Engineer in Charge. It is desired that the materials of one manufacturer only shall be used as far as possible and paint of particular shade be obtained from the single batch. All paints shall be subjected to analysis from random samples taken at site from painter's bucket, if so desired by the Engineer in Charge.

All prime coats shall be compatible to the material of the surface to be finished as well as to the finishing coats to be applied.

All unspecified materials such as shellac, turpentine or linseed oil shall be of the highest quality available and shall conform to the latest I.E. Standards. All such materials shall be made by reputable recognized manufacturers and shall be approved by the Engineer in Charge.

All colours shall be as per painting/finish schedule and tinting and matching shall be done to the satisfaction of the Engineer in Charge. In such cases, where samples are required, they shall be executed in advance with the specified materials for the approval of the Engineer in Charge.

5.2 Storage

The contractor shall arrange for safe and proper storage of all materials and tools. Paints shall be kept covered at all times and mixing shall be done in suitable containers. All necessary precautions shall be taken by the Contractor against fire hazards.

5.3 Preparation of Surface

Before starting the work the Contractor shall obtain the approval of the Engineer in Charge regarding the soundness of the surface to be painted on.

5.3.1 Masonry, Concrete and Plastered Surface

Surface shall be free from all oil, grease, efflorescence, mildew, loose paint or other foreign and loose materials. Masonry cracks shall be cleared out and patch filled with mortar similar to the original surface and uniformly textured. Where this type of resurfacing may lead to the finishing paint being different in shade from the original surfaces, the resurfaced area shall be treated with minimum one coat of cement primer which shall be continued to the surrounding area for a distance of minimum 100 mm.

Surface with mildew and efflorescence shall be treated as below:

i. Mildew

All mildewed surfaces shall be treated with an approved fungicide such as ammonia wash consisting of 7g. of copper carbonate dissolved in 80 ml liquid ammonia and diluted to 1 litre with water, or 2.5 per cent magnesium silico fluoride solution and allowed to dry thoroughly before paint is applied.

ii. Efflorescence

All efflorescence shall be removed from affected surfaces with a solution of muric acid in water (1:6 to 1:8), washed fully with clear water and allowed to dry thoroughly.

5.3.2 Metal

All metal surfaces shall be absolutely clean, dry and free from wax, grease and soap films. All steel and iron surfaces in addition shall be free from rust. All galvanised iron surfaces shall be pre-treated with a compatible primer according to the manufacturer's direction. Any abrasion in shop coat shall be touched up with the same quality of paint as the original coat.

5.4 Application General

The method of application shall be as recommended by the manufacturer. In case of selection of special shades and colour (not available in standard shades) the contractor shall mix different shades and prepare test panels of minimum size 1 meter square as per instruction of the Engineer in Charge and obtain his approval prior to application of finishing paints.

Proper tools and implements shall be used. Scaffoldings if used shall be independent of the surface to be painted to avoid shade differences of the freshly repaired anchor holes.

Painting shall be done by skilled labours in a workmanlike manner. All materials shall be evenly applied, so as to be free of sags, runs, crawls or there defects. All coats shall be of proper consistency.

In case of application by brush, no brush marks shall be visible. The brushes shall be clean and in good condition before application of paints. All priming undercoats for painting shall be applied by brush only, and rollers, spray equipments etc. shall not be used.

No work shall be done under conditions that are unsuitable for production of good results. No painting shall be done when plastering is in progress or is drying. Application of paint which seals the surface to moisture shall only be done after the moisture on and below the surface has dried out.

All coats shall be thoroughly dry before being sand papered or before the succeeding coat is applied. Coats of painting as specified are intended to cover surfaces perfectly. In case the surface is not covered properly by applying the specified number of coats, further coats shall be applied by the Contractor when so directed by the Engineer in Charge.

All primer and undercoats shall be tinted to approximate the colour of the finishing coats. Finishing coats shall be of exact colour and shade as per approved samples and all finish shall be uniform in colour and texture. All parts of mouldings and ornaments shall be left clean and true to finish.

5.5 Synthetic Enamel Paint

Shall be applied on properly primed surface. Subsequent coat shall not be applied till the previous coat is dry. The previous coat shall be lightly sand papered for better adhesion of subsequent coats.

5.6 Bituminous Painting

Two coats of bituminous paint of approved make and grade with 0.5 litre per sqm spread shall be provided on all internal surfaces of all water retaining structures including channels.

5.6.1 Application

All corners and junctions shall be properly rounded off to present a uniform and smooth finish. After complete curing of the plaster, it will be allowed to dry up. The surface should be well cleaned with smooth brush to make it dust free. The coating shall be allowed to dry and kept in dry condition till final setting takes place. The work should be done according to the entire satisfaction of the Engineer in Charge.

5.7 Painting of Structural Steel/ Miscellaneous Steel Scope

The specification covers painting of the structural/ miscellaneous steel supplied and erected either by other agencies or by the Contractor for work under the scope of this contract. One shop coat of red oxide zinc chromate primer including necessary touching up has already been completed by the concerned agency. One coat of red oxide zinc chromate primer followed by a coat of undercoating and two or more finishing coats of synthetic enamel paint as described hereunder are only required to be provided under the item for painting structural /miscellaneous steel.

5.7.1 Type of Structures to be Painted

Painting shall be done on all exposed surfaces (including undersides wherever exposed of various structural steel members like columns, trusses, beams, roof girders, oil tanks, trestles, bracings, crane girders, chequered plates, gratings, brackets, base plates, CI / DI pipes, specials and equipments etc. in the plant as directed by the Engineer in Charge. It shall be clearly noted that all structures are already erected/placed in position or are under erection, hence the quoted rate by Contractor shall account for all aspects involved in painting keeping in view the heights, available access to members etc.

5.7.2 Painting

1. In general, painting work shall be in accordance with **IS: 1477** (Part I & II)
2. Surface of steel work to be painted shall be thoroughly cleaned of all grease, oil, dirt, rust, foreign matter like cement splashings, etc. by suitable solvent and mild rubbing with abrasive paper/hand scrapping to the full satisfaction of the Engineer in Charge. Cleaning with solvents/scraping shall be limited to the affected areas only.
3. In cases where the existing primer is removed while cleaning the surface, damaged portions shall be provided with a coat of wash or etching primer on suitable chemical pre-treatment solutions and another coat of red oxide Zinc chromate primer.
4. After the surface is prepared in a manner described above, the primer coat shall be dry cut without scratching or in any way damaging the primer coats and clean the surfaces from dust.
5. Over this dry surface apply an optimum coat of undercoating (Synthetic enamel Paint) by brush or spray with minimum brush marks.
6. Finishing coats shall consist of two coats of synthetic enamel paint of approved colour and brand. The secondary coat, if so directed by Engineer in Charge, shall be applied only after the first coat is hard dry, it's gloss is gently removed over the entire surface and dusted off.
7. The total dry film thickness of each coat shall be not less than 23 microns.
8. The paint shall be applied by brushing/spraying, Spraying shall be adopted with prior approval of Engineer in Charge generally on large surface areas. Paints shall be stirred frequently to keep the pigment in suspension. Paint shall be ready mixed in original sealed containers as packed by the paint manufacturers and no thinners shall be permitted.

5.8 Protection

Furniture and other movable objects, equipments, fittings and accessories shall be moved, protected and replaced upon completion of the painting work. All stationary items of equipments shall be well covered so that no paint can fall on them. Work finished by other agencies shall be well protected. All protection shall be as per instruction of the Engineer in Charge.

5.9 Cleaning Up

The Contractor shall upon completion of painting etc. remove all marks and make good surfaces, where paint has spilled, splashed or splattered, including all equipments, fixtures, glass furniture, fittings, etc. to the satisfaction of the Engineer in Charge.

5.10 Acceptance Criteria

1. All painted surfaces shall be uniform and pleasing in appearance.
2. The colour, texture, etc. shall match exactly with approved samples.
3. All stains, splashes and splatters of paint shall be removed from surrounding surfaces.

5.11 Codes of Practice

The following Indian standards are applicable and shall be followed unless otherwise specified:

IS: 104	Ready mixed paint, brushing, zinc chrome, priming
IS: 124(Parts I, II & III)	Ready mixed paint, brushing, finishing semi gloss, for general purposes
IS: 157	Ready mixed paint, brushing, acid and alkali resistant, lead free for general purposes
IS: 158	Ready mixed paint, brushing, bituminous, black, lead free, acid alkali, water and heat resistant for general purposes
IS: 159	Ready mixed paint, brushing, acid resisting for protection against acid fumes, colour as required
IS: 168	Ready mixed paint, air drying, semi-glossy/matt, for general purposes
IS: 430	Paint remover, solvent type non-inflammable
IS: 431	Paint remover, solvent type flammable I.S. 104 1979 ready mixed paint, brushing, zinc chrome, priming
IS: 5411 (Parts I & II)	Plastic emulsion paint.
IS: 5660	Ready mixed paint, brushing, aluminium red oxide primer

6. Doors, Windows, Grills & Rolling Shutters

General

The items under this clause cover doors, windows, grills, rolling shutters etc. normally required to be provided in a building used whether for residential, office, laboratory or industrial purpose.

Doors and windows Shutter shall be of Aluminum as approved or as directed by the Engineer in Charge. The sizes of the above items and locations of the same shall be as approved by Engineer in Charge. The material used shall be of approved make and as per Indian standard.

The frames of Doors and Windows shall be of Aluminum section as approved by Engineer in Charge.

They shall be provided with all necessary fittings like hold fasts, hinges, locking arrangements, stoppers, eyes and hooks, tower bolts, handles, fixing lugs etc., of sizes and quality grade as approved by the Engineer in Charge.

They shall be provided in complete form including painting, glazing, fixing in position true to level and plumb.

Steel rolling shutters shall be of approved make and shall conform to **IS: 6248-1979**.

The builders hardware shall all be as per relevant Indian Standards.

6.1 Door & Window Shutters

6.1.1 Doors

The Contractor shall provide and fix anodized aluminum doors with partly glazing. The frame / chowkhat of the door shall be of 45.0 mm x 100.0 mm x 3 mm thick Aluminum section. Openable leaf frame section, top rail shall be of 48mm x 48 mmx 2.5 mm, lock rail shall be of 84 mm x 45 mm x 2.5 mm, bottom rail shall be of 115 mmx 45 mmx 2.5 mm shall be provided. Snap beading for holding glass shall be of 0.18 kg/m with natural anodizing handle lock and tower bolt. Corner shall be fixed with heavy duty extended aluminum cleats. Inclusion of neoprene gaskets etc complete in all respects shall be provided.

The Contractor shall provide and fix 5 mm thick plain float glass for glazing.

The Contractor shall provide and fix both side prelaminated particleboard 12 mm thk. of approved make and colour, in the blind section of the door.

The Contractor shall provide and fix floor spring, of required size ISI Marked.

6.1.2 Windows

The Contractor shall provide and fix anodized aluminum hollow 'Z' windows partly fixed and partly openable with extended aluminum section equivalent to 44 series of approved make. The Snap beading for holding the glass shall be of Wt. 0.18 kg/m.

The corners shall meet at 45 degrees and fixed by heavy duty extended aluminum sheets inclusive of 4 bar Stainless Steel friction hinges, The Contractor shall provide window locking handle and hardware to match with framing glazing gaskets and polysulphide sealant between building members and framing etc. complete and fully finished in all respects.

The Contractor shall provide and fix 5 mm thick plain glass for glazing.

The design of the Doors and Windows shall be made as approved by the Engineer in Charge.

6.2 Fittings

They shall be provided with all necessary fittings like hold fasts, hinges, locking arrangements stoppers, eyes and hooks, tower bolts, handles, fixing lugs etc., of sizes and quality grade as approved by Engineer in Charge.

All doors shall be provided with handles on both sides and all windows with handles on the inner side. One of the doors of each room shall be provided with outside locking arrangement. Smooth finished handles, tower bolts, sliding bolts (for locking) of approved sizes and makes shall be provided.

They shall be provided in complete form including painting, glazing, fixing in position true to level and plumb.

6.3 Rolling Steel Shutters / Grills

Scope

The specification covers the design, supply of materials, fabrication, delivery and erection of Rolling Shutters/grills crank & gear operated (manually operated) including all accessories as hereinafter specified. All Electrical work shall be in strict accordance with the latest Indian Electricity Rules. This shall conform to **IS: 6248**.

6.3.1 Components

1. Slates for rolling shutters shall be made from tested bright cold rolled, annealed M.S. strips, not less than 0.9 mm thick for shutters upto 3.5m width and above, machine rolled at 75 mm rolling centres, interlocking with each other. The profile will be such as to prevent excessive deflection under specified wind load.
2. End lock shall be heavy type MC/CI and shall be provided at each end of alternate slates.
3. Guides shall be of such depth as to retain the shutter under a wind pressure of 150 Kg/sqm. The minimum thickness of guide to be of 12 G.
4. Shafts shall be of steel pipe of sufficient size to carry the torsional load with a maximum deflection of 1/360 th of span. Grease packed ball bearings or bushings shall be provided for smooth trouble free operation.

5. Bottom bars shall be finished with two angles not less than 6 mm thick external shutters when shown on drawings. A flexible weather strip shall be applied to make tight contact with the floor.
6. Hoods shall be formed of not less than 20 gauge steel, suitably reinforced to prevent sag.
7. Locks shall be slide bolt and hasp or cylinder lock operatable from one or both sides. Provision to securing hand chain with pad-lock, provision for immovable handle for hand cranks etc. shall be made as desired by the Engineer in Charge.

6.3.2 Manually Operated Shutters/Grills

Manually operated shutters shall be easily operatable by one person. Shutter shall be crank & gear operated. The crank handle shall be removable. All shutters shall be lockable from one or both sides as desired by the Engineer in Charge.

6.3.3 Shop Coat

Shutters shall be painted with one coat of red oxide or zinc chromate primer. Shutters shall be painted with one coat of zinc chromate for adhesion of field coat. At site one more coat Red oxide Zinc chromate primer shall be applied. These shall be followed by two coats of Synthetic Enamel paint of approved quality and conforming to IS: 2932, unless specified otherwise.

6.3.4 Inspection

After installing the shutters, the Contractor shall test the performance of the shutter in the presence of the Engineer in Charge. The doors shall be smoothly operable under all ambient conditions. All control and locking devices shall give fault free performance.

6.3.5 Guarantee

The contractor shall give one year guarantee for the successful operation and manufacturing defect of the shutters including aluminum doors, windows and their accessories.

6.4 IS Codes

All relevant IS codes with latest amendments shall be referred to.

- IS: 6248 Metal rolling shutters and rolling grills
- IS: 1038 Specifications for steel doors, windows and ventilators
- IS: 1081 Code of practice for fixing glazing of metal (steel and aluminium) doors, windows and ventilators
- IS: 1361 Specifications for steel windows for industrial buildings
- IS: 1948 Specifications for aluminium doors, windows and ventilators

7. Structural Steel Fabrication Work

General

Structural steel fabrication work shall include all types of steel structural work required for installation of platforms for operation and installation of equipment where rolled steel sections are joined together either by bolting or welding as specified on the approved drawings/directed by the Engineer in Charge. It shall also include fabrication and installation of Electric Hoisting System, MS Stairs etc. Covers for electrical cable trenches along with their seating arrangements are also classified under this heading.

7.1 Materials

Structural steel rolled sections and plates shall conform to specified grade 'A' of **IS: 2062**. However, rolled sections and plates upto 20 mm, conforming to **IS: 226** may be used in place of grade A of **IS: 2062**. Pipes used in Handrails, embedment etc. shall conform to **IS: 1161**. Chequered plate shall conform to **IS: 3502**. All other materials shall be as per the list of standard codes given above or mentioned elsewhere in the relevant sections.

All steel sections and plates shall be straight, sound and free from twists, cracks, flaws, laminations, rough, jagged and imperfect edges and other defects.

In case any defect like laminations is noticed in the steel sections and plates during fabrication and erection, the same shall be brought to the notice of the Engineer in Charge. These sections and plates shall be rejected unless specifically approved for acceptance by the Engineer in Charge.

Structural steel that is used for fabrication shall be conforming to any of the following grades of steel as specified to each of the works:

IS: 226-1975	Structural steel (standard quality)
IS: 1977-1975	Structural steel (ordinary quality)
IS: 2062-1980	Weldable Structural steel (fusion quality)

Whenever steel is supplied by the contractor, he shall on demand produce the test certificates from the manufacturer.

The welding rods used for fabrication shall conform to **IS: 814-1974** (parts I and II).

The fasteners like bolts, nuts shall conform to **IS: 1367**.

Rivets shall conform to **IS: 1148-1982**.

Plain washers shall conform to **IS: 2016-1967**.

Spring washers shall conform to **IS: 3063-1972**.

Article 2.

(a) **Note: All structural steel shall be ISI marked.**

7.2 Fabrication

All the specified shop drawings shall be prepared by the contractor and get approved from Engineer in Charge. The drawings shall be submitted in triplicate. Approval of the shop drawings however shall not relieve the contractor of his responsibility of correct conformation to the designs and fabrications of the structure to meet the requirements of the contract.

Fabrication work shall be carried out as laid down in **IS: 800-1984**, code of practice for general construction in steel.

In the shop drawings to be submitted by the contractor for approval, standard symbols as described in the **IS: 813-1961** shall be followed, as well as the stipulations contained in these specifications.

Welding shall be carried out in accordance with the following specifications as applicable:

IS: 803-1976	Code of practice for design fabrication and erection of vertical mild steel cylindrical welded oil storage tanks.
IS: 816 -1969	Code of practice for use of metal arc welding for general construction in mild steel.
IS: 822-1970	Code of practice for manual arc welding of mild steel.
IS: 9595-1980	Recommendations for metal arc welding of carbon Radiographic tests are required to be carried out as directed by the Engineer in Charge in case of pressure vessels.
IS: 818-1968	Code of practice for safety and health requirements in electric and gas welding and cutting operations.
IS: 3016-1982	Code of practice for fire precautions in welding and cutting operations
IS: 7205-1973	Safety code for erection of structural steel work

The stanchions shall be fixed absolutely vertical or to the specified angle as shown on the approved drawings/as desired/directed by the Engineer in Charge.

All connections like angle brackets, cleats, gusset plates, anchor bolts, bearing plates shall be fixed as shown on the approved drawings or as directed by the Engineer in Charge.

The item of work shall include supply of materials, fabrication and erection in position on site as shown on the approved drawings. This shall also include all labour costs, materials and equipment required for all fabrication, hoisting, erection, and satisfactory completion of the item of work.

The supply of materials includes all structural members like rolled sections, plates, brackets, rivets, bolts and nuts and welds.

The steelwork shall be painted as specified in the approved drawings, or as directed by the Engineer in Charge. Unless otherwise provided for the rate quoted for the

item is inclusive of all costs for painting like cost of paint, cost of labour, scaffolding etc. Welding work shall be done generally using electric arc welding.

Gas welding shall not be allowed to be resorted to for welding. Under special circumstances if in the opinion of the Engineer in Charge it cannot be avoided, gas welding can be done with the prior permission of the Engineer in Charge. However gas welding shall not be used where structural strength is the criteria for consideration.

All arrangements shall be made by the contractor for access for inspection by the Engineer in Charge or his representative to the workshop where the welding work is being carried out and necessary equipment like gauges, measuring instruments etc., shall be made available to the inspecting personnel.

Painting work shall not be started without the approval of the Engineer in Charge and the painting shall be started only after his inspection and approval of the works after carrying out surface preparations.

All holes shall be carefully marked and drilled. Holes shall have their axis perpendicular to the surfaces bored through. Holes through two or more members shall be truly concentric. Holes shall not be formed by gas cutting process.

All the temporary connections of parts during assembly shall be done in the following ways: For welded structures: Tack welding fastening devices, fixtures.

For riveted and bolted structures: Joining shall be done by adequate number of bolts. If tack welding is permitted by the Engineer in Charge the same shall be adopted but they shall be removed after the work is completed.

For the riveted structures in which holes are to be drilled after assembly, joining shall be done by appropriate fixtures.

Welded joints shall be free from defects that would impair the service performance of the construction. All the welds shall be free from incomplete penetration, incomplete fusion, slag inclusion, burns, un-welded craters undercuts and cracks in the welded metal, porosity etc. All the defects shall be rectified as directed by the Engineer in Charge. Defective portions shall be removed to the sound metal and re-welded. Rectification of the welds by caulking shall not be permitted.

All welds shall be cleaned of slag and other deposits after completion.

7.3 Straightening

All steel materials shall be straight and free from bends or twists. If the sections are distorted or twisted during transit, storage etc. they shall be straightened and/or flattened by straightening machine at ambient temperature, though minor kinks or bends may be corrected by limited heating under careful supervision. Normally all steel issued by the department shall be reasonably straight although it may have minor kinks and bends.

7.4 Bending

The bending of plates and sections to specially required shapes shall be done either on appropriate machine or by angle smithy and black smithy processes.

7.5 Cutting

Cutting may be affected by shearing, cropping, sawing or by gas cutting by mechanically controlled torch. Gas cutting by hand may only be used when specifically authorised in writing by the Engineer in Charge. The edges of all plates shall be perfectly straight and uniform throughout. Shearing, cropping and gas cutting shall be clean, square and free from distortion and burrs, and shall the Engineer in Charge find it necessary the edges shall be ground afterwards by the Contractor.

7.6 Grinding

All the edges cut by flame shall be ground before they are welded. Ends of all bearing stiffeners shall be ground to fit tightly at both top and bottom. The maximum permissible gap between the bearing stiffeners and the flanges shall not be more than 0.2 mm locally.

In case of gantry girders the bottom of the knife-edge support shall be accurately ground to provide effective bearing on the column bracket with a clearance not exceeding 0.2 mm locally at any place. The top surface of the column bracket shall also be ground similarly. The column splices and butt joints of struts and compression members shall be accurately ground and closely butted over the whole section with tolerance not exceeding 0.2mm locally at any place. Notwithstanding the above, full load shall be transferred through welds.

The ends of shafts together with attached gussets, angles, channels, etc. after welding together shall be accurately ground so that the parts connected, butt over the entire surface of contact. Care shall be taken to see that these connecting angles or channels are fixed with such accuracy that they are not reduced in thickness by grinding by more than 1 mm.

The slab bases shall be similarly ground over the bearing surface and shall have effective contact with the end of the shaft. The bearing face which is to be grouted direct to a foundation need not be ground if such face is true and parallel to the upper face. To facilitate grouting and escape of air, holes shall be provided wherever necessary in column bases.

7.7 Clearances

The erection clearance for cleated ends of members connecting steel to steel shall not be greater than 2 mm at each end unless specifically approved by the Engineer in Charge.

7.8 Holes

Holes through more than one thickness of materials for members, such as compound stanchion and girders, flanges, shall where possible, be drilled after the members are assembled and tightly clamped or bolted together. Sub-punching may be permitted before assembly, provided at the holes are punched 3 mm less in

diameter than the required size and reamed after assembly to the full size. Punching shall not be adopted where the thickness of metal exceeds 16 mm.

When holes are being drilled in one operation through two or more separable parts, those parts, when so specified by the Engineer in Charge, shall be separated after drilling and burrs removed.

Holes in connecting angles and plates, other than splices, also in roof members and light framing, may be punched full size through material not over 12 mm thick, except where required for close tolerance.

Matching holes for rivets and black bolts shall register with each other so that a gauge of 1.5 mm or 2.0 mm (as the case may be, depending on whether the diameter of the bolts is less than or more than 25 mm) less in diameter than the diameter of the hole will pass freely through the assembled members in a direction at right angles to such members. Finished holes shall not be more than 1.5 or 2.0 mm (as the case may be) larger in diameter than the diameter of the black bolts passing through them unless otherwise specified by the Engineer in Charge.

Holes for bolts shall not be formed by a gas cutting process, except in special cases with specific permission of the Engineer in Charge. Wherever a horizontal member is likely to collect water, suitable holes for drainage shall be provided.

7.9 Notches

The ends of all joints, beams and girders shall be cut truly square unless required otherwise and joist flanges shall be neatly cut away or notches where necessary, the notches being kept as small as possible.

7.10 Assembly

The component parts shall be assembled in such a manner that they are neither twisted nor damaged and shall be so prepared that the specified camber, if any is provided. In order to minimize distortion in a member the component parts shall be positioned by using clamps, clips, dogs, jigs and other suitable means and fastener (bolts and welds) shall be placed in a balanced pattern. If the individual components are to be bolted, parallel and tapered drifts shall be used to align the parts so that the bolts can be accurately positioned.

For columns which are fabricated in two or more parts, controlled assembly shall be carried out before dispatch to the erection site.

7.11 Bolting

Every bolt shall be provided with a washer under the nut so that no part of the threaded portion of the bolt is within the thickness of the parts bolted together.

Flat washers shall be circular of a diameter 2.5 times that of bolt and of suitable thickness. Where bolt heads/nuts bear upon the beveled surfaces they shall be provided with the square tapered washers of suitable thickness to afford a seating square with the axis of the bolt.

All bolts and nuts shall be of specified steel, with well-formed hexagonal heads unless specified otherwise, forged from the solid and shall be dipped in hot boiled linseed oil as soon as they are made. The nuts shall be good fit on the bolts and clear threads shall show through the nut when it has been finally tight end up.

Notwithstanding anything to the contrary contained in **IS: 1363**, **IS: 1364** and **IS: 1367**, the unthreaded length of the bolt shall be equal to total thickness of metal being bolted together plus 2 mm. The threaded length shall be equal to at least the diameter of bolt plus 6 mm.

7.12 Chequered Plate

Chequered plates shall be fixed to supporting members by welding as shown/specified in relevant approved drawings or as directed by the Engineer in Charge. The edges shall be made smooth and no burrs or jagged ends shall be left. While splicing care shall be taken so that there is continuity in pattern between the two portions. Care shall also be taken to avoid distortion of the plate while welding of stiffening angles/vertical-stiffening ribs. Surface shall be provided with primer paint.

7.13 Welding

The works shall be done as per approved fabrication drawing or as directed by the Engineer in Charge which would clearly indicate various details of joints to be welded, type of weld, length and size of weld, whether shop or site weld. Symbols for welding on approved fabrication drawings shall be according to **IS:813**. Efforts shall be made to reduce site welding so as to avoid improper welding due to constructional difficulties.

7.14 Welding of Structural Steel Work

Welding of structural steel shall be done by an electric arc process. The procedure to be followed, materials, plant and equipment to be used, testing and inspection procedures to be applied shall be subject to the approval of the Engineer in Charge and shall conform generally to relevant acceptable standards viz. **IS: 816**, **IS: 9595**, **IS: 814**, **IS: 4354** and Indian Standard Hand Book for metal arc welding, and other standard codes of practice internationally accepted.

Necessary jigs & fixtures and rotation of structures shall be so arranged that vertically down-hand position of welding becomes possible.

Open-Arc welding process employing coated electrodes shall be employed for fabrication of welded connections and field welding. The cost of electricity for arc welding shall not be charged extra. The lump sum rate quoted for the item shall be inclusive of cost of electricity.

Wherever welding is done for assembling the components of structures, the job shall be so positioned that down hand welding is possible. In cases where down hand positioning of job is not possible other manual welding positions could be resorted to.

Any structural joint shall be welded only by those welders who are qualified for all welding procedures and positions required in such joint that is welded.

7.15 Girders for Movement of Hoisting System

All civil items related to Hoisting System shall be provided in Sludge sump, Filtrate sump etc. complete in all respect.

7.16 MS Stair

The Contractor shall provide MS staircase where ever required. The MS staircase shall be 1000 mm wide and the tread shall be 200 mm made of MS chequered plates. Rise of steps will be 150 mm. The main supporting beams shall be made of ISLC 200. The hand rail of the staircase shall be of MS 75 mm x 10 mm with PVC cover on it.

8. Water Proofing and Damp Proofing

This specification covers furnishing, installation, finishing, curing, testing, protection, and maintenance till handed over of water proofing and allied works.

8.1 Water Proofing

Water proofing treatment of 110 mm avg thickness consisting of 12 mm thick layer in cement mortar 1:3 with water roofing compound at 1 kg per bag as base, constructing and laying brick bat coba in cement mortar 1:5 with water proofing compound at 1 kg per bag and having average thickness of 80 mm thick and finishing with 20 mm thick cement plaster layer in cement mortar 1:3 with water proofing compound 1 kg per bag including all lead, lift and laid to proper slope to drain off water entirely including treatment at junction of parapet and wall upto a height of 300mm or as directed including finishing the top layer of water proofing treatment with false marking of 30 x 30 cm or as directed.

8.2 Damp Proofing

Damp proof coarse shall consist of cement, coarse sand and stone aggregate of 1:2:4 proportion with standard water proofing compound (1 kg per bag of cement). The DPC shall be applied at the plinth level in the horizontal layer of 40 mm thickness. The DPC shall be properly cured as per specifications. Two coats of bitumen of 20/30 penetration at 1.65 kg/cm² spread shall be applied uniformly on the surface when the concrete is dry.

9. Gates

9.1 Aluminum Control Gates

The construction of Aluminum open channel gate shall be in accordance with the specifications mentioned hereunder. The open channel gate shall be capable of performing the duties set out in this specification without undue wear or deterioration. They shall be constructed, so that maintenance is kept to a minimum. The open channel gate shall be rising spindle type.

Specifications of Aluminum Open Channel Gate

Shape of water way	: Square / Rectangular.
Mounting	: Suitable for mounting in between two parallel walls of an open channel.
Type	: Self contained type gate with headstock mounted on the yoke of the gate frame.
Type of head	: Seating as well as Unseating.
Distance between channel bed/invert of gate opening to top of operating platform	: as per drawing approved by Engineer in Charge.
Method of operation	: Manually operated suitable for opening with maximum 18 kgs effort by a single person with maximum diameter of Hand wheel/crank being 750mm.
Specific Construction Requirement for gate	: Gate frame shall be manufactured of non-corrosion 6061-T6 high strength extruded aluminum section weighing minimum of 5 Kg/m. Frame guides shall be made of UHMWPE (Ultra High Molecular Weight Polyethylene) to prevent metal to metal rubbing between frame and shutter. The shutter shall be made of same composition as the frame and sufficiently reinforced to restrict deflection to less than 1/360 of span under the design head. All parts of shutter shall have minimum thickness of 6mm. The complete gate assembly shall be given a coating of suitable epoxy lacquer.
Stem	: Rising type unless otherwise specified.
Type of closure	: Flush Bottom closure.
Sealing	: Only at two vertical and bottom sides of gate aperture due to open channel installation.
Seal seat clearance	: With the slide in the closed position shall not exceed 0.10mm.
Fluid flowing	: Raw unscreened sewage.

Pipe hood cover to cover the threaded portion of spindle and with additional mechanical stop nut on threaded stem.	
Indicate number of hand wheel revolutions required to fully open the gate.	
MATERIAL OF CONSTRUCTION :	
PART	MATERIAL
Gate frame, shutter/Door	: Aluminium Alloy 6061-T6
Side Guides	: Ultra High Molecular weight polyethylene
Seating faces	: Aluminum
Rubber Seals	: EPDM Rubber
Rubber seal retainer bar	: Stainless Steel AISI-304
Drive Nut	: Leadless Tin Bronze to Is : 318 LTB-2
Assembly bolts, nuts and fasteners	: Stainless Steel AISI-304
Stem & connecting pin	: Stainless Steel AISI-304
Yoke	: Mild Steel to IS : 2062
Headstock	: Cast Iron
Pipehood	: Transparent Polycarbonate
PAINTING	
Paint for gate assembly	: Epoxy primer and finish paint.
Paint for yoke and headstock	: Epoxy primer and finish paint. Minimum coating thickness to be 250 microns.
SHOP TESTING	: Following shop tests at manufacturer site will be conducted as per procedure mentioned hereunder.
Movement Test	: Movement test should be conducted in assembled condition using stems & headstock. The gate should be operated once from full close to full open and back to full close condition with a max. force of 135 Newton-meter on the crank or hand wheel.
Dimensional Check	: Important Dimensions shall be checked with reference to approved drawing.
Seat clearance check	: With the gate in closed condition 0.1 mm thick feeler gauge should not pass through the sealing faces.
Material Test Certificates	: Material test certificates for important components such as Frame, Side guides, Shutter, Rubber seals & Fasteners to be furnished at the time of inspection.

10. Electrical Requirements

10.1 Electrical Requirements

General

The bidder shall execute all works related to electrical lighting requirements of operations building. The bidder shall provide all indoor/outdoor lighting fixtures complete with lamps, ceiling fans complete with speed controlling device, receptacles, fuses, lighting panels for each unit, earthing and all other miscellaneous works required to fulfill the lighting requirements. **Mercury lamp fittings will not be accepted.**

10.1.1 Internal Lighting of Buildings

Internal Lighting of Buildings include the following work:

- a) Furnishing and installation of lighting fixtures (complete with Lamps).
- b) Executing works related to cabling, internal wiring, lighting fixtures components and support material.
- c) Earthing

10.1.2 Conditions

The decision of the Engineer in Charge regarding the acceptability of any fixture shall be final.

10.1.3 General Lighting Requirements

- a) Provide a lighting fixture for each lighting outlet as per the Lighting Schedule
- b) Provide complete fixtures including glassware, diffusers, lenses, canopies, sockets, reflectors, ballast, wiring, hangers and any other auxiliaries necessary to complete such fixture installation.
- c) Verify ceiling materials employed and co-ordinate fixtures to mount to the ceiling system used.
- d) All lighting fixtures and fittings shall be ISI marked.
- e) Provide support materials of all types necessary to secure lighting fixtures to the building structure. Such support shall include all material required to support lighting fixtures to the basic building structural members. Method of support shall comply with local codes and ordinances effecting each type of installation.
- f) Submit an initial sample of each fixture and obtain an approval from EIC before manufacturing total quantities required.
- g) The actual location of fixtures shall be as per the site condition and shall be finalised with the Engineer in Charge before starting the work.
- h) All products shall be as per Indian Standards

Lighting Schedule for Buildings & Plants

Sl. No.	(b) Unit	Type of Fittings	No. of Fittings	No. of Ceiling Fans	No. of Exhaust Fans
1	SBR Air Blower cum MCC & Control House	CSFL Tubes	15	10	6
		Decorative Fluorescent Fittings (2 x 40 W)	10		

10.1.5 Lighting Panels for Different Units of Building

The lighting distribution panel shall be of sheet with Bakelite top. The switches shall be 5 A, single pole, rocker type and shall conform to **IS: 3854**. Each light fixture, fans and plug point shall have an individual switch.

Each lighting panel shall have fuse on incoming side and shall have one 5 ampere multi-pin (3+2 pins) plug socket with switch.

(c) A. Point Wiring

Unless otherwise specified, the point wiring shall be with heavy duty I.S. marked PVC conduit as approved by Engineer in Charge.

(d) B. Fixture Finish

- Cold-rolled sheet steel shall be degreased, washed and have a corrosion resisting, paint bonding surface applied, using a non-metallic phosphate or equivalent coating.
- Cast-iron or steel shall be degreased, and washed with a primer containing a phosphoric or equivalent thinner.
- Aluminium shall be degreased, washed and etched as required to provide proper paint bonding, unless anodised Aluminium finishes are specified.
- Aluminium alloys and similar alloy metals shall be degreased and washed with a primer containing phosphoric or equivalent thinner.
- Reflectors in fluorescent fixtures shall be finished with white enamel baked as per specifications and shall have a reflection of not less than 82 percent. Porcelain enamel shall be used where specified.
- Fixture parts not finished by anodising shall be given a baked enamel finish. Finish shall be white unless otherwise specified. Enamels shall be baked as per specifications and where a white finish is used the reflection efficiency shall not be less than 82 percent.
- Where fixtures are noted to have standard finish, the normal colour scheme used by the manufacturer will be acceptable. Exterior Aluminium shall be anodised. Where finish colour is not evident obtain correct finish information from the EIC prior to ordering lighting fixtures.

(e) C. Fixture Location

Prior to installing fixture outlets, approval from EIC is necessary.

- a) Locate fixtures to suit site condition and as directed by the Engineer in Charge.
- b) Locate fixtures symmetrical with patterns and room dimensions.
- c) Fixture outlets shall be accessible and fixtures shall hang clear of ducts and piping. Verify exposed duct and piping locations prior to final location of electrical outlets. Adjust outlet locations to co-ordinate with ducts and piping.
- d) Follow standard mounting heights.

10.1.6 Fixture Support and Installation Conditions**(f) A. General**

- a) Lighting installation shall be carried out strictly in accordance with relevant Indian Electricity Rules, I.S. codes of practice, Fire Insurance and other applicable codes and regulation.
- b) Lighting fixtures, receptacles and junction boxes shall be properly earthed by 14G GI wire run along with the Lighting Wires/Cables.
- c) All junction boxes shall be fabricated from galvanised iron sheet steel as per I.S. 2667.
- d) Lighting wiring from lighting panel to junction box shall be carried out with 2.5/4 mm² PVC insulated solid copper conductor and from junction box to lighting fixture with 2.5 mm² PVC insulated flexible copper conductor.
- e) A separate neutral shall be provided for each circuit.

(g) B. Fluorescent Fixture

- a) Provide material required for complying with code requirement. Install in perfect vertical and horizontal alignment.
- b) Support surface fixtures with a minimum of 2 fastenings per fixture, located near each end of fixture.
- c) Locate fastening for all surface-mounted fixtures to provide maximum fixture support and optimum fixture alignment.
- d) Individually mounted, suspended fluorescent fixtures shall have a minimum of two supports per fixture.
- e) Fastening for suspended fixture supports attached to concrete slab shall consist of a minimum of 10mm screws fastened to concrete inserts for each individual fixture support.
- f) Provide canopies on stems fitting to and concerning outlet boxes and support devices.
- g) Cable entries shall be sealed with cable compound.

10.1.7 Expansion Shield Anchors

Expansion shields may be used for supporting lighting fixtures instead of concrete inserts under the following conditions:

- a) Fastening and expansion shield anchors shall be one trade size larger than specification requirements for fastening used with concrete inserts.
- b) Holes for expansion shield anchors, clinch anchors, etc. shall be self-drilled with carbide tipped rotary type concrete drills.

- c) Drill holes for expansion shields carefully in a workmanlike manner. Drill to the depth of the expansion shield anchor and in a manner that will develop the full strength of the fastening.

10.1.8 Fixture Schedule

A1- Decorative fluorescent fitting with 2 x 40 W (or 2 x 36 W) fluorescent tube pendent support of 500 mm. Fitting comprises of basic channel fully wired and provided with attachments like plates opal acrylic diffuser. It will comprise ballast, capacitor, starters and holder for starters etc. Ballast are copper wire wound encapsulated in a CRCA can with polyester resin, conforming to IS 1534.

F1- High Breeze 48" (120 cm) ceiling fan shall comply with IS 374. They shall be suited for 220/240 volts, single phase, 50 C/S and shall have three Aluminium blades hanging shackles cover and top cover. The fan shall have two ball bearings one at upper end and the other at lower end. The fan regulator shall be of electronic type and shall be mounted on the distribution board where its control switch is provided. The fan regulator switch shall not cause humming at all it's positions of regulation.

10.1.10 Receptacles

The Contractor/ bidder shall provide suitable number of indoor receptacles as per requirement of site conditions.

(h) General

- a) Protective metallic plug and deeply recessed contacts in the sockets shall be provided such that it gives very high degree of safety for operating personnel against risk of accidental exposure of live contacts.
- b) Earthing connection of plug while inserting and removing shall be made first and broken after the main circuit connections.
- c) Plug shall be provided with compression gland to grip the cable firmly.
- d) Casting of plug, sockets and conduit boxes shall be of non-corroding Die-cast Aluminium alloy.
- e) Guide pin shall ensure the non-reversibility.

(i) Receptacle Type Z-2

Receptacle Z-2 shall be 15 or 20-Ampere single phase metal clad totally enclosed wall-mounting type, interlocked switch, socket and plug unit shall conform to the relevant Indian Standards. Switch shall be interlocked with plug such that plug cannot be inserted or removed while the switch is in 'ON' position. Plug and sockets shall be Crompton make ASSP 20 type.

(j) Office Receptacles Type Z1

Receptacle shall be single phase 15 Ampere multi-pin, plus ground plastic moulded with switch, fuse and plug mounted in common enclosure. Receptacle shall conform to IS 1293 and switch shall conform to IS 3854.

10.1.11 Exhaust Fans

Exhaust fans of approved make shall be provided in the operations building 6 nos. 300 mm dia. heavy duty, noise free, wall cowl acoustic lining shall be provided and fixed.

11. Internal Water Supply & Sanitary System

Water supply system consists of providing water pipe lines, connections, taps etc. complete with all the fittings to Operations Building. The water pipe lines include excavation, laying, refilling, jointing etc. Fittings such as stop cock, bib cock, valves, taps, etc. of various capacities are to be provided as complete work. The service connections and internal pipe line shall be of GI (Class – B) having diameter of 15 & 20 mm. Peet Valves, Bib cock, stop cock etc. shall be of Chromium plated brass as per relevant IS Code. Sufficient no. of taps, stop cock, bib cocks etc. should be provided in office cum laboratory building. The schedule / plan and make of all fixtures of building will be got approved from Engineer in Charge before execution of works. One number water tank of 1000 Litres capacity on the roof shall be provided.

Sanitary works consist of water closet, wash basin / sink, footrest, flushing cistern, mirror, flushing pipe, towel rail, etc. Gully traps, floor traps and inspection chambers shall be provided wherever required. In the toilet, one water closet (European Type), along with ablution jet one wash basin, three urinals, one towel rail, flush cistern, footrest shall be provided. Additional tap for bathing shall also be provided. The scope of work also includes provision of floor traps, gully traps, manhole chamber, vent pipe and interconnections required thereof. Carriage & disposal system beyond manhole chamber is included in this contract. The sanitary wares shall be first quality of Hindustan / Hind ware / Johnson / Parry ware make I.S.I marked and other fittings shall conform to relevant IS code. White glazed tiles shall be provided in bath room, kitchen and laboratory as approved by Engineer in Charge before execution of work.

Note: Consider the all the specifications applicable to Sewage Treatment Plant only.

CHAPTER-IV

SPECIFICATIONS FOR MECHANICAL & ELECTRICAL/INSTRUMENTATION WORKS FOR 5 MLD SEWAGE TREATMENT PLANT

1. General Requirements for E & M Works

This section covers mainly the job requirements before and after the supply of Electrical & Mechanical equipment at site and before / after start of work. This section also covers the liabilities of the contractor and the quality standards that the contractor has to maintain for the work to be carried out by him.

1.1 Prerequisites before the supply of equipment

1.1.1 Submission of Drawings / design sheets / Data sheets

1.1.1.1 The Contractor shall submit the following detailed drawings for review and approval of the Engineer in Charge.

- (i) Data sheets for electrical and mechanical works / equipment.
- (ii) General arrangement drawings for all electrical works/equipments to be supplied.
- (iii) Technical Specification sheets showing rating, make and quantity of various components used in a specific mechanical/electrical item.

1.1.1.2 Approval of Drawings \ Documents \ Technical Data Sheets

Drawings will either be approved by EIC or he will convey comments that contractor shall incorporate by modifying the drawings accordingly.

The review of design calculations and drawings shall be carried out only in respect of orientation and sizes of important members, general design principles and approach, adherence to requirements of the relevant IS or other statutory codes, compliance with the technical specifications given in the tender document, general or specific notes and with the requirements of good engineering practice. Check for any interference and taking remedial action is the responsibility of the contractor.

Approval by the Engineer in Charge of the contractor's design or drawings shall not relieve the contractor of any of the contractual obligations or liabilities under the contract or his responsibilities for correctness of dimensions, material of construction, weights, quantities, design details, assembly fits, performance particulars and conformity of the supplies with the Indian statutory laws as may be applicable.

Should it be found at any time after approval has been given by the Engineer in Charge that any drawings or documents submitted by contractor are not consistent with any technical data, drawings or documents submitted or approved previously or substantially deviate from any major aspect of the contract, then such alterations

or additions as may be deemed necessary by the Engineer in Charge shall be made therein by the contractor and the works carried out accordingly without any extra cost.

The contractor shall make no revision after a design; drawing or document is “approved” by the Engineer in Charge. In case the contractor desires to incorporate any amendments in any amendments in an “approved” drawing, he shall re-submit the same for formal approval giving reasons for the change required.

1.1.2 Tests and Inspection before supply of equipment

Prior to the supply of any equipment, the contractor shall submit a schedule to Engineer in Charge for inspection of shop tests to be carried out at the manufacturer's factory from where the equipment is supposed to be brought / supplied. The contractor shall inform Engineer in Charge at least 15 days prior to the commencement of the shop tests for the equipment he wishes to supply as per the schedule of supply of equipment. Engineer in Charge shall either witness the tests or a representative authorized by him shall witness the tests.

1.1.2.1 Shop Tests

For tests carried out at the manufacturer's factory, relevant test certificates shall accompany the supply of equipment however two copies of test certificates shall be provided by the contractor immediately to the Engineer in Charge at the time of completion of the shop test. Some of the equipment may have to be tested for certain parameters only when installed in position at site. The Engineer in Charge or his representative reserves the right to visit manufacturer's workshop or at site on their own without informing the contractor. Where certificates are required by the specification or relevant reference standard, the original and one copy of each such certificate shall be provided by the contractor.

1.2 Prerequisite along with supply of equipment

1.2.1 Submission of Document related to Installation, Operation and Maintenance

The contractor shall submit instructions / operation & maintenance manual to the Engineer in Charge at the time of delivery of items at site.

- Information supplied by the sub-contractor and Manufacturers employed by the contractor shall be coordinated into the comprehensive manual. The instruction manual shall describe the installation as a whole and shall give a step by step procedure for any operation likely to be carried out during the life of each item of the plant including the erection, commissioning, testing , operation, maintenance, dismantling and repair.
- Where applicable , fault location charts shall be included to facilitate tracing the cause of manufacture or breakdown.
- A section dealing with procedures for ordering spares shall also be included in the instruction manual.
- Technical Specifications of equipment.

- Schedule of preventive, maintenance, calibration and repair instructions.
- Parts list and spare parts recommendations.
- Safety precautions to be furnished while handling different units and First aid instructions.
- Do's and don'ts in equipment operation. Operators attention shall be drawn to all operations considered to be dangerous to operate or likely to cause damage to the plant.
- A complete list of recommended lubricants, oils and their charts.

1.3 Prerequisites after completion of supply of equipment

Contractor shall make arrangements for proper storage of the equipment supplied by him at site before being installed at their respective positions.

All equipment shall be installed in accordance with the equipment manufacturer's recommendations and good practice. Sufficient notice shall be given to the EIC prior to equipment installation in order that the EIC or his representative may be present during installation.

Some of the equipment may have to be tested for certain parameters only when installed in position at site.

Contractor shall also submit a proper commissioning schedule for commissioning of the STP as agreed by the Engineer in Charge. The commissioning of machinery shall be run in order to ensure the normal functioning of the plant to the satisfaction of E.I.C. The problems faced shall be trouble-shooted immediately.

Final test certificates carried out during the construction or on completion of the whole works/at the successful commissioning of the equipment shall be submitted within seven days of the completion of the test.

1.3.1 Tests on Items of Plant during Erection

Devices and equipment shall be checked for correct functional performance in accordance with apparatus rating, operating sequence and code requirements. All motors shall be checked and adjusted for correct direction of rotation. Loading of circuits and feeders in panel boards shall be checked and balanced.

Interior installation and distribution systems, 600 volts and less, shall be tested for insulation resistance after all wiring is completed and fixtures and equipment are connected being ready for use. Tests shall be made with an instrument capable of measuring accurately the resistance involved and having a voltage rating as specified by IS. Reading shall be taken after the high voltage test of insulation resistance between conductors and also between each conductor and ground.

The contractor shall carry out all tests on plant witnessed by the Engineer in Charge or his authorized representative. All tests shall be to the satisfaction of the Engineer in Charge / authorized representative appointed by him who may require tests to be

repeated prolonged or modified as may be necessary to ensure that any or all items of plant confirm with the contract.

If during or after testing any item of plant fails to achieve its intended duty or otherwise proves defective, it shall be modified or altered as necessary and re-tested and re-inspected as required by the Engineer in Charge and the contractor shall bear all costs for such rectification/modification / replacement work.

The Engineer in Charge or his representative will have the power to omit, add, modify or adjust during stages of erection of any item of work as may be necessary or expedient for the work. No claim for compensation or damage will be entertained on the account of such changes.

1.3.2. Commissioning and testing

Commissioning shall commence after installation of all equipments and their installation checks carried out successfully and inspected / approved by the Engineer in Charge's or his authorized representative.

Ground Tests

Ground readings shall not exceed 5 ohms and tested as per I.S. 3043.

After installation and before placing in service, the system shall be given a high potential test by applying alternating or direct current between each conductor of the system as one terminal consisting of the ground. Prior to making the tests, the wires and cables shall be disconnected from the equipment. The method, voltage, length of time shall be in accordance with the cable manufacturer's and I.S.I Standards.

1.3.3 Special tools and accessories

All special tools, equipment, or accessories required for the installation and maintenance for plant equipment as well as five sets of copies each of instruction manuals necessary for the proper use of such tools, equipment or accessories shall be provided by the equipment manufacturer.

1.4 Quality Assurance from contractor side

The contractor shall provide all the required labour, permanent equipment and materials, tools, safety equipment, transportation and test equipment for supplying, installing, adjusting and fully testing all the mechanical work shown on the approved drawings or included in the tender document or ordered by the Engineer in Charge.

1.4.1 Standards

All mechanical equipment and the materials used shall comply with the relevant Indian Standards unless a more rigorous requirement is specifically stipulated. If no applicable Indian Standard is available for any item of equipment or materials, the specifications will be decided by EIC. In every situation the latest specifications, standards etc. shall apply unless otherwise stated.

All main items of electrical equipment such as switchgear and motor controllers, motor control centers, panels, starters etc. shall have an etched metal or laminated Bakelite name plate identifying these pieces of equipment and securely mounted on the equipment by screws.

1.4.2 Packing and Transport

The equipment shall be transported to site packed in wooden crates. They shall be wrapped with polythene sheets to prevent damage to the finish.

1.4.3 Materials and Workmanship

All equipment furnished under this or allied sections shall be new and guaranteed free from defects in materials, design and workmanship. If inadequate information is provided in the specifications, it shall be the contractor's responsibility to ascertain the conditions and service under which the equipment is required to operate and to warrant accordingly that operation under such conditions shall be successful. All parts of the equipment shall be adequately proportioned to safely withstand all stresses that may occur or be induced in them during fabrication, erection and intermittent or continuous operation.

All equipment shall be designed, fabricated and assembled in accordance with the latest standards and workshop practice. Individual parts shall be manufactured to standard sizes and gauges so those spares, furnished at any time, can be installed in the field. Corresponding parts of duplicate units shall be fully interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required for tests.

All materials used shall be appropriate for the service conditions. Iron castings shall be tough, close-grained grey iron free from blowholes, flaws or excessive shrinkage and shall comply with the requirements of IS 210. Except where otherwise specified structural and miscellaneous fabricated steel used in items of equipment shall conform to the relevant Indian Standards. All structural members shall be considered as subject to shock or vibratory loads.

Contractor shall assign a competent representative who shall supervise the electrical construction work from beginning to completion and final acceptance.

1.4.4 Cutting, Drilling and Welding

1. The Contractor shall provide the required cutting, drilling and welding etc. that will be required for the mechanical/electrical construction work.
2. Cutting and drilling of structural members shall not be permitted, except when approved by the Engineer in Charge. A core drill shall be used wherever it is necessary to drill through concrete or masonry.
3. The Contractor shall provide the required welding for equipment supports as desired by Engineer in Charge.
4. Junction Pull Boxes and Hand holes shall have covers stencilled with box number when shown on the drawings. Data shall be lettered in a conspicuous manner with a colour contrasting to finish.

5. Switch plates in designed areas shall be suitably engraved with a legend showing function or areas when required by Codes or shown on the drawings.

1.4.5 Drives:

To ensure vibration free operation all rotating components of each pumping unit shall be statically and dynamically balanced. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the amplitude of vibration as measured at any point on the pumping unit shall not exceed the limits set forth in the latest edition of the Indian Standards.

Upon completion of the electrical work, the Contractor shall remove all surplus materials, rubbish, and debris that accumulated during the construction work. The entire area shall be left neat and acceptable to the Engineer in Charge.

1.4.6 Lubrication

Contractor shall ensure constant presence of lubricant on all wearing surfaces. Lubricant filling and draining openings shall be readily accessible. Easy means for checking the lubricant level shall be provided. Prior to testing and/or operation, the equipment shall receive the prescribed amount and type of lubricant as required by the equipment manufacturer.

1.4.7 Painting

Shop painting should conform to the standard requirements. Electric motors, gears, starters and other similar self-contained or enclosed components shall be shop primed and finished with high-grade, oil-resistant acrylic enamel or other coating. Surfaces that will be accessible after assembly shall be painted or otherwise protected before assembly by a method that provides effective protection throughout the expected economic life of the equipment.

Unless otherwise required in the detailed equipment specification, surfaces to be painted at the plant site shall be shop-painted with one or more coats of a primer which will adequately protect the equipment until finishing coats are supplied at site.

Machined and polished metallic surfaces that are not to be painted shall be coated with an approved rust-preventive compound.

Before applying paint, the surfaces to be painted shall be cleaned and shall be free from rust, dust, oil etc. The painting shall be with two coats of zinc rich /chrome primer and two coats of finish paint. Each coat shall not be less than 50 micron.

Electrical equipment, which shall be installed outdoors shall be provided with a proper cover and the protection provided shall conform to the latest IS codes for outdoor installations.

Contractor shall provide the required painting for all unfinished surfaces of electrical materials, including supports.

All scratched or marred surfaces shall be refinished with touch-up paint to match the original finish.

1.5 Equipment Guarantee

This requirement shall conform to the conditions given in volume 1 of the tender document. Unless specified otherwise elsewhere, the Contractor shall furnish and replace at no cost to the Department any component of the equipment that is defective or shows undue wear within guaranteed period of twelve months from the date of stabilisation of STP. In addition to performance guarantees, processes or systems shall comply with the requirements stipulated in the relevant sections of the specifications.

1.6 Liability of the contractor

The contractor shall obtain and pay for the required bonds, insurance's, licenses, permits and inspections and pay all taxes, fees and utility charges that shall be required for the mechanical/electrical works.

If during the period of erection, Contractor or his workmen damage willingly or accidentally any part of the building structure or materials without written permission of Engineer in Charge, the contractor shall be completely responsible for the damages and he will have to make rectification /replacement at his own cost.

Incidental items not included in the tender drawing and specifications, that can legitimately and reasonably be inferred to belong to the electrical work shall be provided by the Contractor at no additional cost to the Department. The decision of the Engineer in Charge in this matter shall be final.

All equipment and materials shall be of latest design, and standard products of established manufacturers.

The equipment approval at the factory only allows the manufacturer to ship the equipment to the project site. The contractor shall be responsible for the proper installation and satisfactory start-up operation of the equipment in accordance with the manufacturer's requirement and to the satisfaction of the Engineer in Charge.

Inspection of the equipment at the factory by the Engineer in Charge will be made after the manufacturer has performed satisfactory checks, adjustment tests and operations.

Contractor shall make arrangement of all power required during the construction period and tests performed during erection of equipment.

The contractor shall be absolutely and solely responsible for damages due to accidents, injuries or losses, occurring to any person and property by his sub-contractors, agents or employees involved on his behalf in the execution of the work.

2. Technical Specifications for E & M Works

2.1 MECHANICAL FINE BAR SCREEN FOR STP

The manual bar screen will be of opening not more than 6 mm for FINE screen and inclination about 40° with respect to horizontal.

The screen shall be rectangular in shape. The screen shall be fabricated out of stainless steel SS 304 of not less than 2 mm thick bar.

2.2 RETURN ACTIVATED SLUDGE PUMPS & SURPLUS ACTIVATED SLUDGE PUMPS

Return sludge pumps shall pump the return sludge from the SBR Reactor (main) to Selector Zone. Surplus Activated Sludge Pumps shall pump the sludge to sump. Pumps shall be submersible type of non-clog design. They shall be suitable for pumping soft solids of size 80 mm. Only pumps with maximum 960 rpm shall be provided. In addition to this, the pumps shall be fitted with a special tearing system on the suction side for tearing soft solid material. The impeller shall be of a non-clog design with smooth passage and solid handling capability of 80-mm size. Maintenance-free anti-friction bearing, deep grooved permanently greased filled ball bearings shall be provided to take care of all the axial and radial forces at any point of operation. The pump installation design shall be such as to facilitate automatic installation and removal of the pumps without having to enter into the sewage pit. The motor shall be squirrel cage type, suitable for three phase supply continuous duty with class 'F' insulation. Motor shall have integral cable parts and the cable entries shall be sealed. The cables must be leak tight with respect to liquids and firmly attached to the terminal block. The motor shall be designed for non-overloading characteristics. There shall be thermal protection against overheating of the motor winding. The pump design shall ensure that seal does not come directly in contact with the liquid being pumped as well as cooling / lubrication by oil is provided. The moisture sensor of the tripping unit shall be located inside the oil chamber.

The pump unit shall be supplied along with the special duck foot bend, flanged elbow, lifting chain with shackles, enough guide wire / pipe, sufficient tough rubber sheeted water proof cable, as well as stainless steel foundation bolts and nuts. Alternatively pump unit can be with SS wire rope guiding system and pedestal cart integrated with the discharge head.

Reverse Rotation

The pump shall be designed to operate safely in the reverse direction of rotation, due to wastewater returning through the pump.

PUMP CONSTRUCTION

(a) Pump Casing

The pump casings shall be of cast iron and conform to IS: 210 Gr FG 260. The internal surfaces shall be free of rough spots. The casing shall have centre line discharge.

(b) Impellers

The material of impellers shall be as specified and they shall be of the single vane type. They shall be dynamically balanced. The leading edge of the vanes shall be rounded and cut back to prevent rags, stringy material etc. from impinging on the impeller vanes.

(c) Pump Shaft

The pump shaft shall be hard chrome plated alloy steel or stainless steel. The shaft shall be of one-piece construction.

(d) Pump Bearings

Pump bearings shall be of the antifriction type. The bearings shall be able to take normal axial thrust loads due to unbalanced hydraulic loads on the impellers plus the weight of all rotating parts of the pumps. Pump bearings shall be designed with a minimum life of 40,000 hours. The bearings shall be grease lubricated for life and shall be maintenance free

(e) Guide Arrangement

The assembly may have C.I. pedestal, bracket, delivery bend, SS 304 guide rail pipe, upper guide rail holder, etc complete. The pedestal and bracket may provide automatic coupling between pump delivery and discharge bend. Alternatively, the guiding system can be with S.S. wire rope and the pedestal cast integrated with the discharge bend.

(f) Mechanical Seals

A double mechanical seal of approved type shall be provided to prevent pumped liquid entering into the motor winding. The seals shall be running in oil bath. The oil bath shall have moisture sensors to sense water leakage. The sensors shall be used for tripping the pump and also for alarm.

(g) Pump Balance

All rotating parts shall be accurately machined and shall be in rotational balance. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case the amplitude of vibration as measured at any point on the pumping unit shall not exceed the limits set forth in the latest edition of Indian Standards. At the operating speed, the ratio of relative speed to the critical speed of the unit or its components shall be less than 0.8 or more than 1.3.

(h) Lifting chain

Each pump shall be provided with galvanized steel lifting chain of suitable capacity. One end of the chain shall be attached to the pump and the other end fixed near the upper bracket for guide rail / wire rope assembly, by means of GI D shackle. The chain shall have GI rings fixed at an interval of about 1 meter for engaging the hook of the chain pulley block.

(i) Submersible Cable

Each pump shall be provided with submersible cables of equal length for power and control so that the pump positions can be interchanged with each other. The cable shall be terminated in a common weatherproof junction box.

(j) Moisture Sensor

The moisture sensor shall be provided in the oil chamber to detect the failure of the mechanical seal.

(k) Motor

The motor shall be integral part of the pump. The enclosure for motor shall be IP-68. Each phase of the motors shall be provided with thermistor. The motor winding shall be suitable for star delta/soft starter. The motor shall be designed for minimum 10 starts/stops per hour, irrespective of whether it is DOL start or otherwise.

Materials of construction:

Pump casing	CI IS: 210 Gr FG 260
Discharge casing	CI IS: 210 Gr FG 260
Impeller	CI IS: 210 Gr FG 260
Shaft	SS AISI 431
Mechanical Seal	Silicon Carbide
Fasteners	SS AISI 304.

2.3 AIR BLOWERS (AERATION TANK)

The blowers shall be provided for providing adequate oxygen into the reactor tank for aeration. The air requirements shall be calculated for summer and winter as well as mixing power at 15 Nm³ / minute per 1000 cum of tank volume and the higher duty installed. The summer sewage temperature shall be taken as 38 degrees C and that in winter at 15 degrees C.

The blowers shall be capable of developing the required total pressure at the rated capacity for continuous operation. The blowers shall be Twin lobe type. One number VFD drive shall be provided with each set of blower. Directly coupled design shall be preferred. VFD motors shall be suitably derated.

The blowers shall be provided with suction air filter, silencer, dead weight pressure relief valve and pressure gauge and the air delivered shall be clean, dry and oil free. The blower noise level and velocity of vibration shall be within 90 dB(A) and less than 4.5 mm/s at a distance of 1.86 m respectively. The blower shall be driven by squirrel cage induction motor

The speed of the blowers shall be below 1200 rpm. The power rating of motor shall be at least 10% above the maximum power requirement by the blower. The kW of single blower shall not exceed 220 kW. The blowers shall be mounted at a level necessary to avoid back flow or siphoning of sewage into the blower. The accessories shall be complete with common base plate for blower and motor, suction and discharge connection, non return valve, safety valve, pulley and V- belt guard, eye bolts etc.

Material of construction

Casing	C I conforming to IS: 210 Gr FG 260
Rotor	Alloy steel
Shaft	Carbon steel C40/EN 24/19
Timing gear	Cast alloy steel
Pulley and gear side plates and cover	CI conforming to IS 210 Gr FG 260

Parameter

Type	Twin lobe
Discharge pressure	To suit process requirement
Power transmission	direct drive preferred
Cooling	Air cooled
Code	BS 1571

Tests

Sl. No	Tests	Specs
1	Hydrostatic tests	Twice the maximum working pressure
2	Performance test	As per BS : 1571
3	Strip test	Clearances with tolerance limit
4	Mechanical balancing	ISO 1940 Gr. 6.3 or better
5	Visual Inspection	Before painting

2.4 Diffused Aeration System

This comprises piping to diffusers and the diffusers.

• Type of diffuser system

A fine bubble diffused aeration system shall be applied to aeration tank for oxygenation. The number of diffuser elements can be varied by the bidder depending on the manufacturer selected, subject to the condition that sufficient design calculations are attached along with it and the manufacturer is a standard one having supplied the diffusers to various waste water treatment plants of similar nature.

- **Diffuser Elements**

The diffuser elements shall be of PU tubular membrane type and resistant to such ingredients as hydrocarbons, oil and grease. This shall afford a high oxygen transfer rate coupled with a minimal pressure drop besides permitting simple erection onto the horizontal air manifold. They shall have self-cleaning properties while in action. The diffuser unit shall be of corrosion resistant material. The membrane diffusers shall permit connection to the air manifolds of circular or square cross section and the entire lot of diffusers shall be capable of discharging designed flow of air at an average flow (maximum of summer and winter requirement) when installed in the said SBR tanks.

The diffuser grid shall be of fixed type. The headers onto which the diffusers are fixed shall be of standard Imported PVC/UPVC pipe sections of suitable inner bore and shape with custom fixtures of the diffuser elements as directed by the membrane manufacturers. Alternative pipe materials shall be acceptable provided the same are a mandatory part of the diffuser supplier and have been in the supplier's line of supply as original equipment. The headers shall also be procured from the equipment manufacturers who are the suppliers of the membrane diffusers. These headers shall have enough counterweight or alternative arrangement to surmount any buoyancy lift from the floor during air charging.

- **Air Supply Piping**

The air piping from the blower to the basin header (above water) shall be of MS epoxy painted material and pressure rated for the sewage depth plus frictional losses etc. Each air header shall travel downward from the air piping by aligning itself onto the sidewall of the aeration tank and thereafter travel horizontally onto the tank floor. These shall be fixed securely to the concrete surfaces in the horizontal plane and vertical plane so that they are not clamped horizontally onto vertical sides of the walls. The clamping shall be so designed as to permit "in-situ" screw driven fittings. Breaking open concrete surfaces shall not be permitted.

2.5 STAINLESS STEEL DECANTERS

The decanting device shall be rotating moving arm devices of Stainless Steel with top mounted gear box, drive, scum guard, down comers, collection pipe, bearings.

Rope driven decanters, Floating decanters, GRP products and Valve-arrangement are not acceptable.

The maximum design travel rate shall be 60 mm/min. with proven hydraulic discharge capacity of the decanter proportional to the selected basin area. Bidders to provide sample graphs of executed projects with such decanting speeds with decanters of min. same size (length)

There should be Maximum 1 decanter per basin.

The hydraulic design based on design flow rates as given above shall not exceed flow speeds of 1.3 m/s.

Flexible rubber hose kind of decanter sealing is not acceptable.

Each Decanter mechanism shall be inclusive of local control boxes with manual operation selection and function buttons, communication to main PLC by DH485 or Ethernet.

2.6 CENTRIFUGE FEED PUMPS

These pumps shall be used for pumping sludge to centrifuge. The pumps 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 range of total head. The pump shall have the maximum efficiency at the specified duty point. The unit shall be designed to operate safely at the maximum speed attainable in the reverse direction of rotation due to sewage returning thro the pump at times when power supply of the motor is interrupted. The first critical speed of the pump set shall be at least 30% above the operating speed.

The pumps shall run smooth without undue noise and vibration. The velocity of vibration shall be within 4.5 mm/sec. The noise level shall be limited to 85 dB at a distance of 1.86 m.

All rotating parts shall be statically and dynamically balanced as per ISO standards.

A stationary coupling guard shall be provided for the coupling conforming to all relevant safety codes and regulations. Guards shall be designed for easy installation and removal. They shall be complete with necessary support accessories and fastener.

The pumping unit shall be provided with a common base plate. The base plate shall be of sufficient size and rigidity to maintain the pump and motor in proper alignment and position.

The pump design shall be as per IS 6595 and pump performance shall be as per IS 9137.

The power rating of the pump motor shall be the larger of following

- 115 % of power required by the pump at the duty point
- 110 % of maximum power required by the pump from zero discharge to the runoff point total head

Material of Construction

Type	Screw
Rotor	Alloy Steel / SS 316
Casing	CI
Stator	Synthetic Rubber
Shaft	SS 316
Base plate	CI / MS Epoxy painted
Fastener	SS AISI 304.

Parameters of Pump

Capacity	As per bidder
Head	To pump to Centrifuge
Efficiency	Minimum 30 %
Pump speed	960 rpm (maximum)
Ball passing size	40 mm minimum

Applicable code

Design	IS 6595
Performance	IS 9137

Testing

Material test certificate	Casing, Impeller, Shaft
Hydrostatic test	1.5 times shutoff head or twice the rated discharge head whichever is greater
Performance test	IS 5120 and IS 9137 at full speed
Mechanical balancing	As per ISO 1940, Gr. 6.3 or better
Visual inspection	Pump shall be offered for visual inspection before shipment. The pump components shall not be painted before inspection
Field Tests	Field performance tests required for satisfactory operation

2.7 MAIN ELECTRICAL PANELS

Electrical Panels would be provided for feeding and controlling the various electrical loads.

2.7.1 General Specifications

Material specifications are given below and bill of quantity for each equipment given in the description against each item. It shall be the responsibility of the bidder to match the rating to the various equipments. Under no circumstances will the rating of the Electrical Equipment be less than that specified in bill of material for each equipment.

The Control Panels would be fabricated from 14SWG CRCA sheet, cubical type, floor mounting and free standing, suitable for indoor installation with a separate base rolled channel of 40 x 75 x 9 mm section. All gland plates shall be

manufactured to 3.15 mm thickness. Adequate bus bar supports should be provided for better fault withstanding.

The Panel will be made dust and vermin proof by providing good quality gaskets on doors, removable covers, gland plate etc. It will have a compartmental design, where in the incoming and outgoing feeders, bus bars etc will be mounted in separate compartments having its own front door. The Panel will be made extensible type; the main switch of each feeder will be inter-locked with its front door so that the door can not be opened in the closed position of the switch. All the live parts inside the panel would be covered with perforated sheet from the rear and with fibre glass / acrylic from the front as per the degree of protection specified.

The Panel will be completely wired internally with brought out terminal blocks for external wiring. Due to heavy corrosive atmosphere in the surroundings, the sheet metal work of Panel will be Powder coated of 60 Micron after going through 7-tank treatment with shade of RAL-7032 OF IS-5. The construction method would conform to Indian Standards. The Panel height would not exceed 2450mm and operating height will be limited to 2000 mm from finished floor to the top of the cabinet. Cabinet doors will be equipped with concealed or detachable type hinges and with flush or semi-flush., spring catch type, flush cylinder locks.

All joints and connections will be made by galvanized or cadmium plated high tensile strength bolts, nuts and washers between feeder compartments between bus bar chamber and feeder compartments & vertical partition between feeder compartments and cable alleys would be provided in order to prevent short circuiting of Power and/or control terminals due to accidental dropping of maintenance tools.

Access from front and top only will be limited to buses and cables. All other equipment will be mounted on the front side and will be accessible from the front through he hinged doors, Selector Switches, Ammeters, Voltmeters, and indicating Lamps, Push Buttons etc will be mounted on doors. Opening of Bus Bar Chamber will be permitted with special tools only. Compartments door will be interlocked against opening when the Air Circuit Breaker is in 'ON' Position. However it will be possible to bypass this interlock for inspection purpose. Opening for natural ventilation will be provided and will have screen of perforated sheet. All unpainted steel parts will be cadmium plated to prevent rust corrosion. If these parts are moving elements, then they will be greased. Suitable lifting lugs will be provided which will not leave any openings when removed separate Air Vent Boxes at least 2 Nos. will be provided on top of the panel for proper heat dissipation. Name Plates will be provided for each piece of equipments such as lamps, push buttons, switches, ACB's, measuring instruments etc. mounted on the panel. Special warning plates will be provided on all removable covers or doors giving access to cable or brushes, identification tag will be provided inside the panel for switches, fuses etc. Engraved nameplates will be preferable of 3-ply (red-white-red or black-white-black) lamicoid sheets. Size of the 'Letter' will be 5 mm height. 'Screws' and not adhesives will fasten nameplates. Sizes of 'Letter' of the main nameplates will not be less than 20mm in height.

The Manufacturer will furnish the test certificates of the components where ever applicable.

2.7.2 Moulded Case Circuit Breaker (MCCB)

The MCCB (Moulded Case Circuit Breaker) will conform to the latest IEC947-2 & IEC 947-3 1989. The Service Short Circuit Breaking Capacity (ICs at 415V AC) would be as specified at the required level.

The MCCB will be Current Limiting type and comprise of Quick Make – Break switching mechanism, preferably Quick Break Contact system, are extinguishing device and the Tripping unit, contained in a compact, high strength, heat resistant, flame retardant, insulating molded case with high withstand capability against thermal & mechanical stresses. All MCCBs will be capable of defined overload adjustment. All MCCB's rated 200A and above will have required Magnetic short circuit pick up.

The Trip command will over ride all other commands. The MCCB will employ maintenance free double break contact system to minimize the let thru' energies and shall be capable of achievements discrimination up to the full short circuit capacity of the downstream MCCB.

The manufacturer will provide all the technical information and I-t Characteristic curves. The MCCB shall have distinct Line / Load connections.

The handle position will give positive indication of 'ON', 'OFF' or 'TRIP' thus qualifying to Disconnection as per the IEC947-3 indicating the true position of all the contacts. In case of 4 Pole MCCB, the neutral will be fully rated and capable of suffering protection. The MCCB will have protection against Overload, Short Circuit & Earth Fault; minimum breaking capacity of MCCB will be 25 KA.

2.7.3 Volt and Ampere Meter with Selector Switch

96mm square, Voltmeters (0-500V) and Ampere Meters of suitable range of high quality industrial 'A' grade conforming to latest relevant IS specifications. The Voltmeter and Ammeter should be of Panel type. Selector Switch shall be rotary type.

2.7.4 Indicating Lamps

Two Indicating Lamps green and red coloured will be oil and dust proof, LED type bulb rating about 230V for showing 'Pump Off' and Pump Running' respectively.

2.7.5 Starter

For Motors upto 10HP Air Break Direct on line starter would be provided. For motor above 10HP upto 50HP fully automatic Auto Transformer Starter with Auto Transformer should be provided having tapping of 60%, 80% & 100%.

2.7.6 Contactors

The contactors should comply with the latest IEC947-4 and the corresponding IS13947-4 standards. They will have CPRI test Certificates. It would be manufactured by a company having got ISO9001 approval. The contactor would be rated for AC3 duty at 415V and 50HZ. The Contactors would be fast closing and fast opening type. The making and breaking capacity values of the contactors would be as follows (as per IEC947-4) :-

For AC3 Duty

Making Capacity more than 10 le

Breaking Capacity more than 8 le

For AC4 Duty

Making Capacity more than 12 le

Breaking Capacity more than 10 le

The Contactors would be capable of frequent switching and should operate without derating at 55°C for AC3 applications. They should be climate proof as standard. The coil of the Contactor would have class H insulation to support frequent switching.

The rated voltage of the contactor will be equal or superior at 440V and rated insulation voltage will be 690-1000 V. The rated impulse voltage of the contactor would be 8KV.

The contactor will have 2NO + 2NC Auxiliary Contact Block. The Contactor would be modular in design and would be suitable for the addition of auxiliary contacts and other electrical auxiliaries without any compromise on the performance or the operations of the contactors. The Contactors from 4KW to 400KW will be designed to accept the respective auxiliary contact block range.

The contactor upto 80 A would have a mechanical life of more than 10 million operations.

Contactors from 95-550 A would have mechanical durability of more than 10 million operations.

There will safety clearance distance on the front of the contactor. In case of screw or lug terminals, the terminals will be delivered in closed position resulting in safety during installation time. All Contactors will be having terminal marking as per standards.

The thermal over load relay if used will be direct/separate mounting over the contactor without any specific connections.

For Capacitor use, the Contactor would be suitable for Capacitor Duty i.e. AC-4 Category as per the required current ratings as per the Capacitor Banks.

2.7.7 Over Load Relay

The overload relay would comply with the latest IEC 947-4 and the corresponding IS13947- 4 standard. They will be having CPRI certification. They will be manufactured in an organization in accordance with the requirements of ISO 9001 standard.

The Relay would be direct contactor mounting type and should have the provision to be mounted separately also. The Over load Relay would be ambient compensated type and would be operable up to 55°C. It will be designed for utilization category AC3. The Relay will be tripping as per the specified tripping curves given in the technical data. The overload Relay would have build in phase loss and phase unbalance protection as per IEC 947-4. The Over load Relay would be capable to withstand up rated currents and inrush currents. The overload relay would have the possibility to select manual / auto reset at site.

In case of screw clamp terminals or connectors they will be delivered in closed position resulting in safety in wiring time. The rated operational voltage will be greater than or equal to 690 V. The rated impulse should be 6 KV. All over load relays would have been subjected to variable ambient conditions.

The Selection of the overload relay would be such that up to 93 A thermal bimetal over load relay would be used and beyond ratings of 90 A only CT operated overload relay would be used.

The Relays will have to assure protection of the connected equipment in case of overload and partial single phase as per the characteristics.

Correct operation of over load relay contacts will be checked by pressing the test button on the relay. A trip indicator will indicate the relay status. Reset following tripping would be automatic or manual. This is selected by the user by toggle switch on relay. For ratings greater than 45 KW reset will be manual & auto both.

The Over Load Relay will have potential free contact for indication / alarm purpose.

In combination with a contactor and a short circuit protective device the resulting motor starter will be Type 1 or Type 2 co-ordinated conforming to IEC 947-4-1. Co-ordination will be in accordance with tables tested and certified by the manufacturer of the respective switchgear.

2.7.8 Air Circuit Breaker

The ACB will conform to IEC 947-2 1989. The Service Short Circuit Breaking Capacity will as specified and equal to the Short circuit Withstand values. The ACB will be provided for controlling the in coming supply feeder or as required and specified in schedule. Shall be available in 3 or 4 Pole with left aligned mechanism, fixed or draw out manually or electrically operated versions as specified. ACB will be capable of providing short circuit, over load and earth fault protection (30 – 40 – 50 %), Zone Selective Interlocking, thermal memory thru microprocessor based

control unit sensing the true RMS values to ensure accurate protection as per standards.

The breaker would have at least 3 distinct positions from – Service / Test / Isolated / Maintenance within cradle. It should be possible to withdraw the breaker for testing while fitted on cradle. Safety interlock must be provided to prevent the ACB from Falling out in a fully withdrawn position. The ACB will be provided with a Door interlock. The contact would be copper and silver plated alloy only with a feature of replacing the arcing contacts for enhancing the life of main contacts. The ACB will have proper insulation as per the standards. All 4 pole ACBs should have fully rated Neutral pole.

All electrical closing of breaker would be with Electrical motor wound stored energy spring closing Mechanical indicator to provide ON/OFF status of ACB.

For all ACB's the Operating handle would be provided for charging the spring in continuous action. The spring will be released with ON/OFF Push Button command in one operation at the correct speed independent of operator speed. A direct Mechanical coupling would indicate the ACB in ON to OFF position thus qualifying to disconnection as per the IS/IEC indicating the true position of all the contact. One Set of NO/NC potential free contacts shall be provided for operation on building Management System. All accessories like shunt, under voltage releases shall be fitted to the ACB to ensure the interlocking arrangements.

The manufacture will provide details of opening time and duration with temperature to ensure discrimination and proper selection for feeder protection.

2.7.9 Safety Features

The safety shutter prevents inadvertent contact with isolating contacts when breaker is withdrawn from the Cradle.

It should not be possible to interchange tow circuit breakers of tow different thermal ratings. There would be a provision of positive earth connection between fixed and moving portion of the ACB either thru connector plug or sliding solid earth mechanism. Earthing bolts must be provided on the cradle or body of fixed ACB.

Arc Chute covers wherever necessary.

The incoming panel accommodating ACB will be provided with indicating lamps for ON-OFF positions, voltmeter and ammeter of size not less than 96 mm selector switches, fuses for potential circuit and current transformers.

The cradle of the ACB shall be welded structure to ensure better mechanical strength to take care of vibration & shocks at the time of fault in the circuit during abnormal conditions.

2.7.10 Protections

The Electro magnetic and thermal release or Microprocessor based unit with zone selective interlocking, thermal memory would be provided on circuit breaker for short circuit, over current and earth fault protection.

Specific indication should be provided for over current and earth fault operation.

Protection Release would be CT operated and direct acting on the trip bar.

Under Voltage relays would be provided.

Minimum 6 NO and 6 NC auxiliary contacts will be provided on each breaker.

Rated insulation voltage is 1000Volt AC.

2.7.11 Danger Plate

A Danger Plate of suitable size would be fixed on the front side of the Pump Controller.

2.7.12 Bus-bar

The bus bar shall be of electrolytic grade (E91E) Aluminum as per IS specifications. The current carrying capacity should not be less than 0.8 A/mm². Neutral bus bar should be rated for 50% capacity. the bus bar shall be duly insulated with heat shrinkable colour coded sleeves in case of links and droppers. However the main bus should be powder coated with black paint after proper pre treatment of the Aluminum. The Vendor should have a in-house conductivity test facility & primary current shall be conducted for temperature rise test.

The bus bar should be duly supported on fiber glass based finger type / pyramid type supports with minimum glass contents 25 mm.

2.7.13 Single Phase Preventer

S.P.P. should be current sensing suitable for checking the Negative Sequence current having built-in time delay relay up to 40 Millisecond, so that this may not trip while starting at NO load , shall be provided. Rating of CT's, if required, may also be indicated.

2.7.14 Shop Tests required for Control Panel

The design of the Control Panels shall be type tested as per IS. 8623 and shall comprise the following:

- Verification of short time current withstand and peak current withstand of main and vertical bus-bars.
- Through fault withstand on power draw-out contacts with HRC fused in series.
- Through faults withstand of control draw-out contract with HRC fuses in series.
- Temperature rise tests on main busbars, vertical risers, power and control contacts.

Routine tests shall be conducted on each panel as per ISA. 8623 and shall comprise the following:

- Inspection of panel including inspection of wiring and electrical operational tests where necessary.
- Insulation resistance test.
- High voltage test of bus bars, power and control wiring.
- Any other tests and checks not mentioned above but relevant to the panel.

2.8 AUTOMATION AND CONTROL

PLC based automation system with application software based on Rockwell to control all pumps, valves, blowers, VFD, decanting mechanism, limit switches and probes as per bidder's design including I/Os with 20 % spares, power supplies, UPS, etc. complete.

HMI Panel to comprise of up-to-date standard PC with monitor, printer, mouse, internet connection, RS-view, RS-links (gateway version), entire process and operator software with dynamic flow charts, pictures, screens, alarms, historical trends, reports etc.

SCADA based Automation system to monitor continuously in each tank the followings:

- (a) Filling volume
- (b) Discharge quantity
- (c) DO-level
- (d) Temperature
- (e) Oxygen Uptake Rate
- (f) Blower speeds
- (g) Decanting mechanism

The components of Automation are:

1	PLC-Cum-Control Panel	1 No
2	Online 2 KVA UPS with 1/2 Hours Battery Back-up	1 No
3	PC with SCADA, Printer & Desk	1 No

2.9 CABLING

2.9.1 Scope

This specification covers design, manufacture, testing and supply of Medium Voltage PVC Cables and High Voltage XLPE Cables.

2.9.2 Standards

The cables shall conform to latest edition of the relevant Indian Standard Specifications with amendment upto the date of issue of Enquiry, particularly the following Standards:

IS 1554	PVC insulated (heavy duty) electric cables for working voltages upto and (Part 1) including 1100 Volts
IS 1554	PVC insulated (heavy duty) electric cables for working voltages from 3.3kV (Part 2) upto & including 11kV
IS 7098	Cross – linked polyethylene insulated PVC sheathed cables for working (Part 1) voltage upto and including 1100 V.
IS 7098	Cross – linked polyethylene insulated PVC sheathed cables for working (Part 2) voltage from 3.3kV upto and including 33 kV
IS 7098	Cross – linked polyethylene insulated thermoplastic sheathed cables for (Part 3) working voltages from 66 kV up to and including 220 kV
IS 8130	Conductors for insulated electric cables and flexible cords
IS 5831	PVC insulation and sheath of electric cables
IS 3975	Mild Steel wires, formed wires and tapes for armouring of cables
IS 2633	Methods for testing uniformity of coating of zinc coated articles
IS 3961	Recommended current ratings for cables PVC insulated and PVC (Part 2) sheathed heavy duty cables
IS 10418	Drums for Electric Cables

A. General

1. This specification covers wires and cables for general construction.
2. Provide new wire and cable manufactured within one year prior to installation. The wires & cables shall be ISI marked and fulfil the standards mentioned here. The manufacturers name, conductor size, insulation type, volt rating shall be as per IS standards.
3. Where not otherwise specified or indicated, wire sizes are referenced to a capacity of 98 percent conductivity copper conductors. Do not install wire and cable having conductors of other metal unless approval for any such changes is obtained in writing.

B. Products

1. Provide stranded conductors for 16 mm² and larger, and solid conductors for 10 mm² and smaller. Stranded conductors in wire size smaller than 16 mm² may be used where subject to vibration or frequent flexing, and shall be used for control systems wiring.
2. The conductors are made from annealed high conductivity copper. The conductor for control cables shall be copper. Normally Copper conductors, up

to size 10 sq mm are solid, circular in cross section, and sizes above 10 sq. mm. are stranded. In case of single core and twin core cables, they are circular in cross section while for 3 core and 4 core cables conductors of cross section 50 sq. mm and above are normally sector shaped.

3. Insulation

The conductors shall be insulated with the high quality PVC based compound as per I.S. specifications.

4. Inner Sheath

For all cables having two or more cores a common covering (inner sheath) is applied over the laid up cores either by extruded sheath of non-vulcanised rubber compound or wrapping of plastic tapes. Single core cables do not have inner sheath.

5. Armouring

Armouring is applied over the inner sheath. In case of cables where diameter over the inner sheath does not exceed 13 mm the armour consists of galvanised round steel wires; above this size, normally the armour is of galvanised flat steel wires (strips).

6. Outer Sheath

Over the armouring, or in case of un-armoured cables, over the inner sheath (for single core cables over the insulation), a tough outer sheath of PVC is extruded. This is always black in colour, for best resistance to outdoor exposure.

The manufacturer's name and trade mark alongwith the year/year code of manufacture are embossed on the outer sheath; additionally in the case of HT cables the voltage grade is also embossed, and the voltage grade along with the year/year code of manufacture. The embossing script that repeats in such a way that every meter of the cable bears the same

7. Type Designation

Type designations of cables are based on the following alphabet nomenclature:

C - Copper conductors - when first letter of type designation.

Y - When at first or second or last place in type designation, it stands for PVC insulation.

R - Round steel wire armouring.

F - Flat steel wire (strip) armouring. Number of cores, Conductors cross section,

Voltage grade are written in the usual manner. Cable shall be IS marked

8. LT Cable

Cable shall comply with **IS 1554** part I, cables shall be 650/1100 voltage grade. Power cable shall be CYFY or CYRY type, while control cable shall be YRY type. Joint in the cables shall be permitted only if the length of the cable is more than standard drum size.

Execution

1. Unless otherwise indicated or specified do not install Aluminium conductors of less than 4 Sq mm. For control conductors protected by 15 ampere or lower, 2.5 Sq mm copper conductors shall be installed.
2. Colour code power wire and cable for feeder and branch circuits is as follows, unless otherwise required by local codes or the electrical utility company.

Phase	440 V / 230 V
A	Red
B	Yellow
C	Blue
Neutral	Black
Ground	Green

(i) Splices and Termination**A. Termination**

Provide brass or copper indent type connectors or cables lugs crimping/solder type at both ends of the cable. Aluminium or ferrous metal connectors are prohibited. Dowell's make conductivity grease shall be used while using crimping type cable lugs/sockets. All motors shall be connected using copper or brass ring-torque terminals, brass bolts and nuts. The cable lugs/connectors shall fit the conductor to which it shall be connected. The compression tool shall be equipped with a ratchet attachment, which shall assure proper crimping pressure on the connectors.

Connections shall be made tight and insulated with PVC electrical tape of colour as per I.S. Provide a compression type cable glands at each end to the cable. Glands shall be of nickel-plated brass, with PVC shrouds over it. Before applying a PVC shroud, all bare metal shall be wrapped with pressure-sensitive adhesive PVC tape.

Double compression H type nickel plated brass cable glands with PVC shroud over it shall be used for termination of cable at flame proof junction boxes or flame proof P.B. station instead of single compression type cable gland.

B. Saddle and Clips

Saddles and clips shall be PVC covered or of G.I. Fixing screws shall be round head brass. Where bolts are used nuts shall be of brass, square pressed type.

C. Jointing Sleeves

Jointing sleeves shall be of brass with standard terminations. Solder type cable connectors/cable sleeves shall be used to join the cable/conductors. Non corrosive flux only shall be used.

D. Joints in Cables

Joints in cables shall be kept to a minimum and conductors shall be joined using solder ferrules or Siemens make jointing compound. Joints shall be enclosed within standard adaptable boxes. Siemens make tropolin type or equivalent shall be used. For reference straight through joints shall be enclosed within brass jointing sleeves where joints are enclosed in other than brass sleeves and are buried in the ground, bitumen base filling compound shall be used to completely fill and seal the joint box after the cover is secured. Where joints are enclosed in brass sleeves and are buried in the ground, the ends of the sleeves shall be plugged with plastic filling compound before the glands are screwed into the sleeves.

Jointing shall be done by using Siemens make cable jointing kits taking due care as specified by Siemens.

E. Identification of Conductors

Colour of the sleeves complying with I.S. shall be used to identify all conductors at terminations and joint boxes.

F. Test

Prior to shipment, cable manufacturer shall test and inspect each length of cable in accordance with I.S. in presence of Engineer in Charge or any other authorised personnel.

(ii) Openings, Chassis and Sleeves**A. Products**

1. Sleeves for General Use
Use galvanised steel pipe

B. Execution

1. Provide openings, chases, cutting, patching, sleeves and other products, necessary to permit the electrical raceways and cables to pass through the structure.
2. Establish locations for openings, chases and sleeves sufficiently in advance of construction to avoid cutting and patching. Perform any required cutting and patching for electrical work and obtain approval for cutting prior to work being done.
3. Repair damages to finished work and surfaces caused by cutting, to the satisfaction of the Engineer in Charge.
4. Install sleeves wherever raceways of any type pass through walls or floors.

Earthing**A. General**

1. Unless otherwise indicated, ground each single or poly-phase system neutral conductor at source.
2. Unless otherwise indicated earth, ground exposed non-current carrying metal components of electrical equipment, cable trays, raceway system, cable grounding conductors armour or shielding and enclosures shall be earthed.
3. Maintain continuity of system and equipment grounds throughout the electrical installation. Provide grounds, bushings and jumpers where normal metallic ground paths are interrupted.
4. Grounding shall comply with the Engineer in Charge drawings and specifications, and with the requirements of State and local Code enforcement bodies.
5. Alternate grounding methods in accordance with good accepted practice for this type of work which cover conditions not indicated on the approved drawings or described in these specifications and which meet with the approval of the Engineer in Charge shall be used in order to secure a good substantial and permanent grounding system. Under no conditions shall the maximum ground resistance exceed five ohms when measured in accordance with recommended standards.

B. Products

1. Provide ground conductors and jumpers of copper/ GI wire size as required by relevant code.
2. Provide GI pipe electrode 40 mm minimum diameter and 3400 mm minimum length.
3. Earthing for motor above 40 HP - 40 x 6 mm Copper strip, push button station / Auxiliary item 12 SWG Copper wire to be used.
4. For motor 40 HP and below - 25 x 3 mm Copper strip, push button station/ Auxiliary item 12 SWG Copper wire to be used.
5. Number of Earth Pits shall be selected to keep overall earthing resistance of 1 ohm.

C. Execution

1. Provide ground grids with prior approval of Engineer in Charge.
2. Provide all interconnections, risers, cable, fittings and welding for grounding substations, transformers and other equipment. Bonding jumpers shall be equal in cross section to the corresponding ground connectors and attached by solderless lugs, compression connections, or clamps providing bonding jumpers around all high voltage junction boxes.

3. Minimum size ground conductor shall be 10 SWG-GI conductor, the conductor shall be securely bonded to the conduit at each end.
4. Ground the enclosures of electrical equipment with separate grounding conductor. Connect to the nearest suitable ground point of the electrical ground system. Ground all metal non-current carrying parts of electrical equipment, cable tray, raceways, and bus supports.
5. Ground all motors by running two separate equipment ground conductors and connected to grid. At the motors connect the ground wire solidly to the frame with lugs.
6. Provide a ground conductor from 110 and 240 volt ground terminals to associated outlet boxes.

(iii) D. Grounding

1. Install ground conductors in the earth at least 450 mm. below grade.
2. The earth pits shall be provided as per **I.S. 3043** with GI pipe of 40 mm dia and 3400 mm length and top of the pit shall be covered with chequered plate.
3. Drill and tap equipment frames and attach ground connections with bronze cap screws.
4. Underground taps or splices shall be completed with cad weld connectors.
5. All conduits shall be rigid metallic galvanised. Where PVC or non-metallic conduit is substituted underground, provide an additional equipment ground wire and increase conduit size as required.
6. All equipment except lighting fixture and those rated above 230 V shall be grounded by two separate connections as per **I.S. 3043**. For equipment rated 230 V below can be provided with one ground connection.
7. A ring main grounding system shall be followed. The main ring shall be GI flat of 50 mm x 6 mm size covered with hessian tape and bitumen at the joints. The submain ground connections to panel boards, M.C.C. etc. shall be 25 mm x 6 mm GI flat.
8. All joint to the ring main shall be welded and painted with bitumen. All connections at ground bus and at equipment shall be bolted type.
9. Grounding conductor shall be run along with Power / Control / Lighting cable.
10. All equipment intended to be live shall have an effective ground connection in accordance with Indian Electricity Rules and **I.S. 3043**.
11. Suitable bond shall be provided between cable tray section and also conduit to make them electrically continuous and shall be connected to Earthing System at two points.
12. All 20 A receptacles, junction boxes, light fixtures shall be earthed suitably by 14 gauge copper wire.
13. Size of earthing conductor to be used for earthing of various equipment shall be as per **I.S. 3043**.

2.10 INSTRUMENTATION

2.10.1 Flow Measuring System (If applicable)

Flow measuring system shall consist of flow sensor/ transducers, flow computer and flow transmitter.

Flow transducers shall be rugged in construction and shall be suitable for continuous operation. Flow transducers shall have waterproof construction and shall be suitable for installation in underground/ above ground pipeline.

To avoid the effects of disturbances in the velocity profile, a straight and uninterrupted run, upstream as well as downstream from the location of the flow sensor shall be provided in accordance with the requirements of the flow meter manufacturer.

The flow transmitter shall be suitable for field or panel mounting and shall accept an input from the flow sensor. It shall process the input signal and provide 4-20 mA dc output proportional to flow rate. The flow range shall be adjustable.

A zero span adjustment facility shall be provided for flow transmitter and indicator.

Flow measurement shall not be affected by physical properties of sewage viz., temperature, pressure, viscosity, density etc. within given limits. Contractor shall provide compensating electronic circuits if required. The overall accuracy of flow measuring systems shall be at least $\pm 1.0\%$ of the measured value unless otherwise stated.

2.10.1.1 Electromagnetic Flow meter (if applicable)

Full bore electromagnetic flow meter shall consist of flow sensors (i.e. flow tube), transmitter and remote flow indicator cum integrator.

The flow meter shall have flanged connection and shall be inserted in the sludge line.

The flow computer/ transmitter shall be microprocessor based and shall have diagnosis facility.

Remote flow indicator cum integrator shall be provided on the control panel.

To ensure full electromagnetic compatibility the flow tube flanges and transmitter housing shall be connected earth.

2.10.1.2 Open Channel Flow Meter (if applicable)

Open channel flow measuring system shall consist of level transducer, flow computer and flow transmitter. The level of the fluid in the flume shall be measured by the ultrasonic level transducer. The level measured shall be used along with the physical characteristics of the flume to compute the flow rate.

The level transducer shall be suitable for flange or bracket mounting as required and shall be environmentally protected as per IP 65. It shall have ambient temperature compensation and adjustable datum setting facilities.

The design and application of ultrasonic level meter shall take into account the channel construction, the material size, shape, environment, process fluid or material, the presence of foam granules, size etc.

The installation shall avoid any degradation of performance from spurious reflections, absorption, sound velocity variations, sensor detection area, temperature fluctuation, specific gravity changes and condensation. For application where spurious reflections are unavoidable the control unit shall be provided with facilities for spurious reflection rejection.

The structure required for supporting the level sensor, platform, railings etc. shall be in the Contractor's scope.

2.10.2 Level Measuring System**2.10.2.1 Ultrasonic Level Meters (if applicable)**

Ultrasonic level measuring devices applied for liquid level measurement shall comprise a transducer, control unit and remote indicator.

The transducer shall be suitable for flange or bracket mounting as required and shall be environmentally protected to IP 65.

The design and application of ultrasonic level meters shall take into account the vessel or channel construction, the material, size, shape, environment, process fluid or material, the presence of foam granules, size etc.

The installation shall avoid any degradation of performance from spurious reflections, absorption, sound velocity variations, sensor detection area, temperature fluctuations, specific gravity changes and condensation. For applications where spurious reflections are unavoidable the control unit shall be provided with facilities for spurious reflection rejection.

If turbulence exists, shielding, stilling tubes or other measures shall be provided to avoid effects on the measurement.

2.10.2.2 Conductivity Level Switches

The electrodes used for conductivity level switches shall be stainless steel. Single electrode systems (one electrode per holder) shall be used (except where their use is impractical) with insulated electrodes such that only the tip of each electrode is exposed to the liquid at the operating level.

Relay or control units operating with level electrodes shall have adjustable sensitivity. Electrodes for use in fluids of low or variable conductivity shall be fitted with conductivity discs.

Where relay or control units are not mounted in control panel, they shall be provided with surface mounting enclosures with a degree of protection to IP-54 for indoor locations or IP 65 for outdoor location.

2.10.2.3 Ultrasonic Differential Level Measuring System (If applicable)

The ultrasonic type differential level measuring system shall consist of ultrasonic type level sensors on upstream and downstream of screens, differential level computer / transmitter and indicator.

The flow computer / transmitter shall be microprocessor based and shall have facility for programming (i.e. adjustment of set points).

The ultrasonic transducer shall be suitable for flange or bracket mounting as required and shall be environmentally protected as per IP-65. It shall have ambient temperature compensation and adjustable datum setting facilities.

2.10.3 Pressure Gauges

Pressure Gauges shall comply with BS 1780. Snubber shall be provided where the gauge is subjected to pressure pulsations and / or vibrations. The internal parts of pressure gauge shall be of stainless steel material. In chlorine applications the diaphragm shall be silver or tantalum for other fluids an appropriate diaphragm material shall be used. The pressure gauges shall be provided with diaphragm seal arrangement.

The minimum diameter for round pressure gauges shall be 150mm unless specified otherwise or where the gauge forms part of a standard item of equipment.

The accuracy of pressure gauges shall be $\pm 1\%$ over the operating range.

The zero and span of pressure gauges shall not change by more than $\pm 0.1\%$ of the span per $^{\circ}\text{C}$ changes in ambient temperature.

2.10.4 Surge Protection Devices

Surge protection devices (SPD) shall be suitable for with standing the surge arising out of high energy static discharge / lighting strikes and protect the instrument to which it is connected against damage. SPDs shall provide protection through the use of quick acting semi conductors like Tranzorb, zener diodes, varistors and an automatic disconnect and reset circuit. SPDs shall be passive and shall require negligible power for operation. During the occurrence of a surge it shall clamp on the allowable voltage and pass the excess voltage to the ground. The SPD shall be self resetting to minimize the down time of the measurement loop.

SPDs shall be provided to protect devices transmitting and receiving analogue and digital signals derived from field devices located outdoors.

The surge protection device shall be rated for surge rating of 10 KA.

2.10.5 Cabinets for Field Instruments

Wall mounted cabinets shall be provided for enclosing transducer unit and associated accessories which are mounted outside the main control panel. The cabinet shall be of die-cast aluminum, field provided not less than IP-55 protection and shall be lockable. The cabinet shall have facilities for earthing. A steel plate shall be provided inside the cabinet for mounting instrument and accessories.

2.10.6 Alarm System

Alarms shall be initiated by the opening or closing of volt-free contacts which shall remain unchanged throughout the periods in which the alarm conditions exit. Alarm Circuits shall be cable 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.

Audible devices in the same room or area shall have distinguishable sounds and adjustable sound levels.

2.10.7 Matrix Type alarm Enunciators

The alarm enunciator shall be microprocessor based, modular, split type unit with alarm windows mounted on the front door and electronic modules inside the panel. The weather protection class for alarm enunciator shall be IP-54 of IS 13947, Part-I.

Each alarm shall initiate a visible and audible indication of the specified condition. Unless otherwise specified, alarm indicators shall be grouped together in enunciator units each having at least 20% spare ways. Alarm indicator lamps (Cluster LED type) and shall have transparent screens engraved with appropriate legends. The legend area of each indication shall not exceed 40mm high and 75mm wide.

When any alarm condition occurs, a condition device common to an alarm enunciator system shall sound and the appropriate indicator shall flash on an off. The flashing rate shall not be less than 2 Hz and shall not exceed 5 Hz. On pressing an accept pushbutton, the audible device shall be silenced and the flashing light shall become steady. The alarm indicator shall remain illuminated until the alarm condition ceases and a reset pushbutton has been operated.

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 further alarm condition occurs. At unmanned locations alarms operated on two or more enunciators shall require acceptance at each enunciator.

Alarms shall be accepted automatically and the appropriate audible device silenced after an adjustable period of 1 to 5 minutes.

An integral 'test' pushbutton shall be provided to illuminate each lamp in the appropriate group and to operate the audible device but shall not cause a spurious alarm condition on any other enunciator.

Alarm circuitry shall be arranged so that spurious or transient alarm states persisting for less than 0.5 seconds do not initiate any action.

Alarm enunciator / indicator legends or labels shall be arranged with three lines of text as follows:

Top line	Location
Middle Line	Parameter
Bottom Line	Status

2.10.8 Direct Digital Controllers (DDC)

2.10.8.1 Design and Construction Requirements

Standalone DDC panels shall be microprocessor-based, multi-tasking, multi-user, real-time digital control processors. Each standalone DDC panel shall consist of modular hardware with plug-in enclosed processors, communication controllers, power supplies, and input/output modules with connectivity to the Network Controller through a RS 485 or Ethernet communication bus.

The DDC's should be application specific and should be located as near as possible to the controlled equipment reducing cabling runs. The DDC's should be able to control the equipment connected to it on a standalone mode so that in case of failure of the first tier network the DDC's will be able to perform the minimum control functions assigned to it. The DDC's should have a inbuilt display on its facia with keypad to access all the information being monitored by the DDC.

2.10.8.2 Programming

All the DDCs should be equipped with electrically erasable PROMs and the control software for the DDC can be downloaded through the central operator workstation. It should additionally provide a serial port for downloading and reconfiguring of software through a laptop locally. The control logic for the DDCs should be programmed through a user-friendly graphic programming language with control algorithms like PID loops, ladder logic, sequencers etc inbuilt into the software.

2.10.8.3 Input /Output point types

Each DDC panel shall support the following types of point inputs and outputs:

Analog inputs shall monitor the following analog signals:

4-20 mA Sensors

0-10 VDC Sensors

1000 Ohm RTDs

Binary inputs shall monitor dry contact closures. Input shall provide filtering to eliminate false signals resulting from input "bouncing."

Counter inputs shall monitor dry contact pulses with an input resolution of one HZ minimum.

Analog outputs shall provide the following control outputs:

4.20 mA – Sink or Source

0-10 VDC

Binary outputs shall provide SPDT output contacts rated for 2 amps at 24 VAC and they shall not activate main contactors of starter thus avoiding burdening of relays.

2.10.9 Uninterruptible Power Supply (UPS)

The UPS shall be floor mounted, self contained and metal clad and shall be suitable for operating on a non linear load.

It shall be front door accessible. The UPS system shall be true ON-Line.

The ON LINE UPS shall be incorporating a six-pulse rectifier and pulse width modulation inverter technology with 100% microprocessor control with built in static and manual bypass switch.

The UPS shall incorporate a DC under voltage trip circuit to electrically trip the UPS in order to protect the battery.

The noise level of the unit shall not exceed 60dB (A) at 1m from the UPS cabinet.

The output of the inverter shall be a sine wave having less than 5% THD for linear loads and less than 4% to 50% non linear load. It shall be suitable for load power factor 0.8 lag.

The unit shall have dynamic response such that a 100% step load causes an output voltage transient of less than $\pm 4\%$ with a recovery time of less than 4 ms.

For three phase output units the output voltage shall not vary by more than $\pm 1\%$ for an unbalance for 10%.

The load crest factor shall not be less than 3:1.

The efficiency at full load and 0.8 power factor shall be greater than 88%.

Indicators to indicate

- UPS status
- UPS alarm conditions

The UPS shall provide a volt free contact output to indicate:

- Warning. i.e low battery capacity
- Fault
- Static bypass in use.

The UPS shall have an overload capacity of 150% for 30 seconds and shall be protected in the event of a short circuit of the output.

The batteries shall be housed, either within the UPS enclosure or within a separate matching battery cubicle suitable for location adjacent to the UPS.

The batteries shall be maintenance free lead acid type sealed for life.

Terminals shall be shrouded to prevent accidental contact. The battery enclosure shall be corrosion resistant and ventilated to prevent the build up of gases.

Warning notices shall be provided for wall mounting to warn of the presence of charge gases. The battery supply of the UPS shall be via a fused load break switch disconnecter circuit breaker.

The battery recharge time to 90% of full charge shall be approximately ten times the discharge time at full load.

The UPS battery shall have a back up of 30 minutes at full load and supported with inverter of suitable capacity.

2.10.10 Air Conditioning / Air Handling / Cooling and Ventilation / Exhaust :

The bidder shall design and provide AC / Air cooling / Ventilation and exhaust system as per the norms, regulations, statutory and process design requirement. The control room shall be provided with air conditioning of required capacity. All plant rooms shall be provided with push pull ventilation with air intake through a fan filter unit and exhaust with propeller fans. The design of supply air capacity should be based on 20 air changes per hour or heat load with inside temperature limited to a maximum of 5° C above ambient temperature. The equipment shall comprise of air intake louver, panel type filter, centrifugal air supply fan, GI ducting, Grills, propeller fans and their gravity louvers.

2.10.11 Testing / Inspection**2.10.11.1 Tests on cables :**

Check details are in accordance with the specifications. Check for physical damage, Continuity Check, meggar test for insulation Connections.

No dark visible marks of armoring onto external surface.

2.10.11.2. Tests on electrical installation

Check all closing, tripping, supervision and interlocking of control devices. Check operation of all alarm circuits.

Check CT polarities, give primary & secondary injection. Carry out relay calibration

2.10.11.3. Test on complete control system

On completion, the functioning of the complete system shall be tested to demonstrate its correct operation in accordance with the Specification.

For control system testing, the contractor may provide temporary means to simulate operating conditions, but the system will not be finally accepted until correct operation has been demonstrated to the satisfaction of the Engineer when all the pumps are operating.

The system shall be shown to operate correctly whatever the selection of duty and standby equipment may be.

Conditions to be tested shall include:

- Normal automatic operation.
- Normal manual operation
- Emergency manual operation

2.10.11.4 Commissioning Tests

Correct operation of controllers shall be verified by observing that the final control element moves in the proper direction to correct the process variable as compared to the set point. All logic sequences shall be verified to operate in accordance with the specifications.

All defects and malfunctions disclosed by test shall be corrected immediately. New parts and materials shall be used as required and approved and tests shall be repeated.

A report certifying completion of validation of each instrument system indicating calibration values, verification that the system performs as per requirements and any provisional settings made to devices shall be provided. A format for commissioning checklist shall be provided for approval before performing the commissioning tests.

2.10.11.5 Final Operational Testing and Acceptance

Upon completion of instrument calibration and system validation, all systems shall be tested under process conditions.

The testing shall include, but not limited to all specified operational modes, taking process variables to their limits (simulated or process) to verify all alarms, failures, interlocks and operational interlocks between systems and/ or mechanical equipment.

Any defects or malfunctions shall be immediately corrected using approved methods and materials and the tests shall then be repeated.

Upon completion of final operational testing, a report shall be submitted, indicating that the total control system provided meets all the functional requirements specified herein. This report shall be made in the format approved by the Engineer. The Engineer shall certify this report and it shall constitute final acceptance of the control system.

- **Note: Consider all the specifications applicable to Sewage Treatment Plant only.**

2.11. Submersible Raw Sewage Pumps for MPS

2.11.1 General

The submersible sludge pump should be of single stage mono-block type with non clog design and shall be suitable for pumping all kinds of sewage/sludge/storm water containing long fibers, plastic pieces, cigarette butts, solid admixes etc. The pump should be capable of passing soft solids of minimum 80 mm diameter and capable of dealing with the sewage / sludge with a specific gravity of 1.05. Impeller shall be of single/double Vane with solid handling capacity of 80 mm dia. for selected duty parameter.

Maintenance free anti-friction deep groove, permanently grease filled ball bearings should be provided and this should take care of all the axial and radial forces at any point of operation. The pump installation design should be such as to facilitate automatic installation and removal of pumps without having to enter into the sewage pit. Profile gasket should be provided in automatic coupling system so as to avoid metal to metal contact between the pump and duck foot bend to ensure leak proof joint.

The casing of pump set should be of CI as per IS 210 Gr FG 260 and CF 8M impeller. The pump set shall be supplied along with the guide rail, duck foot bend, lifting chain with shackles, guide-pipe, SS foundation bolts and nuts complete. The pump will have reputed make mechanical seal & moisture sensor, thermistor for tripping of pump in case of any leakages or high temperature. It will be provided with its electronic control unit for such protection.

For easy installation and removal of the pump, a single guide rail system shall be provided. This being a permanent installation, a Pedestal and a Bracket should be provided to enable the pump to be removed from sump without the necessity of removing any nuts and bolts. The pumps should be provided with a reverse rotation trip feature to stop the unit instantly if connected to start in the wrong direction

Pump Details	Capacity /Size /Material
Scope of Supply Pump, motor with requisite length of cable, Guide Rail System, Guide Pipe, Chains ,Shackles with rings and Control Panel	4 Nos.
Submersible Sludge Pump	4 Nos.
Liquid	Sewage
Discharge in m ³ /hr of one pump	As per requirement
Total Pumping Head in m.	As per requirement.
Specific Gravity	1.02
Liquid Temp. 0C max.	40
Pump Motor rpm	1450
Motor rated temp. 0C	40
Electric Supply	3ph. 50 Hz, 415 V
Solid handling cap. in mm	80 mm
Material of Construction	
Casing	CI IS 210 Gr Fg 260
Impeller	C.F 8M
Motor Body	CI IS 210 Gr Fg 260
Shaft	SS 410
Fasteners/Foundation bolt	SS 316
Lower Seal	Si Cr
Guide Rail System	CI with SS 304 Nuts, Bolts and Fasteners
Guide Pipe	SS 304
Chain with shackles	SS 304

2.11.2 Reverse Rotation

The pump shall be designed to run safely in the reverse direction of rotation due to wastewater returning through the pump. The pumps should be provided with reverse rotation trip feature for instant stoppage on long electrical connection. The mechanical seals shall be suitable for running in both directions without damage. The pumps should be provided with reverse rotation trip feature for preventing running in opposite direction in case of wrong electrical connections i.e. interchange of phase sequence.

2.11.3 Pump Construction:

1. Pump Casing

The pumps casing should be of cast iron as per IS 120 Gr FG 260.. The internal surfaces should be free of rough spots. The casing should have Centre line discharge. The finishing of the outer surface should be uniform and smooth.

2. Impeller

The material of impellers should be of Stainless Steel grade CF8M, of single/double vane, non-clog semi-open design. Additionally, a special contra-block cutting and tearing system should also be incorporated on the suction side of the pump for disposing off soft materials like plastic pouches, small jute pieces which is a very typical type of Indian sewage, and which would otherwise clog the pump.

3. Pump Shaft

The pump shaft should be hard chrome plated alloy steel (EN8). The shaft shall be of one-piece construction.

4. Pump Bearings

Pump bearings should be of the anti-friction type. The bearings should be able to take normal axial thrust loads due to unbalanced hydraulic loads on the impellers plus the weight of all rotating parts of the pump. Pump bearings shall be designed with a minimum life of 35,000 hours. The bearings should be grease lubricated for longer life and shall be maintenance free.

5. Guide Rail Assembly

The assembly should have CI pedestal, however the fasteners and foundation nuts and bolts should be of stainless steel with upper guide rail holder etc. The pedestal and bracket should provide automatic coupling between pump delivery and discharge pipe.

6. Mechanical Seals

Double mechanical seal should be provided to prevent pumped liquid entering into the motor winding. The seals should be situated in the oil chamber to ensure proper lubrication. The sensor will be used for tripping the pump and also for alarm. The face combination of lower mechanical seal should be Silicon Carbide Vs Silicon Carbide and upper seal should be Carbon Vs Chrome Steel.

Recommended Make: Burgemann**7. Moisture Sensor**

Moisture sensor or seal monitor should be provided in the oil chamber to detect the failure of the mechanical seal. The sensor should trip the pump motor in the event of ingress of moisture into the oil chamber.

8. Lifting Chain

Each pump should be provided with SS 308 lifting chain of adequate strength. One end of the chain shall be attached to the pump and the other end fixed near the upper bracket for guide rail assembly by means of SS 304 Shackle. The chain shall have SS 304 rings fixed at an interval of about 1 m for engaging the hook of the manual hoist.

A SS 304 Chain 5 m long shall be provided to hold the ring of shackles and another end shall be tied to the platform being accessible to the operator.

9. Fasteners**10. Foundation Nuts & Bolts**

All pump fasteners should be in stainless steel SS 304.
All foundation Nuts & Bolts should be in stainless steel SS 316.

11. Protective Coating

The pumps should be epoxy coated.

12. Pump Balance

All rotating parts shall be accurately machined and shall be in rotational balance. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case the amplitude of vibration as measured at any point on the pumping unit shall not exceed the limits set forth in the latest edition of Indian Standards. At the operating speed, the ratio of relative speed to the critical speed of the unit or components thereof, shall be less than 0.8 or more than 1.3.

13. Submersible Cable

Each pump shall be provided with submersible cables of equal length for power as well as control so that the pump position can be interchanged with each other. The cable shall be terminated in a weatherproof junction box, which should be located outside the main pump sump. Cable between junction box & control panel can be non-submersible type. Power

cables should be selected so as to carry at least 1.5 times the full load current at existing Power Factor of 0.8.

14. Spare Parts

Each installed pump should be supplied with one impeller duly machined, one set of mechanical seals, one set of wear rings (if applicable), and one set of O-rings and gasket, bearing set, set of fasteners.

2.11.4 Performance Tests

1. Shop Test

Each assembled pump shall be shop tested by the manufacturer to determine the following characteristic within the operating range as specified in the schedule.

- .a. Head Capacity Curve
- .b. Brake Horsepower Curve
- .c. Efficiency Curve
- .d. NPSHR Curve
- .e. Balancing (Impeller only)
- .f. Vibration (Bare pump on no load)
- .g. Total Power consumed.

All tests shall be conducted in accordance with the requirements of the latest Indian Standards. In the event of any pump failing to meet the specified test requirements, it shall be rejected. Each pump performance shall be documented by obtaining concurrent readings showing motor voltage and amperage, pump suction head and pump discharge head. Such readings shall be documented for atleast five pumping conditions. One test shall be at the shut off head. These tests shall be carried out through reputed and authorised agencies with the involvement of CMC officials. After it has been demonstrated to the satisfaction of the Engineer-in-charge that the pumping equipment complies with these specifications the Engineer-in-charge In-charge shall be furnished with the Manufacturer's Test Certificates for the following.

Hydraulic test on casing.

- . Routine test certificates on motor including HV test, Megger test, slip test, temp. rise test.
- . Material test certificates certifying the grades of the materials used.

2. Field Test

General operational check shall be carried out after installation and before commissioning.

2.11.5 Submersible Motor:

2.11.5.1 General

The motor should be an integral part of the pump. The enclosure for motor shall be IP-68. Each phase of the motors shall be provided with thermistor or Bimetallic Electromechanical Temperature Detectors. The motor winding shall be suitable for Star – Delta Starter. The motor should be designed for minimum 10 starts per hour, irrespective whether it is star-delta start or otherwise. The rating of the motor shall be designed for 20% extra power margin at duty point & 15% at the lowest head.

2.11.5.2 Scope

This specification covers the design and manufacture of squirrel cage induction motors required for wastewater treatment plant. Contents of this specification are integral part of the contract documents. For other details refer specifications for motors (wherever applicable). The motor shall operate satisfactorily at all operating levels in Sludge Sump.

2.11.5.3 References

Unless they are at variance with the clauses of this specification, the squirrel cage induction motors and their components shall comply with the applicable Indian Standards listed below. Where Indian Standards do not exist, the relevant British or German (VDE) Standards shall apply.

IS 325	Three phase induction motors
IS 1231	Dimensions of three phase, foot mounted induction motors
IS 2223	Dimensions of flange mounted AC induction motors
IS 2253	Types of construction of mounting arrangement of rotating electrical machine
IS 4691	Degrees of protection provided by enclosures for rotating electrical machinery
IS 4889	Methods of determination of efficiency of electrical machines
IS 4722	Rotating electrical machines
IS 4029	Guide for testing 3 phase induction motors

2.11.5.4 Operating Conditions

a. Ambient Conditions

Motors shall be suitable for operating satisfactorily in humid and corrosive atmospheres found in sewage treatment plants. If not scientifically mentioned therein, a maximum ambient temperature of 40 °C and an altitude not exceeding 300 meters above mean sea level, shall be taken into consideration.

b. Frequency and Voltage Fluctuations

Motors will be required for continuous, satisfactory operation at rated output under the following conditions:

- .a. At rated frequency with voltage variations of + 10% of nominal value.
- .b. At rated voltage with frequency variations of + 3% of nominal value.
- .c. With a simultaneous and combined variation in frequency and voltage of + 7.5% from the nominal values but with frequency variation not exceeding + 3%.

c. Starting

Unless otherwise specified motors shall be designed for Star Deltastarting across full line voltage. Motors shall be designed for re-start under full load after a momentary lack of voltage, with the possibility of the restored supply voltage being 100% out of phase with respect to the motor residual voltage. The minimum starting torque should be 140% of Full Load Torque, with minimum torque during running up shall be 100% of Full Load Torque and minimum starting torque shall be 200% of Full Load Torque. The submersible pump motors shall be designed for minimum 10 starts per hour.

d. Direction of Rotation

The motors shall be suitable for operating in both directions of rotation. The direction of rotation is defined as that looking towards the motor from the non-driving end.

e. Noise

The noise level shall be within the permissible limit as specified in the Indian Standard.

f. Performance

1. Starting Current For squirrel cage motors working in the voltage range of 360 V -420 V the starting current shall be limited to 6 times the full load current.
2. Torque Characteristics For motors working in the voltage range of 360 V -420 V, the minimum starting torque shall be 140% for full load torque, with minimum torque during running up 100% FLT and minimum starting torque 200% FLT.

2.11.5.5 General Requirements and Construction Details

The motor should be dry, squirrel cage type, suitable for 3 phase 415V supply, continuous duty with Class F insulation. Winding of the motor should be impregnated by resin in order to achieve required thermal withstanding capacity. Motor should have integral cable port and cable entry should be sealed. The cable must be leak-tight in respect of liquids and firmly attached to the terminal block. The motor should be designed for non-overloading characteristics. There should be thermal protection against overheating of motor winding. Motor should be sealed against entry of liquid being pumped by using two mechanical seals. The lower seal provided should have silicon carbide Vs silicon carbide face combination. Pump design should ensure that seal does not come directly in contact with liquid being pumped as well as cooling/lubrication by oil is provided. Moisture sensor of the tripping unit should be located inside the oil chamber.

A. Windings

All motors shall be provided with Class F insulation. The windings shall be so treated as to resist the action of corrosive agents as may be present in the atmosphere of sewage treatment plant and that tend to dissolve the insulation.

Windings shall be adequately braced to prevent any relative movement during operating conditions and in this respect, particular attention is drawn to the stator windings of Star – Delta squirrel cage motors. Adequate insulation shall be provided between coils of different phases, which lie together.

Star/ delta starting is required, as shown on drawings, the motors windings shall be fully insulated for delta connection.

The rotor shall be balanced to provide a low vibration level and a long life for the bearings.

B. Shaft Extension

Motors shall be provided with a single extended shaft with key way and key as per requirements.

C. Lifting Hooks

All motors shall be provided with lifting arrangement of adequate capacity.

D. Terminals, Terminal Boxes and Cable Entries

The ends of the windings shall be brought out into a terminal box. The terminals shall be of adequate size. The terminal box shall be housed in the motor housing itself. The cable entries should be sealed to prevent water seepage into the terminal box/ motor winding.

E. Phase Marking

Appropriate phase markings as per **IS 325, 1978** shall be provided inside the terminal box. The markings shall be non-removable and indelible.

F. Motor Casing

The motor enclosure shall be IP 68. The housing shall be of C.I. air-filled and water-tight. The housing shall be coated with epoxy after applying primer coating.

G. Bearing and Lubrication

Motors shall have grease-lubricated ball or roller bearings. In all cases, the bearing shall be chosen to provide a minimum operating life of 40,000 working hours. Bearing shall be adequate to absorb axial thrust. The bearing shall be maintenance free with grease fill for life.

H. Special Tools and Spanners

Each rating and frame size of motor shall be provided with 2 sets of any special tools required for dismantling and maintenance of the motor.

I. Name Plates

A nameplate as required under IS 325 shall be provided on each motor.

J. Test and Test Certificates The motor shall be tested in accordance with **IS 325 and IS 4029**. Eight copies of the test report should be submitted for approval.

K. Fasteners

All fasteners shall be SS 316

CHAPTER-V**LIST OF APPROVED MAKES FOR 5 MLD SEWAGE TREATMENT PLANT**

SL. NO.	ITEM	APPROVED MAKES
1.	Pumps	Kirloskar Brothers Limited Mather & Platt (I) Ltd. Beacon Wier Ltd. Worthington India Ltd. KSB Pumps Kishore Pumps, MBH, Johnson
2.	Motors	Kirloskar Electric Co. Ltd. Siemens India Limited Bharat Bijlee Bharat Heavy Electricals Ltd. Crompton Greaves Ltd.
3.	Gate Valves/Knife Gate Valves	Kirloskar Brothers Ltd. Indian Valve Company Jash VASS BDK
4.	Non Return Valves	Kirloskar Brothers Ltd. Indian Valve Company Intervalve BDK
5.	Sluice Gates	The Indian Valve Co. Jash Yashwant
6.	Cast Iron/DI Pipes & Fittings	The Indian Iron & Steel Company Ltd. Oriental Castings Electric Steel Castings Jindal Kejriwal Kesoram
7.	Crane	W.H. Brady & Co. Ltd. Hercules Hoists Ltd. Delta Engineering Works Sharps Engineering Pvt. Ltd. Reva Engineering Electrotechnics Avon Cranes Indef
8.	Chain Pulley Block	Reva Engg. Hercules Hoists Ltd. W.H. Brady & Co. Ltd. Indef
9.	Sump Pump Set	Kirloskar Brothers Ltd. Kishor pumps Jyoti Ltd. Flyght Grundfos

Signature of the Contractor

Signature of the secretary

10.	Dewatering Pump Set	Kirloskar Brothers Ltd. Kishore Pumps KSB Pumps
11.	Exhaust Fan	Bajaj Electricals Ltd. Crompton Greaves Ltd. ALSTOM General Electric Company Ltd.
12.	415 V Switchgear Control Gear Components/ Bus Duct	Larsen & Toubro Ltd. Siemens India Limited Voltas Ltd. English Electric Ltd. Control and Switchgear Electrical Control gear Ltd. ASPL
13.	Power Transformer	Bharat Bijlee Ltd. New Government Electric Factory Ltd. Kirloskar Electric Co. Ltd. VOLTAMP VOLTAS Ltd
14.	11KV/3.3KV Switchgear	Jyoti Ltd. New Government Electric Factory Ltd. Siemens India Limited Asian Brown Boveri ALSTOM Kirloskar Electric Ltd. Bharat Heavy Electricals Ltd. Crompton Greaves VOLTAS Ltd. L & T
15.	Lighting Fixtures	Bajaj Electrical Ltd. Crompton Greaves Ltd. Philips Wipro Ltd. Klipsal
16.	415 V Air Circuit Breaker	English Electric Ltd. Larsen & Toubro Ltd. Siemens India Ltd.
17.	Cables	Indian Cables Ltd. Fort Gloster Industries Ltd. Cable Corpn. Of India Universal Cables Indian Cable Co. Asian Cables Corporation Ltd. Gemscab Finolex Cables Ltd Delton Cables Indocab

18.	Power Capacitors	Crompton Greaves Ltd. Universal Cables Ltd. NGEF Bharat Heavy Electricals Limited. MEHER (L&T) DULATI Khatau & Junker VOLTAS Ltd.
19.	Instrument & Meters	Universal Electrics Ltd. Automatic Electric Ltd. Meco Instruments (P) Ltd. Industrial Motors (P) Ltd. Havells Pvt. Ltd. Gollica Electricals P. Ltd. Endress & Hauser Forbes Marshall Polymetron, CECO
20.	Motor Starters	Bharat Heavy Electrtricals Ltd. Perimal Engineering Ind. Enterprising Engineering Pan Asia
21.	Push Buttons and Indication lights	Larsen & Turbro Siemens Bhartiya Cutler Hammer Vaishnov
22.	Relays (for 3.3 KV 11 KV switchgear)	English Electric Ltd. ALSTOM Universal Electrics Ltd. Easun Reyrolles Relays Larsen & Turbro Asian Brown Boveri JYOTI
23.	Battery	Standard Batteries Ltd. Chloride India Ltd. Amco Batteries Ltd. Exide, Amron
24.	Voltage & Frequency Stabilizer	Applied Electronics Ltd. Jindal Electric Surya Electro Servocon Logicstat
25.	Lightening Protection Unit	National Radio & Electronics Co. Ltd.
26.	Instrument Transformers (CT's & PT's)	Mysore Electrical Industries Automatic Electric Pvt. Ltd. Kappa Electricals
27.	Vaccum Pump	Kirloskar Brothers Ltd. SLM Manek Lal Industries Ltd.
28.	Battery Charger	Uptron Powertronics (Shreetron) Statcom Automatic Electric Ltd. Chabi Kerla State Electricity Crop. APCO

29.	Fire Extinguishers	Steelage Industries Kooverji Devshi & Co. Ltd. Ltd. Vijay Fire Protection System Pvt. Ltd.
30.	Nuts & Bolts	GKW TATA or equivalent, TVS. Fit Tight
31.	Ceiling Fans	Bajaj Orient Usha Crompton
32.	Multimeter	Excrop Motwane
33.	Push Button	Siemens
34.	Flameproof/ Weather Proof / non-flame- proof	FCG BALIGA
35.	Switch / Fuses	GE Power Larsen & Tubro Ltd Siemens HPL
36.	Motors contactors	Bhartia Curtler Hammer Larsen & Tubro Ltd Siemens GE Power
37.	Bus Duct	Best & Crompton Eng. Ltd Power Gears Pvt. Ltd Control & Switchgear Zeta Switchgear
38.	Control System / Instrumentation, PLC & SCADA System	AIMIL Limited Johnson Controls (I) Pvt. Ltd Landis & Staefa (I) Pvt. Ltd TATA Honeywell Rockwell Automation GE FANUC Alstom Alan Bradely Siemens Mitsubishi
39.	Centrifuge	Humbolt Alfa Level Flottweg Guinard
40.	PCC/MCC/PLC/DB/ MLDB Panels	Advance Electro Control Vidyut Control Tricolite Larsen & Toubro Siemens Jakson Associated Electrical Bhartiya Cutler Hammer Control & Switch Gear G.E Power Chavare Engineering Spark Electro J.K. Electrical

Signature of the Contractor

Signature of the secretary

41.	Optic Fibre Cables	Delink Cords RR Cable Icon Aksh
42.	Flow Meters	Krone marshall ABB Schlumberger Endress Hauser YBL Yokogawa Magnetrol
43.	Actuator	Marsh L&T Rotork Auma
44.	DO (Dissolved Oxygen)	Orion Chemtrols Analytical Instruments Forbes Marshall Polymetron DR. Lange. Royce Endress Hauser
45.	Level Transmitter	Endress Hauser ABB Forbes Marshall Polymetron
46.	Level Switch	Endress Hauser EIP Nivo Control ABB Level Cone Magnetrol
47.	Ultra Filtration System	OVIVO, TRISEP-USA, EIMCO(EWT)
48.	Micro Processor Based Relays for Motor Protection	GE Power Rockwell L&T Simens
49.	Scrubber	Excellent engine, Pilani Enuirotec CRA
50.	Coarse & Fine Bar Screens	Jash Johnson Voltas Huber
51.	Grit Mechanism	Shivpad Voltas

52.	Air Blowers	Kay International Everest Transmission Gardner Denver
53.	Fine Bubble Air Diffusers & Pipe Grid	EDI OTT OVIVO
54.	Screw Pumps	Roto Pumps Alpha Helical Ramo Pumps Hydro Prokav
55.	Fine Screen	Jash/ EIMCO (EWT)
56.	Chlorination System	ALDOS Chloro Tech JESCO
57.	HDPE Pipes	Jain Irrigation Reliance Supreme
58.	MS / GI Pipes	Asian Jindal TATA welspun
59.	GRP / FRP Pipes	Balaji (BFRPL) Graphite
60.	Dosing Mixer	Remi Schrutek Fibre & Fibre
61.	UPS	Tata Emerson Merlin Gerin Mitsubishi

All items shall bear IS Specifications and IS Approved makes.

APPROVED LIST OF VENDORS**MECHANICAL EQUIPMENTS**

All equipments shall be IS approved and bear IS Specification.

Item Description	Approved Vendors
Pumps	WPIL, Kirloskar, Beacon, KSB, Mather & Platt, KMB, MBH, Jhonson
Gate Valves	Jash, I.V.Company, VASS, BDK, Kirloskar Bros.
Sluice Valves	Kirloskar, I.V.C., IVI,VAG
Butterfly Valves	Audco, L&T, Kirloskar, Fouress, Inter Valve, IVC,VAG
Knief Gate Valves	Jash / Vass (Dezurick) / Wag
Sampling Pumps	Tullu, Kirloskar, Crompton MBH
Air Blowers	Kay International, Swam Pneumatic, Everest
Agitators / Stirrer / Mixer	Remi, Mixrite, Schurtek, Fiber & Fiber
Air Compressor	Ingersol Rand, Kirloskar
CHLORINATORS	
Chlorinator	Pennwalt, Mettito, Chlorotech
Chlorine Pressure Gauge	WIKA, GLUCK
Chlorine Booster Pump	Grundfoss, Sumo (Japan), KSB, KBL
NRV/Diaphragm Valve	DPP, Parch
PIPES	
G.I. / M.S. Pipes	Any make bearing ISI mark
Cast Iron Pipes and Fittings	Keshrom, Kejriwal, IISCO, Electrosteel
HDPE Pipes	JISL, Supreme, Raliance
Gear Box	Radicon, Elecon
Hosting Equipment	Morris, Indef, WH Brady, Hercules.
OTHERS	
Weighing Scale	Avery, ACME, AVON, J.K. Scale
Cement	Ambuja, Ultra Tech
CRS Steel	Sail-HCR, Tiscon-CRS, Rashtriya Ispat (Vizag), Electrotherm
Paint	Asian, ICI
Glazed Tiles / Ceramic Tiles	Johnson, Somani, Bell Ceramics.

Signature of the Contractor

Signature of the secretary

ELECTRICAL / INSTRUMENT EQUIPMENTS

All equipments shall be IS approved and bear IS Specification.

Item Description	Approved Vendors
Motors	Siemens, Crompton Greaves, Kirloskar, Bharat Bijlee
Cables	CCI, Universal, RPG, KEI, Torrent, Finolex, Havells, Polycab, Ultracab
MCC Components:	
Switch gear	Siemens, L&T., Schneider, GEC-Alstom, HH Elcon, ABB, Control Switchgear
ACB	Siemens, L&T., Schneider, GEC-Alstom, ABB,
H.R.C. Fuses	Siemens, L&T, B.L., E.E., GEC-Alstom, Schneider
Contactor	Siemens, L&T, Schneider, ABB, BCH, Telemechanique.
Timer	Siemens, L&T, BCH
Relays	Siemens, L&T, BCH, ABB, Schneider, GEC Alstom, Ray rolle, Easun
Meters Static	A.E., I.M.P., Meco, L&T, Rishline
Selector Switch	Jyoti, Kaycee, Salzer, Siemens
C. T. (Cast Resin)	Kappa, Jyoti, ABB, Silkana, Gilbert, Ashmor, Precise.
Push button Station	Pushtron (Shrenik) with Components of Siemens, L&T, BCH, Technik,
Indicating Lamp	AEP, IMP, Vaishno, L&T, GEC, Siemens, RAAS Control, Binay, Teknik
Cable Jointing Kit	Raychem, Mseal, Denson
MCB	MDS, EE, Neptune, Versatrip, Sicke, Siemens, L&T, Indokopp, MG
KWH Meter Static	Simco, Jaipur Meter, GEC, BEC, IMP
LIGHTING Materials	
Wire and Accessories (I.S.I. Marked)	Finolex, Universal, Incab, Anchor, Havell's, RR cabel, Ravin, KEI.
Switch & Plugs	Philips, Anchor, Jainex or ISI mark to be got approved prior to supply
Fittings: (Indoor & outdoor luminaires)	Philips, Crompton, Bajaj.
Ballast	Philips, GE, Crompton Greaves, Bajaj, Asian Electronics, Opal
Fluorescent Lamp	Osram, Philips, GE.
Lamps CFL	Philips, GE, Osram
Control Panel	CPRI Approved (To be got approved prior to supply)
Electric Actuator	Auma, Marsh, Rotork

INSTRUMENTATION

Item Description	Approved Vendors
Ultrasonic Type Level / Diff. Level / LOH & ROF / Open Channel Flow Transmitter	ABB, E+H, Krohne, Siemens
Electro Magnetic Flow Meter (Insertion type)	ABB, E+H, Yokogawa
Ultrasonic Portable flow meters (For Pipe Line)	Siemens, E + H, Yokogawa
Differential Pressure / Pressure / Temperature Transmitter	ABB, Emerson, Honeywell, Siemens, Yokogawa
Pressure Switch	Dag Process Instruments, Danfos, Indfos, Orion, Switzer
Float Level Switch	Nivelco, P+F, Punetechtrol
Electric Actuators	Auma, Marsh, Rotork
Solenoid Operated Valve	Asco, Janatics, Rotex, Schrader
Air Filter Regulator	ABB, Divya, Janatics, Placka, Shavo Norgren
Limit Switches	Tata Honeywell, Siemens, BCH
Programmable Logic Controller (PLC) System	ABB, Honeywell, Rockwell (Allen Bradeley), Schneider, Siemens
LT / Instrument Power & Control Cables / Signal (Analog) Cables	CCI, Finolex, Fort Gloster, Havells, Torrent, Universal, Associated Cables, Associated Flexibles & Wires, Brooks Cables, Delton, Havells, Uday Pyro
Alarm Annunciator	Aplab Ltd., Minilec, IIC, equi. reputed
Instrument Valves and Manifolds, Tube Fittings, Pneum. Brass Fittings	Excel Hydropneumatic, Industrial Enterprise, Festo, Multimetal Industries, Placka, SMC, Technomatic, Janatics
Indication Pilot Lamps (LED Type)	Teknic, Schneider, Siemens, equi. reputed
Push Button/ Selector Switch (with NO/NC Element)	Teknic, Schneider, Siemens, equi. reputed
Receiver Indicators (Panel Mounted)	ABB, Masibus, Nivam, Nishko, Electronet
Reocorder	ABB, Honeywell, Yokogawa
Jar Test, Autoclave, Laboratory oven, Bacteriological Incubator, Water Still	Hach, Orbit, Lab Hosp, ASI

Signature of the Contractor

Signature of the secretary

- Note:** 1. Incase of any material not mentioned in above list and required for the execution of work, prior approval is required before using this material for the job.
- 2 Incase of more than one make out of above vender list is suggested by the bidder the selection of brand will be rest with the GUJARAT HIRA BOURSE.

GENERAL MANAGER (TECH. & ADMN.)
GUJARAT HIRA BOURSE
SURAT

SIGNATURE AND SEAL OF TENDERER

NAME :

ADDRESS :-

DATE :-

CHAPTER-VI

OPERATION & MAINTENANCE WORKS FOR 5 MLD SEWAGE TREATMENT PLANT

a) 1.1 Scope of Work

The Contractor shall operate, maintain and monitor the performance of 5 MLD Sewage Treatment Plant (STP) at Gem & Jewellery Park. The scope of work is given below but not limited to the following. This may include other incidental items of work connected with the regular operation of plant as decided by Engineer in Charge from time to time. Operation and Maintenance period includes stabilization period (1 month or more as the case may be) and operation & maintenance of 60 months.

- 1.1.1 The Contractor shall ensure proper running of the plant to give the desired effluent standards. The Contractor shall also be responsible for overall maintenance of the plant i.e. Civil, Electrical and Mechanical. The Contractor shall also be responsible for all repairs of Equipments/Machinery.
- 1.1.2 The Contractor shall monitor the quality of influent and effluent. The Contractor shall take adequate action to ensure smooth and satisfactory performance/running of the plant.
- 1.1.3 The Contractor shall prepare and implement an effective Plant Maintenance Programme in consultation with Engineer in Charge. It shall be absolutely Contractor's responsibility to look after all sorts of maintenance whether preventive or break down. The Contractor shall maintain the operational activity record as prescribed hereunder.
- 1.1.4 The Contractor shall be responsible for keeping updated record of documents including History Card for Equipments and maintaining every day Log Book relating to running of Machinery, consumption of energy, fuel and other consumables etc. and various analysis performed. The Contractor shall record and maintain the Operation and Maintenance data to be decided by Engineer in Charge, in consultation with the Contractor:
- 1.1.5 The Contractor shall be responsible to carry out day to day as well as periodic maintenance necessary to ensure smooth and efficient performance/running of all Equipment/Instruments installed at the Sewage Treatment Plant. The Contractor shall hand over the Machinery & Site to the Department after expiry of the Contract period in good running condition.
- 1.1.6 He shall be responsible for proper maintenance of all the Pumps, Screens, Blowers, Decaners, Centrifuge and all other allied items including Electrical & Instrumentation Works.
- 1.1.7 Round the Clock watch and ward of the entire premises including Plant/Machinery etc. shall also be the responsibility of the Contractor.
- 1.1.8 The entire STP premises shall be kept neat and clean.
- 1.1.9 The records maintained by the Contractor shall be produced periodically to the Engineer in Charge for proper monitoring as desired by him.

- 1.1.10 All necessary transports shall be arranged and made by the Developer at his own costs including transport vehicles required for safe disposal of screening material, grit, sludge etc. The sludge handling and transportation is not in the scope of bidder.

1.2 General Terms and Conditions

- 1.2.1 The chemicals like chlorine, polyelectrolyte, Caustic, Acid solution and reagents shall be arranged by the Developer from his own sources. The Contractor shall employ its own Staff for testing purpose. However, the Developer shall be at liberty to get random sampling & testing done on its own or from any other Agency to the entire satisfaction of Engineer in Charge. In case of testing from other Agency, charges will be borne by Developer.
- 1.2.2 Plant and Equipments covered under this Contract shall be totally attended to by the Contractor including any "Trouble Shooting" to ensure smooth and trouble free operation.
- 1.2.3 For effective maintenance of STP, the Contractor shall employ sufficient Staff with proper qualification. For his guidance, the pattern and number of minimum Staff to be engaged is described in this Chapter.
- 1.2.4 The maintenance period shall be 60 months from the date of complete stabilization of sewage treatment plant.
- 1.2.5 The Contractor shall take operational measures that there shall be no flooding of STP area except HFL in case of heavy monsoon.
- 1.2.6 The Contractor shall abide by all Central/State Govt./Semi Govt./Local Bodies Rules & Regulations pertaining to this Contract without any extra cost.
- 1.2.7 In the event of any damage/loss of life/theft of property due to negligence on the part of Contractor, the Contractor shall be solely responsible and liable for compensation and damages. Regarding negligence and compensation, the decision of Engineer in Charge shall be final.
- 1.2.8 The site shall be open for inspection by the designated Officers/Officials of the developer at all times during the Contract period.
- 1.2.9 The Staff employed shall be provided with all the required Safety Equipments. It shall be ensured that full safety measures are taken by the Staff on duty. Staff employed shall be experienced and trained to handle the respective Job/Equipment.
- 1.2.10 The specification of material used for repair shall be the one used in original work. If not used during execution, specifications of material shall be got approved by the Department prior to commencement of O&M period and must be incorporated in the O & M Manual.
- 1.2.11 All Spare Parts used for the Equipment must be from the Manufacturer of the Equipment or if the Equipment itself has been made with parts of the other Manufacturer then the parts must be of the same Make as used in the Equipment supplied and installed. The Contractor shall maintain sufficient stock of Spares depending upon the importance factor of particular Spare in operation of the plant and time required for purchasing / arranging the Spare.
- 1.2.12 The O & M Manual must be updated periodically for incorporating procedure of maintenance of repairs and breakdowns not incorporated in the earlier O & M Manual.

- 1.2.13 Frequency of spares used in maintenance of electrical, mechanical Equipments must be recorded for updating the contents of manual.
- 1.2.14 Record of troubleshooting points and details of events causing trouble must be maintained and used for updating the contents of manual.
- 1.2.15 The preventive maintenance shall be made according to the Preventive Maintenance Schedule of the plant. Short term Specialists of the Contractor for special maintenance tasks may reinforce the regular Staff. The operation, maintenance and repairs shall be made with the help of the Equipments and Tools available at the plant, backed up and completed with the facilities of the Contractor brought to the plant by him temporarily for a special maintenance.

1.3 FINANCIAL TERMS AND CONDITIONS

- 1.3.1 During Operation and Maintenance, Water and Electricity charges shall be borne by the Developer. Diesel charges (if any) shall be reimbursed by the Developer to the Contractor on submission of detailed documents showing the actual consumption. The reimbursement rate will be as per actual Purchase Bills. However, the Department shall be at liberty to arrange supply of Diesel to the Contractor for consumption at STP
- 1.3.2 The Operation & Maintenance Cost approved by the Department shall be payable on monthly basis on completion of every month on submission of Bill by the Contractor. The Contractor shall maintain the attendance record of the Staff employed by him which can be checked by the Department any time. The Contractor shall also submit copy of all the Data Sheets every month for evaluation.
- 1.3.3 All sorts of Tools & Plant required for proper operation & maintenance of the plant shall be arranged by the Contractor at his own cost.

2.0 Operation and Maintenance Activities

- 1. All Civil Works shall be checked regularly and repaired as and when required.
- 2. Overflowing of various units shall be checked regularly.
- 3. It shall be checked daily that all the units/ Equipments are operational.
- 4. Disposal of Screening, Grit, Sludge and any other waste shall be done to the earmarked dumping site.
- 5. It shall be checked regularly that all Sluice Valve and Gates are functioning properly.
- 6. All pipes and bends shall be checked regularly for chokage and cleaned if required.
- 7. Lubrication of all the moving parts of Equipments as per instructions of Manufacturer or earlier if required shall be done.
- 8. Greasing of Equipment regularly as per instructions of Manufacture or earlier if required shall be done.
- 9. All Equipments shall be cleaned and repaired regularly.
- 10. Electric connections shall be checked/repared regularly.

(1) Following staff is required to be employed by the contractor: -

Post	Nos.	Min. Qualification	Experience
Plant-In-Charge	01	M.Sc.[Chemistry/ Environment]	Min. 2 Year(s)
Electrician	01	I.T.I. in Electrician Trade	Min.2 Year(s)
Fitter	01	I.T.I. in Fitter Trade	Min 2 Year(s)
Plant operator experience	03	10th Pass	Operating
Helper	03	VIII pass	A person with sound health, skill and hard Working attitude.

- Relaxation in qualification and number of staff shall not be allowed. The above staff shall be distributed in three shifts as per mutual agreement between Contractor and M/s.Gujarat Hira Bourse.
- As per agreement the No. of staff in each shift should always remain, present otherwise penalty towards absence of any staff shall be levied and recovered from the Contractor.
- The contractor shall make the arrangement of reliever for weekly off/Holiday etc.. Absence on any ground like weekly off or Holiday shall not be considered.
- The presence of staff in each shift should be marked in muster (to be brought by the contractor) to be maintained at office of shift in charge at Water Works, which shall be considered as final. The contractor's staff must mark their presence in this muster only. The contractor may maintain a separate register for his own purpose.
- Please note that computer system is to be operated and maintained by the contractor's staff and therefore it is in the interest of the contractor to employ plant in charge/ shift chemist who is proficient in the computer operating system.
- The above staff for one day i.e. 24 hours & 365 days is required for normal operation & maintenance. The contractor has to call respective Maintenance Engineer for rectification of fault at any time of the day, during contract period.
- Relaxation in qualification and number of staff shall not be allowed under normal circumstance. The above staff shall be distributed in three shifts as per normal agreement between contractor & M/s.Gujarat Hira Bourse. Contractors shall make the arrangement of reliever for off/ holidays etc.

(2) The staff of contractor will always remain in contact with the Engineer in-charge/ Electrical Supervisor In charge/ Chemist of the shift at Water Works of M/s.Gujarat Hira Bourse and follow their instructions.

Signature of the Contractor

Signature of the secretary

- (3) Unsatisfactory and inefficient running of the plant, supported by the reason(s) that are under control of contractor will be highly objected. In such case(s) Competent Authority decision will be final and binding to the Contractor.
- (4) Contractor will comply with all statutory rule(s) and regulation(s) and all inter-disciplinary measure(s) as followed by M/s.Gujarat Hira Bourse.
- (5) M/s.Gujarat Hira Bourse will not be responsible for any accident/ injury to the staff of the contractor. Further, M/s.Gujarat Hira Bourse will not provide any insurance or medical facility to the staff of contractor.

Repairs and Maintenance Schedules

1. Treatment Plant Complex:

As per indicated period checking the operation, correcting defects, attending to calibration and setting is required attending to minor repairs and proper up-keeping) such as cleaning and painting) required for the following :

i. Monthly

- Roof and surroundings and
- Lightning arrestors.

ii. Annual

- Leakages in structures
- Ladders
- Railings
- Structural damages to the wet and dry well and
- Overflow drain.

2. Pumping Machinery and Treatment Plant Equipment:

As per indicated period checking the operation, correcting defects attending to calibration and setting is required attending to minor repairs and proper up-keeping) such as cleaning and painting) required for the following:

i. Daily

- Screens/ Grit Channels
- Moving parts of screens and grit removal equipment, Blowers /Agitators / Pumps/ Agitators /Return Sludge pumps/ Chemical mixer/Centrifuge/Decanter
- Stuffing box
- Bearing and
- Vibration, balancing on Decanter, chemical dosing and mixing, Motors
- Contact tightness
- Cable insulation near the lugs.
- Panels Breaker and Starter
- Contacts of relay and circuit breaker and
- Setting of over-current relay, no-volt coil and tripping mechanism and off in the dash pot relay.
- Transformer Sub-station
- Ground Operated Dis-connectors (GOD)

- Contacts of GOD and of Over Current (OC) relays
- Radiators and
- Earth pit

ii. Monthly

- Screens and Grit channels
- Chains in mechanically operated components
- Screens performance
- Transformer
- Oil in transformer
- Relay alarm circuit
- Load (Amperes) and
- Voltage

iii. Quarterly

- Transformer
- Bushing and
- Dehydrating breathers

iv. Half -Yearly

- Pumps / Blowers /Agitators / Compressor /Decanters/Centrifuge
- Gland of stuffing box
- Gland bolts
- Gland packing
- Alignment of pump aerator and drive and
- Oil lubricated bearings
- Motors
- Tripping elements for motor protection
- Contact points and
- Fuse ratings

v. Annual

- Paint screens, grit removal mechanism, scrapers, scrapers , motors, pipes,
- Valves, fittings agitators and inlet/outlet weirs with two coats of anticorrosive paints.
- Replace worn out parts of mechanical equipment in sewage pumping station and sewage treatment plant.

3. Buildings and Civil Structures:

Carry out routine maintenance and minor repairs including cleaning, repairs to plaster, doors, windows and painting.

i. Daily

- Sweep the premises
- Clean the floors and parts inside the building
- Clear the cobwebs and other biological growth
- Maintenance of horticulture
- Disposal and transportation of dewatered sludge

ii. Half - Yearly

- Repair damaged floor, plaster, roof, leakages and
- Repair damaged doors, windows and other fixtures

SCHEDULE – I

EQUIPMENT SPECIFICATIONS (BASE OFFER)

DATASHEET FOR PROCESS EQUIPMENTS

Sr. No.	Units	Details
I	General & Process	
	Average flow (MLD)	
	Peak factor	
	Peak flow (MLD)	
	Raw sewage BOD5 at 20 °C (mg/l)	
	Raw sewage TSS (mg/l)	
	Treated sewage BOD (mg/l)	
	Treated sewage TSS (mg/l)	
2	Total head loss in STP (from Stilling Chamber of STP to Chlorine Contact Tank) (m)	
3	Total land area proposed for STP (ha)	
II	Sewage Treatment Plant	
(a)	Stilling Chamber	
1	Design peak flow (MLD)	
2	No of units (No.)	
3	Hydraulic retention time (sec)	
4	Liquid depth (m)	
5	Length (m)	
6	Width (m)	
7	Top Water level (m)	

Signature of the Contractor

Signature of the secretary

(b)	Fine Screen Channel	
1	Design peak flow (MLD)	
2	No of units (Working + Standby)	
3	Clear spacing through bars (mm)	
4	Liquid depth (m)	
5	Width of channel (m)	
6	Length of channel (m)	
7	Upstream water level (m)	
8	Downstream water level (m)	
9	Head loss (mm)	
(c)	Grit Chamber	
1	Design peak flow (MLD)	
2	No of units (No.)	
3	Particle size to be removed (mm)	
4	Specific gravity	
5	Efficiency of removal (%)	
6	Surface overflow rate (m ³ /m ² /day)	
7	Top Water level (m)	
(d)	Cyclic Activated Sludge/SBR Process	
1	Inlet BOD (mg/l)	
2	Inlet SS (mg/l)	
3	BOD removal efficiency (%)	
4	SS removal efficiency (%)	
5	Outlet BOD (mg/l)	
6	Outlet SS (mg/l)	
7	F/M ratio	
8	MLSS (mg/l)	
9	MLVSS / MLSS	
10	SRT (days)	

Signature of the Contractor

Signature of the secretary

11	No. of basins (No.)	
12	Hydraulic retention time (hrs.)	
13	Details of basins	
	Side water depth (m)	
	Length (m)	
	Width (m)	
	Free board (m)	
	Volume of each basin (m3)	
	Total Volume (m3)	
14	Oxygen uptake rate (OUR) control provided (Yes/No)	
	Diffusers	
1	Type of diffuser	
2	Make	
3	Material of diffuser	
4	Dia. and length of each diffuser	
5	Air flow through each diffuser (Nm3/hr)	
6	Total no of diffusers (Nos.)	
	Air Blowers	
1	Type of air blower	
2	Make	
3	No of working blowers (No.)	
4	No of stand by blowers (No.)	
5	Capacity of blower (Nm3/hr)	
6	Head of blower (Kg/cm2)	
7	Motor rating (HP)	
8	No. of blowers with VFD operation (No.)	

Signature of the Contractor

Signature of the secretary

	Decanting Mechanism	
1	Decanting rate of treated sewage (m ³ /hr)	
2	Type	
3	Speed	
4	Decanting capacity of each decanter (MLD)	
5	No. of decanters per basin (No.)	
6	Operating hrs. of each decanter (hrs)	
7	Motor Rating (HP)	
8	No. of decanters with VFD operation (No.)	
9	Material of construction	
	Return Activated Sludge Pumps	
1	Type of pump	
2	Make	
3	No of working pumps (No.)	
4	No of standby pumps (No.)	
5	Capacity of pump (m ³ /hr)	
6	Head of pump (MWC)	
7	Motor rating (HP)	
8	Material of construction	
	Excess/Surplus Activated Sludge Pumps	
1	Type of pump	
2	Make	
3	No of working pumps (No.)	
4	No of standby pumps (No.)	
5	Capacity of pump (m ³ /hr)	
6	Head of pump (MWC)	
7	Motor rating (HP)	
8	Material of construction	

Signature of the Contractor

Signature of the secretary

(e)	Chlorination System	
	Chlorine Contact Tank	
1	Design flow (m ³ /hr)	
2	Hydraulic retention time (minutes)	
3	Liquid depth (m)	
4	Length (m)	
5	Width (m)	
6	Top Water level (m)	
5	Number of baffles (Nos.)	
(f)	Treated Sewage Disposal	
1	Flow (m ³ /hr)	
2	Size of treated sewage disposal pipe/Channel (m)	
3	Length of treated sewage disposal pipe/Channel (m)	
(g)	Sludge Dewatering System	
	Sludge Sump	
1	Sludge flow (m ³ /hr)	
2	Holding time in Sludge Sump (hrs.)	
3	Liquid depth (m)	
4	Length (m)	
5	Width (m)	
6	Top Water level (m)	
7	Type of air grid	
8	MOC of air grid	
9	Air mixing rate provided (m ³ /hr/m ³ of liquid volume)	
	Centrifuge Feed Pumps	
1	Type of pump	
2	Make	
3	No of working pumps (No.)	

Signature of the Contractor

Signature of the secretary

4	No of standby pumps (No.)	
5	Capacity of pump (m3/hr)	
6	Head of pump (MWC)	
7	Motor rating (HP)	
8	Material of construction	
1	Type of pump	
	Centrifuge	
1	Capacity (m3/hr)	
2	Type	
3	Feed sludge consistency (%)	
4	Dewatered sludge consistency (%)	
5	Quantity (Working + Standby)	
6	Material of Construction	
	Body	
7	Motor rating (HP)	

SCHEDULE – II

EQUIPMENT SPECIFICATIONS (ALTERNATIVE OFFER)

 Signature of the Contractor

 Signature of the secretary

DATASHEET FOR PROCESS EQUIPMENTS

Sr. No.	Units	Details
I	General & Process	
	Average flow (MLD)	
	Peak factor	
	Peak flow (MLD)	
	Raw sewage BOD5 at 20 °C (mg/l)	
	Raw sewage TSS (mg/l)	
	Treated sewage BOD (mg/l)	
	Treated sewage TSS (mg/l)	
2	Total head loss in STP (from Stilling Chamber of STP to Chlorine Contact Tank) (m)	
3	Total land area proposed for STP (ha)	
II	Sewage Treatment Plant	
(a)	Stilling Chamber	
1	Design peak flow (MLD)	
2	No of units (No.)	
3	Hydraulic retention time (sec)	
4	Liquid depth (m)	
5	Length (m)	
6	Width (m)	
7	Top Water level (m)	
(b)	Fine Screen Channel	
1	Design peak flow (MLD)	

Signature of the Contractor

Signature of the secretary

2	No of units (Working + Standby)	
3	Clear spacing through bars (mm)	
4	Liquid depth (m)	
5	Width of channel (m)	
6	Length of channel (m)	
7	Upstream water level (m)	
8	Downstream water level (m)	
9	Head loss (mm)	
(c)	Grit Chamber	
1	Design peak flow (MLD)	
2	No of units (No.)	
3	Particle size to be removed (mm)	
4	Specific gravity	
5	Efficiency of removal (%)	
9	Surface overflow rate (m ³ /m ² /day)	
10	Top Water level (m)	
(d)	Submerged MBR Process	
1	Inlet BOD (mg/l)	
2	Inlet SS (mg/l)	
3	BOD removal efficiency (%)	
4	SS removal efficiency (%)	
5	Outlet BOD (mg/l)	
6	Outlet SS (mg/l)	
7	Plant F/M ratio	
8	MBR MLSS (mg/l)	
9	MLVSS / MLSS	
10	SRT (days)	
11	No. of submerged MBR basins (No.)	
12	No. of pre-aeration basins (No.)	
13	Plant Hydraulic retention time (hrs.)	

Signature of the Contractor

Signature of the secretary

14	Details of submerged MBR basins	
	Side water depth (m)	
	Length (m)	
	Width (m)	
	Free board (m)	
	Volume of each basin (m3)	
	Total Volume (m3)	
15	Details of pre-aeration basins	
	Side water depth (m)	
	Length (m)	
	Width (m)	
	Free board (m)	
	Volume of each basin (m3)	
	Total Volume (m3)	
16	Recycle ratio between Pre-aeration and MBR (*Q)	
	Submerged MBR units	
	Type of Submerged Membrane (Flat-sheet or Hollow	
	Submerged Membrane type (MF Or UF)	
	Mean Pore Size (um)	
	Material of construction of membrane	
	Material of Module Frame	
	Normal Operating Suction Pressure	
	CIP Frequency (Maintenance/ Recovery Cleaning)	
	Recovery of permeate through MBR System (%)	
	Flow Direction	
	Average Net Flux (Rate) (m3/m2/day)	
	Peak flow factor	
	Guaranteed Mechanical Warranty for Membranes	
	Submerged MBR Supplier (GE/Siemens/ Ovivo-GLV	
	MOC of in-basin Piping	
	MOC of Frames	

Signature of the Contractor

Signature of the secretary

	Fine Bubble Diffusers for pre-aeration basins	
	Type of diffuser	
	Make	
	Material of diffuser	
	Width (or Dia.) and length of each diffuser	
	Air flow through each diffuser (Nm ³ /hr)	
	Total no of diffusers (Nos.)	
	Submerged MBR Air Blowers	
	Type of air blower	
	Make	
	No of working blowers (No.)	
	No of stand by blowers (No.)	
	Capacity of blower (Nm ³ /hr)	
	Head of blower (Kg/cm ²)	
	Motor rating (HP)	
	Pre-aeration Air Blowers	
	Type of air blower	
	Make	
	No of working blowers (No.)	
	No of stand by blowers (No.)	
	Capacity of blower (Nm ³ /hr)	
	Head of blower (Kg/cm ²)	
	Motor rating (HP)	
	No. of blowers with VFD operation (No.)	
	Return Activated Sludge Pumps	
	Type of pump	
	Make	
	No of working pumps (No.)	
	No of standby pumps (No.)	
	Capacity of pump (m ³ /hr)	

Signature of the Contractor

Signature of the secretary

	Head of pump (MWC)	
	Motor rating (HP)	
	Excess/Surplus Activated Sludge Pumps	
	Type of pump	
	Make	
	No of working pumps (No.)	
	No of standby pumps (No.)	
	Capacity of pump (m3/hr)	
	Head of pump (MWC)	
	Motor rating (HP)	
	Submerged MBR Permeate Pumps	
	Type of pump	
	Make	
	No of working pumps (No.)	
	No of standby pumps (No.)	
	Capacity of pump (m3/hr)	
	Head of pump (MWC)	
	Motor rating (HP)	
	Fine Screens	
	Type of Screen	
	Make	
	No of working Screens (No.)	
	No of standby Screens (No.)	
	Capacity of Screen (m3/hr)	
	Bar Screen Opening (mm)	
	Material of construction (Bars/Rakes)	
	Concrete Channel Dimensions for each (LxWxH, mm)	
(e)	Chlorination System	
	Chlorine Contact Tank	

Signature of the Contractor

Signature of the secretary

	Design flow (m ³ /hr)	
	Hydraulic retention time (minutes)	
	Liquid depth (m)	
	Length (m)	
	Width (m)	
	Top Water level (m)	
	Number of baffles (Nos.)	
(f)	Treated Sewage Disposal	
1	Flow (m ³ /hr)	
2	Size of treated sewage disposal pipe/Channel (m)	
3	Length of treated sewage disposal pipe/Channel (m)	
(g)	Sludge Dewatering System	
	Sludge Sump	
1	Sludge flow (m ³ /hr)	
2	Holding time in Sludge Sump (hrs.)	
3	Liquid depth (m)	
4	Length (m)	
5	Width (m)	
6	Top Water level (m)	
7	Type of air grid	
8	MOC of air grid	
9	Air mixing rate provided (m ³ /hr/m ³ of liquid volume)	
	Centrifuge Feed Pumps	
1	Type of pump	
2	Make	
3	No of working pumps (No.)	
4	No of standby pumps (No.)	
5	Capacity of pump (m ³ /hr)	
6	Head of pump (MWC)	
7	Motor rating (HP)	
8	Material of construction	

Signature of the Contractor

Signature of the secretary

1	Type of pump	
	Centrifuge	
1	Capacity (m ³ /hr)	
2	Type	
3	Feed sludge consistency (%)	
4	Dewatered sludge consistency (%)	
5	Quantity (Working + Standby)	
6	Material of Construction	
	Body	
7	Motor rating (HP)	

Signature of the Contractor

Signature of the secretary

SCHEDULE LIST TO BE SUBMITTED WITH THE TENDER**SCHEDULE-1**

Equipment Specifications

Bidder to quote in detailed with flow chart and operational chart.

Sr. No.	Unit (s)	Details
---------	----------	---------

SCHEDULE-2

Pipe Line Schedule

The bidder to fill in the following pipeline schedule.

Sr. No.	From	To	Flow Cum/s	Size (mm)	MOC
---------	------	----	------------	-----------	-----

SCHEDULE-3

Valve Schedule

Sr. No.	Location	Type	Size	MOC
---------	----------	------	------	-----

SCHEDULE-4

Electrical Load Calculations

The following schedule to be filled in by the Bidder for all drives. The power consumption evaluation shall be done for 5 MLD average flow only.

Sr. No.	Equipment	KW Installed	No. of Drives W S T	BKW Including Motor efficiency	Hrs/day	KWH per day
Total						

SCHEDULE-5

Chemical Schedule

Sr. No.	Chemical	Flow	Unit	Dosage	Unit	Quantity kg/day
---------	----------	------	------	--------	------	--------------------

SCHEDULE-6

PLC- SCADA

Sr. No.	Equipment	Rating	Details
---------	-----------	--------	---------

Signature of the Contractor

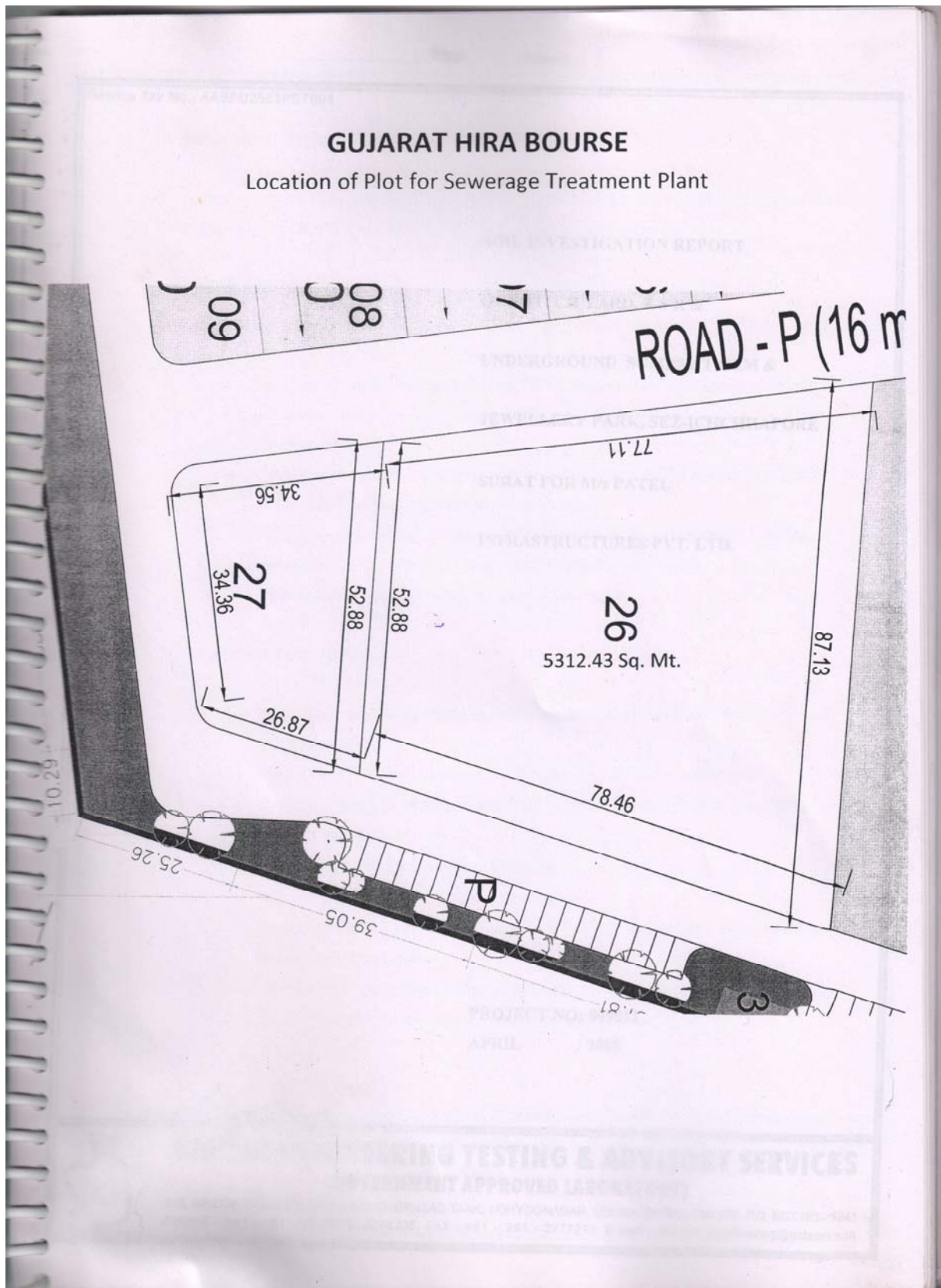
Signature of the secretary

SCHEDULE -7

MEMBRANE REPLACEMENT PER YEAR

Signature of the Contractor

Signature of the secretary



Signature of the Contractor

Signature of the secretary

Service Tax No.: AABFU2563PST001

INTRODUCTION:

Authority of M/s Patel Infrastructures Pvt. Ltd. authorized the work of soil investigation for their project of Gem & Jewellery Park.

SOIL INVESTIGATION REPORT

FIELD TESTS:

OF SWITCH YARD, E S R &

UNDERGROUND SUMPS AT GEM &

JEWELLERY PARK, SEZ-ICHCHHAPORE

SURAT FOR M/s PATEL

INFRASTRUCTURES PVT. LTD.

LABORATORY TESTS:

• Moisture content & unconfined compression test on selected samples of standard specimens.

• Field Density, Moisture content and Dry Density of undisturbed samples.

• Consolidation Analysis of SVT samples, UFI samples and disturbed samples (only if soil is soft).

• Atterberg's Limit for samples as per above.

• Specific Gravity Test for Undisturbed samples.

• Swellage Limit / Free Swell Test / Differential Swell test for selected samples.

• Index to be separate soil.

• Test for shear properties of selected samples.

PROJECT NO: 809011

APRIL : 2008

UNIQUE ENGINEERING TESTING & ADVISORY SERVICES
(GOVERNMENT APPROVED LABORATORY)

216, BRIDGE ROAD 6 F, OPP. LAST OVERHEAD TANK, UDHYOGNAGAR, UDHNA, SURAT -394 210. P.O. BOX NO.-1241
PHONE : +91 - 261 - 2278310, 2278205, FAX : +91 - 261 - 2277213. E-mail : unique_engineering@dataone.in

Signature of the Contractor

Signature of the secretary

Service Tax No.: AABFU2563PST001

INTRODUCTION:

Authority of M/s Patel Infrastructures Pvt. Ltd. entrusted the work of soil investigation for their project of Gem & jewellery Park at Ichchhapore – Surat.

FIELD TESTS:

- Drilling 03 nos. of 150 mm dia. bore hole with casing whenever required up to maximum depth of 10.0 M from ground level.
- Carry out Standard penetration Test (SPT) at every 2.0 M interval alternate to undisturbed sampling or continuous SPT at 1.0 M depending on cohesive & non-cohesive formation.
- Collecting disturbed soil sample at every meter interval or as per the stratification of soil and recording depth at which soil changes.
- Collecting undisturbed samples (UDS) at 2.0 M interval alternate to S P Test or continuous UD Sample at 1.0 M interval if subsoil is cohesive.
- Observation of ground water table using drilled holes.

LABORATORY TEST:

- Water content & unconfined compression test on selected samples of standard penetration test.
- Field Density, Moisture content and Dry Density of undisturbed samples.
- Grain size Analysis of SPT samples, UD samples and disturbed samples covering each soil strata.
- Atterburg's Limit for samples as per above.
- Specific gravity Test for Undisturbed samples.
- Shrinkage Limit / Free Swell Test / Differential Swell test for selected samples judged to be expansive soil.
- Test for shear properties of selected samples.
 - a) Unconfined compressive Strength on saturated cohesive soils.



UNIQUE ENGINEERING TESTING & ADVISORY SERVICES (GOVERNMENT APPROVED LABORATORY)

216, BRIDGE ROAD 6 F, OPP. LAST OVERHEAD TANK, UDHYOGNAGAR, UDHNA, SURAT -394 210. P.O. BOX NO.-1241
PHONE : +91 - 261 - 2278310, 2278205. FAX : +91 - 261 - 2277213. E-mail : unique_engineering@dataone.in

Service Tax No.: AABFU2563PST001

- b) Triaxial Shear Test under UU / CU condition with or without Pore pressure measurement as per in situ conditions. Normally Soft cohesive saturated samples will be consolidated at average Overburden pressure.

DRILLING:

Drilling of 150 mm ϕ borehole is carried out by shell and Auger method above water table. Water is added while drilling but stopped at enough height above the U D sampling or S P Test levels to avoid disturbance.

Drilling below water table is made by percussion method. Casing is required to be lowered if the boreholes do not retain its shape. Care is taken that ground water level is maintained during the drilling and particularly before testing or sampling levels. In no case casing is allowed to advance below the bottom of borehole. Chiseling is carried out if required while drilling.

Drilling of 150 mm ϕ borehole is carried out by rotary drilling machine. Bentonite slurry is used as fluid. Care is taken before conducting S P Test or Collecting U D Samples that the bore is cleaned properly.

The location of exploration is as per the sketch.

STANDARD PENETRATION TEST:

The Standard Penetration Tests are carried out as per I. S. 2131: 1981. In general the tests are conducted at 2.0 M interval alternate to the undisturbed sampling or as dictated by soil strata existing.

Before testing, the borehole is cleaned properly and Split Spoon Sampler is centrally seated in borehole. In case of SPT to be conducted below water table care is taken that casing position is above the borehole depth. The water level in borehole is maintained above or at least at the water table.

A standard hammer of 63.5 Kg. is dropped from a height of 75 cms. and the no. of blows for penetration of Split Spoon Sampler for 0-15, 15-30 and 30-45 cms. are noted in Table - 3. Standard Penetration Test value N_s is considered for 15-45 cms. penetration values. Sample for moisture content is collected in moisture cans. For non-plastic silts and



UNIQUE ENGINEERING TESTING & ADVISORY SERVICES (GOVERNMENT APPROVED LABORATORY)

216, BRIDGE ROAD 6 F, OPP. LAST OVERHEAD TANK, UDHYOGNAGAR, UDHNA, SURAT -394 210. P.O. BOX NO.-1241
PHONE : +91 - 261 - 2278310, 2278205. FAX : +91 - 261 - 2277213. E-mail : unique_engineering@dataone.in

Service Tax No.: AABFU2563PST001

fine Sands N_s value is corrected for effective overburden pressure and dilatancy Correction is added for tests conducted below water table Results are shown in Table – 3.

DISTURBED AND UNDISTURBED SAMPLES:

Disturbed samples from shell or from Split Spoon Sampler is collected in polythene bags with proper levels such that we shall get the data of 0.5 Mt. interval or change in strata.

Undisturbed samples in 38 mm ϕ Shelby tubes are Collected alternate to Standard Penetration Test at 2.0 Mt. interval. The sampling tube is connected to the rod by jarring link in case of 38 mm ϕ Shelby tube or otherwise in case of 75 or 100 mm ϕ tube, 'A' drill rods are connected by suitable adopter with ball check value. Two or three undisturbed Samples are collected at same depth in case of 38 mm ϕ tube to get sufficient sample for physical property tests. Before lowering the sampler, the bore is cleaned properly and sampling tube is lightly oiled from inner and outer side.

Sampling tube is pushed into the borehole by pressure hammering as per the soil stiffness. The sampling tube is immediately waxed after covering with aluminum foil.

In case of medium to coarse, non-cohesive, sand samples, where sampling is unsuccessful, Standard Penetration Test is carried out on cleaning the borehole.

LABORATORY TEST:

Disturbed, undisturbed and S P Test samples from the filed are brought to the laboratory with care and are grouped according to observations in the fields. On completion of shear, compressibility, permeability etc. tests on U D samples, these samples are placed in oven along with the S P Test samples and disturbed samples. Samples are selected such that each soil strata is adequately represented by the physical properties. The representative samples are dried in oven for 24 hours at $110 \pm 5^\circ\text{C}$.



UNIQUE ENGINEERING TESTING & ADVISORY SERVICES (GOVERNMENT APPROVED LABORATORY)

216, BRIDGE ROAD 6 F, OPP. LAST OVERHEAD TANK, UDHYOGNAGAR, UDHNA, SURAT -394 210. P.O. BOX NO.-1241
PHONE : +91 - 261 - 2278310, 2278205. FAX : +91 - 261 - 2277213. E-mail : unique_engineering@dataone.in

Service Tax No.: AABFU2563PST001

PHYSICAL PROPERTIES:

The moisture cans collected from S P T samples from the field are weighed and placed in oven for drying to determine natural moisture content (NMC). Results are tabulated in Table - 3.

U D samples are extracted using screw type extractor and samples are prepared as per the required sizes of the test to be performed. Before extracting from tube, weight and volume of sample are noted. Average bulk density is calculated in laboratory and samples are placed in oven to get the field moisture content for computing the dry density. Results are tabulated in Table - 4.

Specific gravity with specific gravity bottle / pycnometer is calculated as per I. S. 2720 (part - 3, section 1&2): 1980. Results are tabulated in Table -4. From the results of dry density and specific gravity the saturation of sample in % is calculated which is a useful data for deciding the condition of triaxial shear test

Grain size analysis is made by I. S. sieves and sieving is done on timer switch electrically operated sieve shaker I.S sieves commonly used are 4.75 mm, 2.00 mm, 1.00 mm 425 microns, 250 microns and 75 microns. For the coarse grain soil a graph of partial size v/s cumulative % finer is plotted. For fine grain soil wet analysis is made on plummet balance, modern version of hydrometer. Mechanical digital single pan balance of 1 kg capacity with 0.1 gram least count is used. Results are tabulated in Table - 5.

Liquid limits and Plastic limits tests are carried out with distilled water as per I. S. 2720 (part - 5): 1985. The samples are tested at a minimum of 24 hours after the addition of water. For liquid limit test cone penetration method is adopted but occasionally value is checked on Casagrande standard.

For the foundation soil sample shows sample shows high plasticity are checked for swelling and shrinkage. Firstly for rough estimate, free test as per I. S. 2720 (part - 40): 1977 is being carried out and getting positive indication of swelling. Shrinkage limit test is carried out as per I. S. 2720 (part - 6): 1972.



UNIQUE ENGINEERING TESTING & ADVISORY SERVICES (GOVERNMENT APPROVED LABORATORY)

216, BRIDGE ROAD 6 F, OPP. LAST OVERHEAD TANK, UDHYOGNAGAR, UDHNA, SURAT -394 210. P.O. BOX NO.-1241
PHONE : +91 - 261 - 2278310, 2278205. FAX : +91 - 261 - 2277213. E-mail : unique_engineering@dataone.in

Service Tax No.: AABFU2563PST001

SHEAR PROPERTIES:

Shear tests are carried out by three methods.

- 1) Unconfined compressive strength as per I. S. 2720 (part – 10): 1973 for the saturated plastic soil undisturbed samples and cores of SPT samples.
- 2) Triaxial shear test is carried out on sample size of 38 mm ϕ and 76 mm in height on motorized 30-speed load frame with digital display arrangements for load and pore-pressure. The confining pressure σ_3 is applied to the cell by oil-water constant pressure system. The tests are carried out for the condition.
 - a) Unconsolidated undrained (UU) test without pore-pressure measurement as per I.S. 2720 (part – 11): 1971.
 - b) Consolidated undrained (CU) test with or without pore-pressure measurement as per I.S. 2720 (part – 11): 1981.

The condition decided on type of sample and water table condition or designers specifications.
- 3) Direct box shear test is carried out on non-plastic medium to coarse sand soil as per I.S. 2720 (part – 13): 1986.

The graph for triaxial shear test is plotted by modified method where X-axis represents $\frac{1}{2}(\sigma_1 + \sigma_3)$ and Y-axis represents $\frac{1}{2}(\sigma_1 - \sigma_3)$.



UNIQUE ENGINEERING TESTING & ADVISORY SERVICES
(GOVERNMENT APPROVED LABORATORY)

216, BRIDGE ROAD 6 F, OPP. LAST OVERHEAD TANK, UDHYOGNAGAR, UDHNA, SURAT -394 210. P.O. BOX NO.-1241
 PHONE : +91 - 261 - 2278310, 2278205. FAX : +91 - 261 - 2277213. E-mail : unique_engineering@dataone.in

Service Tax No.: AABFU2563PST001

DISCUSSION:**Bore Hole 1 & D.C.P.T (C-1 & C-2): (SWITCH YARD)**

The location of proposed switch yard for G.H.B Ichhapore was explored for geotechnical data. The exploration revealed.

1. Ground Water Level is 3.0 mt below Ground Level.
2. The soil profile Shows:
 - 0.0 to 4.0 mt: Top CI-CH soil high swell potential for 0.0 to m3.0 mt
 $w = 35 \pm 1\%$, $\gamma_d = 1.38 \text{ g/cc}$, $c = 7 \text{ T/mt}^2$, $\phi = 10^\circ$, $N_s = 8$
 - 4.0 to 6.5 mt: Soil is ML group of silt non plastic $w = 20$ to 26% ,
 $\gamma_d = 1.55 \text{ g/cc}$, $N_s = 6$ to 12 , $N_c > 20$.
3. Foundations for light weight structures can be placed at 3.0 mt below soft wet zone. If actual excavation shows soil as drier 20-25 % foundation can be placed on such a layer with minimum depth of 2.0 mt below ground. The subsoil on wetting could swell if stress downward on foundation is less than 10 T/mt^2 . A 300 mm sand cushion on geofilter 300 g/mt^2 P MP woven will be advisable for site.
4. The design SBC will govern design for at 2.4 mt or below. For soil in stress below will have net design bearing capacity of 15 T/mt^2 with Factor of safety = 2.5
5. Drainage of water over area will give more durability to structure.

Bore Hole 2 & D.C.P.T (C-3): (ESR)

6. Ground Water Level is at 4.0 mt below Ground Level.
7. The soil profile shows major change beyond 7.0 mt from cohesive soil to non cohesive sand. N_c at 2.70 mt is 15 which increases to 40 at 7.0 mt. depth.
8. The log of bore hole data shows:
 - 0.0 to 4.5 mt: Cohesive soil 0.0 to 2.0 mt potentially highly
 expansive, $N_s = 10$, $w = 28\%$, $\gamma_d = 1.45 \text{ g/cc}$, $C_u =$
 7 T/mt^2 , $\phi = 10^\circ$, $\text{SBC} = 18 \text{ T/mt}^2$.
 - 4.5 to 8.5 mt: SM group of non plastic silty sand $N_s = 12$ to 13
 under submerged state, $w = 20\%$, $\gamma_d = 1.8 \text{ g/cc}$,
 $P_o = 80 \text{ kPa}$, $R_d = 60\%$, $\phi > 30^\circ$, $q_{p40} = 360 \text{ kPa (wet)}$
 & 240 kPa under submerged state.



UNIQUE ENGINEERING TESTING & ADVISORY SERVICES
(GOVERNMENT APPROVED LABORATORY)

216, BRIDGE ROAD 6 F, OPP. LAST OVERHEAD TANK, UDHYOGNAGAR, UDHNA, SURAT -394 210, P.O. BOX NO. -1241
 PHONE : +91 - 261 - 2278310, 2278205. FAX : +91 - 261 - 2277213. E-mail : unique_engineering@dataone.in

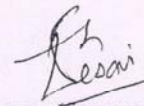
Service Tax No.: AABFU2563PST001

8.5 to 10.5 mt: SM silty sand $N = 25 \pm 2$, $w = 17\%$.

9. Depth of foundation for elevated reservoir for site is best placed at 2.8 mt below Ground Level. The soil 2.8 to 4.5 mt is cohesive overlaying silty fine sand -medium deuce.
10. Design bearing capacity will be governed by SBC which for the soil properties in (8) is net 18 T/mt^2 .
11. A sand cushion of 200 mm or geofilter grade PP-300 g/mt^2 is advisable. The fabric shall be laod as separator of soil & PCC & raised 1.0 mt all around.

Bore Hole 3 & D.C.P.T (C-4 & C-5): (CLEAR WATER SUMP)

12. Ground Water Level at 4.0 mt below Ground Level.
13. The dynamic crone indicate $N_c = 10$ blows/30cm, increasing with depth to 30 blows at 6.0 mt below Ground Level. The strata beyond 6.0 mt could be SM non plastic.
14. Bore Hole 3 shows soil profile as under:
 - (a) 0.0 tom 3.0 mt: CI-CH $N_s = 10$, $w = 26$, desiccated.
 - (b) 30. to 7.0 mt: Silt with variable fine sand. $N_s = 15$ to 22 blows/30cm, $w = 26\%$, $\gamma_d = 1.5 \text{ g/cc}$, $C_u = 0.15 \text{ kg/cm}^2$, $\phi_u = 25^\circ$
 - (c) 7.0 to 8.5 mt: Stiff CI soil $w = 20\%$, $N_s = 17$.
 - (d) 8.5 to 10.5 mt: SM group of sand $N_s = 20 \pm 3$.
15. The foundation for sump wall strip or footings can be placed at 3.3 mt below Ground Level.
16. The design bearing capacity will be governed by SBP for settlement of 40 mm. For $avN_s = 16$ blows for $Po^1 = \text{eff.Pr} = 70 \text{ kPa}$, $R_d = 70\% \pm 10$, $q_{p40} = 400 \text{ kPa}$, $\phi > 33^\circ$, the design bearing capacity will be net 26 T/mt^2 considering Water Table effect.
17. The side walls, beam columns or ring will be subject to earth pressure of cohesive soils up to 3.0 mt & silt. The gap of excavation is to be filled by sand rammed insitu.



For UNIQUE ENGINEERING TESTING
AND ADVISORY SERVICES



UNIQUE ENGINEERING TESTING & ADVISORY SERVICES
(GOVERNMENT APPROVED LABORATORY)

216, BRIDGE ROAD 6 F, OPP. LAST OVERHEAD TANK, UDHYOGNAGAR, UDHNA, SURAT -394 210. P.O. BOX NO. -1241
PHONE : +91 - 261 - 2278310, 2278205. FAX : +91 - 261 - 2277213. E-mail : unique_engineering@dataone.in

Service Tax No.: AABFU2563PST001

I. S. CLASSIFICATION

GW: Well graded gravels, gravel-sand mixture or no fines.

GP: Poorly graded gravels or gravel sand mixture, little or no fines.

GM: Silty gravels, poorly graded gravel-sand-silt mixtures.

GC: Clayey gravels, poorly graded gravel-sand-clay mixtures.

SW: Well-graded sands, gravely sands; little or no fines.

SP: Poorly graded sands or gravely sands, little or no fines.

SM: Silty sands, poorly graded sand-silt mixtures.

SC: Clayey sands, poorly graded sand-clay mixtures.

ML: Inorganic silt and very fine sands rock flour; silty or clayey fine sands or clayey silts with non-to low plasticity.

CL: Inorganic clays, gravely clays, sandy clays, silty clays, lean clays of low plasticity.

OL: organic silts and organic silty clay of low plasticity.

MI: Inorganic silts, silty or clayey fine sands or clayey silts of medium plasticity.

CI: Inorganic clays, gravely clays, sandy clays, silty clays, lean clays of medium plasticity.


OI: Organic silts and organic silty clays of medium plasticity.

MH: Inorganic silt of highly compressibility, micaceous or diatomaceous fine sandy or silty soils, elastic silts.

CH: Inorganic clays of high plasticity, fat clays.

OH: Organic Clays of medium to high plasticity.

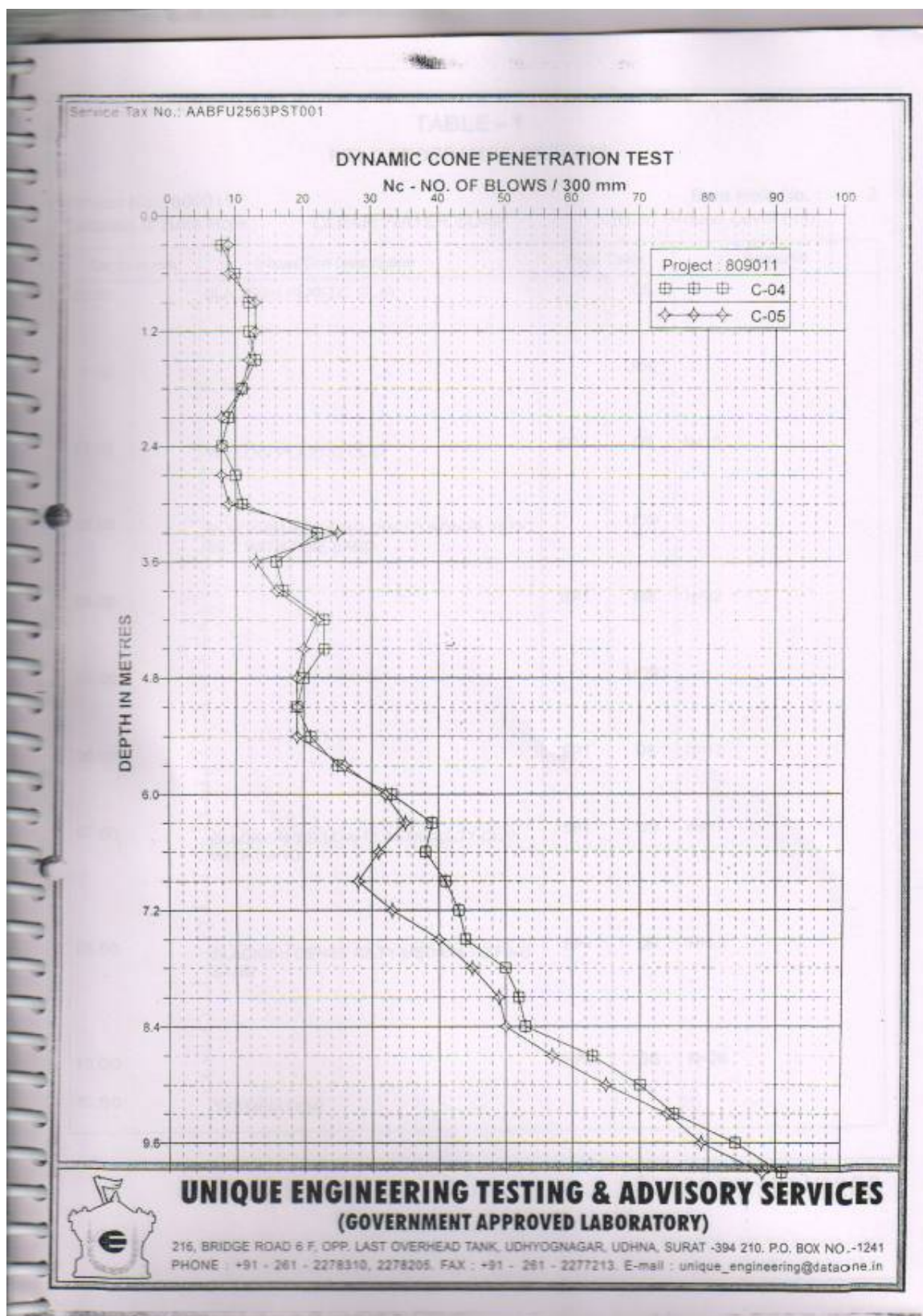
Pt: Peat and other highly organic soil with very high compressibility.

 **UNIQUE ENGINEERING TESTING & ADVISORY SERVICES**
(GOVERNMENT APPROVED LABORATORY)

216, BRIDGE ROAD 6 F, OPP. LAST OVERHEAD TANK, UDHYOGNAGAR, UDHNA, SURAT -394 210. P.O. BOX NO.-1241
PHONE : +91 - 261 - 2278310, 2278205. FAX : +91 - 261 - 2277213. E-mail : unique_engineering@dataOne.in

Signature of the Contractor

Signature of the secretary



Signature of the Contractor

Signature of the secretary


Service Tax No.: AABFU2563PST001

TABLE - 1
FIELD PROGRAMME OF TESTS

Project No. : 809011
Location of Bore Hole : CLEAR WATER SUMP

Bore Hole No. : 3
RL of Ground Level (mt):

Depth in mts.	Visual Soil Description	Field Tests		Remarks
00.00	BLACKISH PLASTIC CLAY		DS	
01.00			UDS	
02.00	YELLOW PLASTIC CLAY	SPT	DS	N=10
03.00	BLACKISH YELLOW LOW TO NON-PLASTIC SILT WITH FINE SAND		UDS	
04.00		SPT	DS	N=22
05.00			UDS	
06.00		SPT	DS	N=13
07.00	BLACKISH YELLOW PLASTIC SILTY CLAY WITH SAND	SPT	DS	N=17
08.50	BLACKISH DENSE SILTY MEDIUM TO FINE SAND	SPT	DS	N=23
10.00		SPT	DS	N=26
10.50	TERMINATION			



UNIQUE ENGINEERING TESTING & ADVISORY SERVICES
(GOVERNMENT APPROVED LABORATORY)

246, BRIDGE ROAD 6 F, OPP. LAST OVERHEAD TANK, UDHYOGNAGAR, UDHNA, SURAT -394 210, P.O. BOX NO.-1241
PHONE : +91 - 261 - 2278310, 2278205, FAX : +91 - 261 - 2277213, E-mail : unique_engineering@dataone.in

Signature of the Contractor


Signature of the secretary

Service Tax No.: AABFU2563PST001

TABLE - 2
LABORATORY PROGRAMME

Project No. : 809011 Bore Hole No. : 3

Depth & Type of Sample	N. M. C.	Density	Specific Gravity	Particle Size Analysis	Atterberg Limits	Shrinkage Limit / Free Swell	Shear Test (UCC/Trx/Box/Vane)	Other Tests
0.00/D				Part	Yes	FRS		
1.00/U	Yes	Yes	Yes	Part	Yes	FRS	UCC	
2.00/S	Yes			Part	Yes	FRS		
3.00/U	Yes	Yes	Yes	Part	Yes	FRS	TRX	
4.00/S	Yes			Part	Yes			
5.00/U	Yes	Yes	Yes	Part	Yes		TRX	
6.00/S	Yes			Part	Yes			
7.00/S	Yes			Part	Yes			
8.50/S	Yes			Part	Yes			
10.00/S	Yes			Part	Yes			



UNIQUE ENGINEERING TESTING & ADVISORY SERVICES
(GOVERNMENT APPROVED LABORATORY)

216, BRIDGE ROAD 6 F, OPP. LAST OVERHEAD TANK, UDHYOGNAGAR, UDHNA, SURAT -394 210. P.O. BOX NO.-1241
PHONE : +91 - 261 - 2278310, 2278205. FAX : +91 - 261 - 2277213. E-mail : unique_engineering@data.one.in

Signature of the Contractor


Signature of the secretary

Service Tax No.: AABFU2563PST001

TABLE - 3
RESULTS OF STANDARD PENETRATION TEST

Project No. : 809011 Bore Hole No. : 3

Depth in mts.	No. of Blows for Penetration			Ns (Blows /300 mm)	Nc(Corrected value of Ns)	N. M. C. (in %)
	0 - 150 mm	150 - 300 mm	300 - 450 mm			
2.00	03	05	05	10	10	26.88
4.00	08	10	12	22	19	23.00
6.00	08	06	07	13	13	21.51
7.00	07	09	08	17	17	20.36
8.50	09	11	12	23	18	13.16
10.00	10	12	14	26	19	17.17

 **UNIQUE ENGINEERING TESTING & ADVISORY SERVICES**
(GOVERNMENT APPROVED LABORATORY)
216, BRIDGE ROAD 6 F, OPP. LAST OVERHEAD TANK, UDHYOGNAGAR, UDHNA, SURAT -394 210, P.O. BOX NO.-1241
PHONE : +91 - 261 - 2276310, 2278205. FAX : +91 - 261 - 2277213. E-mail : unique_engineering@dataone.in

Signature of the Contractor

Signature of the secretary

Service Tax No.: AABFU2563PST001

TABLE - 4

INSITU DENSITY, MOISTURE CONTENT, DRY DENSITY & SPECIFIC GRAVITY

Project No. : 809011 Bore Hole No. : 3

Depth of Sample (mts.)	Bulk Density in gms/cc	Natural Moisture Content (%)	Dry Density in gms/cc	Specific Gravity	Saturation
1.00	1.79	19.98	1.49	2.62	0.69
3.00	1.93	26.42	1.53	2.77	0.90
5.00	1.96	27.60	1.54	2.80	0.94
7.00					
9.00					
11.00					
13.00					
15.00					

UNIQUE ENGINEERING TESTING & ADVISORY SERVICES
(GOVERNMENT APPROVED LABORATORY)

216, BRIDGE ROAD 6 F, OPP. LAST OVERHEAD TANK, UDHYOGNAGAR, UDHNA, SURAT -394 210. P.O. BOX NO.-1241
PHONE : +91 - 261 - 2278310, 2278205. FAX : +91 - 261 - 2277213. E-mail : unique_engineering@dataone.in

Signature of the Contractor


Signature of the secretary

Service Tax No. : AABFU2563PST001

TABLE - 5
PARTICLE SIZE ANALYSIS

Project No. : 809011 Bore Hole No. : 3

Soil Strata	Depth & Sample Type	Gravel in % (>4.75 mm)	Sand in %			Silt in % Clay in %
			(4.75 - 2 mm)	(2mm - 425 μ)	(425 - 75 μ)	
0.00 to 2.00	0.00/D	0	0	2	2	96
0.00 to 2.00	1.00/U	0	0	0	1	99
2.00 to 3.00	2.00/S	0	0	0	2	98
3.00 to 7.00	3.00/U	0	0	0	4	96
3.00 to 7.00	4.00/S	0	0	0	29	71
3.00 to 7.00	5.00/U	0	0	0	5	95
3.00 to 7.00	6.00/S	0	0	0	31	69
7.00 to 8.50	7.00/S	0	1	5	12	82
8.50 to 10.50	8.50/S	0	9	39	18	34
8.50 to 10.50	10.00/S	7	8	35	19	31



UNIQUE ENGINEERING TESTING & ADVISORY SERVICES
(GOVERNMENT APPROVED LABORATORY)

215, BRIDGE ROAD 6 F, OPP. LAST OVERHEAD TANK, UDHYOGNAGAR, UDHNA, SURAT -394 210. P.O. BOX NO.-1241
PHONE : +91 - 261 - 2278310, 2278295. FAX : +91 - 261 - 2277213. E-mail : unique_engineering@dataone.in

Signature of the Contractor

Signature of the secretary

Service Tax No.: AABFU2563PST001

TABLE - 6
ATTERBERG LIMITS

Project No. 809011 Bore Hole No. 3

Soil Strata	Depth & Sample Type	Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit	Freeswell Index	I.S. Classification
0.00 to 2.00	0.00/D	49	27	22		18	CI
0.00 to 2.00	1.00/U	45	26	19		19	CI
2.00 to 3.00	2.00/S	52	28	24		32	CH
3.00 to 7.00	3.00/U	31	-	-		01	ML
3.00 to 7.00	4.00/S	27	-	-			ML
3.00 to 7.00	5.00/U	32	23	09			ML
3.00 to 7.00	6.00/S	29	-	-			ML
7.00 to 8.50	7.00/S	36	22	14			CI
8.50 to 10.50	8.50/S	27	-	-			SM
8.50 to 10.50	10.00/S	27	-	-			SM

UNIQUE ENGINEERING TESTING & ADVISORY SERVICES
(GOVERNMENT APPROVED LABORATORY)

216, BRIDGE ROAD 6 F, OPP. LAST OVERHEAD TANK, UDHYOGNAGAR, UDHNA, SURAT -394 210. P.O. BOX NO.-1241
PHONE : +91 - 261 - 2278310, 2278205. FAX : +91 - 261 - 2277213. E-mail : unique_engineering@dataone.in

Signature of the Contractor

Signature of the secretary

- 6


Service Tax No.: AABFU2563PST001

TABLE - 7A
UNCONFINED COMPRESSION TEST TABLE

Project No. : 809011 Bore Hole No. : 3

Depth of Sample (mts.)	Type of Sample (UD/Rm)	Qu (Kg/cm ²)	Cu (Kg/cm ²)
1.00	UD(Undisturbed)	5.39	

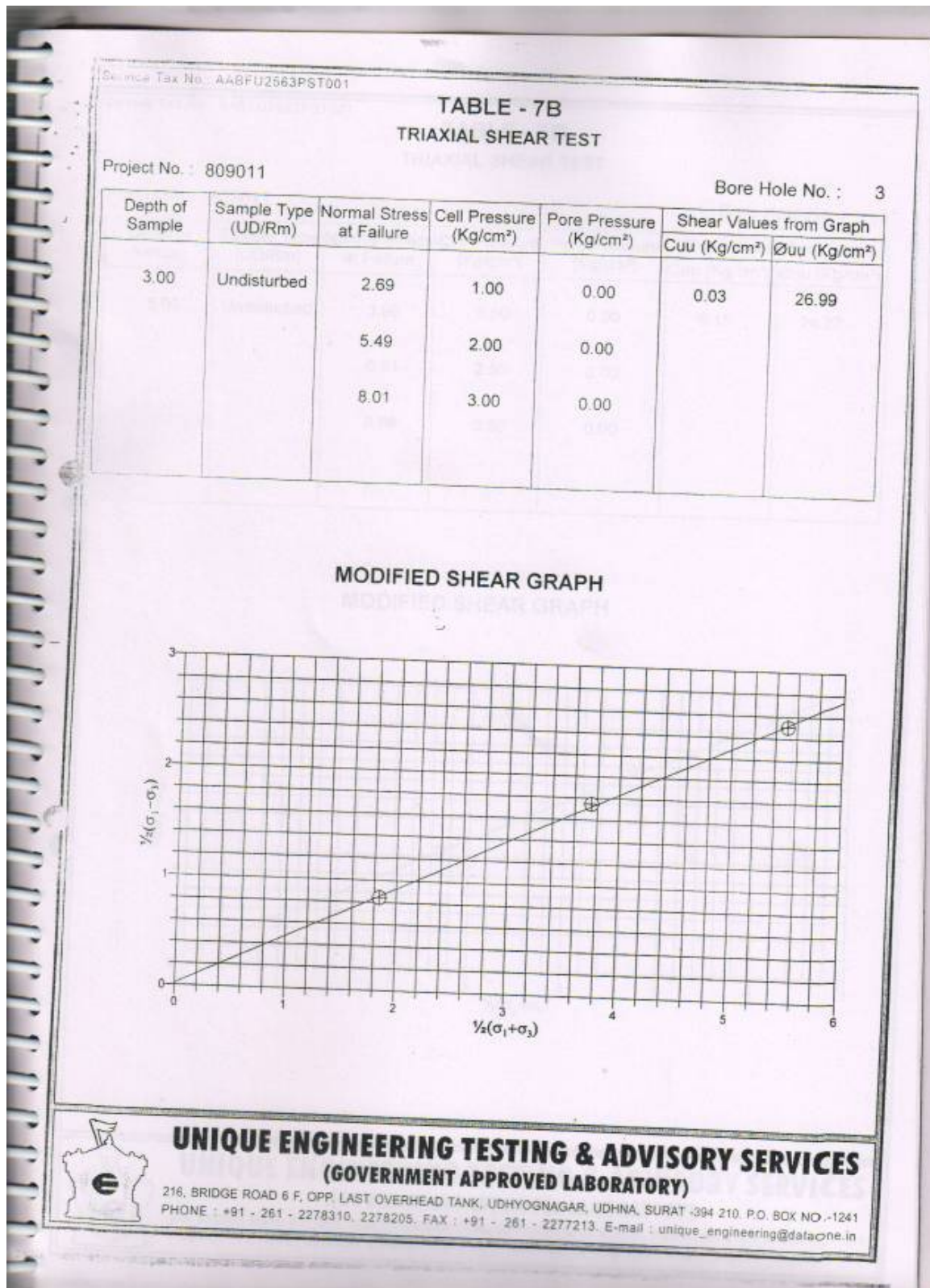
MODIFIED SHEAR GRAPH

 **UNIQUE ENGINEERING TESTING & ADVISORY SERVICES**
(GOVERNMENT APPROVED LABORATORY)

216, BRIDGE ROAD 6 F, OPP. LAST OVERHEAD TANK, UDHYOGNAGAR, UDHNA, SURAT -394 210. P.O. BOX NO. -1241
PHONE : +91 - 261 - 2278310, 2278205. FAX : +91 - 261 - 2277213. E-mail : unique_engineering@dataone.in

Signature of the Contractor

Signature of the secretary



Signature of the Contractor

Signature of the secretary

Service Tax No.: AABFU2563PST001

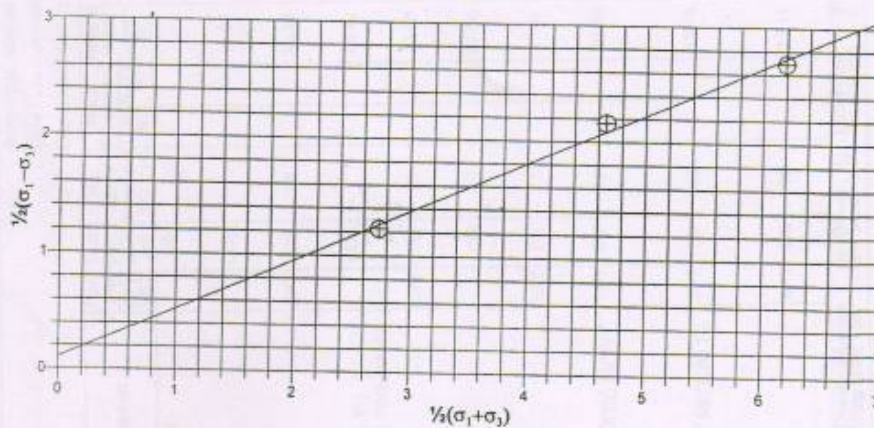
TABLE - 7B
TRIAxIAL SHEAR TEST

Project No.: 809011

Bore Hole No.: 3

Depth of Sample	Sample Type (UD/Rm)	Normal Stress at Failure	Cell Pressure (Kg/cm ²)	Pore Pressure (Kg/cm ²)	Shear Values from Graph	
					Cuu (Kg/cm ²)	Øuu (Kg/cm ²)
5.00	Undisturbed	3.96	1.50	0.00	0.15	24.97
		6.83	2.50	0.00		
		8.88	3.50	0.00		

MODIFIED SHEAR GRAPH



UNIQUE ENGINEERING TESTING & ADVISORY SERVICES
(GOVERNMENT APPROVED LABORATORY)

216, BRIDGE ROAD 6 F, OPP. LAST OVERHEAD TANK, UDHYOGNAGAR, UDHNA, SURAT - 394 210. P.O. BOX NO.-1241
PHONE : +91 - 261 - 2278310, 2278205. FAX : +91 - 261 - 2277213. E-mail : unique_engineering@data one.in

Signature of the Contractor

Signature of the secretary

SUMMARY OF GEOTECHNICAL EXPLORATIONS																			
Project No. : 809011		Bore Hole Started on : 05-04-08		Depth of Water Table : 4.00 mts from Ground Level		Bore Hole No. : 3		R. L. of Ground Level :		Bore Hole Completed on : 05-04-08		Location of Bore Hole : CLEAR WATER SUMP		Diameter of Bore Hole : 150 mm		Particle Size Analysis		Atterberg Limits	
Method of Drilling : SHELL & AUGER		Visual Soil Description		Field Test		Rock Properties		Natural Moist. Content		Density		Gr. Silt + Clay		Gr. Sand		Gr. Silt + Clay		Gr. Sand	
I. S. Classification		No. of Blows per 300 mm		Gr. Sand		Gr. Silt + Clay		Gr. Sand		Gr. Silt + Clay		Gr. Sand		Gr. Silt + Clay		Gr. Sand		Gr. Silt + Clay	
Depth in metres		SPT		SPT		SPT		SPT		SPT		SPT		SPT		SPT		SPT	
00.00		BLACKISH PLASTIC CLAY		DS		DS		DS		DS		DS		DS		DS		DS	
01.00		CI		UDS		UDS		UDS		UDS		UDS		UDS		UDS		UDS	
02.00		CH		SPT		SPT		SPT		SPT		SPT		SPT		SPT		SPT	
03.00		BLACKISH YELLOW LOW TO NON-PLASTIC SILT WITH FINE SAND		UDS		UDS		UDS		UDS		UDS		UDS		UDS		UDS	
04.00		ML		SPT		SPT		SPT		SPT		SPT		SPT		SPT		SPT	
05.00		CL		SPT		SPT		SPT		SPT		SPT		SPT		SPT		SPT	
06.00		CL		SPT		SPT		SPT		SPT		SPT		SPT		SPT		SPT	
07.00		BLACKISH YELLOW PLASTIC SILTY CLAY WITH SAND		SPT		SPT		SPT		SPT		SPT		SPT		SPT		SPT	
08.50		BLACKISH DENSE SILTY MEDIUM TO FINE SAND		SPT		SPT		SPT		SPT		SPT		SPT		SPT		SPT	
10.00		SM		SPT		SPT		SPT		SPT		SPT		SPT		SPT		SPT	
10.50		TERMINATION		SPT		SPT		SPT		SPT		SPT		SPT		SPT		SPT	
Additional Tests or Remarks		Additional Tests or Remarks		Additional Tests or Remarks		Additional Tests or Remarks		Additional Tests or Remarks		Additional Tests or Remarks		Additional Tests or Remarks		Additional Tests or Remarks		Additional Tests or Remarks		Additional Tests or Remarks	
Qu = 5.39		Qu = 5.39		Qu = 5.39		Qu = 5.39		Qu = 5.39		Qu = 5.39		Qu = 5.39		Qu = 5.39		Qu = 5.39		Qu = 5.39	
Tuu = 0.03 27.0*		Tuu = 0.03 27.0*		Tuu = 0.03 27.0*		Tuu = 0.03 27.0*		Tuu = 0.03 27.0*		Tuu = 0.03 27.0*		Tuu = 0.03 27.0*		Tuu = 0.03 27.0*		Tuu = 0.03 27.0*		Tuu = 0.03 27.0*	
Tuu = 0.15 25.0*		Tuu = 0.15 25.0*		Tuu = 0.15 25.0*		Tuu = 0.15 25.0*		Tuu = 0.15 25.0*		Tuu = 0.15 25.0*		Tuu = 0.15 25.0*		Tuu = 0.15 25.0*		Tuu = 0.15 25.0*		Tuu = 0.15 25.0*	
Cv - Coeff. of Consolidation		Cv - Coeff. of Consolidation		Cv - Coeff. of Consolidation		Cv - Coeff. of Consolidation		Cv - Coeff. of Consolidation		Cv - Coeff. of Consolidation		Cv - Coeff. of Consolidation		Cv - Coeff. of Consolidation		Cv - Coeff. of Consolidation		Cv - Coeff. of Consolidation	
C.R. - Core Recovery		C.R. - Core Recovery		C.R. - Core Recovery		C.R. - Core Recovery		C.R. - Core Recovery		C.R. - Core Recovery		C.R. - Core Recovery		C.R. - Core Recovery		C.R. - Core Recovery		C.R. - Core Recovery	
RQD - Rock Quality Designation		RQD - Rock Quality Designation		RQD - Rock Quality Designation		RQD - Rock Quality Designation		RQD - Rock Quality Designation		RQD - Rock Quality Designation		RQD - Rock Quality Designation		RQD - Rock Quality Designation		RQD - Rock Quality Designation		RQD - Rock Quality Designation	
216-BRIDGE ROAD NO. 6-F, P.O. BOX-1241, UDHNA UDYOGNAGAR, SURAT - 394 210, Phone (0261)227 8205, 227 8310, Fax (0261) 227 7213.		216-BRIDGE ROAD NO. 6-F, P.O. BOX-1241, UDHNA UDYOGNAGAR, SURAT - 394 210, Phone (0261)227 8205, 227 8310, Fax (0261) 227 7213.		216-BRIDGE ROAD NO. 6-F, P.O. BOX-1241, UDHNA UDYOGNAGAR, SURAT - 394 210, Phone (0261)227 8205, 227 8310, Fax (0261) 227 7213.		216-BRIDGE ROAD NO. 6-F, P.O. BOX-1241, UDHNA UDYOGNAGAR, SURAT - 394 210, Phone (0261)227 8205, 227 8310, Fax (0261) 227 7213.		216-BRIDGE ROAD NO. 6-F, P.O. BOX-1241, UDHNA UDYOGNAGAR, SURAT - 394 210, Phone (0261)227 8205, 227 8310, Fax (0261) 227 7213.		216-BRIDGE ROAD NO. 6-F, P.O. BOX-1241, UDHNA UDYOGNAGAR, SURAT - 394 210, Phone (0261)227 8205, 227 8310, Fax (0261) 227 7213.		216-BRIDGE ROAD NO. 6-F, P.O. BOX-1241, UDHNA UDYOGNAGAR, SURAT - 394 210, Phone (0261)227 8205, 227 8310, Fax (0261) 227 7213.		216-BRIDGE ROAD NO. 6-F, P.O. BOX-1241, UDHNA UDYOGNAGAR, SURAT - 394 210, Phone (0261)227 8205, 227 8310, Fax (0261) 227 7213.		216-BRIDGE ROAD NO. 6-F, P.O. BOX-1241, UDHNA UDYOGNAGAR, SURAT - 394 210, Phone (0261)227 8205, 227 8310, Fax (0261) 227 7213.		216-BRIDGE ROAD NO. 6-F, P.O. BOX-1241, UDHNA UDYOGNAGAR, SURAT - 394 210, Phone (0261)227 8205, 227 8310, Fax (0261) 227 7213.	

Signature of the Contractor

Signature of the secretary