

Section 6 - Employer's Requirements

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1. Scope of Supply of Plant and Services

1.0 Introduction

1.1. Rajapalayam Town is a Special grade Municipality in Virudhunagar District of Tamil Nadu State. Rajapalayam Municipality is situated at latitude of $9^{\circ} 27' 0''$ N and longitude of $77^{\circ} 33' .0''$ E at an altitude of 156 m from sea level. It is situated at 85 Km South –West of Madurai in Madurai – Kollam NH 208 and is readily accessible by rail and road. The Municipality covers an area of 11.36 Sq.km and the 2011 census population is 130119. The Rajapalayam Special grade Municipality is divided into 42 wards. Rajapalayam Municipality has not been provided with sewerage system. The storm water open drains have been constructed in the town. The storm water drains convey the sewage generated from the areas within the town limit and discharged in to the Irrigation Tank near the Town. Mostly all streets and roads have open drains along their sides. The ablution water from the latrines is being let out into the soak pits. Some of the houses have water seal latrines with septic tank arrangement. In most areas, the night soil is being let into the storm water open drains through soak pits. The sullage from the house is also being let into the soak pits. In the thickly populated areas, the sullage is being discharged into street gutters and storm water open drains directly. In the proposal, the anticipated population for the year 2020 and 2050 has been worked out as 155000 and 220000 respectively. The water supply rate of 135 lpcd for Rajapalayam Municipality has been considered in the design for working out the total sewage flow. Proposed project includes: (i) sewage network system(collection system and pumping main-176.037 kilometre net length of sewers, 5865 manholes), (ii) 4 nos of lift stations, (iii) 3 nos of pumping stations, (iv) sewage treatment plant (STP) of capacity 21.85million litres per day (MLD), and (v) house service connections. Rajapalayam Municipality has so far not been provided with sewerage system. The storm water open drains have been constructed in the town. The storm water drains convey the sewage generated from the areas within the town limit and discharged in to the Irrigation Tanks near the Town.

1.2. The sullage from the house is also being let into the soak pits. In the thickly populated areas, the sullage is being discharged into street gutters and storm water open drains directly.

1.3. Mostly all streets and roads have open drains along their sides. The ablution water from the latrines is being let out into the soak pits. Some of the houses have water seal latrines with septic tank arrangement. In most areas, the night soil is being let into the storm water open drains through soak pits.

1.4. At present there is no drainage scheme. Letting the sullage water from houses into the nearby tanks and River cause water pollution. Letting the effluent of flush out latrines through septic tanks in the nearby ground will ultimately cause contamination of ground water. Because of the above facts there will be health hazards to the public. The problem of odour and mosquito breeding is also there. Hence there is paramount necessity to provide an underground sewerage scheme to this town. Taking into consideration of environmental problems, the Government of Tamilnadu has taken decision to provide Under Ground Sewerage Scheme to all the Municipal Towns.

1.5. The existing open drain system is not functioning satisfactorily. The water is stagnating in many places and due to that mosquitoes and flies are developed, which cause many diseases. Following table gives a statistical data on occurrence of waterborne disease in the municipal area. Therefore, underground sewerage system is a must for Rajapalayam town.

The sub project Description of work:

The subproject is to DESIGN, BUILD, OPERATE one no of Sewerage Treatment Plant of Capacity 21.85 MLD. The units consist of based on proven technology such as EASP. However it is liberty of the bidder to choose any other technology as per his convenience based on DBO methodology The STP shall be designed for 21.85 mld capacity. The land provided (5 Acre) is enough for augmenting the capacity to the ultimate flow of 25.30 mld. The land is inside the premises of Compost yard (20 acres) of Rajapalayam Municipality.

Design methodology will be done by the Contractor on DBO basis. It is the responsibility of the contractor to make design and detailed engineering for the sewage treatment plant. In the first instance the contractor will submit the process design, lay out plan and hydraulic flow diagram for the approval of the client.

After approval of these documents the contractor will prepare and submit the general arrangement drawings for various components of the project. Once these drawings are approved, the contractor will go ahead with the structural designs and submit the structural drawings for approval. Then the contractor will prepare and submit the good for construction drawings for approval. After approval of these drawings only the contractor will do the construction works.

The bidder is expected to come up with advanced treatment technology which will meet the statutory discharge standards. The bidder need to come with a technology which will require less land. Further the bidder to reserve sufficient land for future requirement as well as to add any new treatment units to achieve a higher level of treatment at any time in future. In future re-use of treated sewage may be envisaged and hence the contractor need to keep that in mind and reserve the space for the same while preparing the layout for the sewage treatment plant

The subproject in addition to the plant units will include utilities like Administration Building, Laboratory, Plant Roads, Storm Water Drains, Yard Lighting and Landscaping works. There will a boundary wall around the site boundary. There will be a gate at the entry from the main road to the plant with a security cabin. Green belt all around should be provided with plantation.

The sub-project will include boundary wall, retaining wall, security cabin, and staff quarters. It shall also include provision for adequate water supply for purpose of drinking for the staff and for the facilities within the campus.

2. Scope of work

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

- 2.1 The design shall be based on proven technology such as EASP. Hence the technical specification for EASP is provided. However it is liberty of the bidder to choose any other technology as per his convenience based on DBO methodology. It is the responsibility of the contractor to make design and detailed engineering for the sewage treatment plant. In the first instance the contractor will submit the process design, lay out plan and hydraulic flow diagram for the approval of the client.

After approval of these documents the contractor will prepare and submit the general arrangement drawings for various components of the project. Once these drawings are approved, the contractor will go ahead with the structural designs and submit the structural drawings for approval. Then the contractor will prepare and submit the good for construction drawings for approval. After approval of these drawings only the contractor will do the construction works.

The STP shall be designed for 21.85 mld capacity. The land provided (5 Acre) is enough for augmenting the capacity to the ultimate flow of 25.30 mld. The peak flow handling capacity of the STP is 49.16 mld in Intermediate stage and 56.93 mld in Ultimate stage.

The details related to the future expansion capacity of the plant should be reflected in the General Plan layout drawings.

The area/ land reserved for advance treatment for effluent in near future should be marked.

The design of STP should enable handling influent loads (also capable of handling flow including applicable peak factor) and ensure treated wastewater quality per CPCB/pertinent authority specified norms and discharge standards."

Peak factor of pumping main operation from respective MPS is 2.25. The peak factor to STP shall be calculated for each zone taking the relevant peak factor.

The Green belt all around for required width as prescribed by TNPCB should be provided and that should be marked in the drawings.

- 2.2 Site clearance, site surveys, soil investigation, submission of process design and hydraulic design calculations, plant lay out and hydraulic flow diagram (Process & Instrumentation diagram), preparation, submission and obtaining approval of detailed Environmental Assessment Report, preparation & submission of civil, architectural, General Arrangement Drawings & structural design of all civil works, electrical & mechanical equipment drawings including equipment installation drawings, supporting calculations & technical information, instrumentation & control system, construction of STP of required capacity (21.85mld) including necessary bypass arrangements after de-gritting for aeration & chlorination as per approved designs, testing, commissioning, performance testing of process units & trial run for a period of six months, landscaping of plant area, internal roads with access to all units, illumination of the entire STP yard, pathways, storm water drainage, barbed wire fencing all around & gates, administrative building including store house for tools and spares (covering a plinth area of 60 sqm), laboratory (covering an area of 30 sqm) with water supply and waste water disposal arrangements, O&M manual and as-built drawings for all civil, electrical & mechanical works. All units shall be provided with draining arrangements with suitable valves. It is responsibility of the contractor to design the STP in such a way that the sludge generated in the treatment plant will be properly stabilized, treated and disposed off safely as per the applicable statutory norms.
- 2.3 The scope includes, the treated effluent is proposed to be discharged in to Kothankulam tank by 1.400 km of gravity main of 800mm Non pressure NP4 class RCC sulfur Resistant cement pipes. The alignment of pipeline lies along the Municipal road from compost yard to Thottiyampatti Road. Contractor shall ensure that the disposal level of treated wastewater into the tank will be adequately above the MWL / HFL of the tank/area to ensure that flood waters (duly considering maximum return period) do not flow back through the gravity main and affect plant operations. Contractor shall provide necessary construction drawing pursuant to necessary surveys and investigations, and obtain Client approval prior to proceeding with Work.
- 2.4 Supply and providing safety equipment's namely gas mask, breathing apparatus, Air hose respirator, portable lighting equipment, non-sparking tools ,lighting equipment, portable air blowers, safety belts, inhalators and diver suit at the commencement of O&M.
- 2.5 Training the municipal /corporation staff for O&M works during the entire maintenance period. Municipality/Corporation will depute a team to undertake this training which will help them in maintaining the sewage treatment plant after handing over the plant by contractor to the Corporation in a smooth manner.

Handing over of the Plant in good working condition with all relevant documents such as as-built drawings, physical & operational condition of the assets, rights on proprietary technologies, software, systems, O&M manual, periodical reports along with soft copy to Rajapalayam Municipality.
- 2.6 The offer shall be based on the bidders design, build, operate and transfer concept to be specified by the bidder.
- 2.7 Design shall be such that the plant requires minimum land foot print within the available land leaving area for future expansion of STP

- 2.8 Entire STP area should be provided with site. Specific proper storm water drainage system to avoid flooding during rainy season. The contractor is also to ensure that all the electrical equipment and critical monitoring/communication equipment are installed / stored at a suitable elevation to safeguard against risk of flooding.

3. GENERAL:

- 3.1 The fee paid to TNEB for permanent power supply connection shall be deposited by the Engineer directly. It should be the responsibility of the contractor to project power requirement, prepare an application for the TNEB and help the Engineer with required information and assistance in this regard. All other costs related to obtaining such approval are in the scope of contract. It will be the total responsibility of contractor to obtain approval of entire electrical installation from electrical inspector. The charges alone will be paid by Engineer.
- 3.2 Power supply room of required area as per TNEB requirements shall be provided near transformer yard as required.
- 3.3 Illumination of STP Yard with suitable arrangement for better operation and maintenance of plants.
- 3.4 Barbed wire fencing with RCC fencing post and MS gate of size suitable for entry of lorry etc. with masonry wall of at least 6m on either side of the MS gate.

4. PROPOSED TREATMENT SCHEME

Proposed Treatment scheme shall consist of based on proven technology such as EASP. Hence the technical specification for EASP is provided. However it is liberty of the bidder to choose any other technology as per his convenience based on DBO methodology.

The bidder is expected to come up with advanced treatment technology which will meet the statutory discharge standards. The bidder need to come with a technology which will require less land. Further the bidder to reserve sufficient land for future requirement as well as to add any new treatment units to achieve a higher level of treatment at any time in future. In future re-use of treated sewage may be envisaged and hence the contractor need to keep that in mind and reserve the space for the same while preparing the layout for the sewage treatment plant.

The sewage treatment plant shall be designed in such a way that there will not be any odour / foam problem in the plant premises or outside the plant premises which will cause health problems to the nearby general public. Foam and odour nuisance normally takes place at aeration tanks and hence utmost care should be taken while designing these aeration tanks. Contractor is required to include a note on these aspects while submitting the process designs to avoid any complications. All the primary units shall be designed for ultimate stage with peak factor.

4.1 Receiving of Sewage

Raw Sewage will be delivered through two numbers of pumping mains from MPS @ Avarampatty and SPS @ North Andapuram (size 700 mm dia. and 400 mm CI pipe) at a residual head of 8 m into a Receiving Chamber from where it will be taken into downstream screens. The function of the Receiving Chamber is to reduce the incoming velocity. Receiving Chamber shall be of adequate size to meet the requirements of workability inside it. The flow from the receiving chamber will lead to screen Chamber.

4.2 Coarse Screening

After the receiving chamber minimum two numbers of coarse screens are to be provided for removal of upstream of Wet well for removal of floating and oversized material coming with the sewage. One shall be mechanically operated and must be suitable for sewage applications.

The other shall be of Manual screen as standby. The coarse screens should be capable to screen out most of the medium & large floating and oversized material such as plastic rags, debris, weeds, paper, cloth, rags etc which could clog the waste water pump impellers. The coarse screen shall be inclined bar screen. It should be of sturdy design to take care of all sorts of materials envisaged in the gravity sewer. The bar screen shall be of stainless steel flats. The screenings shall be dropped on conveyor above the top of the screen channel. A conveyor system of suitable width shall be provided which shall be adjacent to the screens. The screening material as collected will drop automatically into a wheelbarrows for its disposal. The Coarse Screening shall be designed for the ultimate flow with peak factor.

4.3 Fine Screening

Fine screen channels to be provided up stream of Grit removal system Minimum two nos. of Fine screens are to be provided for removal of fine floating material coming with the sewage. It shall be mechanically operated and must be suitable for sewage applications. There shall be minimum one number of Manual fine screen as standby. The fine screens should be capable to screen out most of the medium & fine floating and material such as hair, debris, weeds, paper, rags etc. which could clog the downstream units

The Fine screen shall be inclined bar screen. It should be of sturdy design and the bar screen shall be of stainless steel flats. The screenings shall be dropped on conveyor above the top of the screen channel. A conveyor system of suitable width shall be provided which shall be adjacent to the screens. The screening materials as collected will drop automatically into a wheelbarrows for its disposal.

4.4 De-gritting

Screened Sewage will be gravitable to minimum two numbers of Grit separator tank for removal of grit and small inorganic particulars matter of specific gravity above 2.65 and particle size above 150 microns. The Grit separator tank shall be of RCC construction complete with mechanical internals and square in size. The grit separated shall be properly collected and be transferred for disposal. The de-gritted sewage shall flow through open channels from the grit separators and confluence into a single channel of suitable width.

4.5 Flow Measurement

A Flow measurement unit in the form of ultrasonic flow transmitter shall be provided in the common header of the Raw sewage Pumps. This flow will be flown in to the Aerator which have suitable diffuser system.

4.6 Secondary Treatment Process.

Screened, de-gritted sewage shall be fed into the Secondary Biological Treatment system to meet the treated effluent quality prescribed in 4.12.

4.7 Chlorination System

The Treated Sewage from the Secondary treatment units will be collected in a chlorination tank where chlorine will be added for disinfection at suitable dosing rate with necessary mixing arrangements. The treated sewage is to be disposed into the water stream by suitable outfall arrangements.

4.8 Sludge Handling System

The sludge from the Treatment Plant shall be collected in a sludge sump where it is aerated continuously for mixing. The aerated sludge shall be treated through mechanical dewatering system with required aeration and polymer dosing before de watering. Safe disposal of sludge can be proposed by any one of the processes namely thickening, digestion, aeration and de watering. The sludge cake shall be transported to the adjoining compost yard of the municipality in a safe manner and disposed off by the ULB as per applicable section Solid Waste Management Rules of CPCB. The cent rate shall be re circulated into the inlet of the receiving chamber.

4.9 Design criteria:

The process considered shall be a modern Technology for treatment of sewage. The Proposed Treatment scheme shall consist of **based on proven technology such as EASP. Hence the technical specification for EASP is provided. However it is liberty of the bidder to choose any technology.** The bidders are to adopt the same nomenclature used for various treatment units in their design report as used in the bid documents.

The STP shall be designed for 21.85 mld capacity. The land provided is for augmenting the capacity to the ultimate flow of 25.30 mld. The General Arrangement Drawing (GAD) of STP units, both for intermediate stage flow of 21.85 MLD and Ultimate stage flow of 25.30 MLD shall be provided; supported by hydraulic sizing calculation, and showing the arrangements of roads, drains and green belt all around and administrative blocks/laboratories/ other utilities and buildings. The unit arrangements shall be optimized as much as possible. **However the detailed design shall be furnished for only 21.85 mld.**

To the extent possible, the plant must be designed in modules so as to augment the capacity as and when the plant reaches its designed capacity. It is also informed that the expected sewage flows cannot be generated immediately after construction and that they are likely to increase gradually and that the STP should be able to perform at the designed levels with these low flows.

The process design of various units shall be done as per the norms prescribed in the CPHEEO Sewerage Manual (2013) and with the following criteria for guidelines. Any other specific criteria required for designing the units for the technology proposed by the bidder shall be get approved by the Employer by providing due justification.

The material for major interconnecting pipes for various units in the STP shall be as follows.

Air blower discharge header: MS epoxy painted.

All grid piping : PVC/equivalent

All bye pass lines: CI D/F heavy weight

Chlorine solution feeder : PVC/equivalent

Chlorinated treated effluent up to discharge point: RCC NP3/RCC NP4 using sulphate resistant cement with high alumina cement lining

All sludge/sewage/Grit piping : CI D/F heavy weight

The process design of various units shall be done as per the norms prescribed in the CPHEEO Sewerage Manual (Latest Edition) and with the following criteria for guidelines.

Sl.No	Name of the Unit	Design parameter
1.	Receiving Chamber	Average Flow- 21.85 mld. Peak Factor-2.25 Detention Time-60 secs.
2.	Coarse screen	Average flow – 25.30 mld. (ultimate) No. of units-2 Nos.(Mechanical-1 No, Manual-1 No) Approach velocity at Avg. flow –0.3m/sec Velocity through screen at average flow- 0.6m/sec Velocity through screen at Peak flow- 1.2 m/sec
3.	Fine Screen	Average flow –21.85 mld. . No. of units-2 Nos.(Mechanical-1 No, Manual-1 No) Approach velocity at Avg. flow –0.3m/sec Velocity through screen at average flow- 0.6m/sec Velocity through screen at Peak flow- 1.2 m/sec
4.	De gritting	Average flow – 21.85 mld. No. of units-2 Nos.(Working-1 No, Stand by-1 No) Surface overflow rate – $960\text{m}^3/\text{m}^2/\text{day}$ Velocity –0.15m to 0.30m/sec Detention time-60sec.
5.	Primary Clarifier- Centrally driven if required.	Average flow – 21.85 mld Peak factor –2.25 Overflow rate– $35 - 50\text{m}^3/\text{m}^2/\text{day}$ (Avg. flow) $80-120\text{m}^3/\text{m}^2/\text{day}$ (Peak Flow)
6.	Aeration .	Average flow – 21.85 mld Peak factor –2.25 MLSS-3000-4000 mg/lit MLVSS/MLSS –0.80 F/M=0.3-0.5 kg BOD 5day/ Kg MLSS/day HRT- 4-5 Hours. Kg of O ₂ required/Kg of BOD removed-0.8 to 1.0 Return Sludge-25-50%
7.	Secondary Clarifier (if required)	Average flow – 21.85 mld Peak factor –2.25 $25\text{m}^3/\text{m}^2/\text{day}$ (Avg flow) Over flow rate– $15-40-50\text{m}^3/\text{m}^2/\text{day}$ (Peak Flow)
8.	Sludge Handling Units	As per CPHEEO Manual
9.	Chlorine contact Tank	Dosage-10ppm Contact time- 30 minutes Average flow-5.58 mld
10.	Other Secondary Treatment system	Bidder to specify as per deign.

4.10 Raw Sewage Quality

An abstract of Raw sewage characteristics is indicated in the following Table.

Sl.No.	Parameter	Values	Unit of measurement
1	Bio-chemical Oxygen Demand	250 - 325	Mg/l
2	Chemical Oxygen demand	400 - 700	Mg/l
3	Total suspended solids	200 - 300	Mg/l
4	Total Kjeldahl Nitrogen (as N)	30 - 45	Mg/l
5	Ammonia Nitrogen (as N)	10-20	Mg/l
6	Total Phosphorous (as P04)	5-10	Mg/l
7	Fecal Coliform	10 ^ 6	MPN/100 ml
8	pH	7 - 8	
9	Oil and grease	5-10	Mg/l

4.11 Treated Effluent Quality

The contractor shall design the process in such a way that the treated effluent quality attains the following limits or even better. The treated sewage shall meet the latest discharge norms as prescribed by the CPCB/TNPCB.

Sl. No.	Parameters/Pollutants	Values	Unit of measurement
1	Bio-chemical Oxygen Demand (as BODs)	30mg/l or less	Mg/l
2	Total suspended solids	100mg/l or less	Mg/l
3	Chemical oxygen demand	50mg/l or less	Mg/l
4	pH	6.5 - 9.0	
5	Oil and grease	Less than or equal to 5 mg/l	Mg/l
6	NH4	5 mg/l or less	Mg/l
7	Nitrogen	10mg/l or less	Mg/l
8	Fecal Coliform	Less than 1000	MPN/100ML

4.12 Free Board

A Free Board of 0.5 m. should be provided in the each unit and designed accordingly.

4.13 Pathway and Staircase

RCC Platforms with SS 304 railing shall be provided at the upper level to enable operation. The railings shall be provided around the entire structure and as well as for the periphery of the platform. The entire structure is to be as per IS 3370 including the platform for the gates. RCC staircase of 900 mm wide, shall be provided for access from the ground level to the top of the unit & to the operating platforms with SS railings. Pathways for access to various units from the road shall be provided with appropriate precast tiles conforming to I.S specification. RCC linking channel with path way for required width linking all the units with SS railing/ handrails shall be provided all around the periphery of the pathway on both sides and around the individual units. The pathway should be contiguous right from receiving chamber up to the last unit. Necessary RCC staircase with SS hand rails shall be provided for access to each unit from ground level. The path way shall be provide with suitable non slippage ceramic tiles. Necessary shutters of suitable size shall be provided in the channel for diversion of control of flow. All these structures should be confirms to relevant IS specifications.

5. As-built Drawings:

The contractor shall submit six copies with one set of originals of completion plans as executed with all the details for all items of work in the Sewage Treatment Plant. The contractor shall also submit all the above in a compact disc (in recent version of AutoCAD) in a scale not lower than 1:1000 as approved by the Engineer.

The contractor shall also submit six copies of operation & maintenance manual for all items of works for proper maintenance of the system in future. The successful contractor shall also maintain the entire system for a period of ten years from the date of satisfactory commissioning of the project.

6. SPECIFICATION**6.1 INTERPRETATION:**

In this contract the following works shall be understood as having the meaning herein assigned to them.

- a) "Contractor" means the person or persons or firm or company contracting for the work specified, including his or their executors or administrators or legal representatives or successor.
- b) "Engineer" means the Executive Engineer or his representative or any other Engineer appointed from time to time by the Employer to act as such in connection with these works. Whenever any work is specified to be done or materials supplied to the satisfaction of the Engineer, it shall be taken as including his properly authorized assistance and duly authorized representatives.
- c) "Works" mean works to be constructed, completed and maintained in accordance with this contract.
- d) TNBP – Tamil Nadu Building Practice
- e) IS – Indian Standard
- f) ISS – Indian Standard Specification
- g) BIS – Bureau of Indian Standards

II GENERAL SPECIFICATIONS

1. Contractor's Responsibility

The information given hereunder and provided elsewhere is given in good faith but the Contractor shall satisfy himself regarding all aspects of site conditions and no claim whatsoever will be entertained on the plea that information supplied by the Engineers is erroneous or insufficient.

2. Construction Water

The Contractor shall make his own arrangement for the fresh water required for the manufacturing of the pipes, construction of civil works and testing of pipeline as well as for the potable water required for his factory & labour camps.

3. Construction Power

The Contractor shall make his own arrangement for supply of electrical energy required at his sites and the works from the Tamil Nadu Electricity Board.

The Contractor is forewarned that there can be interruptions in power supply for reasons beyond the control of the Tamil Nadu Electricity Board and therefore the Contractor is advised to make his standby arrangement to provide and maintain all essential power supply for his work area at his expense. The Contractor shall not be entitled to any compensation for any loss or damage to his machinery or any equipment or any consequential loss in progress of work and idle labour.

4. Survey

The Contractor shall, at his own expense provide and maintain survey stations which he may require to carry out the works and shall remove the same on completion of the works. The Contractor shall, at his own expense, carry out all the necessary surveys, measurements and setting out of the works and shall for this purpose engage qualified and competent engineering surveyors whose names and qualifications shall be submitted to the Engineer for his approval.

The Contractor shall for the purpose of checking the survey and setting out, provide to the Engineer all the assistance, which he may require. The surveyor shall be selected having appropriate experience and as far as possible, the same surveyor shall be provided throughout the contract period. Before commencing any work at any locations, the Contractor shall give the Engineer not less than two days notice of his intention to set out or give levels for any part of the work in order that arrangements may be made for inspection. The Contractor shall provide for the sole use of the Engineer and his staff, all necessary survey instruments and other equipment and all technicians, labour and attendants which the Engineer may require for checking the setting out and marking of the works. The Contractor shall maintain in good working order at all time during the period of contract the instruments provided by him, for the proper setting out of the works. The Contractor shall make available at his own expense, any poles, staging templates.

5. Temporary Fencing

The Contractor shall, at his own expense, erect and maintain in good condition temporary fences and gates along the boundaries of the areas assigned, if any, to him by the Engineer for the purpose of the execution of the works.

The Contractor shall, except when authorized by the Engineer, confine his men, materials and plant within the site of which he is given possession. The Contractor shall not use any part of the site for purposes not connected with the works unless prior written consent of the Engineer has been obtained. Access shall be made to such areas only by way of approved gateways.

6. Return Of Labour And Plant

The Contractor shall supply to the Engineer by 9 a.m. every working day a return of the men employed by him and his sub-contractors on the previous working day and all of the work on which they were engaged specifying also the number employed in each trade. He shall also supply monthly any other returns which may be required as to the number of men and constructional plant employed and the nature and type of the work done.

7. Sanitary Facilities

The Contractor shall provide and maintain in a clean and sanitary condition adequate W.C.'s and wash places which may be required on the various parts of the site for use of his employees, to the satisfaction of the Engineer. The Contractor shall make all arrangements for the disposal of sewage or drainage in accordance with the directions of the Engineer.

8. Restricted Entry To Site

The Contractor shall get the prior permission of the Engineer before any person not directly connected with the works visits the site.

9. Existing Services

Drains, pipes, cables, overhead electric wires and similar services encountered in the course of the works shall be guarded from injury by the Contractor at his own cost, so that they may continue in full and uninterrupted use to the satisfaction of the Engineer and the Contractor shall not store materials or otherwise occupy any part of the 'site' in a manner likely to hinder the operation of such services. Should any damage be done by the Contractor on any mains, pipes, cables or lines (whether above or below ground), whether or not shown on the drawings, the Contractor must make good or bear the cost of making good the same without delay to the satisfaction of the Engineer and of the Employer.

10. Local Roads and Haul Roads

The approach roads and other public roads in the state may be used by the Contractor to haul construction materials and equipment subject to restriction of load carrying capacity on the roads in particular over bridges and culverts. However, the Contractor will have to pay customary vehicles license and permit fees for use of public roads.

The Contractor shall plan transportation of construction materials to site in such a way that road accidents are avoided.

11. Permission for Road Cuts

Wherever the Contractor considers that it is necessary to cut through an existing road or track he shall submit details to the Engineer for approval, a minimum of seven days before such work commence.

In the event of cutting a road by the Contractor without permission from the Engineer the Contractor shall pay compensation as claimed by the owner of the road until it is restored at the cost of the erring Contractor.

Trench Digging:

Digging of trench by the Contractor beyond the length than that is specified by the Engineer shall invite a fine imposed by respective authorities till such time the damage is restored.

12. Temporary Diversion of Roads

During the execution of the works the Contractor shall make at his cost all necessary provision for the temporary diversion of roads, cart-tracks, footpaths, drains, water courses, channels etc., Should he fail to do so, the same shall be done by the Engineer and the cost thereof will be recovered from the Contractor.

13. Notice to Telephone, Railways & Electricity Supply Under Takings / Depts., etc.

The Engineer shall deposit an amount to the respective local bodies/Highways department for restoration of road surface after completion of pipe laying work. The Engineer shall obtain general permission to cut the road.

Before commencing operations the Contractor has to obtain specific permission from local bodies/Highways Department when he wants to cut any section of the road. Where operations involve cutting of roads, shifting utilities etc. during the process of work, the

Contractor shall also give notice to the concerned authorities viz. the Panchayats / the Municipalities, the Railway department, the Electricity Board, Telegraphs department, the Traffic department attached to the police and other departments or companies as may be affected by the work. The notice should identify the specific details so that the necessary diversion of traffic may be arranged and permissions obtained. The Contractor shall co-operate with the department concerned and provide for necessary barricading of roads, protection to existing underground cables etc. met with during the excavation of trenches. The Contractor shall provide at his own expenses watching and lighting arrangements during day and night and erect required notice board such as "Caution Road closed for Traffic" etc. He should also provide and maintain at his own cost the necessary supports for underground cables etc. to afford best protection to them in consultation with the authorities in-charge of the properties and to their best satisfaction. The Contractor has to make necessary arrangements to get supply of electricity from TNEB for operating the machinery and equipments. The Engineer will pay the necessary service connection and S.D. charges. The Contractor should obtain all approvals for the installation and commissioning of machinery and accessories offered by them from the respective inspecting authorities such as CEIG or CFIG etc., Fees if any, to be paid to the inspecting authorities will be reimbursed by the Engineer

14. Barricading

The pit / trench shall be barricaded on all four sides. The Contractor who has dug up the trench shall be responsible for any mishap, which may occur. Non-barricading of trenches by the Contractor shall be liable for a fine of Rs.500/- per day.

15. Length of Trench Open at One Time

The Pipe line shall be excavated in such length as may be ordered by the Engineer depending on the nature of the ground, the depth from the surface and the risk of damage to the adjoining property. The pipes shall not be covered until they may have been tested to the satisfaction of the Engineer. But in bad ground in close proximity to buildings or in other places where the Engineer shall consider necessary he may limit the length of trench so that there shall not be more than three pipes lengths from the refilled trench to the unbroken ground ahead.

16. Watching and Lighting

The Contractor shall at his expense provide at the site of work sufficient lighting and watching and fencing by night and by day and shall in every respect conform to the police regulations in these matters and he shall free and relieve the Engineer, Should he neglect to do so, the same shall be provided by the Engineer and the cost thereof will be recovered from the Contractor.

17. Filling in Holes and Trenches Etc.

The Contractor immediately upon completion of the Works shall fill up holes and trenches which may have been made or dug, level the mounds, or heaps or earth that may have been raised or made, and clear away all rubbish which may have become superfluous or have been occasioned or made in the execution of the works, and the Contractor shall bear and pay all costs, charges etc. Failure to carry out the work within two days will attract a fine of Rs 500/- per day.

18. Power to Vary Work

The Engineer reserves the power to vary, extend or diminish the quantities of Work, to alter the line, level, or position of any work to increase, change or decrease the size, quantity, description, character or kind of any Work, to order the Contractor to execute the Works or any part thereof, by day or night Work, or to add or to take from the Work included in the contract as he may think proper without violating the contract and the Contractor shall not have any claim upon the Employer for any such variation, extension, diminution, alteration, increase, change or decrease other than for the Work actually done, calculated according to the prices tendered and accepted in this contract.

19. Extra or Varied Work

If the Engineer uses the power reserved to him under Clause 18 above an order in writing signed by the Engineer, shall be given to the Contractor to that effect and any Work executed under such order shall be paid for at the rates set forth in the Schedule of Prices prevailing at the time of execution where such rates in the opinion of the Engineer apply. This shall apply to

unforeseen items of work which are not found in the Bill of Quantities. If the rates are not available in the Schedule of Prices, a rate or price shall be agreed upon between the Engineer and the Contractor in writing and failing their agreement the Contractor shall forthwith execute such order and the Engineer shall determine the rates or prices at which the work shall be paid off.

20. Free Flow of traffic

While executing the work, as soon as possible, the Contractor should allow as much traffic as possible on the roads/streets, by refilling the trenches cut across.

21. Tools and Plants

All tools and plants required for the work including sheet piles and timber for shoring and strutting, pump sets etc. shall be supplied by the Contractor at his own cost. The rate for the relevant items of work are inclusive of all such tools and plants and apparatus required for the execution of the work.

22. Excess Materials

The Contractor shall be responsible for the procurement of required quantity of materials like pipes, specials, machinery, electrical items etc. Any materials procured for the work, if found excess due to any reasons after completion of the works, shall be taken back by the Contractor and the Employer / Engineer shall not be responsible for such excess materials. Amount paid if any for such excess materials shall be deducted from any bills payable to the Contractor.

23. Commissioning of Works

The Contractor shall be responsible for successful commissioning and stabilizing the plant before the commencement of operation and maintenance period of ten (10) years.

24. General

Before submitting the bids, the bidder should carefully go through all the bid documents, drawings and also inspect the place of work so as to get full and firsthand knowledge of the site conditions based on which he has to quote his rate.

The process submitted should be a modern Technology process for treatment of sewage. The tenderness are to adopt the same nomenclature used for various treatment units in their design report as used in the tender document.

24.1 Accidents

It shall be the duty of the Contractor to arrange for the execution of the works in such a manner as to avoid the possibility of the accidents to persons or damage to the properties at any stage of the progress of work. Nevertheless he shall be held wholly responsible for any injury or damage to persons and properties, which may occur irrespective of any precautions he may take during the execution of the works. The Contractor shall make good all claims and loss arising out of such accidents and indemnify the Engineer from all such claims and expenses on account thereof.

24.2 Flood Damages etc.

The Contractor has to take risk insurance at his cost against losses due to unprecedented floods and other acts of God. No claim shall be entertained on this account and paid for.

24.3 Water and Lighting

The Contractor shall pay all fees and provide water and light as required from Municipal mains or other sources and shall pay all charges there for (including storage tanks, meters etc.) for the use of the works and workmen, unless otherwise arranged and decided on by writing with Engineer. The water used for the works shall be free from earthy vegetable or organic matter and from salts or other substances likely to interfere

with the setting of mortar or otherwise prove harmful to the work and conform to relevant standards.

24.4. Rates

The Contractor shall particularly note that the accepted rates of the various items shall be inclusive of all incidental charges such as bailing by manual labour, dewatering, shoring etc. if found necessary during the execution and no extra shall be due therefore on any account during the currency of the contract, unless stated otherwise.

24.5. Royalty Charges

The Royalty will be charged for the materials obtained from P.W.D. or other Government quarries. Assistance as necessary will be given to the Contractor by the Engineer. No plot rent shall be charged for materials stacked on Employer's lands during the course of construction provided all such materials are removed within one month after the work is completed. Royalty or charges due in the case of private quarries and private bodies shall be paid by the Contractor.

24.6. Payment to Labourer

The Contractor should note, it is the responsibility of the contractor if the event arises that, he shall pay all Labourer every day. The Contractor shall not employ any labours below the age of 18 years.

24.7 Night Works

If night work is required to fulfill the agreed rate of progress and to complete the work within the period stipulated, prior written approval is necessary and all arrangement shall be made by the Contractor including lighting without any claim for extra rate.

24.8. Errors, Omissions And Discrepancies

In the case of errors, omissions, and/or disagreement between the written and the scaled dimensions on the drawings or between the drawings and the specifications, the following order of precedence shall apply.

- i) In case of discrepancies in dimensions of any item of work as described between the descriptive specifications and detailed working drawings, the dimensions given in the detailed working drawings shall apply.
- ii) In case of discrepancies in description of scope of work between what is indicated in the item of work given in Bill of Quantities and the corresponding detailed technical specifications, the latter shall apply.
- iii) Figured dimensions shall supersede scaled dimensions. The drawings on a large scale shall take precedence over those on a smaller scale.
- iv) Drawing issued as construction drawings from time to time shall supersede the corresponding drawings previously issued.

24.9. Equivalence of Standards and Codes

Whenever reference is made in the contract to the respective standards and codes in accordance with which plant, equipment or materials are to be furnished and work is to be performed or tested the provisions of the latest current edition or revision of the relevant standards and codes in effect shall apply, unless otherwise expressly set forth in the contract. Where such standards and codes are national in character, or relate to a particular country or region, other authoritative standards which ensure equal or higher quality than the standards and codes specified will be accepted subject to the prior review and written approval by the Engineer. Difference between the standards specified and the proposed authoritative standards must be fully described in writing by the Contractor and submitted to the Engineer well in advance for approval. If on the prior review, the Engineer determines that such proposed deviations do not ensure equal or higher quality, the Contractor shall comply with the standards set forth in the contract document.

24.10 Bidder to Satisfy Himself

It will be the Contractor's responsibility to satisfy himself from the inspection of the site that sufficient quantities of construction materials required for the works exist in the designated borrow areas and quarry sites.

Failure by the Contractor to have done all the things, which in accordance with this condition he is deemed to have done shall not relieve him of the responsibility for satisfactorily completing the work as required.

24.11 Employment of Scarcity Labour

If Government of Tamil Nadu declares a state of scarcity or famine to exist within 16 kms. of the project site, the Contractor shall be required to employ in his works for which he will need unskilled labour and to the extent his works can accommodate any person or persons certified to him by the Engineer to be in need of relief and the Contractor shall pay to such persons wages not below the minimum wage which the Government may fix in this behalf from time to time.

24.12 All labours and other employees of the Contractor should be covered by a suitable accident insurance policy to cover liabilities under the Workman's Compensation Act.

24.13 Electricity Tariff

The unit rates and prices quoted by the Bidder in the Bill of Quantities shall include the cost of electric energy required for construction at the rates fixed by the Tamil Nadu Electricity Board.

III GENERAL SPECIFICATIONS FOR MATERIALS AND CIVIL WORKS

A. Materials

All materials required for the works shall be procured and supplied by the contractor himself. The materials shall be of good quality and conforming to relevant BIS. The materials which are classified for ISI marking should be supplied with ISI marking only.

1. Cement and Reinforcement:

- 1.1 The entire quantity of cement and steel required for the work will be procured by the contractor. The contractor is responsible for all transport and storage of the materials and shall bear all related costs. The Engineer shall be entitled at any reasonable time to examine the cement and steel supplied by the contractor.
- 1.2 The cement procured by the contractor shall comply with the requirements of IS 269/ 1976 with the latest revision thereof for 33 grade ordinary port land cement and IS 12330/ 2001 for sulphate resistance cement, IS 8112/1989 with the latest revision thereof for 43 grade ordinary portland cement IS: 12269-1987 with the latest revision thereof 53 grade ordinary Portland cement. It shall be of the best normal setting quality unless specially rapid hardening or quick setting quality if expressly instructed by the Engineer to be supplied. Each bag shall bear ISI Certification mark and as per specification no. 10 of TNBP volume I.

Corrosion Resistance Steel and Structural Steel:

- 1.3 The steel bars shall comply with the requirements set forth in the BIS Codes (Grade TMT Fe 500 D, BIS Code 1786-2008) as the case may be with the latest revision thereof and the test as described for ultimate tensile strength, bend test and elongation tests.

All reinforcing steel shall be clean and free from oil, grease, loose scales or rust or other coatings of any character, which would reduce or destroy the bend. Each bundle containing the bars shall bear the ISI Certification mark.

Storage of reinforcement - suitable pre-treatment of rebar to be made using appropriate agent/ solvent to remove mill oxide layer and other rust / existing coating and then follow up coating with corrosion protection material and or cement wash as directed by the client Engineer.

Store bars of different class, sizes and lengths separately to facilitate issues in such sizes and lengths so as to minimize wastages in cutting from standard lengths. Coat steel reinforcement with cement wash before staking to prevent scaling and rusting. If reinforcement bars have to be stored for a long period, then stack it above ground level by at-least 150 mm.

- 1.3 The cement/ steel shall be tested in nearby accredited laboratories of Polytechnic or Engineering College/NABL accredited laboratories as directed by the Engineer. Two samples should be taken by the Engineer in charge in the presence of the contractor or his authorized representatives or the technical personnel employed by the contractor as in the agreement. The contractor shall without extra cost provide samples and cooperate in the testing of the cement/ steel. One sample shall be got tested and the other sample shall be retained by making clear identification in the sample by the Engineer in charge so as to identify at a later date. The cost of such test shall be borne by the contractor.
- 1.5 All cement shall be procured in bags and shall be stored in a dry place for which the contractor shall be responsible. Consignment of bagged cement shall be properly stacked in a manner which will permit easy access for inspection and definite identification. Cement shall be used in approximately in the chronological order in which it is received, but cement that has been stored for a period longer than 4 months from the date of initial sampling shall not be used unless it has been retested at the expenses of the contractor and passed by the Engineer in charge as good quality on the retest. Cement aged more than 180 days from the date of initial sampling shall be rejected.

- 1.6 Cement which has become caked or perished shall on no account be used on the works and shall be rejected. Although the Engineer may have passed any consignment, he shall however have the power at the subsequent time to reject such consignment if he finds that any deterioration in the quality thereon has taken place.
- 1.7 A record of the quantity of cement/ steel procured with the name of dealer, bill number and date shall be maintained by the contractor. This should be produced for examination by the Engineer in charge at any time. The age of the cement shall be reckoned from the date of manufacture and it shall be verified by the Engineer in charge.
- 1.8 The rejected consignment of cement and steel should be removed from the site within two days.

2. Aggregates:

- 2.1 Sand for use in masonry and plaster works shall conform to relevant specification in TNBP (specification No.7) and I.S.2116/ 1985, I.S.1542/ 1977.
- 2.2 The coarse and fine aggregates for concrete shall conform to I.S.383/ 1970 and as specified in the relevant clauses of I.S.456/2000. Other aggregates free from deleterious materials shall be used at the concurrence and approval of the Engineer after sufficient tests have been carried out at the contractor's cost.
- 2.3.1 The maximum quantities of deleterious materials in the aggregates, as determined in accordance with I.S.2386 (Part II)/ 1963 shall not exceed the limits given in table I of I.S.383. Unless otherwise specified all coarse aggregate in RCC shall be graded aggregate of 20mm nominal size. All aggregates shall be stored in hard impervious surface to ensure exclusion of all foreign materials and as per IS 4082/1996 and specification no. 5 of TNBP volume I.
- 2.4 Aggregate having a specific gravity below 2.6 (saturated surface dry basis) shall not be used without the special permission of the Engineer.

3. Bricks:

3.1 Manufacture :

Common burnt clay building bricks shall conform to the requirements of IS 1077 and shall be of quality not less than class 50 with moisture absorption rate not exceeding 15% as defined in IS : 1077. The bricks shall be chamber burnt and shall not be damaged in any manner and sizes shall conform to the works sizes specified with tolerance as given in 6.2 of IS:1077.

3.2 Samples :

The Contractor shall deliver samples of each type of brick to the Engineer, and no orders shall be placed without the written approval of the Engineer. All the bricks used in the works shall be of the same standard as the approved samples. The samples shall be preserved on site, and subsequent deliveries shall be checked for uniformity of shape, colour and texture against the samples. If in the opinion of the Engineer any deliveries vary from the standard of the samples, such bricks shall be rejected and removed from the site.

3.3 Uniformity :

The bricks selected for exposed pointed brickwork walls shall be of uniform colour, deep cherry red or copper colour and uniform texture. Only such bricks as are permitted by the Engineer shall be used.

3.4 Testing :

Samples of the bricks shall be tested in accordance with IS: 3495 by the Contractor for compliance with the aforesaid, before any order is placed, and soon after receipt of a consignment. Tests shall be carried out as and when required by the Engineer on samples selected by the Engineer's representative.

B CIVIL WORKS**4. General:**

- 4.1.1 Tamil Nadu Building Practice (TNBP) shall be strictly followed for carrying out different items of the work for which no standard specifications are available and no alternate specifications have been given under the description of works.
- 4.1.2 Barricading of all the work areas and trenches is the responsibility of the contractor to ensure zero accidents. The work areas / trenches shall be barricaded (Casurina Barricading arrangements) on all four sides, if required. The Contractor who has dug up the trench shall be responsible for any mishap, which may occur. Non-barricading of work areas/ trenches by the Contractor shall be liable for a fine, which will be decided by the Engineer.
- 4.1.3 Where any provision of the TNBP is repugnant to or at variance with any provision under BIS or description of work, technical specifications and conditions of contract, the provisions of the later shall be deemed to supersede the provision of the TNBP.
- 4.1.4 The Contractor shall provide and maintain in clean and sanitary condition adequate W.C.'s and wash places, which may be required on the various parts of the site or use of his employees, to the satisfaction of the Engineer. The Contractor shall make all arrangements for the collection and disposal of sewage of drainage in accordance with the directions of the Engineer

4.2 Design Considerations:**4.2.1 Design Submissions**

The contractor shall be responsible for the safety of structures, correctness of design and drawings, even after the approval of the same by Engineer-in-Charge. Complete detailed design calculations of foundations and superstructure together with general arrangement drawings and explanatory sketches shall be submitted to the Engineer-in-charge. Separate calculations for foundations or superstructures submitted independent of each other shall be deemed to be incomplete and will not be accepted by the Engineer-in-charge.

The design considerations described hereunder establish the minimum basic requirements of plain and reinforced concrete structures, masonry structures and structural steel works. However, any particular structure shall be designed for the satisfactory performance of the functions for which the same is being constructed.

4.2.2 Design Loading**(a.) General**

All buildings and structures shall be designed to resist the worst combination of the following loads/ stresses under test and working conditions: dead load, live load, wind load, seismic load, stresses due to temperature changes, shrinkage and creep in materials dynamic load, vehicular load and uplift pressure etc.

i) Dead Load

This shall comprise all permanent construction including walls, floors, roofs, partitions, stairways fixed, service equipments and other items of machinery. In estimating the loads of process equipment for the purpose of design, the empty weight of the equipment including all fixtures and attached piping, but excluding contents, shall be considered. Dead loads shall be taken as per relevant BIS codes.

ii) Live Load

Live loads shall be in general as per BIS: 875. However, the following minimum loads shall be considered in the design of structures:

a)	Live load	
	Building (non – plant)	250 kg/sq.m.
	Roof of Building Structures	300 kg/sq.m.
b)	Live load on floors supporting equipment as pumps, blowers, compressors, etc	1000 kg/sq.m
c)	Live load on all other floors and walkways /cable trench covers.	500 kg/sq.m
d)	Live load on roof of Tanks/Plant Structure	250 kg/sq.m.
e)	Live load on Stairways	500 kg/sq.m.
f)	Surcharge load for underground structures if any	As per actual condition
g)	Equipment load	As per manufacturers specification

In the absence of any suitable provisions for live loads in BIS codes or as given above for any particular type of floor of structure, assumptions made must receive the approval of the Department / prior to taking up the design work. Apart from the specified live loads or any other load due to material stored, any other equipment load or possible overloading during maintenance or erection shall be considered and shall be partial or full whichever causes the most critical condition.

iii) Wind Load Wind loads shall be as per BIS: 875.

iv) Earthquake Load

Earthquake load shall be computed as per B.I.S. 1893 taking into consideration soil foundation system, importance factor appropriate to the type of structure, basic horizontal seismic coefficient/ seismic zone factor & average acceleration coefficient as applicable.

An importance factor of 1.5 shall be considered for design of all the structures. The soil foundation system coefficient shall be considered as 1.2.

v) Dynamic Load

Dynamic Loads due to working of machines/ equipments such as pumps, blowers, compressors, switch gears, travelling cranes, etc., shall be considered in the design of structures as given by the manufacturers or in BIS code, whichever is more.

IRC Class AA (wheeled vehicle) loading shall be considered for design of structures under or by the side of roads.

4.2.3 Design Conditions for Underground or Partly Underground Liquid Retaining Structures

Liquid retaining/conveying structures including the members covering the same (such as roof of a chamber, channel etc.) shall be designed by uncracked method of design as per BIS:3370 and 6494. Basement RC walls and slabs below ground shall also be designed by uncracked method of design as liquid retaining structures. Shear shall be checked by working stress method as per BIS:456. Minimum temperature and shrinkage reinforcement shall be 0.3% in each direction.

All underground or partly underground liquid containing structures shall be designed for the following conditions:

- a) liquid depth up to full height of wall including free board : no relief due to soil pressure from outside to be considered;

- b) structure empty (i.e. empty of liquid, any material, etc.) : full earth pressure and surcharge pressure wherever applicable, to be considered;
- c) partition wall between dry sump and wet sump : to be designed for full liquid depth up to full height of wall; i/c free board
- d) partition wall between two compartments : to be designed as one compartment empty and other full including free board;
- e) structures shall be designed for uplift in empty conditions with the water table and due care should be taken for seasonal variation on higher side. Factor of safety against uplift shall be 1.2.
- f) walls shall be designed under operating conditions to resist earthquake forces from earth pressure mobilization and dynamic water loads;
- g) under ground or partially underground structures shall also be checked against stresses developed due to any combination of full and empty compartments with appropriate ground/uplift pressures below base slab. The design shall be such that the minimum gravity weight (empty conditions) exceeds the uplift pressure at least by 20%.
- h) For design purpose, sub soil water level is to be considered as one meter below the average natural ground level.

4.2.4 Foundations

The top soil to an average depth of 0.6m is Black cotton soil and beyond that Soft disintegrated rock exists. All the data and details as provided are indicative only and bidders are advised to verify them before submission of their offers. No extra payment shall be made against any discrepancies in the above documents.

Foundation depths and the type of footings shall be appropriately computed from the parameters given or obtained during the soil testing by the contractor whichever is stringent, and got reviewed and approved by department. Earth fill above virgin ground level till formation level shall be taken as a surcharge load and shall be added in the loads coming on foundations appropriately. In some special cases, where contractor wishes to provide the footing in continuation of the sloping floor and taking the wall footing to the minimum depths as mentioned below is not possible, the shortfall

- (i) The minimum depth of foundations for all structures, equipments, buildings and frame foundations and load bearing walls shall be as per the recommendation of BIS provided adequate bearing pressure is available at that depth.
- (ii) Bearing capacity of soil shall be determined as per BIS : 6403.
- iii) Care shall be taken to avoid the foundations of adjacent buildings or structure foundations, either existing or not within the scope of this contract. Suitable adjustments in depth, location and sizes may have to be made depending on site conditions. No extra claims for such adjustments shall be accepted by PMC.
- (iv) A structure subjected to groundwater pressure shall be designed to resist floatation. The dead weight of empty structure shall provide a factor of safety of 1.2 against uplift during construction and service.
- (v) Where there is level difference between the natural ground level and the foundations of structure or floor slab, this difference shall be filled up in the following ways.
 - a) In case of non-liquid retaining structures the natural top soil shall be removed till a firm strata is reached (minimum depth of soil removed shall be 500 mm) and the level difference shall be made up as per specifications. However the thickness of each layer shall not

exceed 150 mm. The area of backfilling for floor slabs shall be confined to prevent soil from slipping out during compaction.

- b) In case of liquid retaining structures, the natural top soil shall be removed as described above and the level difference shall be made up with Plain Cement Concrete of M-10 grade.
- (vi) Wherever the plinth level is above the ground level, a curtain wall shall have to be provided from plinth level up to 300 mm below ground level, but not less than 1m in total height.
- (vii) If pile foundations are used, the contractor shall conduct the initial routine test as per IS 2911 at his own cost, to determine the safe load bearing capacity of piles.

If pile foundations are considered desirable by the tenderer for some/all the units the piles shall be *bored cast-in-situ piles* only. To verify the load carrying capacity of the piles a minimum of two initial load tests shall be conducted and routine load tests as required as per the relevant BIS code shall also be conducted. Soil report should provide capacity of various dia. of pile considering the lowest sub soil condition. Under reamed piles shall not be allowed.

Pressure Release Valve Use of pressure release valves to reduce uplift pressure due to ground water table shall not be allowed.

4.2.5 Design Requirements

4.2.6 General

- a) The Civil & Structural design shall be carried out in accordance to BIS: 456, and BIS: 3370 and other relevant Indian Codes. For the seismic forces, the structure should be designed as per IS: 1893.
- b) According to Bureau of Indian Standards (BIS) [IS 1983 (Part I):2002], Rajapalayam town falls under Zone III and on the macro seismic intensity scale the project area falls under MSK VII (Moderate Damage Risk Zone).

Special care should be taken for design of base slab of Tanks having liquid depth more than 5 meter such base slabs should be designed for a settlement of 40 mm before laying the mud mat concrete. The area for the base slab should be compacted with Coarse Sand till 90% proctor density is achieved.

The following are the design requirements for all reinforced or plain concrete structures.

- a) All blinding and leveling concrete shall be of minimum 100 mm thickness of concrete mix- M15, unless otherwise specified.

Liquid Retaining Structures/Buildings

- b) All structural reinforced cement concrete shall be M30 as per IS 456:2000 for severe condition and shall be designed as per IS 3370:2009.
- c) The minimum reinforcement in walls, floors and roofs of liquid retaining structures in each of two directions at right angles shall be 0.3% using HYSD bars.
- d) All buildings shall be provided with damp proofing for basement and floors and water proofing for roofs as specified in specific requirements.
- e) Any structure or pipeline crossing below roads shall be designed for Class AA of IRC loading or as classified by the respective authority. NP3 RCC pipe (with encases) shall be used below roads inside the plant.
- f) All pipes and conduits laid below the structural units such as PST, FST etc. shall be embedded in reinforced concrete of grade M30 of minimum thickness 150 mm.
- g) Suitable admixtures may be used with the approval of engineer in charge.

Minimum Thickness

The following minimum thickness shall be used for different reinforced concrete members, irrespective of design thickness.

(i)	Walls for liquid retaining structures except at (x) below	:	200 mm
(ii)	Roof slabs for liquid retaining structures (other than flat slabs)	:	150 mm
(iii)	Bottom slabs for liquid retaining structures	:	200 mm
(iv)	Floor slabs including roof slabs, walkways, slabs	canopy	: 125 mm
v)	Wall of cables/ pipe trenches, underground pits	:	150 mm
(vi)	Column footings	:	300 mm
(vii)	Parapets, Chajja	:	100 mm
(viii)	Pre-Cast trench cover	:	75 mm
(ix)	Beams, columns	:	230 mm
(x)	Channels, launder	:	150 mm

5. Earth Work:

5.1 Specification

Tamil Nadu Detailed Building Practice (specification No.23 to the extent applicable) shall be followed for earthwork excavation.

5.2 Conveyance

The excavated earth, blasted rubble etc., shall be conveyed and deposited in suitable places as directed by Engineer in charge within 150m of plant site on one side of the trench only.

5.3 Disposal of Surplus Earth

The excavated soil which is surplus to that required for refilling and after allowing for settlement will have to be removed, spread and sectioned at places shown on the site during execution shown by the Engineer within a radius of 5km from the site. Sectioning is to be done as detailed in TNBP. It is to be understood that no extra payment, will be made for this. The cost of removal of surplus earth after spreading/leveling/sectioning at site approved by the Engineer-in-charge to the disposal site will be borne by the Contractor by himself.

5.4 Shoring, Strutting and Baling out Water

While baling out water during excavation, care should be taken to see that the bailed out water is properly channelized to flow away without stagnation or inundating the adjoining road surfaces and properties.

All costs towards shoring, steel shuttering and baling out of water will be borne by the Contractor.

6. Concrete:

6.1 Specification

Concrete for use in the works shall generally comply with TNBP (specification No.30) and the relevant BIS. The concrete mix design shall be in specified proportions satisfying the maximum aggregate size, water cement ratio and required cube strength and workability as per IS 456-2000. Such concrete must be adequately vibrated to form solid mass without voids. The entire concreting works should be done only with the prior approval and in the presence of Engineer in charge.

6.2 Mixing of Concrete

The concrete shall be proportioned as far as cement and aggregates are considered by volume. The amount of water required being measured either by weight or volume. The adjustments must be made to frequent intervals at the discretion of the Engineer or his assistant to account for the moisture content of the aggregates. The mixing operation shall be performed only in a mechanical concrete mixer and shall continue until the whole batch of uniform consistency and colour is achieved. The mixing of concrete shall be done in accordance with clause 8 and 9 of IS 456-2000.

6.3 Transporting, Placing and Compacting Concrete

- 6.3.1 Transportation, placing and compaction of concrete mix by mechanical vibrators shall be done in accordance with clause 12 of IS 456-2000. It is imperative that all concreting operations be done rapidly and efficiently with minimum rehandling and adequate manpower shall therefore be employed to ensure this.
- 6.3.2 The forms shall be first cleaned and moistened before placing concrete.
- 6.3.3 The mix should not be dropped from such a height as it may cause segregation and air entrainment. When the mix is placed in position, no further water shall be added to provide easier workability.
- 6.3.4 No concrete mix shall be used for the work if it has been left for a period exceeding its initial setting time before being deposited and vibrated into its final position in the member.
- 6.3.5 While one concrete is being placed in position it shall be immediately spreaded and ramped sufficiently to attain dense and complete filling of all spaces between and around the reinforcement and in to the corners of form work for ensuring a solid mass entirely free from voids.
- 6.3.6 Construction joints required in any of the structural members shall be provided generally complying with clause 12.4 of IS 456-2000 and as directed by the Engineer in charge. The efficiency of tempering and consolidation will be judged by complete absence of air pockets, voids and honey combing after removal of form works.
- 6.3.7 Minimum cover suggested is 75 mm for concrete facing/in contact with sewage and 50 mm for concrete facing earth/open.

6.4 Curing

- 6.4.1 Curing shall be done to avoid excess shrinkage or harmful effort to the members generally complying with clause 12.5 of IS 456-2000. Minimum number of days to be adopted for curing is 21 days for achieving desired strength of concrete as per norms/standards.
- 6.4.2 The method adopted shall be effective and any special method used must be approved by the Engineer and be subject to complete supervision.
- 6.4.3 Any deficiency in concreting such as cracking, excessive honeycombing, exposure of reinforcement or other fault which entail replacement of the defective part by fresh concrete and whatsoever remedy reasonable required without hampering the structural safety and architectural concept, all at the cost of contractor.

6.5 Removal of Form Work.

- 6.5.1 Removal of form work shall be done as per T.N.B.P. and as per I.S.456/2000 and as directed by the engineer in such a manner that no damage is caused to the concrete work. Minimum number of days to be adopted for removal of form work after pouring concrete is 14 days or 21 days as required and as directed by the Engineer.

6.5 scaffolding

All scaffolds are to be capable of supporting, without failure at least 4 times maximum intended load. Never allow debris/ Materials to collect on scaffolds. Always use netting to catch anything that falls' and make sure scaffold is secure. Stay off scaffold during loading or unloading. All workers boarding scaffolding should be provided with safety harness/ belts/ brass and affixed / tethered to a firm base for preventing risk. The contractor shall use steel scaffolding only.

6.6 Testing of Concrete.

- 6.6.1 During the course of construction works, preparation of test specimens, curing and casting of concrete shall be done in accordance with IS 1199 and IS 516 to ascertain the strength requirements and acceptance criteria indicated in IS 456-2000. The contractor shall provide all apparatus, labour and arrange to test the cubes at his own cost at the test laboratory decided by the Engineer.
- 6.6.2 In addition to the above tests, any other test which may if desired by the Engineer in charge be carried out from time to time as per relevant specifications at the cost of contractor. In case the concrete does not meet the strength required, all corrective measures shall be taken at once at the contractor's cost.
- 6.6.3 The inspection and testing of structures shall be done in accordance with clause 16 of IS 456/ 2000.

7. BRICK WORKS**7.1 Laying :**

Brickwork shall be uniformly bedded, bricks being laid upwards. Each brick shall be floated and rubbed in upon such sufficient quantity of mortar that the mortar is squeezed up into the joints, but if such joints are not filled with mortar by this process they shall be flushed up with the mortar from the next succeeding bed. The courses shall be laid truly and strictly to line and horizontal level.

7.2. Bond :

Brickwork courses shall be alternately laid in stretcher bond and header bond. Damaged bricks shall not be used. The greatest care shall be taken to prevent mortar dropping on to or in any other way disfiguring or discoloring the bricks, and all edges and sides shall be kept strictly plumb and square, in-line, and flush with the required finished face. As the work proceeds, it shall be continuously checked with a 2 m long straight edge and spirit level.

7.3 Construction :

Walls shall be carried up in a uniform manner and no one portion raised more than 1 m above another at any one time, the open end being racked out. Over-hang work shall in no case be permitted. Brickwork shall be cleaned down after each day's work and newly laid brickwork shall be protected by suitable means.

7.4. Dry Weather :

In dry weather the suction rate of clay bricks shall be adjusted by wetting as necessary before use. Bricks shall be stored in a free draining area and protected from rain.

7.5. Lintels :

Where brickwork rests upon lintels or supporting ribs of concrete, the bricks shall be cut as necessary and carefully bedded so that proper support to the outer leaf of brickwork is obtained.

7.6 Pointing :

At the time of laying, all joint of exposed brickwork shall normally be raked out neatly and pointed to 15mm depth.

7.7 Approval :

All workmanship shall be strictly in accordance with the foregoing. The Engineer or the Engineer's representative reserves the right to reject any of the work on grounds of shabby workmanship. Such rejected work shall be removed and rebuilt to the Engineer's satisfaction.

7.8 Quantity of Mortar :

Quantity of mortar to be used in one Cum. of masonry shall vary from 0.30 Cum. for thin masonry to 0.32 Cum. for massive masonry of conventional bricks.

7.9 Cement Mortar :

The cement mortar to be used on the work should be generally conforming to specification No.13 of TNBP. Only sufficient mortar shall be mixed as required for immediate use. Partly set mortar shall not be used.

8. Water required for Construction:

- 8.1 The water used in the construction shall be of potable quality and shall be tested at the contractor's cost. The contractor has to make his own arrangements at his cost for water required for construction, testing, filling, etc., either from local bodies or from elsewhere, by paying the charges directly and arranging tanker etc., as per necessity. No claim for extra payment on account of non availability of water nearby or extra lead for bringing water shall be entertained. All required piping arrangements and pumping if required for water shall be made by the contractor at his cost. Water for mortar, mixing and curing of concrete shall be free from harmful matter or other substances that may be deleterious to concrete or steel and taken from a source approved by the Engineer. Ground water for mixing and curing shall conform to the provisions in the class 4.3 of IS 456/ 2000.

9. Admixtures:

Only where a beneficial effect is produced shall any admixture be used and that too after test has been carried out to convince the Engineer that no harmful effect will be produced by the use of such admixture and after approval by the Engineer. The admixture shall conform to IS 9103/ 1972

10. Form Work and Centering

- 10.1 It may be noted that only steel form work shall be used in the project.

11. Separator (Cover Block)

- 11.1 For bottom cover of beams, slabs etc., separators of pre cast cement mortar blocks of suitable size with wire embedment as directed shall be used and tied to the reinforcement. Between layers of reinforcements, separators consisting of pieces of bars of suitable diameter shall be used. The required cover shall be provided as per clause 24-4 of IS 456/ 2000.

12. Masonry:

- 12.1 All masonry works such as Random Rubble / Coarse Rubble / Brick work must be done as per TNBP Specification.

13. Plastering:

- 13.1 Plastering would be 12mm, 20mm and 25mm thick cement plaster either plain or with water proof cement as may be specified.
- 13.2 The plastering items shall be executed in thickness and cement mortar of proportion as required. Similarly the plastering shall be either ordinary or with water proof for components as required.
- 13.3 In case of water proof plaster standard and approved water proofing compound shall be mixed in cement mortar in required percentage as directed and then the plaster is applied.
- 13.4.1 The finishing shall be either smooth or rough as may be directed by the Engineer unless otherwise specifically mentioned in the BOQ.
- 13.4.2 Neat finish wherever directed by the Engineer shall be done at no extra cost.

- 13.4.3 Curing and watering shall be done as directed and plaster shall be in alignment and level. Any substandard work is liable to be rejected and shall have to be re-done at contractors cost. Sand to be used shall be of approved quality only.

14. Flooring:

- 14.1 If cement concrete shall be provided for flooring, it shall be with minimum M20 grade with 40 mm thickness. The size of metal shall not be more than 12 mm and it shall be properly graded. A thin coat of very fine plaster shall be provided on top to give a smooth finish. The marking of false grooves to surfaces shall be made as directed.

15. Doors and Windows:

- 15.1 The work shall be executed as per the requirements viz. Plain planked paneled, glazed, etc., and fixture, etc., as required. Iron bars for windows and ventilators are to be provided as per specifications in TNBP.
- 15.2 The design of shutters and quality of wood shall be got approved from the Engineer-in-charge before manufacture. The CW/TW to be used for woodwork shall be uniform in substance straight, free from large dead knots, flows flanks. The work shall be done as per specification of TNBP latest edition. The joints shall be perfect.
- 15.3 Part of wood embedded in masonry shall be painted with the tar. The frames of doors, windows, ventilators, etc., shall have proper holdfasts embedded in masonry.
- 15.4 The painting shall be done as per the specifications. No painting, however, shall be permitted till the woodwork is approved by the Engineer-in-charge.
- 15.5 Any substandard work not conforming to the specifications are liable to be outright rejected and Executive Engineer's decision in such cases shall be final and binding on the Contractor.

16. Painting:

- 16.1 The work shall be carried out as directed by Engineer-in-charge. It shall be white washing, distemping and /or cement painting. Shade and make shall be as directed by the Engineer and for decorative purpose, Engineer may ask for different shades to be provided for different components or different parts of the same component which the Contractor shall have to do at no extra cost to the Engineer. The priming coat as directed, scaffolding, etc., shall be included in the estimate as per the specifications of TNBP for painting.

In general, all items of works must be done as per TNBP specifications.

17. Architectural Details of the Building:

	Administration cum laboratory (60 sqm)	Chlorine House (As required)		Building
	Ground Floor	Ground Floor		Storage
Plant in charge room	Foyer	-		Room Type
	-	RCC Framed		Main Structural Construction
	500	500		Plinth Height (mm)
	4500	5000		Ceiling Height (mm)
	RCC	RCC		Roof
	230	230	Ext. mm)	Wall
	115	115	Int. (mm)	
Vitrified Tiles	Vitrified Tiles	Acid /Alkali Tiling / Kota		Flooring
Teak	Teak	Teak	Door	Doors / Windows
Aluminum Glazed Powder Coated with vanishing blinds	Aluminum Glazed Powder Coated with vanishing blinds	Acrylic Powder Coated	Window	
-	-	MS	Roll. shutter	
20 mm thick In CM 1:4	20 mm thick In CM1:4	20 mm thick In CM 1:4	Ext.	Plaster
12mm thick In CM 1:4	12mm thick In CM :4	12mm thick In CM 1:4	Int.	
6mm thick In CM 1:3	6mm thick In CM1:3	6mm thick In CM1:3	Ceiling	
Luster Paint	Luster Paint	Oil bound distemper 2m high dado in acid alkali tiling	Int.	Painting
Cement Paint	Cement Paint	Cement Paint	Ext.	
Luster Paint	Luster Paint	White Wash	Ceiling	
India Water Proofing on Brickbat Coba or Equivalent	India Water Proofing on Brick Bat Coba or Equivalent	India Water Proofing on Brick bat Coba or equivalent		Roof Water Proofing

				Building
				Storage
Toilet	Laboratory	Staff Room		Room Type
				Main Structural Construction
				Plinth Height (mm)
				Ceiling Height (mm)
				Roof
			Ext. (mm)	Wall
			Int. (mm)	
Glazed	Vitrified Tiles	Vitrified Tiles		Flooring
Syntax	Teak	Teak	Door	Doors / Windows
Aluminum Glazed louvers	Aluminum Glazed Powder Coated with vanishing blinds	Aluminum Glazed Powder Coated with vanishing blinds	Window	
			Roll. Shutter	Plaster
	20 mm thick In CM 1:4	20 mm thick In CM 1:4	Ext.	
	12mm thick In CM 1:4	12mm thick In CM 1:4	Int.	
	6mm thick In CM1:3	6mm thick In CM1:3	Ceiling	
Oil Paint	Luster Paint	Luster Paint	Int.	
	Cement Paint	Cement Paint	Ext.	Painting
	Luster Paint	Luster Paint	Ceiling	
	India Water Proofing on Brickbat Coba or equivalent	India Water Proofing on Brickbat Coba or equivalent		Roof Water Proofing

			Building
			Storage
Toilet for laborers	Passage		Room Type
2 Water Closet, 2 Bathing, 4 Urinals			Main Structural Construction
			Plinth Height (mm)
			Ceiling Height (mm)
			Roof
		Ext. (mm)	Wall
		Int. (mm)	
			Flooring
	Kota / Vitrified		Doors / Windows
	Teak	Door	
	Aluminum Glazed Powder Coated	Window	
		Roll. Shutter	Plaster
		Ext.	
		Int.	
	Luster Paint	Ceiling	Painting
		Int.	
		Ext.	
	Luster Paint	Ceiling	Roof Water Proofing

18. ROAD WORKS

18.1 GENERAL

Roads shall be 10m wide out of which 7.0 m wide in metalled portion with bituminous carpet and 1.5m berm on either side. The roads should be given suitable camber and longitudinal slopes. The cross section of roads shall be as per attached drawing no 2962/E/M-01.

The tenderer should include preparation of 500mm thick sub-grade to the required level and camber, leveling and dressing of the filling and compaction upto 97% of laboratory dry density as per IS : 2720 (Part 8) by vibro roller. The earth of soaked CBR value not less than 5% required for making the roads i/c embankment for access road will be arranged by the contractor at his own cost if required.

18.2 GRANULAR SUB BASE

18.2.1 Scope:

This work shall consist of laying and compacting well-graded material on prepared sub-grade in accordance with the requirements of these specifications. The material shall be laid in one layer as sub-base to a 150mm thickness as necessary according to lines, grades and cross sections shown on the drawings or as directed by the Engineer.

18.2.2 Materials:

The material to be used for the work shall be natural sand, murram, gravel, crushed Stone or combinations thereof depending upon the grading required. The gradation is specified below.

Table 1: Grading for coarse-graded Granular Sub-base materials

Sieve Designation	Percentage passing by weight Grade II
75 mm 53 mm	-100
26.5 mm	50-80
9.5 mm	-
4.75 mm	15-35
2.36 mm	
0.425 mm	
0.075 mm	<10
CBR value	25

18.2.3 Physical requirements:

The material shall have a 10 percent fines value of 50 KN or more when tested in compliance with BS: 812 (part 111). The water absorption value of the coarse aggregate shall be determined as per IS:2386 (part 3); if this value is greater than 2 percent, the soundness test shall be carried out on the material delivered to the site as per IS: 383 for grading II materials, the soaked CBR shall be determined at the density and moisture content likely to be developed in equilibrium conditions which shall be taken as being the density relating to a uniform air voids content of 5 percent and shall not be less than 30%.

Strength of sub-base:

It shall be ensured prior to actual execution that the material to be used in the sub-base satisfies requirement of soaked CBR and other physical requirements when compacted and finished. When directed by the Engineer, this shall be verified by performing CBR tests in the laboratory as required on specimens re-molded at Field dry density and moisture content and any other tests for the quality of materials, as may be necessary.

18.3 WET MIX MACADAM (WMM)

18.3.1 Scope:

This work shall consist of laying and Compacting clean, crushed, graded aggregate and granular material, pre mixed with water, to a dense mass on a prepared sub base in accordance with the requirements of these specifications. The material shall be made in one or more layers as necessary to lines, Grade and cross sections shown on the approved drawings or as directed by the Engineer. Vibrating or other approved types of Compacting equipment shall be used, the compacted depth of single layer of WMM course shall be 150mm.

18.3.2 Materials

18.3.2.1 Aggregates:

Physical requirements:

Coarse aggregates shall be crushed stone. If crushed gravel or shingle is used, not less than 90 percent by weight of the gravel or shingle pieces retained on 4.75mm sieve shall have at least two fractured faces. The aggregate shall conform to the physical requirements set forth in table 2.

Table 2: Physical requirements of coarse aggregates for WMM for sub-base or base Courses

S. No.	Test	Test Method	Requirements
1	Los Angeles Abrasion value Impact Value	IS: 2386 (part 4) IS: 2386 (part4) or IS:5640	40 percent (max.) or 30 percent (max.)
2	Combined Flakiness (Total)	and IS: 2386(part1)	30 percent (max.)
			Elongation indices

If the water absorption value of the coarse aggregate is greater than 2 percent, the soundness test shall be carried out on the material delivered to site as per IS: 2386 (part-5).

18.3.2.1 Grading requirements:

The aggregates shall conform to the grading given in Table 3.

Table 3: Grading requirements of aggregates for WMM

Sieve Designation passing the IS sieve	Percent passing by weight
53 mm	100
45 mm	95-100
26.5 mm	-
22.4 mm	60-80
11.2 mm	40-60
4.75 mm	25-40
2.36 mm	15-30
600 Microns	8-22
75 Microns	0-8

Materials finer than 425 micron shall have plasticity index (PI) not exceeding 6.

The final gradation approved within these limits shall be graded from coarse to fine and shall not vary from the low limit on one sieve to the high limit on adjacent sieve or vice versa.

18.4 DENSE BITUMINOUS MACADAM (DBM)

18.4.1 Scope:

This work shall consist of construction, in a single course of 50 mm thick base course to the following specifications on a previously prepared WMM course with prime coat.

18.4.2 Materials

The bitumen shall be a paving bitumen of penetration grade S65 or A65 as per Indian standards specifications for "Paving bitumen" IS: 73. In case of a non-availability of bitumen of this grade, S90 grade bitumen may be used with the approval of Engineer.

18.4.2.1 Coarse aggregates:

The coarse aggregates shall consist of crushed stone, crushed gravel or shingle or other stones. They shall be clean, strong, durable, of fairly cubical shaped and free from disintegrated pieces, organic or other deleterious matter and adherent coating. The aggregates shall preferably be hydrophobic and of low porosity. If hydrophilic aggregates are to be used, the bitumen shall be treated with anti-stripping agents of approved quality in suitable doses. The aggregate should satisfy the physical requirements set forth in table-4 below.

If crushed gravel or shingle is used, not less than 90 percent by weight of gravel or shingle pieces retained on IS 4.75 mm sieve shall have at least two fractured faces. The plasticity index of the fraction passing through the 425-micron sieve shall not exceed 4.

Table 4: Physical requirements of coarse aggregates for DBM

S.N.	Test	Test Method	Requirements
1	Los Angeles Abrasion value	IS: 2386 (part)	40 percent (max.)
2	Aggregate Impact Value	IS: 2386 (part4)	30 percent (max.)
3	Flakiness and Elongation indices	IS: 2386(part1)	30 percent (max.) (Total)
4	Coating and stripping of Bitumen AASHTO 182	T Minimum retained coating	95 percent
5	Soundness		
i	loss with sodium sulphate	5 cycles	12 percent maximum
ii	Loss with magnesium sulphate	5 cycles	15 percent maximum
6	Water absorption	IS: 2386(part3)	2 percent maximum

18.4.2.2 Fine aggregates:

Fine aggregates shall be the fraction passing 2.36 sieve and retained on 75 microns sieve, consisting of crusher-run screening, gravel, sand or a mixture of both. These shall be clean, hard, durable, uncoated, dry and free from any injurious, soft or flaky pieces and organic or other deleterious substances.

Filler: Filler consist of finely divided mineral matter such as rock dust, hydrated lime or cement s approved by the Engineer. The filler shall be graded within the following limits:

Table 5: Grading requirements of aggregates for DBM

<u>Sieve Designation</u>	<u>Percent passing by weight passing the IS sieve</u>
600 Microns	100
300 Microns	95-100
75 Microns	85-100

The filler shall be free from organic impurities and have a plasticity Index not greater than 4. The plasticity Index requirement shall not apply if the filler is cement or lime. When the coarse aggregate is gravel, 2 percent by mass of total aggregate of Portland cement or hydrated lime shall be added and the percentage of fine aggregate reduced accordingly. Cement or hydrated lime is not required when the gravel is limestone.

- 18.4.2.3 Aggregate gradations:** The combined course and find aggregates and filler shall produce a mixture to conform to the grading set for a table-6 below.

Table 6: Aggregate gradation for DBM

<u>Sieve Designation</u>	<u>Percent passing by weight</u>
37.5 mm	100
26.5 mm	90-100
13.2 mm	56-80
4.75 mm	29-59
2.36 mm	19-45
300 Micron	5-17
75 Micron	1- 7

Preparation of Surface

This work shall consist of preparing of existing WMM surface. The work shall be done on such widths as shown in drawings. The existing surface shall be firm, cleaned with mechanical broom and treated with prime coat (@ 0.9kg /sq.m), 24hrs. in advance of laying of DBM course. The laying shall be done with paver finishers and compacted with road roller.

18.5 PREMIX CARPET

The Dense Bituminous Macadam roads shall be provided with 2cm thick premixed bitumen carpet surfacing with 1.8cum of stone aggregate 12.5mm nominal size and 0.90 cum of stone aggregate, 10mm nominal size using 144kg. Of residual petroleum of penetration 80/100 (S-90) of approved quality per 100 sqm. And 52 kg of hot bitumen per cum of 12.5 mm nominal size stone and 56 kg of hot bitumen per cum of 10mm nominal size including a tack coat with residual petroleum bitumen of penetration 80/100 (S-90) of approved quality @ 0.35 kg/sqm of road surface including consolidation with road roller etc.

Providing and consolidation with road roller seal coat of premixed stone dust with residual petroleum bitumen of penetration 80/100 (S-90) of approved quality and using 68 kg. Of residual petroleum bitumen of penetration 80/100 (S-90) and 0.6 cum of stone dust per 100 sq.m. of road surface complete. The seal coat is to be provided immediately after laying the bitumen carpet layer.

Pipe culverts with size not less than 300mm dia NP3 S&S pipes S&S Rubber rings joint with necessary 150mm CC/RCC M15 cradle & encasement with C.C. / R.C.C. M 15 with nominal reinforcement as per site requirement shall be provided at road crossings for storm water drainage of the area at the required number of places. Pipe shall be ISI marked.

Adequate / classified road roller of 8/10 MT capacity for the use of work as directed by the Engineer-in-Charge shall only be arranged by the contractor for consolidation. Log books of such road rollers shall be maintained. Maximum quantity of any items to be consolidated by each sprayer or roller / day shall be as under :

i) Prime Coat	3200 sq.m
ii) Consolidation of sub-grade	1860 sq.m
iii) Granular sub base	100 cum.
iv) Wet Mix Macadam	100 cum.
v) Dense Bituminous Macadam	40 cum.
vi) 2 cm. Premix carpet	930 sq.m

For less use of rollers recovery for less roller days shall be made @ Rs. 1000 per day.

Aggregate and bitumen will be mixed in a mechanical mixer of approved type, and will be heated to required temperature as directed by Engineer-in-Charge. Bitumen boiler of suitable design avoiding local heating and ensuring continuous supply will be arranged by Contractor. The Contractor shall maintain a thermometer for measuring the temperature at site of work. The contractor shall also make the necessary arrangement for weighting the material at site of work.

Fresh supply of bitumen from Bharat Petroleum / Indian Oil / Hindustan Petroleum as approved by Engineer-in-Charge will be arranged by the Contractor and brought to the site of work and stored properly. Receipt for purchase in original as proof of purchase will be submitted to the department by the contractor.

No variation in bitumen on lower side shall be allowed. In case bitumen used by contractor is found less than the quantity calculated theoretically, based on the coefficient for bitumen consumption given in CPWD/TNDSS specification 1997 or as decided by the Engineer-in-Charge for the items for which coefficient are not available in CPWD/TNDSS specification 1997. The cost of bitumen not so used shall be recovered from the contractor.

Wherever, necessary RCC pipe / Box culvert shall be provided for crossing of drain pipes and effluent channel etc. For pipe culverts NP3 RCC pipes fully encased in concrete / RCC shall be used. All RCC cover slabs of drains / channels & of culverts subjected to vehicular traffic shall be designed for I.R.C. class AA loading.

18.6 QUALITY CONTROL

For quality control of road works following table 7 and 8 shall be used for frequency of tests :

Tests on Earthwork for Embankment, Sub-grade Construction and Cut Formation

18.6.1 Borrow material: Grid the borrow area at 25 m c/c(or closer, if the variability is high) to full depth of proposed working. These pits should be logged and plotted for proper identification of suitable sources of material. The following test on the representative samples shall be carried out:

- Sand Content [IS: 2720 (Part-4)]** : 2 tests per 3000 cubic metre of soil.
- Plasticity Test [IS: 2720 (Part 5)]** : Each type to be tested, 2 test per 3000 cubic metre of soil.
- Density Test [IS: 2720 (Part-8)]** : Each soil type to be tested, 2 test per 3000 cubic metre of soil.
- Deleterious Content Test [IS: 2720 (Part-27)]** : As and when required by the Engineer.
- Moisture Content Test [IS: 2720 (Part-2)]** : One test for every 250 cubic metre of soil.
- CBR Test on materials to be incorporated in the subgrade on soaked/un-soaked samples [IS: 2720 (Part-16)]** : One CBR test for every 3000 cubic metre at least or closer as and then required by the Engineer.

18.6.2 Compaction control: Control shall be exercised on each in their by taking at least one measurement of density for each 1000 square metre of compacted area, or closer as required to yield the minimum number of test results for evaluating a day's work on statistical basis. The determination of density shall be in accordance with IS :2720 (Part- 28). *Employer's Requirements (Vol.-II)*

18.6.2 Table 7– Control Tests and their minimum frequency for sub-base & base (excluding bitumen bound basis bases)

Sl. No	Type of Construction	Test	Frequency (min.)
1.	Granular		
i		Gradation	One test per 200 m ³
ii		Atterberg limits	One test per 200 m ³
iii		Moisture content prior to compaction	One test per 250 m ³
iv		Density of compacted layer	One test per 500 m ²
v		Deleterious constituents	As required
vi		C.B.R	As required
2 i		Aggregate Impact value	One test per 200 m ³ of aggregate
ii		Grading	One test per 100 m ³
iii		Flakiness Index and Elongation index	One test per 200 m ³ of aggregate Wet Mix macadam
iv		Atterberg limits of portion of aggregate	One test per 100 m ³ of binding material passing 425 micron sieve
v		Density of compacted layer	One test per 500 m ³

Table 8 – Control Tests and their minimum frequency for bituminous works

Sl. No.	Type of Construction	Test	Frequency (min.)
1.	Prime Coat / Tack Coat	(i) Quality of binder	Two samples per lot to be subjected to all or some tests as directed by the Engineer
		(ii) Binder temperature for application	At regular close intervals
		(iii) Rate of spread of Binder	Two tests per day
2.	Seal Coat / Surface Dressing	(i) Quality of binder	Two samples per lot Dressing to be subjected to all or some tests as directed by the Engineer
		(ii) Aggregate Impact Value	One test per 50 m ³ of aggregate
		(iii) Flakiness Index and Elongation Index	-do-
		(iv) Stripping value of aggregates	Initially one set of 3 representative specimens for each source of supply. Subsequently when warranted by changes in the quality of aggregates.

		(v) Water absorption of aggregates	-do-
		(vi) Grading of aggregates	One test per 25 m ³ of aggregate
		(vii) Stone polishing value	As required
		(viii) Temperature of binder at application	At regular close intervals

Sl. No.	Type of Construction	Test Frequency (min.)	
		(ix) Rate of spreading of materials	One test per 500 m ² of work
3.	Dense Bituminous Macadam / Semi-Dense Bituminous Concrete / Bituminous Concrete	(i) Quality of binder	Two samples per lot to be subjected to all or some tests as directed by the Engineer
		(ii) Aggregate Impact Value	One test per 50 m ³ of aggregate
		(iii) Flakiness Index and Elongation Index	One test per 200 m ³ of aggregate
		(iv) Atterberg limits of portion of binding material aggregate passing 425 micron sieve	One test per 100 m ³ of aggregate
		(v) Density of compacted layer	One test per 500 m ³

18.6.3 Acceptance Criteria

The acceptance criteria for test shall be subject to the conditions that the mean value is not less than the specified values plus $[1.65 - 1.65/(\text{No. Of Samples})^{0.5}]$ times the standard deviation

19. ILLUMINATION:

All internal and external areas shall be provided with lighting. The illumination levels to be achieved shall be as follows:

AREA LUX.

Office and labs	300	Lux
Switchgear Room	200	Lux
Control Room	300	Lux
Pump House	200	Lux
DG set room	200	Lux
Chemical and general store	150	Lux
Chemical Plant room	200	Lux
Other indoor areas	100	Lux
Outdoor plant from and walkways	50	Lux
Building entrance	100	Lux
Indoor Plant Area	200	Lux
Outdoor Plant Area	50	Lux
Transformer Area	100	Lux
Roads	10	Lux

Fluorescent luminaries shall be used primarily for internal lighting. High pressure vapour or metal halide type luminaries shall be used in indoor application where their use is appropriate. If mercury or metal halide is used in indoor then they should be supplemented with fluorescent luminaries to assure that minimum illumination levels are maintained following momentary power dips. All other internal areas shall be lit with fluorescent luminaries. Where specific recommendation of lux level are not covered above, illumination level in such areas shall be finalized in consultation with ULB in sewage pumping stations. Contractor shall be required to measure levels of illumination after completion of lighting installation work and short fall in illumination level shall be made good by the contractor. Complete set of calculations showing, room, index, copy MF shall be given during detailed engineering.

19.2 Switches / sockets of piano type shall be used in general and in offices of staff, control room, MMI room, decorative modular switches shall be used. Suitable fans shall be provided in rooms/ plant areas as per MMC/CPWD standards. For exhaust fans it must be provided in panel rooms, pump rooms, chemical rooms, stores, toilets and at least 20 air changes per hour must be maintained.

19.3 The following type of lighting fixtures shall be proposed:

- a) Decorative type 2x36W fixtures for fluorescent luminaries inside office/ administrative buildings and control rooms.
- b) Corrosion resistant fixture with canopy made of FRP for fluorescent luminaries for corrosive areas like chlorine handling or chemical store or area with corrosive smell/gases etc.
- c) Industrial type vitreous enameled fixture for fluorescent luminaries inside 415V switchgear, MCC room and pump house.
- d) In outdoor process areas, lighting fixtures shall be sodium vapour type subjected to minimum of IP protection class.
- e) All outside lights as plant field lights, building outside lights, flood lights etc. which are to be switched on only during night hours should be controlled through photo cell/ clock switch installed at a central place. All lights shall have minimum IP65 protection class.
- f) Street lighting wiring shall be through buried underground.

- g) All bulb fittings (except fluorescent lamps) will have screw type caps.
- h) For outdoor lighting, the lighting feeder shall be operated through a contractor, controlled by photocell/ clock switch and shall also have a manual by pass switch.
- 19.4 Luminaires shall be installed to permit ease of maintenance i.e. it shall not be necessary to shut down plant in order to carryout maintenance or to access luminaries located over areas of water etc. The contractor shall provide all equipment necessary to carryout maintenance on the lighting installation and demonstrate its operation to the satisfaction of MMC.
- 19.5 Indoor lighting circuit will be arranged in such a way that 50% lighting can be put off in each room through switches. All lighting circuits will be wired with 2.5sq.mm. stranded copper wire or through 2.5 sq.mm. armoured cable laid in cable trays. Sub circuit from switch to fixture could be wired with 1.5 sq.mm. stranded copper wire in MS conduits or armoured copper cable of similar size provided total voltage drop in any lighting distribution board to last lighting point shall not exceed 2%. All lighting circuits will have separate neutral, separate earth from Lighting Distribution Board.
- 19.6 For illumination of roads, outdoors areas where operation of equipment or units required and sub-station area, lighting fixtures of appropriate type (such as street lighting type, flood lighting type, post top lanterns etc.) incorporating high pressure sodium vapour lamps shall be proposed. Street light poles shall not have less than 7500 mm height above the finished road level and the arm shall not project more than 1200 mm along the road width. Poles of bigger heights may also be used if some outdoor areas are to be illuminated. Poles of 4 / 4.5 Mtrs using post top lantern may be used in gate office, walk way or in front of office area. Complete area, streets, lanes, boundary shall be covered with street lighting.
- 19.7 Receptacles (Lighting & Small Power) :
- a. Decorative and industrial type units of above shall be proposed in all plant areas, offices, stores, workshop, plant room and they shall be located at least two numbers in each room. Distance between two receptacles shall not be more than 8 – 10 mtr. All small 5 amps 5 pin lighting & small power sockets shall be wired by multi stranded copper wire of 2.5 sq. mm laid in rigid MS conduits along with earth wire of 1.5 sq.mm flexible copper wire or equivalent size armoured cables. All wiring shall be coded with Red, Yellow, Blue & Black as per the phase used. If required, wiring can be done alternatively through armoured copper cables of similar size laid in MS perforated trays of minimum 2.0 mm thick.
- b. Three phase power receptacles (convenience outlets) suitable for operation of 415V, 3 Phase 4 wire, 50 Hz power supply shall be proposed. In indoor areas one such unit shall be provided to cover areas of 20 meter radius (or at least one in each room housing plant items) and in outdoors areas on such unit shall be provided at 50 meter interval. Actual requirement of such units shall be finalized by MMC during detailed engineering. One three phase receptacle shall be provided near entrance of each building for utilities like welding.
- c. Single phase 15 Amp 5 Pin / 6 Pin receptacles will be provided in each room and in halls they will be provided in such a way that with 15 meter cord we should reach every place in building. These shall be wired with 4 sq. mm copper earth wire in MS rigid conduits along with 2.5 sq. mm earth wire. Not more than two sockets shall be looped in one circuit. Alternatively they can also be connected through armoured cable of 4 sq. mm running in appropriate cable trays.
- 19.8** Separate lighting panels and lighting distribution boards shall be installed and they shall not take tapping for power from motor control centers or power distribution boards.

IV. LIQUID RETAINING STRUCTURES

1. General:

All structures shall be designed as liquid retaining RCC structures with minimum M 30 grade concrete. Minimum cover shall be 25mm

All structures coming in contact with sewage shall be constructed with Sulphate Resistant Cement.

2. Testing for Water Tightness:

2.1 The testing of the liquid retaining structure and other water retaining structures should be done by the contractor at his own cost inclusive of all necessary equipment, water etc., complete. The test for water tightness of the structure as well as materials of construction used shall be conducted in conformity with the standard specification as per IS 3370 (Part-I) – 1965 as amended from time to time.

2.2 If the structure does not satisfy the condition of the test period, the test may be extended for a further period of seven days and if the specified conditions of the test are satisfied the structures shall be considered to be watertight.

2.3 In case of unsatisfactory test results, the contractor shall ascertain the cause, make all necessary repairs and repeat the procedure in the preceding clauses until the test has been passed satisfactorily at no extra cost to the Engineer.

V. Specification for electro mechanical work

(Sewage treatment plant and pumping station)

1. General requirements

1.1 Material

All materials incorporated in the Work shall be the most suitable for the service conditions and duty concerned. They shall be new and of reputed make / approved quality, free from imperfections and selected for long life and minimum maintenance. Non-destructive tests, if called for in the Specification, shall be carried out. All submerged moving parts of the Plant, or shafts and spindles or faces etc. in contact with them shall be of corrosion resistant materials. All parts in direct contact with various chemicals, shall be completely resistant to corrosion, or abrasion by these chemicals, and shall maintain their properties without aging due to the passages of time, exposure to light or any other cause. All materials shall conform to the material standards as per BIS or any equivalent standard.

1.2 Workmanship

Workmanship and general finish shall be of first class quality and in accordance with best workshop practice. All welds shall be as per IS, BS, ASME standards. All tolerances and clearances shall be as per good and sound engineering practices. Should the Employer's representative not consider any material acceptable, it shall be replaced.

1.3 Design Features

As far as practicable, all designs shall be as per latest concept and practices. The equipment shall be new, of robust design for a long reliable operating life. These shall be capable of 24 hours per day continuous operation for prolonged period in the climatic and working conditions prevailing at the site and with a minimum of maintenance. Particular attention shall be given to extra temperature and the rating of electrical and mechanical equipment, cooling systems and the choice of lubricants shall be for the temperatures as specified.

Paints used shall be the manufacturers' standard and shall be suitable for duty as described. The equipment shall be designed to provide easy access to and replacement of component parts which are subject to wear without the need to replace whole units. All parts in contact with water shall have a life from new to replacement for 15 years minimum and new to repair of not less than five years.

Design features shall include the protection of equipment against damage caused by vermin, dirt, dust and dampness and to reduce risk of fire. Equipment shall operate without undue vibration. Noise reduction measures shall be adopted such that levels of 75 dB (A) at 3 meters are not exceeded. Parts shall be designed to withstand the maximum stresses under the most severe conditions of normal service. Materials shall have a high resistance to change in their properties due to the passage of time, exposure to light, temperature and any other cause which may have a detrimental effect upon the performance or life of the Plant.

All rotating elements shall be dynamically and statically balanced.

All equipment shall have name plates specifying the makes, model, rating and other pertinent information.

1.4 Lubrication

The equipment shall be lubricated by long life lubricants such that working life is not less than 3000 operation hours or as recommended by equipment manufacturer.

A complete schedule of recommended oils and other lubricants shall be furnished by the Contractor. The number of different types of lubricants shall be kept to a minimum. The schedule and the name of the supplier of the lubricants shall be submitted to the Employer's representative for approval.

Lubricants shall be oil and grease. The Contractor shall indicate indigenously available equivalent lubricants, with complete specification.

Where the lubricant is grease, preference shall be given to a pressure system which does not require frequent adjustment or recharging. Preferably, life lubricated grease packed bearings shall be used.

Where more than one special grease is required, a grease gun for each special type shall be supplied and permanently labeled.

1.5 Name Plates

Each equipment of the Plant shall have permanently attached to it a nameplate and rating plate in a conspicuous position. Upon these shall be engraved or stamped, the manufacturers name, type and serial number of the equipment, details of the loading and duty at which the equipment has been designed to operate, and such diagrams as may be required by the Employer's representative. All indicating and operating devices shall have securely attached to them or marked upon them designations as to their functions and proper manner of use.

1.6 Painting

1.6.1 At Manufacturer's Works

The Contractor shall be responsible for the cleaning, preparation for painting, and priming or otherwise protecting, as specified, all parts of the Plant/ Equipment at the place of manufacture prior to packing.

Parts may be cleaned but surface defects may not be filled in before testing at the manufacturer's works. Parts subject to hydraulic test shall be tested before any surface treatment. After testing, all surfaces shall be thoroughly cleaned and dried out, if necessary by washing with an approved de-watering fluid prior to surface treatment. Except where the specification provides to the contrary, all painting materials shall be applied in strict accordance with the paint manufacturer's instructions.

Steel and cast iron parts shall be sand blasted to near white cleaning before painting. Edges, sharp corners etc. shall be ground to a curve before sand blasting. A primer coat of a zinc rich epoxy resin based coating with at least 75 microns dry film thickness is to be provided. In addition, the parts for wet duty are to be provided with an adequate number of coats of coal tar epoxy polyamine coating to a dry film thickness of 175 microns excluding primer coating.

1.6.2 At Site

Immediately on arrival at the site, all items of Plant shall be examined for damage to the paint coat applied at the manufacturer's works. Any damaged portions shall be cleaned down to the bare metal, all rust removed, and the paint coat made good with similar paint.

After erection, such equipment/ items which are not finish painted shall be done so. Items that have been finish painted at the manufacturer's works shall be touched up for any damaged paint work. For finish painting, two coats of synthetic enamel conforming to IS: 2932 shall be applied. Dry film thickness of each coat shall be at least 25 microns.

The dry paint film thickness shall be measured by Elcometer or other instruments approved by the Employer's representative. In order to obtain the dry film thickness specified, the Contractor shall ensure that the coverage rate given by the paint manufacturer will enable this thickness to be obtained. Strength of adhesion shall be measured with an adhesion tester and this value shall not be less than 10 kg/cm². Painted fabricated steel work which is to be stored prior to erection shall be kept clear of the ground and shall be laid out or stacked in an orderly manner that will ensure that no water or dirt can accumulate on the surface. Suitable packing shall be laid between the stacked materials. Where cover is provided, it shall be ventilated.

1.7 Galvanising

Wherever galvanizing has been specified the hot dip process shall be used And electro-galvanized parts, equipment shall not be permitted. The galvanized coating shall be of uniform thickness. Weight of zinc coatings for various applications shall not be less than those indicated below:

a)	Fabricated steel	:	460 gm /sq. m
b)	Fasteners	:	300 gm / sq. m

Galvanising shall be carried out, after all drilling, punching, cutting, bending and welding operations have been carried out. Burrs shall be removed before galvanizing. Any site modification of galvanized parts should be covered well by zinc rich primer and aluminum paint.

1.8 Supports for Pipe Work & Valves

All necessary supports, saddles, slings, fixing bolts & foundation bolts shall be provided to support the pipe work. Valve and other equipment mounted in the pipe work shall be supported independently of the pipes to which they connect.

All valves to be installed in straight lines shall be installed between the flanges with a dismantling joint or SS expansion bellow at one side of the valve. The dismantling joint must allow a minimum clearance of 20 mm. The pressure rating of the dismantling joint / expansion below shall be same as that of the valve.

1.9 Mechanical & Manual Coarse Screens & Conveyor

1.9.1 Purpose & Scope:

- a. Mechanized screens should be suitable for installation in Sewage pumping stations for removal of floating wastes coming along with sewage. These screens should be capable to screen out most of the medium and large floating material such as plastic bags, floating debris, weeds, paper wastes, clothes and rags etc. which are generally clogging the impellers of the pumps installed downstream of the screens.
- b. The operation of the screen shall be automatic. An ultrasonic type differential level controller shall be provided to sense the head loss through the bar and give the signal to the traveling raking mechanism to start its operation. The sensor will signal the raking mechanism to operate continuously till the head loss is reduced to a preset level.
- c. A complete electrical control system shall be supplied with each screen and shall be mounted independently near to the screen installation. The system shall provide for total automatic operation of the screen with the feedback from the level controller.
- d. Manual bar screens should be provided in addition to mechanical bar screens which can be raked, cleaned, screened material removed and deposited onto the conveyor in a safe manner without maintenance personnel entering the influent channel /screen well.

1.9.2 General Material And Equipment Requirements:

- a. Fabrication and design features:
 - (i) Use power grinder to dull and produce smooth edges.
 - (ii) Use bolted field connections. Field welding will not be allowed.
 - (iii) Design all components for continuous 24 hours per day service.
- b. The screen shall be so constructed so as to mechanically remove the waste from the bottom most portion of the bar portion using a traveling type raking mechanism without shutting the water flow through the screen. The raking mechanism shall then travel up to the top of operating platform and automatically discharge the waste through a discharge chute.
- c. The screen shall have protection against overload conditions, which might damage the equipment.
- d. All screens shall be constructed and shipped as an integrated product comprising of frame structure and guides, rake and rake arm mechanism, dead plates, cog wheels, sprockets and chains, discharge chute, drive unit and cover apron.
- e. The screen shall be supplied factory assembled and duly tested at manufacturer's works before dispatch. This integrated and factory assembled screen shall involve minimum dismantling and assembly at site for erection.
- f. Upon receipt at site these shall be installed resting on the channel floor and mechanically or chemically anchored to the parallel sidewalls of the channel (without making grooves in concrete or breaking open the concrete side walls and thereby weakening the civil structure) in a way that there are minimum chances of misalignment.
- g. All parts shall be designed to withstand the stresses that will be imposed upon them during handling, shipping, erection and operation.
- h. All stainless steel fabricated materials will be pickled and passivated before dispatch to remove ferrous contamination, if any.

1.9.3 Specifications :

1.9.3.1 Material of construction:

All parts of screen including fixed bars, raking mechanism, screen frame and guide rails, dead plate and discharge chute shall be constructed from stainless steel material SS304 for long life in aggressive sewage environment. Suitable measures should be taken to ensure long life of parts like bearing, chains, sprocket and cogwheels etc, which are not made from stainless steel material.

1.9.3.2 Drawings & Documents:

Drawings for the following shall be submitted for approval before taking up manufacturing of Screens:

- ☐ General Arrangement drawing of screens.
- ☐ Bill Of Material (BOM) & Wiring diagram of control panels.
- ☐ Quality Assurance Plan.

All drawings shall be submitted in 3 copies of which one will be returned duly commented / approved.

Approval of manufacturer's drawings shall not relieve the manufacturer of his responsibility for supplying equipment conforming to the Technical Specification laid herein for any mistakes, errors or omissions in his drawings.

1.9.3.3 Level controller

The level controller shall be of ultrasonic differential type.

1.9.3.4 Electrical motor

The motor shall be of TEFC type with IP 55 protection and suitable for operation on 415V \pm 10% and frequency of 50 Hz \pm 5%.

1.9.3.5 Control Panel

The control panel shall have IP 65 protection, painted with epoxy paint and shall be comprising of

- Mushroom head emergency stop.
- Overload relays for motor protection.
- Circuitry to operate the screen with ultrasonic level sensor.
- Selector switch to operate the screen in Auto, off and JOG mode.
- Provision to run the screen on timer in case of failure of level sensor.

1.9.3.6 Shop Testing

The screen should be completely manufactured and offered for inspection at the plant of the manufacture confirming the above mentioned eligibility criteria. A screen assembled by a vendor and offered for inspection at the plant of a vendor / sub contractor shall not be accepted. The screen shall be subjected to following tests at manufacturer's premises by third party inspection and / or Municipal Employer representative(s):

- **(a) Dimensional Check:** The overall dimension of the screen shall be conforming to the approved drawings.
- **(b) Operational Test:** The complete screen including its carriage, rake, drive system and brake motor shall be mechanically operated and tested to verify interference free movement and satisfactory operation.

1.9.3.7 Miscellaneous:

Any type of work, either supply and or erection of material / equipment which have not been specifically mentioned in this specification, but are necessary to complete the works for trouble free and efficient operation and guaranteed performance of the entire plant system and equipment offered shall be deemed as included within the scope of this specification and shall be provided by tenderer without any extra price to purchaser.

1.9.4 Manual Bar screen

Manual bar screens should be provided in addition to mechanical bar screens which can be raked, cleaned, screened material removed and deposited onto the conveyor in a safe manner without maintenance personnel entering the influent channel /screen well.

The manual bar screen will be of opening not more than 25 mm for coarse screen and inclination about 60° with respect to horizontal. Specifications for Manually raked screen shall be as under.

The trash screen shall be rectangular in shape. The screen shall be fabricated out of stainless steel SS 304 of not less than 10mm thick and 75 mm wide in section. The screen shall be rigidly fixed to the frame and provided with 2 sets of cleaning rakes.

1.9.5 Belt Conveyor

The conveyor shall be common to the mechanical and manual screens. The conveyor system shall be a combination of a horizontal conveyor and upward inclined conveyor (if required) and shall have a capacity to transfer the maximum screenings anticipated at the peak flow. The conveyor provided for discharge of screenings shall be inter-locked with all the screenings discharging on to the conveyor so that it operates when the screenings are discharged on to it and stops automatically after a time lag when the screen stops discharging the screenings on top the conveyor.

Conveyor type	Horizontal
Speed	15 m / minute (maximum)
Type	Troughed
Belt	3 ply Z duck, 3 mm top, 1.5 mm bottom, rubber cover CR M –24

1.9.6 Mechanical fine Screens

GENERAL :

- Mechanically operated step Screen completely made of Stainless Steel having 6 mm clear spacing between the bars shall be provided in inlet screen channel for screening out floating materials such as plastic pouches, bags, rags, floating debris, weeds, paper wastes and other floating materials from the raw sewage coming from the pumping station / gravity mains.
- The screen shall include discharge chute as required to discharge the screenings on the belt / screw conveyor without employing any external mechanism / rake mechanism.
- The screen shall be factory assembled & movement tested at plant before dispatch to site & shall only be installed at the site in factory assembled condition thereby avoiding chances of misalignments.

1.9.6.1 SCOPE:

Design, Supply, Installation, Testing & Commissioning of screening equipment consisting of following:

- (a) Mechanized step screen having 6mm spacing between bars and suitable for installation at an inclination of 40 degrees in channel.
- (b) Level sensing instrument connected to control panel for automatic operation of screen mechanism and allied accessories.
- (c) Local control panel installed near screen.
- (d) Belt/screw conveyor to discharge the screened material of the screen to the waste bin.

1.9.6.2 SPECIFICATION

(a) **Material of construction:**

The fixed as well as movable bars, mechanism, support frame, fixings discharge chute shall be manufactured from stainless steel for long life in the aggressive sewage environment. No component of the screen assembly shall be made of carbon steel or any other material, which can get corroded in sewage environment.

1.9.6.3 Level Controller

The level controller shall be upstream type Ultrasonic level switch.

1.9.6.4 Electrical Motor

The motor shall be TEFC type with IP 55 protection and shall be suitable for operation on 415V $\pm 10\%$ and frequency of 50Hz $\pm 5\%$.

1.9.6.5 Control Panel

The Control Panel shall have IP 55 protection, painted with Epoxy paint and shall be comprising of

- Mushroom Head Emergency stop
- Overload relays for motor protection
- MCB's, HRC Fuses and Glass Fuses
- Circuitry to operate the screen with level sensors.
- Selector Switch to operate the screen on JOG mode

1.9.6.6 TESTING

The Fine bar screen shall be Factory assembled and subjected to following tests at the manufacturer's premises.

Dimensional Check: The overall dimensions of the screen shall be conforming to the approved drawings.

Operational Test: The complete screen including its mechanism, Electro-motor/hydraulic operating mechanism level probing system and control panel shall be integrated and mechanically operated to verify free movement and satisfactory working.

1.10 Mechanical grit separator

The grit separator shall be square in size and twin unit construction. A Central drive mechanism of worm reduction type driven through helical gear and motor or by geared motor shall be mounted on the RCC platform spanning the tank. All exposed steel parts shall be sand blasted and painted with epoxy. The walkway shall have RCC posts and handrails of anodized aluminum. All wetted parts shall be in mild steel with epoxy coating. The epoxy coating shall be suitable for corrosion as well as abrasion of the grit. The drive shall be provided with electro-mechanical device, torque indicating arrangement and mechanical trip contacts with electrical overload relays. Flow regulating vanes shall be provided at the inlet side of the collection chamber and shall be of FRP. The vanes shall be adjusted as per the flow requirement. The weirs at the outlet of grit chamber shall be SS 304 with minimum 3-mm thickness. The spacing of anchor bolts of SS 304 for the fixing of the weir shall not be more than 450 mm.

1.11 Classifier Mechanism

The classifier mechanism shall comprise of a screw driven by a suitable motor. The material of construction of the mechanism shall be SS 304 and the diameter shall be minimum 400 mm. The length of screw shall be such that the grit can be elevated up to the discharge end. SS puddle pipe shall be provided in the concrete trough at the discharge point of wet grit.

1.12 Air blowers for Oxygenation

The blowers shall be provided for providing adequate oxygen into the reactor tank for aeration.

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 for each set of Blowers. Directly coupled design shall be preferred.

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 4.5mm/s at a distance of 1.86 m respectively. The blower shall be driven by squirrel cage induction motor

1.12.1 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

Tests

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

1.13 Diffused Aeration System

This comprises piping to diffusers and the diffusers.

1.13.1 Type of diffuser system

A fine bubble diffused aeration system shall be applied to both the selector zone and 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 for at least two years.

1.13.2 Diffuser Elements

The diffuser elements with SS304 shall be 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 also permit easy retrieval above the liquid surface by lifting the air vertical header feeding the horizontal air manifold.

Suitable mechanical provision for lifting the headers easily above the water level for maintenance without the need for draining the tank shall be provided for each header. Isolating valves of polypropylene shall be provided upstream of the coupling to cut off the flow through the specified header for purposes of attending to the diffuser header and also diffusers.

1.13.3 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. 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. However the air piping submerged in sewage has to be in SS304 conforming to I.S specification.

Two spare drop pipes with diffuser elements shall be supplied by the Contractor one for each compartment. This will be used to replace the choked diffusers drop pipe or on preventive basis on rotation. The choked one will be attended to and used as spare drop pipe.

1.13.4 Specifications for Epoxy Painting

Zinc rich epoxy primer and epoxy paint of approved quality shall be used for external and internal painting. No primer shall be applied without prior approval from the Employer's Representative. The max of zinc rich epoxy primer shall be prepared at work site not earlier than 15 minutes before applying the same on pipes and special surfaces. One coat of zinc rich epoxy primer of DFT 75 micron shall be applied along with two coats of epoxy paint DFT 40 micron and DFT 30 micron respectively. No thinner shall be added to ready mix paint without previous approval of the Employers' representative and the finishing coats on top of the primer coat shall only be applied after allowing the film to cure for at-least 48hrs.

After application of zinc rich epoxy primer the surface should be cleaned by duster and inspected. If during inspection any portion is found rusting the same shall be removed by emery paper and coated with zinc rich epoxy primer.

Mixed paint should be used within 3 to 4 hrs. of mixing and fresh mixing shall be done for every new application. Every successive coat of paint shall be given only after 48 hrs. of previous coat. Before applying the next coat the surface should be properly cleaned by duster.

1.14 SPECIFICATIONS FOR DECANTING DRIVE FOR ANY ONE OF THE MODERN TECHNOLOGY PROCESS

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. The following type of decanter assemblies are 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. 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 DH 485 or Ethernet

1.15 Submersible Pumps for Raw sewage, return and excess sludge

Raw sewage pumps shall pump sewage from wet well at sewage pumping station to inlet chamber of STP. Return sludge pumps shall pump the return sludge from the sump to the aeration tank. 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.

1.15.1 Reverse Rotation

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

1.15.2 Pump Construction

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.

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.

1.15.3 Pump Shaft

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

1.15.4 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

1.15.5 Guide Arrangement

The assembly may have C.I. pedestal, bracket, delivery bend, SS 316, 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.

1.15.6 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.

1.15.7 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.

1.15.8 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.

1.15.9 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.

1.15.10 Moisture Sensor

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

1.15.11 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. For other requirements refer subsection VI. The motor shall operate satisfactorily at all operating levels in wet well.

(a) Materials of construction:

Pump casing	: CI IS: 210 Gr FG 260
Discharge casing	: CI IS: 210 Gr FG 260
Impeller	: CF 8m or SS316
Shaft	: SS AISI 431
Mechanical Seal	: Silicon Carbide
Fasteners	: SS AISI 304.

(b) Protective Coating:

The pumps shall be epoxy painted.

1.16 Air blowers for sludge mixing

The blowers shall be provided for providing air mixing through Coarse bubble aeration in the Sludge Sump.

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.

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 4.5mm/s at a distance of 1.86 m respectively. The blower shall be driven by squirrel cage induction motor

1.16.1 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

Tests

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

1.17 Sludge feed pumps to centrifuge

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 through 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 DBA at a distance of 1.86m.

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

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

1.17.1 Material of Construction

Type	Screw
MOC	Alloy Steel
Base plate	CI / MS Epoxy painted
Fastener	SS AISI 304.

1.17.2 Parameters of Pump

Capacity	As per bidder
Head	To pump to Centrifuge
Efficiency	Minimum 30 %
Pump speed	960 rpm (maximum)
Ball passing size	25 mm minimum
Applicable code	
Design	IS 6595
Performance	IS 9137

1.17.3 Testing

Material test certificate	Casing, Impeller, Shaft
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
Pump shall be offered for visual inspection before shipment. The pump components shall not be painted before inspection	
Field performance tests required for satisfactory operation	

Note:- The type, capacity & duties of return and excess sludge pumps shall be as proposed by the bidder. However, minimum 100% standby capacity shall be provided and the same set of pumps may be used for the pumping of excess sludge and return sludge

1.18 Recycle pumps to recycle supernatant and centrate

The specifications shall be the same as that of raw sewage pumps.

1.19 Polyelectrolyte tank & agitators

The equipment shall include drive motor, direct coupling, impeller assembly, and such other fittings, devices or appurtenances necessary for a complete operating installation.

The drive motor shall not exceed rpm of 1,500 and directly coupled with the gearbox. It shall be wired for 415 volts, 50 cycles, and three-phase service and shall be totally enclosed, fan cooled, rated for severe chemical duty with a minimum service factor of 1: 1.5.

The rotary speed of the impeller shall not exceed 100 rpm.

The drive motor output shaft and the impeller rotary shaft shall be connected by a direct coupling using such couplings as "Lovejoy" type to avoid cumbersome erections and de-erections. The drive assembly for each agitator shall consist of a suitable drive motor, directly coupled to a helical gearbox. The Gear reducer shall be of heavy duty, high efficiency type with a rugged housing. It shall have a minimum service factor of 2.0 and suitable for 24 hours continuous service. The gear reducer shall have oil bath lubrication and dry well construction on the vertical out put shaft to prevent leakage of the lubricant. The casing of the gear reducer shall be of CI. The gears shall be hardened and ground for precision.

Each impeller shaft shall be solid SS304 shaft of suitable diameter designed to resist the applied radial and axial thrust loads. All fasteners and anchor bolts shall be of such metallurgy that they are compatible with the stipulated duty conditions shall be used.

1.20 Polyelectrolyte Dosing Pumps

The Polyelectrolyte solution from the preparation tanks shall be pumped by the use of Polyelectrolyte solution dosing pumps to the Centrifuges. The pipe and the pipe fittings shall be HDPE and valves shall be Polypropylene.

1.20.1 Parameters

Standby	minimum 50%
Capacity of each pump	to suit each centrifuge requirement
Material of construction of wetted parts	AISI SS 304

1.21 Centrifuges

Minimum 2 Nos of Centrifuge capable of handling sludge and de watering the sludge into cake for safe disposal shall be provided. - **Installed stand by shall be adopted.** The dewatered cake shall be based on minimum consistency of 20% by weight dry solids. The centrifuge and its accessories shall be mounted on a common base frame so that entire assembly can be installed on an elevated structure.

The wetted parts of Centrifuge shall be stainless steel, 304. The base frame shall be in epoxy painted steel construction and provided with anti-vibration pads. All steps necessary to prevent transmission of structure borne noise shall be taken. The noise level shall be 88 dB (A) measured at 1m distance under dry run. The vibration level shall be below 50 micron measured at pillow blocks under dry run condition. Adequate sound proof shall be carried out for the housing the centrifuges to ensure that the noise level at 5 m distance from the enclosure is less than 75 dB (A).

A hoist shall be provided above centrifuge for maintenance purpose. The hoist shall be such that it shall be possible to erect or de-erect the centrifuge while one centrifuge is in operation

1.21.1 Parameters

Type	Solid Bowl
Mixing arrangement of Polyelectrolyte and sludge:	online-mixing

1.22 Disinfection system

Chlorination System:

1.22.1 General

Chlorine diffusers shall be supplied and installed at the dosing point.

Treated sewage shall be dosed with chlorine gas at suitable concentrations so that effluent from the chlorine contact tank shall not have more than 0.2 mg /l residual chlorine.

1.22.2 Chlorinators

Vacuum type chlorinators shall be supplied with one duty and one stand by unit.

Mal-operation of the duty chlorination system shall be indicated in the Central Control room.

1.22.3 Dosing Pumps

- Dosing pumps (1 working + 1 standby) shall be installed.
- The dosing pumps shall draw their supply from treated sewage line.
- The pumps shall be placed inside the chlorination room and shall be made from material resistant to corrosion by chlorine.

1.22.4 Injectors

Two injectors shall be provided, each serving a duty /standby pair of chlorinators. The injectors shall be located in the chlorination room.

1.22.5 Chlorine

Chlorine shall be supplied as liquid from nominal 1 tonne chlorine toner.

1.23 The Toner Room

- (a) Storage shall be provided for chlorine tonners sufficient for at least one month's usage at normal rate of withdrawal.
- (b) The system shall be designed to prevent freezing of the liquid chlorine at the maximum rate of withdrawal.
- (c) Tonners on line, tonners on standby and full and empty tonners shall be stored separately in the tonner room.
- (d) Four sets of tonner rollers shall be provided. Tonners not in use shall be stored on concrete cradles.
- (e) A 2 tonner overhead single girder electric traveling crane shall be provided in the chlorine tonner room for the following functions:
 - i) offloading (and reloading) of tonner from trucks;
 - ii) handling of tonners within the storage area.
 - (ii) The system shall serve the tonner store width over the entire length including the loading/unloading area.
 - (iii) The hoist and traverse speeds shall be as follows;
 - (i) Long traverse speed : 5m/min
 - (ii) Cross traverse speed: not more than 5m/min
 - (iii) Slow lifting speed : 1m/min
 - (iv) High lifting speed : 5m/min
- (h) The container lifting beam shall be specifically designed for handling chlorine containers and equipped with necessary shackles and hooks.
- (i) Operation of crane system shall be from the floor level using independent push button pendent controls operating at a 230 volt 50Hz AC supply.

- (j) Two lifting beams shall be provided (a duty and a spare) and a one tonner weighed to be suspended from the crane hoist.
- (l) A pit and alkali absorption systems shall be provided to contain and neutralize chlorine in the event of leak. The system shall comprise a pit located in the tonner storage room and accessible by the overhead crane system. The pit shall be surrounded with removable guard railing. The pit shall be kept full with a neutralizing solution of lime. The pit shall be capable of holding side by side two chlorine tonners. A provision shall be made to drain the pit.
- (m) Special consideration shall be given to any floor drainage system in the tonner building; adequate shall be provided to ensure that chlorine gas cannot escape. All leader tubes carrying cables or pipes out of the building shall be sealed at either end to prevent any chlorine gas leaking out.

1.24 Chlorination Room

- a) The chlorination room shall be constructed adjacent to the tonner room but no interconnecting door or other form of access.
- b) Gas lines from the tonner room into the chlorination room shall run in ducts to be sealed after installation and prior to commissioning.

1.25 Chlorine Leak Detectors

- a. Not less than three chlorine gas leak detectors shall be provided each, with a single detector cell. At least two sensors shall be located in the chlorine tonner storage room and at least one sensor in the chlorination room.
- b. The chlorine leak detectors in the tonner room shall be mounted at each end of the tonner room.
- c. The chlorine leak detectors shall have two adjustable alarm levels sensitive to chlorine concentrations above 1mg/m³. The range of adjustment of alarm levels shall facilitate selection of the following alarms:
 - (i) low level 2mg/m³
 - (ii) High level 4mg/m³
- d. The low level alarm shall initiate a local audible and visual alarm;
- (e) Statutory warning notices relating to the storage and handling of chlorine shall be provided. The signs shall be pictorial and provided in Tamil and English.

1.26 Ventilation System

Each area where chlorine is stored or used as gas or liquid shall be provided with a good ventilation and exhaust system.

1.27 Chlorine Residual Test Kit

Chlorine residual test Kit shall be provided for monitoring of the residual free chlorine at plant outlet.

1.28 Safety Equipments

Materials and equipment necessary to ensure the safety of personnel operating the chlorination plant and others shall be provided.

1.29 Chlorination Power and Control

- a) A combined MCC and control panel shall be provided and located in a suitable location protected from the weather and effects of the process. The control panel shall provide facilities for :
 - (i) Duty Pump selection
 - annunciate alarms associated with the chlorination systems;
- b) The chlorination system shall operate using a fixed manually set dose rate. The quantity of chlorine dosed will therefore be adjusted in direct proportion to the process flow at the dosing point.

1.30 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 450mm 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 1.0.

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.

1.30.1 Material of Construction

Body, Bonnet, Wedge	: CI conforming to IS 210 Gr FG 260
Spindle	
Drain and Air Plug	: IS 318 Gr LTBZ
Seat Ring, Wedge Ring	: SS ASTM A743 CF8
Back seat Bush	: Bronze IS: 318 Gr LTB 2
Gland Packing	: Graphite Asbestos

1.30.2 Parameters

Type	: Rising spindle
Nominal pressure	: 2 times working pressure in pipeline
Nature of operation	: Horizontal / vertical
Applicable code	: IS 14846
Tests:	Acceptance tests as per IS 14846

1.31 Knife Gate Valves

Knife gate valves shall be suitable for use at suction and delivery side of pumps in a sewage pumping station. The valve should be provided with gate made of stainless steel and the gate should have beveled 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.

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

- 1) Body: Cast Iron FG 260 as per IS 210
- 2) Knife gate: AISI:304 Gr. ASTM A240
- 3) Retainer ring: SS:304 ASTM A351 Gr. CF:8
- 4) Inlet Seal: EPDM
- 5) Spindle: AISI:410 Gr. ASTM A276
- 6) Spindle Nut: Cast Iron Gr. FG 200 as per IS 210
- 7) Stuffing plate: Cast Steel ASTM A216 Gr. WCB
- 8) Stuffing seal: Synthetic yarn with PTFE

1.31.1 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.

1.32. Reflux Valves

Reflux valve shall possess high speed closing characteristics and be designed for minimum slam conditions while closing. External counterweights are not acceptable. Dual plate check valves shall conform to API 594 and API 598. They shall have metal to metal sealing. The spring action shall optimize the equal closing rates of each plate, especially when the friction coefficients are uneven due to one plate resting upon another. The plates shall not drag on the seat while opening. The plates shall not vibrate under full or partial flow condition. The pressure drop in the valve at design flow shall be limited to 0.4 mWC.

1.32.1 Material of construction

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

1.32.2 Parameters

Type	Dual 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

1.33 Pipe Work

The Piping within the pumping stations shall be CI D/F. All other sewage pipes inside the plant premises shall be made of CI D/F pipe. The treated and chlorinated sewage should be disposed off to the disposal site by closed RCC pipe or CI D/F pipe.

In general, the colour code for piping shall be blue for potable water, white for air, red for gas and as received colour from manufacturer for all other sewage pipes. The pipe works for the plant involves procuring, supply, laying and jointing of suitable size cast iron, u PVC, and RCC pipes internally lined sulfur resistant cement along with matching specials etc. as required. All yard piping inside the plant shall be cast iron. All pipe work and fittings shall be a class rating in excess of the maximum pressure attained in service including any surge pressure. The pipe work installation shall be so arranged to offer ease of dismantling and removal of pumps or major items of equipment. CI Piping above ground level shall be only flange jointed and adequately provided with structural/ masonry supports. Stainless steel AISI 304 expansion bellows which can take radial and axial misalignment of minimum one percent of the valve nominal size and tie bolts shall be provided. All pipe work shall be adequately supported with purpose-made fittings. When passing through walls, pipe work shall incorporate a puddle flange. Flange adapters and union shall be fitted in pipe work runs, wherever necessary, to permit the simple disconnection of flanges, valves and equipment. The Contractor shall be responsible for ensuring that the internal surfaces of all pipe work are thoroughly cleaned before and during erection and commissioning. Cleaning shall include removal of dirt, rust, scale and welding slag due to site welding. Before dispatch from manufacturer's works, the ends of the pipe, branch pipes etc., shall be suitably removed until immediately prior to connections adjacent pipes, valves or pumps. All small-bore pipes shall be blown through with compressed air before connection is made to instruments and other equipment. No point of passage of pipes through floors or walls shall be used as a point of support, except with the approval of Employer's representative. All underground-buried mild steel piping unless found otherwise necessary, shall be protected by the application of hot coal tar enamel and fiberglass wrapping. The coating shall consist of one coat of tar primer one coat, wrapping of fiber glass one more coat of enamel and the final wrap of enamel impregnated fiber glass. However, all water supply plumbing pipelines shall be of UPVC class 4 thick-walled inside the premises in concealed piping. They shall be GI class B in external locations and either anchored externally with SS AISI fasteners or appropriately buried below the ground with a sand cushion of 20 cm all round. All sanitary piping shall be of UPVC class 4 suitably buried below the ground with a sand cushion of 20 cm all round. Changes in direction on the ground shall be

achieved with inspection chambers of 45 cm x 45 cm and heavy-duty CI/Steel reinforced fiberglass chamber covers.

1.34 Galvanized Iron pipe

The procurement, supplying, laying, jointing and testing at works and site of Galvanized Iron (G.I.) pipes and fittings shall be in accordance with IS 1239 (Part I and II) and its latest revisions. The general requirements relating to the supply of mild steel tubes shall conform to IS 1387. The sulphur and phosphorus requirements in steel shall not exceed 0.05 percent each. The galvanizing of the pipes shall be as specified in IS 4736. The zinc coating shall be uniform adherent, reasonably smooth and free from imperfections. The pipes shall be galvanized before screwing. All screwed pipes and sockets shall have pipe threads conforming to the requirements of IS 554. Gauging in accordance with IS 8999 shall be considered as an adequate test for conformity of threads of IS 554. Screwed tubes shall have taper threads while the sockets shall have parallel threads. The specifications for G.I. pipes shall be generally in accordance with Clause 15.4 of standard specifications. The tolerances on the length of pipes shall follow clause 11.0 of IS 1239 (Part I). The fittings for G.I. pipes shall be of mild steel tubular or wrought steel fittings conforming to I.S. 1239 (Part II). The laying of G.I. pipes and fittings shall follow the relevant I S code of practice. These pipes shall be used for drinking water supply for the office and laboratory buildings. The pipes shall be painted with two coats of anticorrosive bit mastic paint.

1.34.1 Testing of G.I. pipes

Hydrostatic test shall be carried out at works at a pressure of 5 M Pa, maintained for at least 3 sec and shall not show any leakage in the pipe. The tensile strength of length or strip cut from selected tubes, when tested in accordance with IS 1894 shall be at least 320 N / mm². The elongation percentage shall be as per clause 14.1.1 of IS 1239 (Part I). The bend test shall also be carried out as per clause 14.2 of IS 1239. The G.I. pipes and fittings shall be tested at site, after they are laid and jointed as per clause 15.4.11 of standard specifications.

1.35 Unplasticized Poly Vinyl Chloride (uPVC) Pipes

The latest versions of Indian standards and codes of practice shall be adhered to for the design, manufacturing, inspection, factory testing, packing, handling, and transportation, laying, and jointing of the uPVC pipes. The rubber rings shall be vulcanized from Ethylene Propylene (EPDM) confirming to IS 5382. The uPVC pipes shall be of minimum 4 kg / sqcm and as per IS 4985 and the pipes for plumbing works in office building shall be SWR (Type B) as per IS 13592, with electrometric sealing rubber ring joints. The method of sampling of rubber rings should be in accordance with IS 5382. The material from which the pipes are made shall consist substantially of unplasticized polyvinyl chloride conforming to IS 10151, to which only those additives shall be added that are absolutely needed to facilitate the manufacture of the polymer and the production of sound, durable pipes of good surface finish, mechanical strength and opacity. The total quantity of additives like plasticizers, stabilizers, lubricants and fillers shall not exceed more than 7.0%. The bulk density of UPVC pipes shall be 1.39 to 1.44 g/cm³. The PVC resin of suspension grade K-66/K-67 shall be used for extrusion of UPVC pipe. The uPVC fittings shall be fabricated from Class 4 uPVC as per IS 4985.

1.35.1 Tests on Material:

Following in house tests shall be carried out on the raw material:

- (i) Grade (K-value)
- (ii) Particle size distribution
- (iii) Bulk density of resin
- (iv) Bulk density of compound

1.35.2 Acceptance Test on Pipes:

The acceptance test shall be conducted in accordance with IS 4985 and in presence of the Engineer's representative—

- (i) Visual and dimensional check
- (ii) Reversion test
- (iii) Vicat softening test
- (iv) Ash Content
- (v) Bulk density
- (vi) Resistance to external blows
- (vii) Internal hydrostatic pressure test for pipes and joints
- (viii) Opacity

1.35.3 Marking on Pipe:

Each pipe shall be clearly marked as indicated below:

- (i) Manufacturer's name and trade mark
- (ii) Outside diameter (OD) in mm
- (iii) Class of pipe and pressure rating
- (iv) Month and year of manufacturing
- (v) Length of pipe
- (vi) Marking of insert depth of spigot

1.35.4 Marking on rubber ring:

Each sealing ring shall be permanently marked with

- (i) The manufacturer's name or trade mark.
- (ii) The month and year of manufacture
- (iii) Diameter of pipe for which the ring is suitable.
- (iv) Type of rubber material

1.35.5 Tests on rubber ring:

Following tests shall be conducted on rubber rings conformity:

- (i) Hardness
- (ii) Tensile strength
- (iii) Elongation at break
- (iv) Compression set
- (v) Accelerated ageing
- (vi) Water Absorption
- (vii) Stress relaxation

2.35 Cast Iron pipe and fittings:

Cast iron pipe of LA clause shall conform to 1536/2001 Amendment No.3.July 2008 and fittings as per IS:1538 and laying shall be as per IS:3114.

Cast iron D/F PIPES as per IS 7181/1986 & IS 1537 and CI D/F Specials & S/S Specials as per IS 1538/1993

.In general, pipes inside the buildings and below the structures shall be jointed as double-flanged pipes with rubber insertion with MS bolt and nuts and those outside the building can be Socket and spigot socket joints with rubber rings/gaskets(tyton joints).

The test procedure, the scale of sampling and the criteria for acceptance of rubber rings shall be as per IS 5382 and IS 3400 in case of rubber ring joints.

The spigot socket joints shall also be with lead joints wherever necessary as per instruction of the Engineer. The lead jointing is done by first caulking in spun yarn and then filling the remainder of the joint space by running in molten lead, taking care that no extraneous material enters the joint and then thoroughly caulking the lead. The spun yarn shall be used to center the spigot in the socket and to prevent the flow of molten lead in to the bore of the pipe. The CI flanged pipes and specials shall conform to IS 1538. After laying and jointing of CI pipes and fittings the pipe line shall be tested at work site in suitable stretches before back filling excavated earth, as per specifications.

1.36.1 Inspection and Testing:

The pipes shall be subjected to following tests for acceptance:

- (i) Visual and dimensional check as per IS:1536/2001 and fittings as per IS:1538 & Cast iron D/F PIPES as per IS 7181/1986 & IS 1537 and CI D/F specials & S/S specials as per IS 1538/1993
- (ii) Mechanical tests as per IS:1536/2001 and fittings as per IS:1538 & Cast iron D/F PIPES as per IS 7181/1986 & IS 1537 and CI D/F specials & S/S specials as per IS 1538/1993
- (iii) Hydrostatic test IS:1536/2001 and fittings as per IS:1538 & Cast iron D/F PIPES as per IS 7181/1986 & IS 1537 and CI D/F specials & S/S specials as per IS 1538/1993
- vi) The test reports for the rubber gaskets shall be as per acceptance tests of the IS:1536/2001 and fittings as per IS:1538 & Cast iron D/F PIPES as per IS 7181/1986 & IS 1537 and CI D/F specials & S/S specials as per IS 1538/1993 and in accordance to clause 3.8

The sampling shall be as per the provisions of the IS:1536/2001 and fittings as per IS:1538 & Cast iron D/F PIPES as per IS 7181/1986 & IS 1537 and CI D/F specials & S/S specials as per IS 1538/1993

1.36.2 Markings

All pipes shall be marked as per IS:1536/2001 and fittings as per IS:1538 & Cast iron D/F PIPES as per IS 7181/1986 & IS 1537 and CI D/F specials & S/S specials as per IS 1538/1993 and in accordance to clause 3.8 and shown as below:

- (i) Manufacturer name / stamp
- (ii) Nominal diameter
- (iii) Class reference
- (iv) A white ring line showing length of insertion at spigot end.

1.36.3 Packing and Transport

The pipes should be preferably transported by road from the factory and stored as per the manufacturer's specifications to protect them from damage.

1.36.4 Specials for CI Pipes

The CI D/F specials & S/S specials shall be manufactured and tested in accordance with IS 1538/1993.

The mechanical test and hydrostatic test shall confirm to as per IS:1536/2001 and fittings as per IS:1538 & Cast iron D/F PIPES as per IS 7181/1986 & IS 1537 and CI D/F specials & S/S specials as per IS 1538/1993

1.36.5 Supply

All the CI fittings shall be supplied with rubber rings for each socket. The rubber ring shall conform to IS 12820 and IS 5382. Flanged fittings shall be supplied with one rubber gasket per flange and the required number of nuts and bolts.

2.36 Sluice Gates

The construction of sluice gates shall be in accordance with the specification and generally as per AWWA C 501 or IS 13349. The sluice gates shall be capable of performing the duties set in the specification without undue wear or deterioration. They shall be constructed so that maintenance is kept to a minimum. All parts of sluice gate, including mechanism components shall be designed for the heads specified with a minimum safety factor of five. All sluice gates shall be of the raising spindle type.

All sluice gates shall be manually operated. Motorized gates, if provided by the Contractor, the actuator specs be got approved from the Employer's representative.

1.37.1 Constructional features

The sluice gates shall be standard design of manufacturer's and of robust construction. The special features shall be as follows

1.37.2 Frame:

The frames shall be of ample section and cast in one piece. All surface forming joints and bearings shall be machined. The frame shall be of the flange back type and shall be machined on the rear face to bolt directly to the machined face of the wall thimble.

1.37.3 Guide:

The guide shall be bolted to the frame or cast integrally with it and shall be machined on all bearing and contact faces. The length of the guide shall be such that it should support the gate upon the horizontal line of stem nut pocket. Arrangements shall be such that it should support the gate upon the horizontal line of stem nut pocket. Arrangements shall be made to prevent lateral movement of bolted on guides. They shall be capable of taking the entire thrust produced by water pressure and wedging action. Wedges or wedge facings shall be attached to the guides at point where, in the closed position, they will make full contact with the wedging surface on the slides.

1.37.4 Seating Faces

The seating faces shall be of full width, solid section. They shall be secured firmly by means of counter sunk fixings in finished grooves in the frame and slide faces in such a way as to ensure that they will remain permanently in place as well as free from distortion and loosening during the life of the sluice gates.

1.37.5 Wedging devices

Sluice gates shall be equipped with adjustable side, top and bottom wedging devices required providing contact between the slide and frame facing when the gate is closed position. All faces shall be machined accurately to give maximum contact and wedging action. Wedges shall be fully adjustable with suitable adjusting screws and lock nuts and so designed that they will remain in the fixed position after adjustment.

1.37.6 Gate slides

The slide shall be with strengthening ribs where required and reinforced section to receive the seating faces. The slide shall have tongues on each side extending its full length and tongues shall be machined accurately on contact surfaces. Surfaces of the slide that in come in contact with the seat facing and wedges shall be machined accurately. The maximum allowable clearances between the slide and slide gate shall be 1.6 mm. An integrally cast stem nut pocket with reinforced ribs shall be provided above the central line of the slide.

1.37.7 Stem nut and Lift nut

A gate shall be provided with lower fixed stem nuts for connecting the stem to the slide and revolving lift nut located in the lifting mechanism in the head stock. They shall be of ample design to endure the thrust developed during gate operating under maximum gate operating condition loads in opening and closing direction. The stem nut and slide shall be constructed to prevent turning of the stem nut in the pocket in the slide. The stem nut shall be threaded and keyed or threaded and pinned to the stem.

Stem

The operating stem shall be designed for a tensile strength to withstand 90 kg effort on the crank and for a critical buckling compressive load assuming a 36 kg effort on the crank. The threads of the stem be machine cut or rolled and of the square or acme type. The number of threads per inch shall be such as to work most effectively with the lift mechanism used. The top of the stem be provided with a stop collar. Stem shall be provided with polycarbonate cover fixed to the headstock.

1.37.8 Stem coupling

The coupling shall be threaded and keyed or threaded and bolted and shall be of greater strength than the stem

1.37.9 Stem guide

Stem guides shall be cast, with bushings and mounted on cast brackets. Guides shall be adjustable in two directions and shall be so constructed that when properly spaced they shall hold the stem in alignment. The number of stem guides shall be such that the unsupported length of stem shall not exceed one hundred times its diameter.

1.37.10 Lifting Mechanism

Sluice gates shall be operated through a suitable lifting mechanism, which shall incorporate gearing if required. The lifting mechanism shall be suitable for operation by one man under all conditions. The lifting mechanism shall incorporate a strong locking device suitable for use with a padlock or padlock and chain. The manual operation shall be of the hand wheel crank operated type and shall have a lift nut threaded to fit the operating stem. The crank shall be removable. Ball or roller thrust bearings shall be provided above and below flange on the lift nut to take the load developed in opening and closing the gate with torque of 14 kg-m on the crank. Fittings shall be provided to lubricate gears and bearing. The design of the lift mechanism of the hand operated gates shall be such that the slide can be operated with torque is not more than 7 kg-m on the operator after the slide is unseated from wedges based on the operating head. The maximum crank radius shall be 380 mm.

1.37.11 Gears and bearings

All gears and bearings shall be enclosed in cast iron housing with labyrinth seals. The lifting mechanism shall be of cast iron pedestal, machined and drilled to receive the gear housing and suitable for bolting to the operating floor. The gates shall close with clockwise rotation of the crank. The direction of rotation to close the gates shall be indicated on the lift mechanism. A suitable means shall be provided for lubricating the stem threads directly adjacent to the lift nut. An inspection cover shall be provided to access the lift nut and gearing.

1.37.12 Fasteners

All anchor bolts, assembly bolts, screw, nuts etc., shall be of ample section to safely withstand the forces created by the operation of the gate.

1.37.13 Wall thimbles

The wall thimbles shall be made of cast iron and shall be supplied along with the gate. The wall thimbles shall provide a rigid mounting and designed to prevent warping of the gate frame during installation. The cross section of the thimble shall have the shape of the letter 'F'. The front, or mounting flange, shall be machined and shall be attached to the thimble with bolts and studs. The depth of the wall thimbles shall not be less than 300mm. To permit entrapped air to escape as the thimbles are being encased in the concrete, holes not less than 35 mm diameter at not more than 600 mm span, shall be cast or drilled in each entrapment zone formed by the reinforcing ribs or flange and water stop.

a) Material of Construction

Frame, Guide, Thimble, Stem	C I conforming to IS 210 Gr 260
Guide Bracket, Wedges,	
Door Sealing faces	Bronze conforming to IS 318 Gr LTB 2
Spindle	SS AISI 431
Flush bottom resilient seal	Natural or synthetic rubber conforming to IS: 1855
Anchor bolts	SS conforming to IS 6603
Hand wheel	Cast iron
Stem cover	Polycarbonate transparent tube.

b) Parameters

Type	Rectangular rising spindle
Size	As per requirement
Applicable code	IS 13349
Class	1
Maximum seating head	As per contractors design
Unseating head	As per contractors design
Maximum distances between gates centre line and operating platform	As per contractors design.
Seat clearance check, moving tests, leakage tests and Hydrostatic tests as per IS 13349/ AWWA C 501 shall be conducted at Manufacturer's works in accordance with the Inspection category.	

1.38 Open channel Gates

The manufacture of open channel gates shall be in accordance with the manufacturer's standard.

All open channel gates shall be of the rising spindle type.

All open channel gates shall be manually operated.

Open channel gates shall be tested as per manufacturer's standard.

The open channel gates for pumping stations shall be CI sluice gates. All other gates shall be aluminum gates.

The material of construction shall be as follows.

Components	Material	Specification	Grades
Gate frame, shutter, Headstock, Flush bottom seal support bar, Stop nut.	Cast Iron	IS: 210 – 1993	FG: 260
Sealing faces/ Seat facings	Stainless Steel	ASTM A276	AISI: 304, 316
Resilient rubber seal	Natural Rubber EPDM Rubber Neoprene Rubber		
Seal retainer bar	Stainless Steel	ASTM A276	AISI: 304, 316
Stem / Spindle	Stainless Steel	ASTM A276	AISI: 304, 316
Operating Nut/ Stem Nut	Leaded Tin Bronze	IS: 318 – 1981	LTB 1, LTB 2
Fasteners	Stainless Steel	ASTM A276	AISI: 304, 316
Anchor Bolts	Stainless Steel	ASTM A276	AISI: 304, 316
Yoke	Mild Steel	IS: 2062 – 1992	Grade A

1.39 Fire Extinguishers

The Contractor shall provide 3 Kg CO2 fire extinguishers of suitable capacity and numbers for the treatment plant at the following locations after consultation with the Employer's representative. These shall be provided as adhoc at the start itself and replaced fully up to date before handing over of the work. However for providing fire extinguishers in substation, PMCC/MCC and control rooms, please refer to sub-section VI

1. Laboratory - 1
2. Blower room - 2

These shall be installed in a fashion such that their use is facilitated in case of fire emergency.

1.40 First Aid kits

The first aid kit shall consist of all materials, medicines necessary for treatment of cuts, wounds, burns etc., These shall be provided in addition to requirement mentioned in sub-section VI as adhoc at the start itself and replaced fully up to date before handing over of the work

- (a) Laboratory
- (b) Rest room

1.41 Emergency Lamps

The Contractor shall provide for lamps with autonomy of 5 hours continuous service. The units shall be DC 6V and shall be rechargeable from any 5A plugs. They shall be continuously chargeable without damage to the battery at the following locations

- (a) Laboratory
- (b) Administrative Building
- (c) Toilets

1.42 Exhaust fans

The fans shall be as per IS 2312 and the blades shall be of mild steel dynamically balanced to avoid noise and vibration. The blade and its carriers shall be securely fastened to avoid loosening in operation and shall have a SS AISI guard as a grill inside and a 10 sq mm mesh screen to safeguard birds from getting sucked in. The duty of the fans shall be calculated to ensure 3 to 10 air changes per hour in the command area depending on requirement. These shall be provided at the following locations

- Laboratory
- Toilets

1.42.1 Materials of Construction

Casing
Impeller
Test

M S as per IS 2062
Cast Aluminium
As per IS 2312

1.43 Chain Pulley Blocks

Geared Chain Pulley Blocks shall be adopted. The monorail and trolley and the chain pulley block shall be provided for lifting the blowers and submersible pumps. The trolley and chain pulley block shall be hand driven. The capacity of the trolley and the chain pulley block shall be for the maximum weight to be lifted during erection and maintenance of the equipment but should not be less than 1 tonner. The traveling trolley shall run on the lower flange of the rolled steel joist. The trolley shall have two wheels on both sides of the joist web. The trolley wheels shall be single flanged with treads machined to match the flange of the beam. The wheels shall be of carbon steel casting conforming to IS 1030. The trolley shall have an arrangement for the fixing chain pulley block and sling. Pushing the load shall move the trolley. Suitable arrangement shall be provided on the joist to prevent over traveling. The chain pulley block shall have frame housing gears load sheave, brake unit, hand chain wheel and load chain wheel shall have hooks on both sides, one fixed with traveling and other for the load. The frame shall be of welded construction.

The gears shall be of spur type incorporating high grade hardened carbon steel pinion and heat treated carbon steel wheels. The width of the gear shall be adequately sized for long life. The driving pinion shall be integrated with the driving shaft. The load hook (bottom hook) shall rotate on the ball bearing. The chain shall be electrically welded, accurately calibrated, pitched and polished. The length of the load chain shall be sufficient for taking out the blower/pumps from their location. The hand chain wheel shall be provided with roller type guarding to prevent slipping the chain. The hand chain wheel shall hang to clear of the hook. The braking shall be automatic, the screw and friction disc type and shall offer no resistance. The load shall be sustained in any position of lift when effort for hoisting or lowering is removed. Each chain pulley block shall be supplied with one set of 1 tonner sling with galvanized D- shackles and clamps. The slings shall be about 3 m long.

The monorail shall be 'I' section. The exposed mild steel surfaces shall be enamel painted. The fasteners shall be GI or Cadmium plated. The chain pulley block shall be tested for 150% overload through a length of lift which will ensure that every part of the block mechanism and every teeth of gears come under load.

1.44 Valve Actuators (Wherever required)

1.44.1 General

All actuators shall be motorized type and local controls shall be protected by a lockable cover. Each actuator shall be adequately sized to suit the application and be continuously rated to suit the modulating control required. The gearbox shall be oil or grease filled, and capable of installation in any position. All operating spindles, gears and head stocks shall be provided with adequate points for lubrication.

The valve actuator shall be capable of producing not less than 1½ times the required valve torque considering valve spindle jamming and shall be suitable for at least 5 continuous operation.

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

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

Each actuator shall be equipped as follows:

- (a) AC electric motor with engage/disengage clutch mechanism of the dry type.
- (b) Reduction gear unit (with thrust bearing if required)
- (c) Torque switch mechanism
- (d) Limit switch mechanism
- (e) Geared hand wheel for manual operation of valve.
- (f) Valve position indicator – open/closed
- (g) Auto-Manual lever with suitable locking arrangement
- (h) Valve position transmitter
- (i) Reversing contactor starter complete with overload relays of suitable range and adequately rated control fuses
- (j) Actuator with integral starter shall have selection between local/remote operation
- (k) Local control switch/push buttons
- (l) 415 V/110 V AC control transformer
- (m) A white lamp for supervision of main supply to be provided locally.
- (n) A potential free contact shall be provided to annunciate over-load trip/main supply failure on remote panel
- (o) Provision for local as well as remote operation

1.44.2 Special Features

- (a) Two (2) nos. interposing relays for matching the control voltage of remote commands.
- (b) The motor shall be specially designed for valve operation, combining low inertia with a high torque and with linear characteristics.
- (c) All motor actuators shall be provided with visible local valve position indicators mounted on the actuator assembly itself.
- (d) The torque switch shall function to stop the motor on closing or opening of the valve, on actuation by the torque when the valve disc is restricted in its attempt to open or close. A minimum of two (2) torque switches, one for closing direction and one for opening direction shall be provided.
- (e) The non-adjustable limit switches shall stop the motor and give indication when the disc has attained the fully open or close position. Provision shall be made for indication of stuck or jammed valve.
- (f) All wiring connections from the various switches shall be brought out on to separate terminal box mounted on the valve, having liberal space for wiring and making connection.

- (g) The terminal box shall be suitable for outdoor use and shall be weather-proof and dust tight

1.45 Laboratory Equipment

Laboratory equipment's shall be provided as mentioned below:

	Description	Quantity
1	PH Meter	1 no.
2	Conductivity Meter	1 no.
3	D.O. Meter	1 no.
4	Distillation Apparatus	2 nos.
5	B.O.D. Incubator	1 no.
6	C.O.D. Apparatus	1 nos.
7	Hot Air Oven	2 nos.
8	Incubator	2 nos.
9	Refrigerator	1 no.
10	Water Bath	1 no.
11	Dessicator	3 nos.
12	Hot Plate	2 nos.
13	Auto Clave	1 no.
14	Thermometers	4 nos.
15	Electronic Balance (Single Pan)	1 no.
16	Automatic Burettes	4 nos.
17	Fixed Vol. Pipettes	6 nos.
18	Laminar Flow	1 no.
19	Centrifuge	1 no.
20	Magnetic Stirrer	1 no.
21	Filtration Assembly	1 no.
22	Vaccume pump	1 no.
23	Aeration Pump	1 no.
24	Microscope	1 no.
25	Physical Balance	1 no.
26	Muffle Furnace	1 no.
27	Fish aquarium	1 no.
28	TOC analyzer	1 no.

In addition to these, contractor shall also provide necessary chemicals, glassware and reagents required for testing in the laboratory.

VI. ELECTRICAL WORKS

A ELECTRICAL

1 General

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

2 Standards

The equipment offered shall comply with the relevant Indian Standards. The equipment conforming to any other approved International Standards which is considered equivalent or superior shall be acceptable. The tenderer however, shall have to substantiate equivalence or superiority.

3 Requirement of Statutory Authorities

The electrical equipment/installations shall comply with the requirements of Rules/Regulation as amended up-to-date, required by Statutory Acts or Authorities.

- The Indian Electricity Rules, 1956
- The Indian Electricity Act.
- The Indian Electricity (Supply) Act, 1948
- The requirements of Chief Electrical Inspector to the Government of Tamil Nadu.
- The requirement of Tamil Nadu State Electricity Board.
- Fire advisory Committee Insurance Act.
- The contractor shall get the drawings, layouts of HT sub-station etc. approved from TNEB

and chief Electrical Inspector to the Govt. of Tamil Nadu, wherever necessary. The contractor also shall arrange to get the installation inspected by CEIG and carryout modifications/rectifications as required by CEIG, prior to commissioning of sub-station / electrical equipments.

4 H-Frame Steel Structure

H-frame galvanized steel self supporting structure shall generally have the following equipments.

- Lightning Arresters
- Gang Operated A.B Switch
- DO Fuses
- String Insulators
- Pin Insulators
- ACSR conductors of appropriate sizes to connect all the equipments

4.1 Lightning Arrester

Lightning arresters shall be provided on each 11KV line before the termination on the 11KV isolators in the switch yard. Lightning Arresters shall be suitably mounted on H pole structure or 4 pole structure for receiving 11kv supply as per IS 3070 Part I.

4.2 Gang Operated AB Switch

The Switches shall be provided with horizontal connecting bar, for gang operation, G.I pipe as down rod lever coupling and operating handle with padlock and other components necessary for complete assembly.

4.3 11KV Drop-Out Fuses

The 11KV drop-out fit off fuses shall offer protection against short circuit and suitable for use in conjunction with 11KV system having fault level of 500 MVA as per relevant ISS.

A suitable insulated operating rod shall be provided with each fuse assembly. Two pairs of rubber hand gloves for working on 11KV shall be provided.

4.4 Insulators

The disc, pin and post type insulators used shall be of high quality glazed porcelain. The electrical and mechanical characteristics shall conform to IS:731 and IS:254. The insulators shall have following characteristics suitable for use in an effectively earthed system.

-	System voltage	:11kv
-	Dry Wet one- minute power Frequency to withstand voltage	:22 kv
-	1.2/50 micro second impulse withstand voltage	:75KV
-	Power frequency puncture with stand test voltage on units	:1.3 times of the dry flash overvoltage of the unit Visible discharge voltage 9 KV
-	Total minimum creep age distance for post and disc insulator	:320 mm for post insulation

5 HT Sub Station

5.1 In general HT substation shall be out door type. The transformer shall be suitable for outdoor type and installed on cement concrete platform, having capping level well above the flood level of that area. The size of the platform shall be decided by the contractor, depending on the capacity number of transfer to be installed. In case of indoor substation, the transformer shall be suitable of indoor type. The transformer HT/MV panel rooms shall be decided to suit requirement. The transformer may be erected on the structure also with suitable provision made in the H pole structure. Fencing shall be provided as per relevant IE rules.

6 Power Transformers

6.1 General

TRANSFORMER SHALL BE 11KV /0. 433KV

Type: Outdoor in general. In case of indoor, substation shall be indoor type, mineral oil filled natural cooled ONAN as per standard IS 2026 with of circuit tap changer of + 5 to - 10% in steps of 2.5%. Adequate number of radiator elements made of low carbon sheet steel should be provided for cooling.

Technical Particulars:

No. of Winding : 2
 No. of Phase : 3
 Winding connection: primary - Delta
 Secondary - Star
 Connection Symbol: DYN 11
 Rated frequency: 50 Hz
 Rated kVA: 400
 Rated primary voltage: 11kV
 Short circuit level: 26.2kA
 Method of system earthing : Solidly earthed
 Rated Secondary voltage: 433 V
 Impedance voltage: 4%
 The temperature rise at reference ambient as per IS: 2026

Top oil 45°C by thermometer method
 Winding 55°C by resistance method
 Primary and secondary side cable box for cable termination.
 All standard fittings and accessories as per IS
 Acceptable makes CGL, EMCO, Bharat Bijlee, WSON

6.2 Insulating Oil

The transformer shall be supplied with insulating oil duly filled. The insulating oil shall conform to IS: 335 10% excess oil shall also be supplied to account for loss.

6.3 Transformer Accessories

The transformers shall have the following Accessories

- Off Circuit manual tap changing switch externally operated as specified and positioned on side of transformers accessible from the ground level;
- Conservator with drain plug, filling as specified.
- Explosion vent with diaphragm
- Air-relief vents;
- Inspection cover on the tank covers for all transformers;
- Filtering connections with required valves
- Following valves shall be provided

Oil sampling valve-One No

Oil Drain valve-One No

Filtering valves-Two Nos

- Grounding terminals, two for the transformers tank for clamping to purchaser's grounding grid connection;
- Lifting lugs or eyes for the over top part of tanks, cores and coils, and for the complete transformers
- Pulling eyes, for pulling the transformers parallel to and at right angles to the axis of bushings.
- Diagram and rating plate for transformers,
- Rollers
- Thermometer pockets with dial type thermometers for top oil temperature indication. The thermometer shall be clearly visible from ground level as specified.
- Weather proof control cabinet
- Buchholz relay

Transformer shall be tested as per IS 2026.

7. LT Panel Board

Panel board shall be either cubicle type floor mounted or wall mounted. The board shall be Vermil and dust proof powder coated made of 14 SWG MS sheet and MS angle, iron frame work with copper/Aluminum bus bar 4 nos. enclosed with insulated sleeves of approved colour and required current carrying capacity as per IE rules. The bus bars shall be mounted on a suitable insulating support. The panel board shall be complete with all internal wiring including twin copper earthing.

8 Air Circuit Breakers

The Air Circuit Breakers shall conform to IEC/Indian standards. The ACBs shall be manually draw out type in open execution with over current trip device adjustable 64% to 110% time setting for overload adjustable current setting for short circuit protection and adjustable current and time setting for earth fault protection.

No. of poles	- 4 or 3
Rated insulation voltage	- 1000
Rated short circuit breaking	- 50 KA – (AC – 415V)
Rated making capacity AC	- 105KA
Rated short time withstand current	- 50KA
Total making time	- 30 millisecond
Total Breaking time	- 38 ms.
Motorised mechanism	- 220/240V
Under voltage released AC	- 150/(66)VA
Opening line delay	- 20 – 30 MS
System protection	- overload, short circuit, Earth fault
Overload protection	- adjustable current settings aeration 50% to 100%
Short circuit protection	- adjustable pickup level
Earth fault protection	- relay shall have sensitivity of adjustable Between 10% to 30% of ACB rating

Air circuit Breaker shall be fitted with following

- Heavy duty switch having not less than 4 No. + 4 N C - contacts
- Built in resin cast current Transformer
- Auxiliary contacts
- Shunt and under voltage tripping device
- Neutral CT for earth fault protection
- ACB shall be suitable for locking the breaker in various positions. Provision of door locking with requisite end termination lug and sockets. Terminal bars for connecting more than one terminal.

9. Moulded case circuit breakers

The Moulded case circuit Breakers shall have overload, and Short-circuit protective elements. The contact system shall be designed to have minimum wear and also energy loss. Arc extinguishing device shall be provided. The MCCB shall have 'ON' – 'OFF' or 'Trip' indicators. The interrupting capacity of the breaker shall be 35KA – 50 KA at 415V. The MCCB shall be tested as per IS 2516.

The container shall be of non-conducting materials and withstand high temperature, and flame retardant.

10. Miniature Circuit Breakers

Miniature circuit breaker working on residual current device having 6000A short circuit breaking capacity and 30 mille amp. Sensitivity and 30 millisecond tripping time conforming to IS 12640 trip free mechanism operating for rated leakage at nominal 10 Volts. Earth leakage circuit breaker also may be provided wherever necessary instead of MCB.

11 Fuse Switch Units.

The fuse switch unit shall be suitable for 415/430V operation and conform to IS 13947 (Part 3) and IEC 947-3.

The switch shall conform to following Technical specification

Rated operational voltage	- 415V
Rated insulation voltage	- 660V
Rated Thermal current	- 125A/160A/250/400A
Number of Poles	- Three (TPN) isolate
Rated operational current	- as required
Rated making capacity	- 10 times the rated current
Rated fuse short circuit making capacity at 415V	- 176 KA
Rated fuse short circuit withstand capacity	- 80 KA

12. Indicating Instruments

All electrical indicating instruments shall be digital square type of size suitable to the panel. These shall be suitable for flush mounting with only flanges projecting on vertical panel. Instrument dial shall be white with black numerical lettering.

Instrument shall conform to IS 1248 and shall have accuracy class 1.00 or better. The current coil and potential coil of Ammeters and Voltmeters respectively, shall withstand 120% of rated current and voltage, without loss of accuracy.

The meters shall have external zero adjustments. The ammeters fitted in the motor circuits shall have suppressed scale to indicate the maximum starting current. The instrument shall be provided with glass cover to avoid the possibility of measurements due to static charge.

The three phase three wire trivector meter shall comprise of KWH meter and KVAH meter mounted together with KVAH meter in one case with special summator mounted between them to register correct KVAH at all power factors.

All the factors shall have respective maximum demand indicators to record the average power over a period of half an hour. The tri-vector meter shall conform to relevant IS.

13 Under Voltage Relays.

The induction disc type, single pole under voltage relay shall have inverse time voltage characteristics on all taps. The relay shall be designed to develop maximum torque at supply frequency and shall be insensitive to the voltage at harmonic frequencies.

The operating time shall be adjustable by time setting multiplier. Selection of the required voltage setting shall be possible by means of a plug setting bridge having an insulated plug. The relay shall conform to IS-3231.

14. Protective Relays

Relays shall be rectangular in shape, flush mounting type, having dust tight covers, removable from front, and shall be equipped with externally reset, positive action operations indicators. The relay shall have auxiliary units of either series connected or shunt connected type. All auxiliary relays shall be non-draw out type and protection relays shall be draught type with test facilities.

Test plug shall be supplied loose. All relays shall conform to the requirements of IS - 323 or relevant IEC in general and IS - 3231 in specific.

Relays shall be provided with adequate number of potential free self reset/hand reset output contacts as required. Provision shall be made for easy isolation of trip circuits of each relays for the purpose of testing and maintenance. Current transformer short circuiting arrangement shall be provided in case of draught type relays.

Voltage relays shall have sufficient thermal capacity for continuous energisation using external resistance, if necessary.

No control relay, which will trip a circuit breaker when relay is de-energized, shall be used.

15. CABLES

15.1 1100V/660V Grade cables shall be PVC insulated, PVC sheathed, G1 strip armored, Aluminum conductor.

The control cables and cables for lighting system shall be with PVC insulated, multi stranded copper conductors. Cables in general shall conform to IS 694, IS 1554 part I & II, and cross section 25,16, 10, 6, 4, 2.5 and 1.5 sq.mm.

The cables from main distribution panel board to the equipment shall be free of joints.

15.2 Laying of cables

Cables shall be laid directly buried on earth, in conduits along walls, ceiling etc. The cable installation shall conform to relevant ISS.

- Cable inside the Sub-station/Building shall be laid in the prepared trench. If any hole or breaking of wall is required for cable laying work, it shall be done by the contractor and the wall shall be closed after completion of the work as original.
- The cable trench dimensions inside the Sub-station and the route shall be indicated to the civil contractor well in advance while Sub-station civil work is in progress, depending upon the cable entry, and location of different equipments, transformers, panels, etc.
- Laying of underground cables outside the building shall be done by excavating a trench covered by brick and sand of 0.75 meter depth for HT and LT cable and protecting each run of cable by sand and earth filling.
- The HT and LT cables shall be taken through the cable duct provided on the ground floor roof as shown in the sketch, by properly clamping.

- Fixing of cable on the wall by clamping the cable, using suitable GI clamps with wooden saddles. The distance between two clamps shall not be more than 750mm. The cables shall also be taken through PVC pipes on the wall. The cable route on the walls shall be decided with the Engineer in site. The cables shall be covered with GI plates, trays or wooden covering. Sharp bending, twisting and Kinking of cables shall be avoided. Suitable cable duct shall be provided in the wall connecting all switch rooms of Railways and Commercial Complex.

16. Distribution Boards

All the switch Boards, Panels shall be neatly wired using 1100/660V PVC insulated stranded copper cable of minimum 2.5 sq.mm. Copper Bus Bars also may be provided to suit the requirements.

Each wire shall be identified at both ends with cable marker.

Distribution Boards shall be housed in metal clad case or board conforming to IS 4237. The Sub-Distribution Boards shall be equipped with rigidly fixed miniature circuit breaker complying with IS 8828 in the phase leads with over load and short circuit protection. The MCBs shall have adequately sized terminals for the outgoing leads. The distribution boards shall have adequately rated phase and neutral bus bars of high conductivity copper. Earth the bus bar with the necessary number of terminals for connecting the earth continuity conductors.

Each SDB shall have circuit schedule pasted or permanently fixed inside the cover stating the details of circuit controller and rating of MCB. Non-flammable insulating shields shall be provided to prevent fire hazards during operation of MCBs.

The Sub-Distribution Boards shall not be mounted at a height exceeding 180CM from ground level.

Main Distribution Boards shall be surface mounted. Main Distribution Boards shall be erected in each switching room, and sub-distribution boards shall be located according to the distribution of load and the equipments to be connected and its location.

17. Lighting System

17.1 Point Wiring

Point wiring shall include all work necessary to complete wiring from switch circuit of any length from the tapping point on the distribution circuit switchboard to the following:

- Ceiling rose for fans, lighting etc.
- Socket outlet (in the case of socket outlet points)
- Lamp holder (in the case of wall brackets, batten points, bulk head and similar fittings).
- Call bell buzzer (in the case of the works "via the ceiling rose/socket outlet or bell push where no ceiling rose/socket outlet is provided").

17.2 Circuit wiring

Circuit wiring shall mean the length of wiring from the distribution board upto the tapping point of the nearest first points of that circuit, viz., upto the nearest first switchboard measured along the run of wiring. Such wiring shall be measured on linear basis.

18 Electric Motor

Type	:	Squirrel cage induction motor suitable for continuous duty.
Standards	:	Performance - IS 325, IEC 34 Dimensions - IS 1231, IEC 71
Site condition	:	Ref. Ambient -45°C Max humidity - 100%

Cast iron body with integral feet and frame. The stator core shall be that of high grade carlite insulated low loss silicon steel lamination stacked together and fully tightened. The rotor shaft made of high grade forged/rolled steel. A spacious terminal box is to be provided to accommodate aluminum conductor cables.

Technical Particulars	:	Rated voltage: 415V \pm 10% Frequency: 50Hz \pm 3% Temperature rise of 75°C over ambient of 45°C Enclosure: IP 55 Type of cooling: Totally enclosed fan cooled
Acceptable makes	:	Siemens, NGEF, CGL, KEC

18.1 Auto transformer starter

Automatic auto transformer starter shall be assembled in 14 SWG sheet steel, floor mounted with following accessories

- Oil immersed auto transformer with 50%, 65% and 80% tapping including first filled oil.
- Bimetallic overload relay
- Timer on delay and off delay.
- Ammeter with CTS and selector switch.
- Voltage with selector switch.
- No voltage release
- Indicating lamp, Power On, Trip
- (Single phasing current sensing preventor with protection CTS)
- Thermo stat for oil temperature.(Optional)

19 Earthing

- Earthing in general shall comply with C.P.(Code of Practice) 3043 of Indian Standards.
- Earth electrode either in the form of pipe electrode or plate electrode should be provided at all premises for providing earthing system.
- As far as possible, all earth connection shall be visible for inspection and shall be carefully made.
- Except for equipment provided with double installation all the non-circuit carrying metal parts of electrical installation are to be earthed properly. All metal conduit trunking cases. Sheets, switch gears, distribution fuse boards, lighting fittings and all other parts made of metal shall be connected to an effective earth electrode.
- The main earth electrode should be a G.I perforated pipe driven into the soil as per standard practice. continuous looped earthing should be provided with adequate size G.I. wire /feat. Earthing work should conform to I.E. Rules.
- The electrodes shall be situated at a distance not less than 3.0 m from the building fencing structure and equipment foundations. The earth pit shall conform to IS: 3043 and GI earth electrodes of not less than 100 mm external dia shall be driven to a depth of at least 3 m in the ground below the ground level. The surrounding the electrodes, soil shall be treated up with salt, coke and charcoal.
- Earth electrodes shall be installed near the main supply point and shall comprise a copper/GI earth of appropriate diameter and driven to depth of 3 metres below ground level,. or to a greater depth, if so required to obtain a sufficiently low earth resistance value. Alternatively copper plate mach be used as the main earth electrode conforming to IS: 3043. The electrodes shall be driven at least 3 m away from the building or any other earth station.

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

- Two numbers independent for transformer body
- Two numbers independent for transformer neutral
- Two numbers independent for four pole structure
- One number for lightning arrestors.
- Two numbers of L.T. panel at sub-station and at pump house.

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

- An earth continuity conductors shall run continuously from the farthest part of installation to the main earth electrode and shall be connected by branch conductor to all metal casing and sheathing housing electrical apparatus and/or wires and cables. all branch shall be connected to earthing. The earth continuity conductors shall have a cross-sectional area at least half to the size of the phase conductor and in no case less than 1.5 sq.mm of copper/GS.

- All earth wires and earth continuity conductor shall be galvanized M.S flats of appropriate size. Interconnections of earth continuity main conductors and branch wires shall be brazed properly, ensuring reliable, permanent and good electrical connections. The earth lead run on structures must be securely bolted. Neutral earth leads shall be run on separate supports without touching the body of the transformers. Earth wires shall be protected against mechanical damage and possibility of corrosion particularly at the junction points of earth electrodes and earth wire interconnections. Earth electrodes shall be connected to the earth conductors using proper clamps and bolt links.

- It shall not be allowed to use the armor of the incoming feeder cables to the sub-distribution board as the only earthing system.

- Sheathed lugs of ample capacities and size shall be used for all underground conductors for sizes above 3 mm² whenever they are to be fitted on equipment of flat copper conductor.

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

- No strands shall be allowed to be cut in case of stranded ground round conductors. G.I embedded conduits shall be made eclectically continues means of good continuity fixing and also be rounding copper wires and approved copper clamps.
- Suitable earth wire/flats as per requirement of electrical design for earthing material to be used depending upon the equipment to be earthed.
- The earth electrode pit has to be filled up with 3 layers of charcoal mud and salt of sufficient quantity as per IS 3043.

19.1 Earthing of Lighting Poles

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

19.2 Earthing for Lighting Installation

This shall be common grid system, the main grounding conductor laid and embedded in concrete being grounded at earth pits outside the buildings at approved locations or other places. The earthing of L.T. panels shall be connected to two main grounding conductors each of which along with main cables shall run with cables to distribution boards in which floor. This shall run along with the cable and at the top floor be connected same section completing the grid.

19.3 Sizes of Earthing Conductors

No	S . System	Earthing conductor size and Material	
		Buried in ground/ Above ground concrete	
-	Main earthing grid	40 X 10 mm MS	
-	11 kV outdoor sub-station and 11 kV switchgear	40 X 10 mm MS 50 X 6 mm GS	
-	415 V switchgear, transformer, DG set, Capacitor Control Panel	Suitable to its rating.	
-	Battery charger	25 X 3 mm GS	
-	415 VLT Motors		
-	Valve motors	10	SWG GS wire
-	0 - 15 HP	8	SWG GS wire
-	15 - 40 HP	4	SWG GS wire
-	40 - 50HP	25 X3 mm GS flat	
-	50 HP and above	25 X6 mm GS flat	
-	Lighting distribution Board, 30 V DC Tripping Unit.	25 X 3 mm GS flat	
-	Local Push Button stations, Junction Boxes.	14 SWG GS wire	
-	Lighting and receptacle system	12 SWG GS wire	
-	earth Electrode	50 mm dia.3000mm long heavy duty GI Pipe electrode	
-	Street lighting Poles	8 SWG GS wire	

Notes:

1. Conductors above ground shall be galvanized steel to prevent atmospheric corrosion.
2. Conductors buried in ground or embedded in concrete shall be mild steel.

19.4 Battery, Battery Charger & DC Distribution Board

- The charger and DC distribution board shall be enclosed on a common sheet steel enclosure with necessary compartment for each incoming and outgoing feeder.

- Complete information regarding battery layout, space requirement for locating battery, wall painting of battery room floor, ventilation, method of lighting etc. shall be supplied by the Contractor. The battery room shall preferably be located inside MCC room as shown,. The battery room shall have acid proof tiles as flooring and upto 4 ft. level. Also there shall be an exhaust fan of appropriate capacity to extract vapours from the room.

19.5 Tests

- Batteries and battery chargers shall be routine tested before despatch in accordance with Indian Standards. Capacity test shall be carried out on the batteries at site after installation.

20. Street Light

Street Light fixtures shall be complete with integral semi-cut off lantern with glass cover complete with internal wiring, control gear, mounting accessories, street light bracket for HPSV 150W made from 60mm dia (B Class G I Pipe) 2 m in length and welded to the pole cap of size 100mm and 30 cm long duly welded.

21. Street Light Poles

The street light mast shall be 65m/75 diameter G.I pipe of 7.5 meter long with 300mm x 300mm x 6mm of M.S base plate, duly welded at the bottom. A suitable MS box to have 5A control switch, 16A fuse unit with suitable frame work shall be fitted in the street light mast with door and locking arrangements.

A terminal box with fuse shall be fixed in all the poles.

22. Capacitor

To improve the power factor capacitor shall be provided in the LT bus bar in the sub-station.

- The capacitor shall be as per ISS 2834 and IS 2544.
- **The capacitor shall be all polypropylene film capacitors. The film shall be oriented bi-axially.**
- The oil used for impregnation under vacuum shall highly purified non- toxic.
- Low loss discharge resistance, to reduce the residual voltage to 50V or less within one minute after the capacitor is disconnected.
- The capacitor container shall be painted with epoxy-based paint, to prevent corrosion/rusting.
- 4 stage switching ON/OFF shall be provided to match with the load.
- Automatic Power Factor Correction Unit shall be provided if necessary.

Test requirements

The following inspection / testing has to be carried in the factory before dispatching \

Name of items	Visual checking	Testing	Certificate
Transformer	Leakage of oils, quality of wiring Panel board bus/bars checking etc	Insulation testing continuity of wiring ratio testing short circuit test die- electric strength of transformer oil with high voltage as per IS 335	Type test certificate for the transformer to be given
	Name board details of the transformer and testing		
Electrical Panel Board	Measurement of panel board as per drawing quality of wiring provision of wire	Testing of operation closing and opening	Type test certificates for

450 Volts	tag numbers brand name of equipment switch case which is provided is as per the procured from the approved vendors list.	of switch gears relay functioning testing insulation testing	equipments provided in the panel board
Cables	Brand Name	Continuity test one test between phases	Type test certificate for the pump
Pump motor	Name plate details testing insulation testing between phases and between earth	no load operation of pump	Type test certificate for the pump
TEST TO BE CARRIED OUT AT SITE (as per IS3403)			
Earthing to be done on the site independent earth electrode for lightning has to be provided	Check the diameter of the electrode (G.I pipe) and size of connecting wire and flat	Measurement of earth resistance to be carried out with earth mugger	

23. Safety

The following minimum safety equipment's shall be supplied and installed in the Sub-Station switch rooms and Diesel Generating rooms.

- Portable chemical fire extinguishers conforming to IS 935 or its latest version shall be supplied and installed at the Sub-Station, Switch rooms and Diesel Generating Stations.
- Fire buckets with M.S. angle stand each consisting of 4 Nos. round bottom fire buckets painted with red and marked fire and filled with clear dry river sand shall be supplied and installed at a convenient locations at the proposed Sub-Station.
- First-Aid boxes equipped fully with required materials, shall be supplied and kept at a convenient place in the Switchgear room so that the same is easily accessible.
- Shock Treatment chart.
- Rubber matting of not less than 25 mm. thick and 600 mm width and standard lengths, shall be provided in from of all the switch gear panel, Transformer, Control cubicles, etc.
- Rubber gloves tested for 15 KV about 4 sets shall be supplied.
- Surge protection equipment – the contractor shall provide suitable ELCB and over voltage relay to protect the equipment from lightening and over voltage.

24. Diesel Generating Equipment

24.1 General

- Electrical power supply for each pumping arrangement will be availed from nearby TNEB supply point. According to the load requirement HT at 11KV/22KV or LT at 415V - 3 Phase will be availed from TNEB.

- One Diesel driven alternator set of required capacity as specified shall be provided to permit operation of all the units in the plant including lighting units in the event of failure of the TNEB electricity supply, complete with all equipments like. The equipment shall conform to the latest relevant ISS or BS.

- Control gear, circuit breakers, cabling, synchronizing equipment etc.

- The engine alternator sets shall be designed such that the starting power peak shall not exceed 10 per cent of the continuous engine rating and the voltage dip shall not exceed 15 per cent whilst starting the connected load under the worst conditions.

- The Drawings shall show the building, floors and other details as they will be constructed and the space allocated for the generating plant, control gear and circuit breakers.

- Tenderers attention is specifically drawn to the operating conditions where by generator sets could be running at little or no load due to the intermittent and differing flow rates and pump capacities.

- A system using dummy loads to maintain a safe minimum working level is envisaged and the Tenderer is required to comment upon this or any other proposed system at the time of Tender submission together with supporting documentation and calculations.

It is the responsibility of the contractor to provide proper installation of exhaust stack as per norms of PCB/CEIG. Also necessary consent / NOC from PCB / CEIG should be obtained by the Contractor.

In case of out door pumps/motor / panel boards etc necessary shelter will be made by the contractor to ensure operator safety during emergency /routine operation during extreme weather conditions such as thunder storms, heavy rainfall and cyclones.

25 Statutory Approval

The Contractor shall be totally responsible for obtaining statutory approval from the electrical inspector or any other statutory authority for the entire installation carried out by him unless otherwise specified and agreed. Necessary test reports shall be submitted by him to electrical inspector. This will be an integral part of the contract and shall not be paid for separately. However fees payable to statutory authorities shall be borne by the Engineer.

26 Acceptance of Installation

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

VII OPERATION AND MAINTENANCE OF SEWAGE TREATMENT PLANT

1. SCOPE OF WORK

The contractor shall operate and maintain the Sewage Treatment Plant, and all other allied works under this contract, for a period of 10 years. Salient features of works are:

- 1) To Operate and maintain the sewage treatment plant, all instruments and mechanical, electrical equipments in accordance with the aim and purpose of treatment. The plant & equipments covered under the above contract will be totally attended to, by the contractor including any "Troubleshooting" to ensure smooth and trouble free operation.
- 2) The contractor will monitor the performance of the sewage treatment plant; conduct the analysis of the inlet sewage and water quality after treatment. Contractor shall initiate and take adequate actions to ensure smooth and satisfactory performance / running of the plants on a 24 hours / round the clock basis.
- 3) The contractor shall prepare and implement an effective plant maintenance programme in consultation with the Engineer. It is an absolutely contractor's responsibility to look after all sorts of maintenance whether preventive, Minor, Major, or break-down
- 4) The contractor will determine operating parameters, select settling (Chemical doses etc.) and generally optimize the process, and working of the treatment plant. Excessive chemical dosing i.e. dose more than normal should be avoided otherwise penalty shall be levied and recovered from the contractor.
- 5) The contractor should plan & procure all spares, Polyelectrolyte and all consumables including chemicals, grease, lubricating oil, cleaning agents, laboratory reagents etc. Further the contractor will plan about the requirement well in advance (At least 4 months) and procure the material from the market.
- 6) The contractor will be responsible for keeping up-to-date record of documents including History Card for equipments and maintaining every day log book relating to various analysis performed.

The contractor shall maintain and update logbook, in which details of operational parameters are recorded in every shift and at regular interval say hourly or as decided mutually.

- 7) The contractor will prepare and submit a daily report of plant performance and will assist the Engineer in preparing the necessary documents for their purpose and records.
- 8) The contractor will be responsible to carry out day to day periodic maintenance, necessary to ensure to smooth and efficient performance / running of all equipments / instruments comprising the sewage treatment plant and maintaining the record of the same.
- 9) The contractor shall have to issue identity cards with photographs to all the staff employed for Operation and Maintenance. The list of the same shall be submitted to the Engineer mentioning qualification & experience.
- 10) The contractor will also be responsible to carry out day to day Maintenance of the rising main inside the STP premises.

The contractor will employ minimum staff for operation and maintenance of the Plant as per the list mentioned in the detailed scope of work.

- 11) The above staff shall be distributed in three shifts as per mutual agreement between Contractor and Engineer. As per agreement the number of staff in each shift should always remain present otherwise penalty towards absence of any staff shall be recovered from the Contractor as per Volume-I GCC. 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 maintained at office of shift in charge at Sewage Treatment Plant that shall be considered as final. The Contractor's staff must mark their presence in this muster.

The Contractor may maintain a separate register for his own purpose.

The staff of contractor will always remain in contact with the Junior Engineer, Assistance Engineer/Electrical Supervisor, in charge of the Plant deployed by the Engineer and follow their instruction.

Unsatisfactory and inefficient running of the plant and unnecessary and excessive usage of spare, consumable, etc. supported by the reasons which are under control of contractor will be highly objected. In such cases Engineer-in-charge's decision will be final and binding to the contractor.

It is required that at least once in every one months a technical expert other than the Monthly Staff of the contractor will visit the plant and will suggest if required, to improve the efficiency and working of the plant etc. No separate payment will be made for such visits. The visit must be recorded and outcome of the visit/minutes of the meeting should be got signed by Employer authorities without which the visit shall not be considered.

Contractor will comply with all safety rules and regulations and all inter disciplinary as followed by the Engineer

The Engineer will not be responsible for any accident /injury to the staff of the contractor. Further the Engineer will not provide any insurance or medical facility to the staff of contractor. The responsibility lies with the contractor.

- 12)** All Central/State Government / Semi-Government / Local Body's Rules and Regulations pertaining to this contract shall be followed and observed by the contractor without any extra cost to the Engineer.
 - 13)** No accommodation / guesthouse / transportation facility will be provided to the contractor. Operation & maintenance staff will not be allowed any accommodation facility inside the plant premises. The staff should be engaged only on shifts basis ie., 8 hrs duty per day per person. The contractor shall be required to ensure proper upkeep and ensure necessary refurbishment of facilities at end of O & M period at no additional cost prior to handing over to ULB.
 - 14)** The duration of the O&M shall be 10 years from the date of successful commissioning of the STP. The same can be extended for the further period if the Engineer so desires.
 - 15)** The contractor should employ all the staff at least one month prior to successful commissioning.
 - 16)** The contractor will provide the necessary tools and tackles required for day-to-day maintenance.
 - 17)** The scope of work also includes cleaning of complete plant area including floor, toilet block railing, door, windows, light fixtures and ceiling etc. The entire premises of the plant area shall also be cleaned and maintain by the contractor regularly.
 - 18)** This work is inclusive of but not limited to operation, maintenance, house keeping, cleaning, removing sludge by its own carrier arrangement & dispose it off as per Engineer's instructions. Preparing data recording, correspondence work to Engineer and Government Departments, etc. All this work should be done as per standard practices and by following labour, factory, electrical, TNPCB, and all other old and new law and order, Indian standards etc. as applied of Local, State and Central Government of India.
- The contractor will employ no offense, guilty person or indisciplined man.
- 19)** Right is reserved by Engineer of suspension, dismissal, termination of any officer / staff employed by contractor. He shall have taken prior permission to employ or to terminate his personals.
 - 20)** No watch and ward, safety insurance, security, storage, housing accommodation etc. will be provided by Engineer. This will be responsibility of contractor.

- 21)** Consumable items like rubber bush, graphite packing, rubber sheet, nut-bolts, material require for cleaning and housekeeping etc. are to be brought by the contractor.
- 22)** Electricity required for operation & maintenances of the plant will be provided by Engineer The contractor should provide all other consumables like chlorine, polyelectrolyte, oil & grease etc. All the formalities to all Government authorities for factory, Electrical, TNPCB etc. for having NOC, water consent, Hazard waste concern, approval etc. shall be done by the contractor.
- 23)** Monitoring should be done as per guideline given by Engineer-in-charge. Contractor has to maintain all the parameter of effluent within stipulated limit or he will be penalized for not maintaining the parameters given by TNPCB and EMPLOYER. All expenditure incurred for the same like, suite fee, court fee, case fee, or the penalty as decided by Engineer of EMPLOYER and penalty charged by TNPCB will be charged to contractor and deducted from his bills, S.D etc.
- 24)** Contractor shall have to test the effluent / influent at his own cost at the plant lab on daily basis. The same be verified by and checked by Engineer whenever required. The contractor shall also have to test the effluent / influent at TNPCB lab for different parameter on weekly basis at his own cost.
- 25)** No equipment shall remain ideal or un-attended or damaged for the period of 3 days. If any equipment is not repaired, rectified and or replaced within 3 days, the contractor will be penalized with no limit at the rate of Rs. 2000/- per day delay per each individual equipment of the plant.
- 26)** The payment of O & M charges will be made as per the tender conditions. The other terms and condition described in these complete tender documents, wherever applicable shall remain unchanged. In case of any discrepancy the decision of Engineer-In-Charge will remain final & binding on the contractor.
- 27)** During Operation & Maintenance period, contractor has to supply all the spares, at his cost during preventive, major-minor breakdown, replacement and maintenance work. No extra payment will be made for such maintenance on any ground. The payment for the same will be made strictly as per tender document irrespective of the number of break down / minor, major repairs replacements. During the O & M contractor will have to enter annual maintenance agreement with Manufacturers of all major Mechanical Equipments like Centrifuge, Air Blowers, Screens, Decanters etc.
- 28)** Contractor will have to maintain required Power Factor as per TNEB rules and regulations. Incase penalty is levied by TNEB for not maintaining the Power Factor the same will be recovered from the contractor.
- 29)** Maintenance of Garden, Lawns, Plants, Bushes, Plantation of new Plants, Lawns etc. and feeding, gardening, cleaning etc. is in the scope of the contractor. No separate payment will be made for the same.
- 30)** The Contractor during his O&M period will have to follow all the guidelines set by TNPCB for Operation & Maintenance of STP.
- 31)** Operation and maintenance of all General facilities and utility services including all other components of work done under this contract.
- 32)** Operation and maintenance PLC based automation system and all instruments installed in the STP. All repairs, replacements towards the entire instrumentation works during the O & M period shall be in the scope of contractor.
- 33)** Any other services required for smooth running of the scheme.
- 34)** The contractor shall also dispose off the sludge, screenings, grit and any other material, as per specifications and to the satisfaction of the Engineer-in-Charge. It is to be noted that all costs during the O&M period, excluding the cost of power and chlorine are to be borne by the contractor. Within his quoted cost, the contractor is to ensure that the following guarantees are maintained during the operation & maintenance period:

- 1) for quality of treated effluent
- 2) for consumption of chemicals
- 3) for automation

35) The contractor shall provide on job training to the Local body staff as per specifications.

36) At the end of every 2(1/2) year of operation & maintenance period, an assessment of the condition of the plant has to be done by the contractor through third party inspection at his own cost and based on that assessment the contractor shall, at no extra cost to the Engineer repair and re-condition all the mechanical equipments in the concluding year of the O&M contract to a condition so that they are in running condition with regular preventive and recommended maintenance as per manufacturer's recommendations or as per CPHEEO manual.

37) Variability of Throughput: If the quantity of treated sewage from the Facility can be increased in the existing system without impacting the annual fixed costs to the Contractor, the Contractor shall comply with such requirements

38) For a sustained requirement of higher throughout from the Facility, the Contractor may be required to frame and submit a proposal that shall be implemented if mutually acceptable.

1. OUTPUT AND OPERATIONAL GUARANTEES

The contractor is fully responsible for treating all the Sewage reaching at the Receiving chamber. The performance of the contractor shall be treated as unsatisfactory

- if he fails to treat the complete sewage to the expected effluent parameter as per PCB norms
- does not maintain the guarantees listed in this clause excepting in force majeure condition
- fails to fulfill other conditions of the contract.

2.1 Treated Effluent Quality

The contractor shall operate the Sewage Treatment Plant in such a way that the treated effluent quality attains the following parameters:-

Sl.No.	Parameters/Pollutants	Values	Unit of measurement
1	Bio-chemical Oxygen Demand (as BODs)	30 or less	Mg/l
2	Total suspended solids	100 or less	Mg/l
3	Chemical oxygen demand	50 or less	Mg/l
4	PH	6.5-9.0	Mg/l
5	Oil and grease	Less than or equal to 5 mg/l	Mg/l
6	NH ₄	5 or Less	Mg/l
7	Nitrate Nitrogen as NO ₃	10 or less	Mg/l
8	Total Coliform	Less than 1000	MPN / 100 ml

2.2 Treated Sludge Disposal

The contractor shall operate the Sewage Treatment Plant such that the sludge produced is of a spade-able consistency and the volume of sludge produced after necessary process, is minimum. The sludge generated from the STP shall be disposed off through proper approved means of transport to the Compost yard site as designated by the Engineer

2.4 Chemical Requirements

All chemicals consumed to operate the Sewage Treatment Plant and other facilities under this contract will be borne by the contractor.

3. Adverse Operating Condition

During which the raw sewage quality deteriorates beyond the specifications in Volume I, the following provisions will be applicable

- a) If the raw sewage can still be treated to meet the Output Standards, the Contractor shall comply with such specifications.
- b) In the event it is not possible to meet the Output Standards, the Contractor shall immediately inform the Engineer.
- c) In the event it is possible to meet the Output Standards, but an increase in fixed and variable costs is unavoidable, the Contractor shall, as soon as practically possible, inform the Engineer

3.1 Alternate Output Standards;

The treated effluent output BOD, shall be 10% of the influent BOD, the period of adverse condition is 30 days.

4. TESTS TO BE CARRIED OUT DURING O&M PERIOD

The sampling and testing to be carried out twice a day and at least at the points given below. This schedule shall also be maintained during the O&M period.

- Inlet chamber at sewage treatment plant for flow, BOD, pH, SS, temp., COD and oil & grease, TDS.
- Outlet of the sedimentation units for BOD, suspended solids. PH, COD and oil & grease, TDS.
- Inlet of the reactor unit for MLSS, Dissolved Oxygen & pH.
- Outlet of the reactor unit for Dissolved Oxygen, Sludge volume Index & pH.
- Outlet of the secondary treatment units for BOD, Suspended solids, pH, COD and oil & grease
- Outlet of the chlorination units for BOD, Suspended solids, pH
- Excess sludge for Volatile suspended solids, total solids, specific gravity
- Various parameters to be tested by online monitoring system at these locations as per specific requirements of Instrumentation.
- Residual Free Chlorine after Chlorination.

**REPORT FORMAT FOR DAILY TESTING SCHEDULE FOR VARIOUS PARAMETERS TIME :
(1000 & 1600 HOURS)**

[illegible]

5. Laboratory Chemicals & Tamil Nadu Pollution Control Board Testing Charges:

Contractor should run the laboratory (both chemical & Biological) by expertise hand to evaluate the results & different parameters stated above and for that he should supply required chemicals, reagents filters & glass wares etc complete.

He should analyze the treated & untreated sewage samples for Fecal Coliform Count once in a week for that also contractor should support & supply necessary chemicals.

The Contractor should submit the weekly test reports to Engineer . The list of minimum Chemicals to be procured monthly by the contractor is as follows.

LABORATORY CHEMICALS FOR ONE MONTH O & M

S. No.	Particular	Qty	Unit	Make
1	PH Tablets - 40	1.00	No	
	PH Tablets - 7.5	1.00	No	
	PH Tablets - 9.2	1.00	No	
2	Whatman filter paper	1.00	Box	
3	Manganese Sulphate	500.00	gm	
4	Sodium Hydroxide	500.00	gm	
5	Sodium Azide	100.00	gm	
6	Sodium Iodide	100.00	gm	
7	Starch	500.00	gm	
8	Sodium Thiosulphate	500.00	gm	
9	Disodium Hydrogen Phosphate	500.00	gm	
10	Ammonium Chloride	500.00	gm	
11	Magnesium Sulphate	500.00	gm	
12	Ferric Chloride	500.00	gm	
13	Calcium Chloride	500.00	gm	
14	Sulphuric Acid	1500.00	ml	
15	Petroleum Ether	1000.00	ml	
16	Ammonium Ferrous Sulphate	500.00	gm	
17	Potassium Dichromate	500.00	gm	
18	Ferron Indicator	100.00	ml	
19	Beakers- 500 ml	2.00	No.	
	Beakers- 200 ml	2.00	No.	
	Beakers- 50 ml	2.00	No.	
20	Distil Water Coil	1.00	No.	
21	Water Bath Coil	1.00	No.	

Contractor shall also procure the other chemicals required to carry out the different tests as per Engineer requirements, TNPCB & Other governing authorities. The TNPCB guidelines for Operation & maintenance of ETP should also be followed for performing different laboratory tests, record keeping, as well for Operation & Maintenance of the entire plant.

Tamil Nadu Pollution Control Board Testing Charges:

The contractor should get analysed / checked the untreated as well as treated sewage samples every week from TNPCB for parameters like BOD, COD, TSS, SS, PH, etc. The necessary TNPCB testing charges are to be borne by the Contractor. The TNPCB Vigilance testing charges for samples directly collected by TNPCB are also to be borne by the Contractor.

6. STAFFING

The minimum personnel required for O & M is as given below. Non-employment of the personnel during O&M as per the Bid will lead to imposition of penalty as mentioned in Volume I Section IV. Contract Data. However the Contractor shall mention the personnel required for O&M in his bid.

6.1 **MINIMUM STAFF REQUIREMENT**

Sewage Treatment Plant

Plant Operator	2
Electrecian grade - I	1
Lab Chemist/ Grade II	1
Lab Assistant/ Grade III	1
Watchman / Helper	2
Gardener / Farm Assistant.	1

The work shall be carried out on a 24 hr basis, without intermission and the staff deployed by the contractor shall be in accordance with this contract.

The contractor shall give or provide all necessary superintendence during the O&M and as long thereafter as the Engineer-in-charge may consider necessary. Such superintendence shall be given by a competent person having adequate knowledge of the operation and Maintenance to be carried out (including the methods and techniques required), the hazards likely to be encountered and methods of preventing accident) as may be required for the satisfactory working of the entire plant.

No labour below the age to 18 years shall be employed on the work.

List of staff is to be given by the agency to the Engineer-in-charge and advance intimation to be given before deputing/removing any staff from site during the period of contract. Not more than one of the contractor's key staff shall be absent from the project site at any given time. In case it is necessary for more than one of the key personnel to be absent at a given time, the contractor shall provide replacement of equivalent or better qualifications. The CVs of such replacements shall be got approved from Engineer in advance.

Engineer-in-charge shall be authorized to direct the contracting agency to remove any or all staff employed on O&M of the plant if in his opinion continued presence of such staff is detrimental to safety or proper O&M of the plant. The contractor shall comply with such directions & post suitable substitute(s) thereof. Whenever the Engineer has to inform the contractor in writing that any person on the work is in his opinion unsatisfactory or/incompetent or unfaithful or dishonest, untruthful or disorderly or to be otherwise unsuitable/such person shall be discharged by the contractor from the work and shall not be employed again on it.

7.0 SAFETY/SECURITY

The contractor shall take all safety precautions under various Acts/Rules under central/State Govt. from time to time and he shall be responsible for safety of its staff and the consequences thereof. The contractor shall deploy round the clock security personnel at entrance of plant's premises and in the compound for the safety of the plant and premises for the safety of the plant, equipment and personnel during this period. The contractor .The contractor is expected to follow all the applicable occupational health and safety norms as per applicable statutory standards.

Hoisting machinery- All workmen, gang-labor, operator, workers, supervisors involved in signaling, lashing and guidance maneuvering should be provided with pertinent safety gear and protection such as helmets, gloves, work overalls, steel toed boots, goggles and other gear as pertinent.

Risk of flooding-If working near water bodies the contractor should follow the pertinent authorities warning such as weather forecasts, flash floods etc., as per directions of the meteorology department or competent authorities.

7.1 Responsibility for damages

The care of the whole of the permanent works shall remain with the contractor who shall be responsible for all accidents or damages from whatever cause arising and chargeable for any thing that may be stolen, removed destroyed or damaged to whomsoever belonging and also for making good all defects and damages to the said works or to any property adjoining or any cause whatever, whether such damage or defects were occasioned by the negligence of the contractor or not or may be or might have been discovered during the progress to be known after the completion whereof or whether payment may wholly or partially have been made or the works approved as supposed to have been properly done and no certificate of approval of any works by any officers or members of the Board shall affect or prejudice the right of the TNPCB against the contractor or be considered or held as at all conclusive as to the sufficiency of any work materials.

Adequate safety precautions against fire, flooding, lightening, electrical shocks, accident due to moving/non-moving heavy/light equipments shall be strictly observed by the contractor at his own cost. Suitable safety measures like gumboots, gloves, safety belts, ladders, safety lamps, gas masks, Oxygen apparatus, insulated tools, alarms etc. shall be provided by the contractor. Necessary medical first aid kit shall be made available all the time. In absence of observance of above safety precautions, the contractor shall be responsible for any unforeseen loss of the equipments or persons dealing with it. Special care shall be taken by the contractor while carrying out the work in sewage gas zone. Any incidence of human life or accident will be totally contractor's responsibility.

The contractor shall ensure that the staff employed takes all necessary precautions while carrying out the work either in shift duties or any general shift as per Indian Electricity Rules/Factory Act/CPHEEO Manual, or manufacturer's special instruction for safety / gas handling. The staff should use Gas masks, Oxygen apparatus, Gum Boots, Safety Belts and Safety Lamps, etc. while carrying out the work in Bar Screens, sumps etc.

The contractor will make arrangement for all necessary safety equipments for persons working at STP as per Factory Act/Safety Rules. In the event of any accident on or off site, in which the contractor or his personnel are involved, in which an injury occurs to any person whether directly concerned with the project or a third party, the contractor shall inform Engineer within 24 hrs. of the occurrence of the event. The plant will be open to local/state/central agencies for verification of safety/emission/acts compliance.

During night hours, the main gate should be locked. However, shift duty staff should be alert and open the gate during surprise checking of Engineer staff or any other Government Authorities or his nominee without any wait. Only bona-fide persons be allowed in the plant premises being a prohibited area. Smoking and drinking are prohibited in the plant. The staff engaged shall wear common uniform with name plate indicating name and designation during duty hours.

8.0 REPORTING

The Contractor will prepare daily and monthly reports (in Engineer format) of pumping/treatment and project performance and submit to the Engineer-in-Charge and will assist the department in preparing the necessary documents for their purpose and record as per proforma given from time to time. The reports shall contain, inter-alia, the following:

- Raw Sewage quantity and quality and effluent quality as per the on-line monitoring programme and other tests as specified in Clause 3.0 of this section and print outs of online monitoring shall be submitted to Engineer-in charge.
- A description of the maintenance work carried out in the reporting period.
- A report on major failures, if any, their causes and remedial actions taken.
- Sludge quality and quantity (daily basis) in the reporting period.
- Power and chemicals consumed in the reporting period.
- An inventory of the chemicals and spare parts available at the end of the reporting Period.
- O&M staff deployed by the contractor during the reporting period.
- Any major repair works, if any.

Contractor is required to maintain separate register/computerized records at all sites of following information:

- ☐ Pumping register
- ☐ Quantity of sewage treatment and performance register
- ☐ Working hours register
- ☐ Electric break down register
- ☐ Maintenance register
- ☐ Staff attendance register
- ☐ Equipment breakdown, repair record and extent of repair
- ☐ Chlorination equipment and chlorine toner operating and using register.

9. Site Order Book

Site order Book shall be kept by the Engineer -in-charge at the plant site. Orders entered in this Book by the Engineer-in-Charge or his authorised representative shall be held to have been formally communicated to the contractor. The Engineer-in-Charge or his authorised representative shall sign each order as it is entered and will hand over the duplicate to the contractor or his agent, who shall sign the original in acknowledgment of having received the order.

10. Record Keeping

Running Records are required to be kept for various operating machines such as Mechanical Screens, Mechanical Grit Removers, Pumps, Motors, Scrapers, Air Blowers, Chemical consumption, Chlorine consumption etc. as maintained by the operators and kept at Control Room or duty room of the operators that is closer to the location of the machines.

The records of effluent quality and other laboratory tests are kept in the laboratory as per daily sample collection and testing schedules.

The record with respect to flow shall be maintained by operators as per Table below. The operator passes the daily log sheet to the plant Manager on the subsequent day duly signed in the first shift. All operators shall be responsible to fill up their part of observations and calculations. The plant Manager shall verify the daily record as well as the calculations and shall be responsible to generate further data using these.

It is pertinent to mention that there shall be a requirement of drawing site-specific procedures and formats / forms for keeping records. This shall be the responsibility of the plant manager.

11. Hourly record of Flow as measured / recorded through the Notch / Weir / Flow meter:

Date/ Time	Head Over The Notch / Weir / Meter	Rate Of Flow	Average Rate Of Flow In Past Hour	Flow Quantity
//	METERS	CUM./HOUR	CUM./HOUR	CUM
0800				
0900				
1000				
1100				
1200				
1300				
1400				
1500				
1600				

12.0 OPERATION

In case, the motor or any other equipment is burnt or damage due to negligence of the contractor or due to faulty operation it shall be sole responsibility of the Contractor to rewind/replace/repair it as per standards of the equipment free of cost. In case of any fault in operation and performance of the plant, contractor or his staff at duty will immediately report to the Engineer-in-charge about it.

The Contractor shall run the plant unit after ensuring proper voltage. He shall also record all the power failures and voltage in daily log sheet. He will bring into the notice of power supply agency as well as control room and Departmental Engineer about the break down/power failure. He will also get the electricity restored simultaneously.

Any dispute with the workmen shall be contractor's responsibility as per Labour Laws/Govt. Rules and Regulations. In no way the department shall be responsible for the disputes between them.

The contractor shall follow the rules and regulations as per Factory Act as it is applicable.

The contractor shall arrange all necessary required tools, tackles and instruments in advance for proper operation and maintenance of the entire plant.

The contractor shall operate and maintain all (E&M) equipment as per the recommendations of the respective equipment manufacturer. He shall further maintain and operate the plant, as per CPHEEO manual to obtain the treated effluent results as per approved norms specified in this document elsewhere along with the Technical Bid. The contractor shall be free to follow manufactures manual in this regard. However in case of any doubt, the Engineer shall refer to best of the above standards and the contractor shall be bound to carry out the works accordingly.

The floating material/scum should be collected in bins and dispose the same in open pits away from the plant, machinery which should be dried and disposed off regularly at a location outside the plant and approved by statutory authority. During rainy season, this should be buried after using lime.

The treated effluent after the chlorination unit, should be disposed off to the adjacent stream or to be recycled for using for any purpose within the plant . The conveyance of treated and chlorinated sewage should be by means of closed conduit made by RCC or any RCC box channel.

The screened material, grit and the dried sludge cake from the centrifuge should be collected in trailers, trucks or tractor and the same should be disposed off at Municipal Compost yard. away from the plant on his own.

The Tenderers shall know all Central/State Government/ Semi-Government/Local Bodies rules regulations to this contract without any excuse. Gas coming out of sewage is hazardous containing Methane, CO, CO₂ and H₂s etc. Therefore, necessary precaution and measures are to be taken in regard to human life and installations.

13. MAINTENANCE

Every part of the works and all the materials to be used therein shall be subjected to such tests from time to time during the execution of the work as the Engineer-in-charge may direct and the whole of such tests shall in all cases be made at the contractor's sole expense.

The work shall be carried on and completed under the exclusive control direction and supervision and to the satisfaction of the Engineer-in-charge. The Engineer-in-charge shall likewise have full power to reject or condemn any work or material that he may deem unsuitable. In case of any work or material being rejected by the Engineer in-charge, the contractor shall immediately remove and replace the same to the satisfaction of the Engineer-in-charge or the Engineer- in-charge shall have full powers to get the same removed and replaced and deduct the expenditure incurred in the process from any amount due or that may become due to the contractor.

The contractor shall use only the original and genuine spares of the original equipment as per recommendations given in the maintenance booklet of the manufactures/as per directions of the

Engineer- in-charge. Adequate stock of such spares is to be maintained by the contractor. Test certificate of manufacturer is required for bearings along with supplies. Test certificate of all major equipment will be submitted from the manufacturer.

If any material brought upon the site of works or to the places where any Operations have been or are being carried out in connection with or for the purpose of the works, be in the judgment of the Engineer, of an inferior or improper description or improper be used in the works, the said materials or workmanship shall where required by the said officer be removed or amended by the contractor forthwith or within such period for every breach by the contractor in this clause, the Engineer is hereby authorized to remove or cause to be removed the materials and workmanship so objected to or any part thereof and replace the same with such other materials and workmanship as shall be satisfactory to him and there upon the contractor shall on demand repay to the Board the expenses incurred there by or to which the board may be put or be liable in connection therewith, the amount thereof to be certified by the Engineer whose certificate shall be final.

He shall be responsible for civil maintenance of buildings and roads changing of broken glasses, white washing and painting every two years and watering of lawns/plants within the plant premises.

The contractor shall also be responsible to maintain cleanliness in around the plant including machineries, disposal of floatings removed from the Bar Screens/reactors, etc. Grit and other unwanted material.

All the steel structures and machines installed in open areas should be painted after every monsoon period after cleaning the surface as per the instructions of the Engineer- in-charge. Entire plant including all civil structures, mechanical equipments, HT panel and Transformers etc. shall be repainted after every 2(1/2) years as per original painting specifications.

Surface drains shall be cleaned every year before start of monsoon.

All leakages should be attended promptly to avoid any nuisance etc. Chokages should be removed at once. All the valves/gates which are not used regularly should be operated at least once a week and make sure that they are properly lubricated /greased.

All safety valves should be checked daily and ensure that they are working properly. In case of any fault the same should be attended immediately without any wait. The maintenance of the plant shall be as per maintenance manuals of the manufacturer for all equipments. Contractor shall keep all the safety devices in working order.

The contractor should make sure that no unwanted material should float/grow in and around different units. In case it is found the same shall be removed /cleaned immediately. He shall also be responsible for cleaning/sweeping the plant buildings inside and outside, roads, foot path etc.

Launders/Weirs etc. of reactors etc to be maintained clean round the clock. During preventive/ breakdown maintenance, the contractor has to visit the unit/units as and when needed. The pumping units or other machineries required if any shall have to be arranged by the contractor at his own costs for completing the work. In case of battery operated auto system panels and also system alarm etc., batteries are required to be maintained and replaced as and when needed by the contractor.

The contractor has to make sure that proper fire extinguishers are used to cover any kind of fire during any miss-happening within the total boundary area including plant machineries. The expiry period of refills of various fire extinguishers should be watched and maintained during the period of contract.

The contractor has to maintain all the toilets for proper use of the staff etc. In no case, in-sanitation conditions are developed. The contractor has to maintain minor repair in Civil structures, including replacement of sanitary items, glass pans etc. as and when needed.

The Contractor shall maintain the PLC system in working condition for the 10 year O&M period.

The contractor shall not remove/shift any equipments/machinery even temporarily without written permission of the Engineer-in-charge or authorized representative.

Though the contractor has to operate and maintain all the equipments/machineries, lighting (plant area, boundary walls, gate lightening etc.) but the machine of the equipment under warranty should not be dismantled without prior permission of the Engineer-in-charge. The list of such equipments (Under warranty), if any, will be given by the contractor.

POL (petrol/Diesel Oil & Lubricants) has to be arranged by the contractor as and when needed as per manufactures recommendations for periodical maintenance of entire plant. The Department will not provide such items.

The contractor shall have to carry out periodical testing of the installations/equipments as per CPHEEO manual and I.E. Rules as amended up to date and shall have to maintain complete record in the maintenance register. The contractor has to provide necessary protection systems wherever necessary including alarms and fire extinguishers.

The Engineer will be at liberty to post its staff for surveillance/ inspection at the plant along with access to all units, control room and records, log books, MIS (Management Information system), data etc. round the clock as required. The logbooks and attested by the staff from authorized Engineer Officials and this record shall be open for further inspection/checking by Engineer and all other Government Agencies CPCB/TNPCB etc. for further action/improvements/rectifications. The staff in each shift shall mark their attendance on the log sheet individually. The plant and equipments covered under the above contract shall be totally attended by the contractor including any 'Trouble Shooting' to ensure smooth and trouble free operation.

In case of major repair due to normal wear and tear/break down, the contractor should bring the same to the notice of the Engineer-in-charge immediately and necessary measures for its repair should be taken simultaneously. Breakdown, all repairs of any kind are to be attended by the contractor. Any unit/equipment being irreparable in the opinion of the Engineer-in-charge will be replaced by the contractor at no cost to Engineer. During 10 years O & M period, the machinery/media to be replaced from time to time as per manufacturer's recommendations/CPHEEO manual.

All relays and HT equipments shall be calibrated and tested atleast once a year and the report shall be submitted to the Engineer-in-Charge.

The contractor shall give his telephone no., contact addresses, etc. to the Engineer as well as shift duty shift to contact him during emergency/odd hours etc.

The contractor will be responsible to carry day to day as well as periodic maintenance, necessary to ensure smooth and efficient performance/running of all equipments instruments installed at the Sewage Treatment Plant.

He shall be responsible for maintenance/replacement of street light poles and light etc. also. All the plant, building land, Sewage treated/untreated/sludge, etc. shall remain the property of Engineer..

14. Oil & Grease Schedule

Routine & preventive maintenance of electrical /Mechanical/ hydraulic/ machines & equipments is to be carried out as per the operation & maintenance manual. Minimum oil & grease requirement for one year Operation & maintenance of the Plant to be procured by the Contractor well in advance.

15. Routine, Preventive, Minor & Major maintenance of all Civil, Electrical, Mechanical, hydraulic machines & equipments of the plant.

The contractor should prepare schedule of daily maintenance & preventive maintenance of all the equipments & machineries operated & run by him in the premises of the plant. The schedule should be as per the guidelines mentioned in the tender & as per the O&M manual.

The scope covers Routine, Preventive, Minor & Major maintenance of all major minor equipments, and machines in the Plant like Submersible pumps, Coarse & Fine screens Grit Removal Mechanism, Channel gates, Decanters, Sludge pumps, Centrifuge feed pumps, Centrifuges, All dosing systems including Chlorine Dosing equipment, etc.

The scope also covers Routine, Preventive, Minor & Major maintenance of all the instrumentation system installed like PLC, Actuators, Flow meters level indicators etc.

The Contractor should also carry out Routine, Preventive, Minor & Major maintenance of all major minor electrical equipments like Electrical Panels, Switch Gears, Power Cables, Control cables, Changeover switches DG set etc so as to ensure uninterrupted round the clock operation of the Plant.

The Contractor should maintain all civil structures including Administrative building, Store room, Storm Drains, fencing etc in a neat manner. He should maintain all civil structures of the plant sturdy to complete the natural/designed lifetime.

The contractor should carry out the safety audit of the plant & obtain necessary certificate from the competent authorities.

This item includes all types of Routine, Preventive, Minor & Major maintenance of all Civil, Electrical, Mechanical, hydraulic machines & equipments of the plant covering supply erection test & trial run of the part/machine to be repaired/replaced with material & labour expenses, necessary hardware's, sundry materials, lubricant oils, power oils, grease other materials plus machining charges etc.

The contractor should procure all the spares required for all types of maintenances in advance. The part/equipment/machine to be repaired /replaced should be as per the Engineer approved list & as per the O&M manual or as per the existing manufacturer's brand.

16.0 RELEASE OF HAZARDOUS SUBSTANCES OR HAZARDOUS WASTE

The Contractor, after first notifying the TNPCB shall be responsible for fulfilling all requirements associated with any release of any substance into the environment (from the facility or the site) as required by Applicable law or by any Legal Entitlement including but not limit to the notification or reporting of releases / Hazardous substances or Hazardous Waste. The Contractor shall prepare a memorandum evidence such notification or reporting and provide copies thereof to the Board, along with any documents provided to the relevant regulatory agency regarding such release.

The contractor shall process and obtain the clearance of all such agencies as required for the purpose, including all clearances during 10 years O&M period. He shall be fully responsible to comply with all requirements of Laws including hazardous substances, emission standards for air, discharge standards for effluent oil, sub-soil pollution.

The contracting agency shall not release any hazardous/toxic materials inside the premises.

17. Technical Audit

The Engineer has the right to conduct a technical audit of the Facility and to perform any analysis or inspection he deems necessary. The Contractor shall at his cost provide all assistance the Engineer required to complete these inspections. Such audits may cover all or any of the obligations of the Contractor, including without limitation,

- a) Verification of the system capacity and save for normal wear and tear during the O&M Period

- b) Verification of the performance standards and useful life of the individual assets of the Facility, save for normal wear and tear during the O&M Period
- c) Verification of the capacity of the Facility to meet Output Standards during the residual life of the Facility and save for normal deterioration expected during such residual life
- d) Sampling, testing and verification of the Output Standards for treated sewage, sewage losses

18.0 FACILITY VISITS

(i) At any time or at the end of each twelve month period, or at the initiative of the TNPCB, a visit shall be organized so that both parties can check the condition of the installations at the facility.

(ii) A report shall be drawn up to record the opinions of the both parties. The TNPCB reserves the right to call the equipment manufacturers or specialized technicians for these visits. All expenses are to be borne by the contractor for the purpose.

19.0 OPERATION AND MAINTENANCE MANUAL

a) The contractor shall prepare a detailed program (referred to as O&M Manual) covering the operation and maintenance of the treatment plants as a whole. This program shall include the work and activities described in this Chapter, as relevant to the specific items and technology. Notwithstanding the program submitted and approved, the Contractor is deemed to have tendered for and covered in his price, the responsibility for operating and maintaining the treatment plant for the full period of the contract, thereafter handing it over as specified.

b) The contractor shall provide 6 copies of draft O&M Manual to the Engineer, at the time of the commissioning of the project and on approval of draft, 10 copies of operation & maintenance manual shall be supplied by the contractor.

c) The O&M Manual shall include the daily, weekly, monthly, quarterly, half yearly and annual checks and remedies if necessary to be performed for effective operation of the plant, elaborate detail, all operating and maintenance procedures and policies which are required, advisable and / or necessary for the Facility to achieve full compliance with the operational guarantees and to achieve maintenance and repair standard for the Facility which will ensure compliance with the maintenance specifications. The O&M manual shall include inter alia full explanation of all plant procedures and processes.

d) Without limiting the generality of the foregoing the O&M Manual shall include descriptions, procedures and shall comply with the requirements, set forth in the provisions of the Bid Documents.

e) The draft of the O&M Manual shall be subject to the review and approval of Engineer, which shall have the right to make any changes and revisions to the O&M Manual as it may deem appropriate. The Contractor shall revise such draft O&M Manual prior to the commencement of the O&M period.

f) At the end of the construction period, the contractor shall revise the draft O&M Manual to reflect any updates, changes or revisions it deems appropriate, inter alia based on its experience and as necessary to reflect any modifications or adjustments to the plant. Without limiting the above, the contractor shall annually fully review, revise, update and modify the draft O&M Manual as may be necessary or appropriate. Any revision to the draft O&M Manual shall be subject to the review and approval of Engineer.

g) Engineer shall have the right to require revisions to the draft O&M Manual as it may deem appropriate. The contractor shall prepare and submit to Engineer, for its review and approval, 30 days prior to the proposed date of commencement of O&M, a revised draft O&M Manual which reflects all changes, revisions and modifications. The contractor shall prepare the O&M Manual, as approved by the Engineer, prior to the start of O&M.

h) During the term of this Agreement, the contractor shall promptly notify Engineer of any revisions, additions or modifications which he, in his professional opinion, believes should be made to the O&M Manual, whether as a result of additional experience in operating and maintaining the

Facility, changes in influent quality or volume, changes or modifications to any equipment, part, component or structure incorporated in the Facility. Such notification shall set forth the reason for the proposed revision. Any proposed revision shall be subject to the approval of the Engineer. In addition, during the term of this Agreement, Engineer shall have the right to require relevant changes, revisions, or additions to the O&M Manual as it shall deem appropriate to ensure full compliance with the O&M Standards.

i) The contractor shall submit 10 copies of the final O & M manual along with a soft copy in Microsoft Word Format.

20.0 TAKING OVER

The plant will be taken over by Engineer on satisfactory completion of the Operation & Maintenance of the plant provided that

- The plant /equipment are in good, smooth running condition.
- The result of the treated wastewater quality for last three months of operation of the plant is within the limits specified.
- In case of major repairs /replacement of equipment, the performance guarantee for such unit/equipment is extended by six months from the date of putting back in to satisfactory operation of such unit/equipment. In case such putting back is at the end of completion of operation & maintenance period.
- All records of operation & maintenance are handed over to Engineer in proper condition.
- The Third Party Inspection of the plant viz: Civil units, Mechanical units/equipments, Electrical units/equipments, instruments, & all other Major & minor units/machines has to be carried out & the defects unsatisfactory working performances of the equipments/ machines are to be corrected by the contractor at his own cost. The necessary Third Party inspection agency shall be appointed and charges paid by the Engineer.

- The Contractor should repaint the plant including all civil structures, mechanical, electrical equipments/ units /structures as per the tender specifications

In case taking over is delayed on account of contractor's failure, the operation & maintenance period will be extended further till it meets the requirement without any extra cost to Engineer The contractor will also be penalized for such delays.

VIII. Reference to specifications/ code of practice

Description	BIS No.
Ordinary Portland Cement (33 Grade)	269-1976
43 Grade Ordinary Portland Cement	8112-1989
53 Grade Ordinary Portland Cement specification	12269 – 1987
Sulphate resisting Portland cement	12330 – 2001
Hydrophobic Portland Cement	8043-1978
Rapid Hardening portland Cement	8041-1990
Low Heat Portland Cement	12600-1989
Standards for testing of cement	650-1966
Methods of Test for Pozzolonic Materials	1727-1967
Methods of sampling and test for water & waste water (Physical & chemical)	3025-1984 (Part 1 to 37)
Methods of Sampling hydraulic Cement	3535-1986
Methods of Physical tests for hydraulic cement	4031-1988 (1 to 14)
Methods of chemical analysis of hydraulic cement	4032-1985
Aggregates coarse & Fine from Natural resources For concrete.	383-1970 --4082/1977
Sand for Masonry Mortar	2116-1965-- 1542/1977
Methods of tests for aggregates for concrete	2386-1963 (Part 1 to 8)
Part I- Particle size and shape	2386-1963 (Part-I)
Part II- Estimation of deleterious Materials & Organic impurities	2386-1963 (Part-II)
Part III- Soundness	2386-1963 (Part-III)
Methods for sampling of aggregates for concrete	2430-1986
Specifications for test sieves Part-I-Wire cloth test Sieves	460-1978 (Part-I)
Common Burnt clay building bricks	1077-1976
Mild Steel and Medium tensile steel bars and hard Drawn steel wire, concrete reinforcement. Part-I-Mild Steel & Medium tensile steel Bars Part –II- Hard drawn steel wire	432-1982
High Strength deformed steel bars and wires for Concrete reinforcement	1786-1985
High Tensile Steel for PSC Pipes	1784-1986 (Part-I)
Bending and flexing of bars for concrete reinforcement	2502-1969
Recommendations for detailing of reinforcement In reinforced concrete works	5525-1969
Method for tensile testing of steel wire	1521-1972
Method of test for determining modulus of elasticity	2854-1964
Glossary of terms relating to cement concrete	6461-1972 (Part 1 to 12)
Methods of test for strength of concrete	516-1959
Methods of sampling and analysis of concrete	1990-1959
Methods of testing bond in reinforced concrete Pull out test	2770-1967
Methods of test for permeability of cement Mortar and concrete	3085-1965
Methods of test for splitting tensile strength Of concrete cylinders	5816-1970
Methods of tests for determining setting time of Concrete by penetration resistance	8142-1976

Code of practice for construction of Pile foundations (concrete piles) Driven cast-in-situ concrete piles Bored cast -in-situ piles Driven pre-cast concrete piles Bored pre-cast concrete piles	2911 (Part I) Sec-1-1979 Sec-2-1979 Sec-3-1979 Sec-4-1984
Code of practice for construction of raft foundation	2950-1981
Design Aids for reinforced concrete	SP 16-1980
Explanatory Hand Book on codes for earthwork Engineering	SP 22-1982
Explanatory Hand Book on IS Code 456-2000	SP 24-1983
Hand Book on causes and prevention of cracks In buildings	SP 25-1984
Hand Book on concrete reinforcement & detailing	SP 34-1987
Brick Masonry	2212-1962
Construction of Stone Masonry	1957-1967
Concrete pipes with and without reinforcement	458-1988
P..S.C. Pipes (including fittings)	784-1978
Methods of tests for concrete pipes	458-1988 & 3597-1985
Materials for M.S.Specials	226-1976 & 2062-1980
Specifications for M.S.Specials for P.S.C.Pipes.	
Specifications for Steel cylinders reinforced Concrete pipes.	1916-1989
Specials for steel cylinders reinforced concrete pipes	3597-1985
Methods of test for asbestos cement products	5913-1989
Centrifugally Cast (Spun) Iron pressure pipes for Water, gas and sewage Including fittings.	1536-1989
Specifications for Centrifugally Cast (Spun) D.I. Pipes for Water, Gas and Sewage.	8329-1990
D.I.Fittings for pipes for water, gas & sewage	9523-1980
Dimensional requirements of rubber gaskets for Mechanical joints and push on joints for the use With C.I.D.I.Pipes.	12820-1986
C.I. Specials for Mechanical and push on flexible joints for pressure pipe lines for water, gas & sewage	13382-1992
Horizontally cast iron double flanged pipes for water, Gas and sewage	7181-1986
Cast iron fittings for pressure pipes for water, gas And sewage	1538-1976 (Part 1 to 24)
Rubber rings for jointing C.I.Pipes, R.C.C. Pipes & AC. Pipes	5382-1969
Rubber rings for jointing P.S.C. pipes	5382-1985
Hemp yarn	6587-1966
Rubber Insertion to be used in jointing CIDF pipes	638-1979
Bolts & Nuts to be used in jointing CIDF Pipes	1363-1967
Unplasticized PVC Pipes for potable water supplies	4985-1988
Injection moulded PVC socket fittings with Solvent cement joints for water supplies.	7834-1987 (Part 1 to 8)
Fabricated PVC fittings for potable water supplies	10124-1988 (Part 1 to 13)
Methods of test for unplasticized PVC pipes for potable water supplies	12235-1986 (Part 1 to 11)
Sluice valves for water works purposes (50 to 300 mm Dia size)	780-1984
Sluice valves for water works purposes (300 to 1200 mm Dia size)	2906-1984
Surface boxes for sluice valves	3950-1979
Manhole covers for sluice valves	1726-1974
Laying of Concrete pipes.	783-1985
Laying of Cast-Iron Pipes	3114-1985
Laying of PSC Pipes	126 of APSS & 783-1985
Laying of C I Pipes	12288-1987

Laying and jointing of Unplasticized PVC pipes	7634-1975 (Part 3)
Stoneware pipes	IS:651-1992
Code of Practice for Ancillary Stonewares in sewerage system	IS:4111-1986 Part I & II
Precast Manhole covers and frames	IS:12592-1998 Part I & II
Code of Practice for plain and reinforcement concrete	IS:456:2000
Batch type concrete mixer	1791-1968
Sheep foot roller	4616-1968
Safety code for excavation works	3764-1966
Safety code for scaffolds and ladders Part-I Scaffolds Part II- Ladders	3696-1966 (Part I) 3696-1966 (Part-II)
Safety code for piling and other deep foundations	5121-1969
Safety code for working with construction machinery	7293-1974
Tamil Nadu Building Practice	Volume – I&Volume – II
Government of India Manual on Water Supply and Treatment	May 1999 (Revised)
Gravel for packing	4091 –1967
Hard drawn Steel Wire	1785 – 1983 (Part I and II)
Structural Steel	226 – 1975
Hard rolled mills steel for concrete	1139 – 1966
Hard drawn Steel Wire	1566 – 1982
American Society for Testing of Materials	
British Standard	2494 – 1955 Part I
Welding Electrodes	814 – 1970
Steel Sheets	225 – 1975
Guniting	7322 – 1994
Welded Joints	3589 – 1966 & 2041 – 1962
Tensile Test	223 – 1950
Mechanical and Electrical Works	
Earthing	3043 – 1966
Transformer	1180 – 1964

3. Drawings

**Attached Separately in Volume -3
(Drawing Volume)**

4. Supplementary Information

The supplementary information as given hereunder are extracts of project Detailed Project Reports and for knowledge of the bidders only. The bidders may use the information at their own risk and the employer shall not have any binding for their correctness)

LOCATION:

Rajapalayam Town is a Special grade Municipality in Virudhunagar District of Tamil Nadu State. Rajapalayam Municipality is situated at latitude of 9027'0 N and longitude of 777033'0"E at an altitude of 156 m from sea level. It is situated at 85 Km South –West of Madurai in Madurai – Kollam NH 208 and is readily accessible by rail and road. The Municipality covers an area of 11.36 Sq.km and the 2011 census population is 130119.

CLIMATE:

The climate of the town is semi-arid tropical monsoon Type. with average monthly rainfall of 69.16 mm, mostly from North East monsoon from October to December.

TEMPERATURE:

The summer in Rajapalayam (April to June) is usually hot and records a maximum of 37.5° Celsius and a minimum of 34.2° Celsius. The town set's its rain fall mostly during the North East monsoon during the month of October and December. Rajapalayam receives average rainfall of around 830 mm during monsoon. The climate in Rajapalayam remains humid during monsoon with an average maximum temperature of 27° Celsius and a minimum of 20° Celsius Windy surroundings add more chillness during the time of winter.

. HUMIDITY:

The humidity varies from 75 % to 85 %. Hot weather is observed to last from March to June.

RAINFALL:

The average annual rainfall in the town is 830 mm

WIND

The wind direction is mainly east and South east and the normal wind velocity will be 20 miles per hour.

TOPOGRAPHY:-

Contour of this area varies between +144 m to +183.00m Topography of the Town is sloping from West towards east and North towards South. The soil met with, within the town is generally sandy soil SDR,DMR and hard rock.

AREA OF THE TOWN:

The area of the town is 11.36 Sq.km

Existing sewerage system arrangement

Rajapalayam Municipality has not been provided with sewerage system. The storm water open drains have been constructed in the town. The storm water drains convey the sewage generated from the areas within the town limit and discharged in to the Irrigation Tanks near the Town.

Mostly all streets and roads have open drains along their sides. The ablution water from the latrines is being let out into the soak pits. Some of the houses have water seal latrines with septic tank arrangement. In most areas, the night soil is being let into the storm water open drains through soak pits.

The sullage from the house is also being let into the soak pits. In the thickly populated areas, the sullage is being discharged into street gutters and storm water open drains directly.

Mile stones

Sl. No.	Description of Milestones	Time for Completion from the date of Receipt of LTC
1	Submission of layout, unit sizing, process design and drawings	4 Weeks
2	Mobilization to the site and establishment of field office and quality control laboratory	3 Weeks
3	Approval of designs and drawings	4 Months
4	Completion of civil works	19 Months
5	Completion of installation of Plant and equipment	24 Months
6	Completion of Trial Run and performance guarantee test of the Treatment Plant	30 Months

5. Certificates

5.1 Form of Completion Certificate

Contract: [. . . .insert name of contract and contract identification details. . . .]

Date:

Certificate No.:

To: [. . . .insert name and address of contractor. . . .]

Dear Ladies and/or Gentlemen,

Pursuant to GCC Clause 24 (Completion of the Facilities) of the General Conditions of the Contract entered into between yourselves and the Employer dated [. . . .insert date. . . .], relating to the [. . . .brief description of the Facilities], we hereby notify you that the following part(s) of the Facilities was (were) complete on the date specified below, and that, in accordance with the terms of the Contract, the Employer hereby takes over the said part(s) of the Facilities, together with the responsibility for care and custody and the risk of loss thereof on the date mentioned below.

1. Description of the Facilities or part thereof: [. . . .description]
2. Date of Completion: [. . . .date]

However, you are required to complete the outstanding items listed in the attachment hereto as soon as practicable.

This letter does not relieve you of your obligation to complete the execution of the Facilities in accordance with the Contract nor of your obligations during the Defect Liability Period.

Very truly yours,

[. . . .Signature]

Project Manager

5.2 Form of Operational Acceptance Certificate

Contract: [. . . .insert name of contract and contract identification details. . . .]

Date:

Certificate No.:

To: [. . . .insert name and address of contractor. . . .]

Pursuant to GCC Subclause 25.3 (Operational Acceptance) of the General Conditions of the Contract entered into between yourselves and the Employer dated [. . .date. . .], relating to the [. . .brief description of the facilities. . .], we hereby notify you that the Functional Guarantees of the following part(s) of the Facilities were satisfactorily attained on the date specified below.

1. Description of the Facilities or part thereof: [. . . description . . .]
2. Date of Operational Acceptance: [. . . date . . .]

This letter does not relieve you of your obligation to complete the execution of the Facilities in accordance with the Contract nor of your obligations during the Defect Liability Period.

Very truly yours,

[. . . .Signature]

Project Manager

6. Change Orders

6.1 Change Order Procedure

- 6.1.1 General
- 6.1.2 Change Order Log
- 6.1.3 References for Changes

6.2. Change Order Forms

- 6.2.1 Request for Change Proposal
- 6.2.2 Estimate for Change Proposal
- 6.2.3 Acceptance of Estimate
- 6.2.4 Change Proposal
- 6.2.5 Change Order
- 6.2.6 Pending Agreement Change Order
- 6.2.7 Application for Change Proposal

6.1. Change Order Procedure

6.1.1 General

This section provides samples of procedures and forms for implementing changes in the Facilities during the performance of the Contract in accordance with GCC Clause 39 (Change in the Facilities) of the General Conditions.

6.1.2 Change Order Log

The Contractor shall keep an up-to-date Change Order Log to show the current status of Requests for Change and Changes authorized or pending. Entries of the Changes in the Change Order Log shall be made to ensure that the log is up-to-date. The Contractor shall attach a copy of the current Change Order Log in the monthly progress report to be submitted to the Engineer.

6.1.3 References for Changes

- (1) Request for Change as referred to in GCC Clause 39 shall be serially numbered CR-X-nnn.
- (2) Estimate for Change Proposal as referred to in GCC Clause 39 shall be serially numbered CN-X-nnn.
- (3) Acceptance of Estimate as referred to in GCC Clause 39 shall be serially numbered CA-X-nnn.
- (4) Change Proposal as referred to in GCC Clause 39 shall be serially numbered CP-X-nnn.
- (5) Change Order as referred to in GCC Clause 39 shall be serially numbered CO-X-nnn.

Note:

- (a) Requests for Change issued from the Engineer's Home Office and the Site representatives of the Engineer shall have the following respective references:

Home Office	CR-H-nnn
Site	CR-S-nnn

- (b) The above number "nnn" is the same for Request for Change, Estimate for Change Proposal, Acceptance of Estimate, Change Proposal and Change Order.

6.2 Change Order Forms

6.2.1 Request for Change Proposal Form

[*Employer's letterhead*]

To: [*Contractor's name and address*]

Date:

Attention: [*Name and title*]

Contract Name: [*Contract name*]

Contract Number: [*Contract number*]

Dear Ladies and/or Gentlemen:

With reference to the captioned Contract, you are requested to prepare and submit a Change Proposal for the Change noted below in accordance with the following instructions within [*number*] days of the date of this letter [or on or before (*date*)].

1. Title of Change: [*Title*]
2. Change Request No./Rev.: [*Number*]
3. Originator of Change:
 Employer: [Name]
 Contractor (by Application for Change Proposal No. [Number Refer to Annex 6.2.7])
4. Brief Description of Change: [*Description*]
5. Facilities and/or Item No. of equipment related to the requested Change: [*Description*]
6. Reference drawings and/or technical documents for the request of Change:
 Drawing No./Document No. *Description*
7. Detailed conditions or special requirements on the requested Change: [*Description*]
8. General Terms and Conditions:
 - (a) Please submit your estimate showing what effect the requested Change will have on the Contract Price.
 - (b) Your estimate shall include your claim for the additional time, if any, for completing the requested Change.
 - (c) If you have any opinion that is critical to the adoption of the requested Change in connection with the conformability to the other provisions of the Contract or the safety of the Plant or Facilities, please inform us in your proposal of revised provisions.
 - (d) Any increase or decrease in the work of the Contractor relating to the services of its personnel shall be calculated.
 - (e) You shall not proceed with the execution of the work for the requested Change until we have accepted and confirmed the amount and nature in writing.

[*Employer's name*]

[*Signature*]

[*Name of signatory*]

[*Title of signatory*]

6.2.2 Estimate for Change Proposal Form

[Contractor's letterhead]

To: [Employer's name and address]

Date:

Attention: [Name and title]

Contract Name: [Contract name]

Contract Number: [Contract number]

Dear Ladies and/or Gentlemen:

With reference to your Request for Change Proposal, we are pleased to notify you of the approximate cost to prepare the below-referenced Change Proposal in accordance with GCC Subclause 39.2.1 of the General Conditions. We acknowledge that your agreement to the cost of preparing the Change Proposal, in accordance with GCC Subclause 39.2.2, is required before estimating the cost for change work.

1. Title of Change: [Title]
2. Change Request No./Rev.: [Number]
3. Brief Description of Change: [Description]
4. Scheduled Impact of Change: [Description]
5. Cost for Preparation of Change Proposal: [insert costs, which shall be in the currencies of the contract]

(a)	Engineering	(Amount)
(i)	Engineer _____ hours (hrs) x _____ rate/hr =	_____
(ii)	Draftsperson _____ hrs x _____ rate/hr =	_____
	Sub-total _____ hrs	_____
	Total Engineering Cost	_____
(b)	Other Cost	_____
	Total Cost (a) + (b)	_____

[Contractor's name]

[Signature]

[Name of signatory]

[Title of signatory]

6.2.3 Acceptance of Estimate Form

[*Employer's letterhead*]

To: [*Contractor's name and address*]

Date:

Attention: [*Name and title*]

Contract Name: [*Contract name*]

Contract Number: [*Contract number*]

Dear Ladies and/or Gentlemen:

We hereby accept your Estimate for Change Proposal and agree that you should proceed with the preparation of the Change Proposal.

1. Title of Change: [*Title*]
2. Change Request No./Rev.: [*Request number/revision*]
3. Estimate for Change Proposal No./Rev.: [*Proposal number/revision*]
4. Acceptance of Estimate No./Rev.: [*Estimate number/revision*]
5. Brief Description of Change: [*Description*]
6. Other Terms and Conditions: In the event that we decide not to order the Change accepted, you shall be entitled to compensation for the cost of preparing the Change Proposal described in your Estimate for Change Proposal mentioned in para. 3 above in accordance with GCC Clause 39 of the General Conditions.

[*Employer's name*]

[*Signature*]

[*Name of signatory*]

[*Title of signatory*]

6.2.4 Change Proposal Form

[Contractor's letterhead]

To: [Employer's name and address]

Date:

Attention: [Name and title]

Contract Name: [Contract name]

Contract Number: [Contract number]

Dear Ladies and/or Gentlemen:

In response to your Request for Change Proposal No. [Number], we hereby submit our proposal as follows:

1. Title of Change: [Name]
2. Change Proposal No./Rev.: [Proposal number / revision]
3. Originator of Change: Employer: [Name] / Contractor: [Name]
4. Brief Description of Change: [Description]
5. Reasons for Change: [Reason]
6. Facilities and/or Item No. of Equipment related to the requested Change: [Facilities]
7. Reference drawings and/or technical documents for the requested Change:
[Drawing/Document No./Description]
8. Estimate of increase/decrease to the Contract Price resulting from the Change Proposal:

Amount

[insert amounts in the currencies of the Contract]

- | | |
|--|-------|
| (a) Direct material | _____ |
| (b) Major construction equipment | _____ |
| (c) Direct field labor (Total hrs) | _____ |
| (d) Subcontracts | _____ |
| (e) Indirect material and labor | _____ |
| (f) Site supervision | _____ |
| (g) Head office technical staff salaries | |
| Process engineer _____ hrs @ _____ rate/hr | _____ |
| Project engineer _____ hrs @ _____ rate/hr | _____ |
| Equipment engineer _____ hrs @ _____ rate/hr | _____ |
| Procurement _____ hrs @ _____ rate/hr | _____ |
| Draftsperson _____ hrs @ _____ rate/hr | _____ |
| Total _____ hrs | _____ |
| (h) Extraordinary costs (computer, travel, etc.) | _____ |

- (i) Fee for general administration, % of Items _____
- (j) Taxes and customs duties _____
- Total lump sum cost of Change Proposal [*Sum of items (a) to (j)*]
- Cost to prepare Estimate for Change Proposal [*Amount payable if Change is not accepted*]

9. Additional time for Completion required due to Change Proposal
10. Effect on the Functional Guarantees
11. Effect on the other terms and conditions of the Contract
12. Validity of this Proposal: within [Number] days after receipt of this Proposal by the Employer
13. Other terms and conditions of this Change Proposal:
- (a) You are requested to notify us of your acceptance, comments or rejection of this detailed Change Proposal within [Number] days from your receipt of this Proposal.
 - (b) The amount of any increase and/or decrease shall be taken into account in the adjustment of the Contract Price.
 - (c) Contractor's cost for preparation of this Change Proposal: [*...insert amount. This cost shall be reimbursed by the employer in case of employer's withdrawal or rejection of this Change Proposal without default of the contractor in accordance with GCC Clause 39 of the General Conditions*]

[*Contractor's name*]

[*Signature*]

[*Name of signatory*]

[*Title of signatory*]

6.2.6 Pending Agreement Change Order Form

[*Employer's letterhead*]

To: [*Contractor's name and address*]

Date:

Attention: [*Name and title*]

Contract Name: [*Contract name*]

Contract Number: [*Contract number*]

Dear Ladies and/or Gentlemen:

We instruct you to carry out the work in the Change Order detailed below in accordance with GCC Clause 39 of the General Conditions.

1. Title of Change: [*Name*]
2. Employer's Request for Change Proposal No./Rev.: [*number/revision*] dated: [*date*]
3. Contractor's Change Proposal No./Rev.: [*number / revision*] dated: [*date*]
4. Brief Description of Change: [*Description*]
5. Facilities and/or Item No. of equipment related to the requested Change: [*Facilities*]
6. Reference Drawings and/or technical documents for the requested Change:
[*Drawing / Document No. / Description*]
7. Adjustment of Time for Completion:
8. Other change in the Contract terms:
9. Other terms and conditions:

[*Employer's name*]

[*Signature*]

[*Name of signatory*]

[*Title of signatory*]

6.2.7 Application for Change Proposal Form

[*Contractor's letterhead*]

To: [*Employer's name and address*]

Date:

Attention: [*Name and title*]

Contract Name: [*Contract name*]

Contract Number: [*Contract number*]

Dear Ladies and/or Gentlemen:

We hereby propose that the work mentioned below be treated as a Change in the Facilities.

1. Title of Change: [*Name*]
2. Application for Change Proposal No./Rev.: [*Number / revision*] dated: [*Date*]
3. Brief Description of Change: [*Description*]
4. Reasons for Change:
5. Order of Magnitude Estimation (amount in the currencies of the Contract): [*Amount*]
6. Scheduled Impact of Change:
7. Effect on Functional Guarantees, if any:
8. Appendix:

[*Contractor's name*]

[*Signature*]

[*Name of signatory*]

[*Title of signatory*]

7. Personnel Requirements

Using Form PER - 1 and PER - 2 in Section 4 (Bidding Forms), the Bidder must demonstrate that it has personnel who meet the following requirements:

No.	Position	Total Work Experience [years]	Experience In Similar Work [years]
1	Project Manager Graduate in Civil Engineering/ Project Management/ Construction Management	15	10
2	Process Engineer Graduate in Civil Engineering/ Environmental Engineering/ Public Health Engineering	10	5
3	Mechanical / Electrical Engineer Graduate in Mechanical Engineering/ Electrical Engineering	10	5
4	Instrumentation/ SCADA Engineer Graduate in Instrumentation Engineering / Electronics Engineering	10	5
5	Quality Control Engineer Graduate Civil Engineer	10	5
6	Environmental Safeguard Officer Graduate Environmental Science	5	3
7	Safety / Accident Prevention Officer Graduate and Suitably qualified to ensure safety and accident prevention at works	5	3

8. Equipment Requirements

Using Form EQU in Section 4 (Bidding Forms), the Bidder must demonstrate that it has the key equipment listed below:

No.	Equipment Type and Characteristics	Minimum Number Required
1	Excavator cum loader	1 No
2	Weigh Batch type concrete mixers	5 Nos
3	Needle Vibrators	10 Nos
4	Plate Vibrators	3 Nos.
5	Dewatering Pumps 5 HP and 10 HP	2 Nos. Each
6	Smooth wheeled, Vibratory Roller 1 No.	1 No.