

Section 6 - Employer's Requirements

Table of Contents

1	Scope of Supply of Plant and Services.....	6-2
2.	Specifications.....	6-11
3.	Drawings.....	6-100
4.	Supplementary Information.....	6-101
5.	Certificates	6-108
5.1	Form of Completion Certificate	6-109
5.2	Form of Operational Acceptance Certificate	6-110
6.	Change Orders	6-111
6.1.	Change Order Procedure.....	6-112
6.1.1	General	6-112
6.1.2	Change Order Log	6-112
6.1.3	References for Changes.....	6-112
6.2	Change Order Forms.....	6-113
6.2.1	Request for Change Proposal Form	6-113
6.2.2	Estimate for Change Proposal Form	6-114
6.2.3	Acceptance of Estimate Form	6-115
6.2.4	Change Proposal Form	6-116
6.2.5	Change Order Form	6-118
6.2.6	Pending Agreement Change Order Form	6-119
6.2.7	Application for Change Proposal Form	6-120
7.	Personnel Requirements	6-121
8.	Equipment Requirements	6-122

1. Scope of Supply of Plant and Services

I. Scope of work

Introduction

Honourable Minister for MA &RD while moving Demand No.34 for the year 2011-12 had announced that investigation works would be taken up for providing CWSS to Cuddalore and Vridhachalam Municipalities, 9 town panchayats and 1300 rural habitations in 9 panchayat unions of Cuddalore District and 2 town panchayats and 525 rural habitations in 4 panchayat unions of Villupuram District with river Kollidam as source. Accordingly, in G.O. (Ms) No.155, MA&WS (WS2) Department, dated 15.10.2011, it was ordered to take up investigation in respect of the above mentioned areas.

Further the Hon'ble Minister for Municipal Administration and Rural Development, had also announced on the floor of House during Demand No.34 for 2012-13 that the CWSS to Cuddalore, Virudhachalam, Villupuram, Tindivanam Municipalities, 13 Town Panchayats, 3,593 Rural Habitations in 26 Unions in Cuddalore and Villupuram Districts would be taken up for implementation during the year 2012 - 13. The scope of the project extended based on the request of the then Hon'ble Minister for Education, Sports and Welfare of Youth so as to benefit the people of Villupuram, Vickravandi, Mailam and Tindivanam constituencies.

While planning to formulate the above scheme, it was desired to consider the above Project in two phases. DPR for Phase-I, covering Cuddalore Municipality, Bhuvanagiri & Parangipettai Town Panchayats and 812 Rural habitations in Cuddalore District with source located in River Kollidam near Eyyalore had already been sanctioned at a cost of Rs.260.54 Crore vide G.O.Ms.No.10, MA& WS(WS4) / Dt.28.01.2013 and works have been completed and put into beneficial use of the public.

Proposal for the remaining beneficiaries under the mega CWSS, other than those covered under Phase-I, is considered as Phase-II and the discussion below is regarding the Phase-II proposal.

PHASE II:

Proposal for the remaining beneficiaries under the mega CWSS, other than those covered under Phase-I, is considered as Phase-II and the discussion below is regarding the Phase-II proposal.

Taking into account the mega Ph II proposal the Board directed to do proper sizing of the Project. Different proposals on sizing, with different sources and coverage areas were discussed at Head Office and Government level and finally, an implementable solution was derived as follows.

- i. To cover the beneficiaries in Sedimentary area through augmentation of local sources and improvements to existing infrastructure, in a phased manner.
- ii. To cover the deprived/Hardrock area, with River Kollidam at Sarukkai, under Phase-II of Government announced CWSS for Cuddalore and Villupuram Districts.

Accordingly, Phase II proposal for providing CWSS to Villupuram Municipality added area, 5 Town Panchayats and 836 Rural Habitations in Cuddalore and Villupuram Districts with River Kollidam as source (45 mld) was Administratively approved vide G.O. Ms .No. 150/ MA&WS(Ws4) Dept., Dt. 03.12.2014 with an estimate cost of Rs.621.00 Cr to install and Rs.7.28 cr to maintain annually.

The Ph II proposal did not take off due to delay in fund tie up for Villupuram Municipality and CMA's request to commence the Tender process after necessary financial tie-up and subsequent announcement of Kallakurichi CWSS.

The Principal Secretary to Government, MA&WS department on 22.07.16 convened a meeting to deliberate on the PH II CWSS and Kallakurichi CWSS and suggested to analyze the feasibility and sustainability for drawing water from various sources apart from the prime source of Kollidam.

DTP accorded consent for Thittakudi, Pennadam, Mangalampettai T.Ps & recommended to District Collector to include Vadalur, kurinjipadi and Gangaikondan T.Ps.

Pending implementation of NLC proposal Hon'ble Chief Minister of Tamil Nadu during M.G.R Centenary celebration in Cuddalore District on 16.08.2017 announced that 100 mld desalination plant will be installed at a cost of Rs. 1000 Cr as a permanent measure for water supply in Cuddalore and Villupuram Districts.

In this connection, a meeting was convened on 12.04.2018 by Principal Secretary to Govt, MA& WS Dept with Additional Chief Secretary to Government, Finance Dept and during the meeting, TWAD Board was directed to come up with cost optimization by different sources to move forward with the centenary Celebration projects in Cuddalore and Villupuram Dts. Accordingly suggestions came up for analyzing and to split into three projects as below.

- i. Investigation of separate CWSS for the beneficiaries of Cuddalore Ph II CWSS **in Cuddalore Dt** with NLC mine water as source.
- ii. Investigation of separate CWSS for the beneficiaries of Cuddalore Ph II CWSS **in Villupuram Dt** with Desalination sea water as source considering the Industrial/Commercial requirements especially Tindivanam SIPCOT.
- iii. Investigation of Kallakurichi CWSS (2015-16 announcement) in Villupuram District with local sources within economic distance including Thenpennaiyar, Sathanur dam etc

Government permitted to take up investigation works for all the three projects (i, ii & iii) simultaneously and send the investigation report along with availability of funding source to Govt.

The Honourable Minister for Municipal Administration and Rural Development and implementation of Special Programme and Chief Secretary to Government's review held on 3.7.19 at Chief Secretary's Conference hall, Secretariat, Ch-9, it is suggested to provide

- a. 30 MLD CWSS to Thittakudi, Pennadam and surrounding rural habitations in Cuddalore District **with NLC mine water as source** and directed to complete the DPR preparation by 31.08.2019.
- b. 60 MLD Desalination Plant at Marakanam to serve Villupuram, Tindivanam and adjoining villages.
- c. 20 MLD CWSS to Kallakurichi Municipality, Chinnasalem, Sankarapuram and the surrounding rural habitations with Sathanur Dam as source.

The DPR for the **CWSS to Thittakudi, Pennadam, Mangalampettai, Vadalur, Kurinjipadi and Gangaikondan, Town Panchayats and 625 rural habitations in Mangalore, Nallur and Virudhachalam, Unions of Cuddalore District with NLC mine**

water as source project has been prepared and submitted to Government for according approval. Accordingly administrative Sanction was accorded vide G.O Ms No.47/MA & WS Dept (ws-2), dt.21.04.2020 for Rs.479.00 Crores.

WATER DEMAND FOR THE PROJECT

Net clear water Demand calculated after deducting the existing sustainable supply of 85 lpcd for Town panchayats and 20 lpcd for rural & keeping the minimum flow in pipes as 10 lpm, transmission losses @ 10% works out to 23.92 mld, 31.26 mld & 39.43 mld for the present (2022), intermediate (2037) & ultimate (2052) stages respectively. Demand is calculated at the rate of 135 lpcd for Town Panchayats and 55 lpcd for rural habitations.

The population forecast is approved by the Chief Engineer, TWAD Board, Vellore Vide Lr.No.F.CWSS to Tittakudi/NLC/T4/CE/VLR/2019/dt.22.07.2019. Population is projected for 5.94 Lakhs(2022), 7.12 Lakhs(2037) and 8.43 Lakhs(2052).

After deducting the beneficiaries covered under existing TWAD owned CWSS, the final population is calculated for 5.61 Lakh, 6.72 Lakh & 7.96 Lakh for the Base year (2022), intermediate year (2037) & ultimate year (2052).

Since, ground (mine) water is proposed to be utilized, 18 hours of pumping was considered, as per the guidelines framed by the Board vide BP MS No 103/dt 31.10.2012.

The Demand for water during Intermediate and Ultimate Stages is furnished as follows.

Sl. No.	Name of Beneficiary	Population			Net Requirement in MLD including 10% Transmission Losses		
		2022	2037	2052	2022	2037	2052
I.	Town Panchayats						
1.	Thittakudi	26559	32515	39818	1.46	2.35	3.43
2.	Pennadam	22324	26856	32308	1.23	1.90	2.71
3.	Mangalampettai	10984	13974	17719	0.60	1.05	1.60
4.	Vadalur	7391	8696	10000	0.41	0.60	0.79
5.	Kurijipadi	45391	53404	61417	2.50	3.69	4.88

Sl. No.	Name of Beneficiary	Population			Net Requirement in MLD including 10% Transmission Losses		
		2022	2037	2052	2022	2037	2052
6.	Gangaikondan	31556	37128	42699	1.74	2.56	3.39
	Sub Total	144205	172573	203961	7.94	12.15	16.80
II.	Rural (625 Habns)	413977	495709	557701	15.98	19.11	22.64
	Total	558182	668282	791662	23.92	31.26	39.43
	Add water treatment loss @ 5%				1.20	1.56	1.97
	Net source requirement in MLD				25.12	32.82	41.40
	Net source requirement in GPM				3842	5021	6333
	Source assured by NLC for 6500 GPM up to 2042-43						

Source

The water supply source for the scheme is the surface runoff of the NLC mine II discharge water which is let into the Paravanar river Channel leading to Walaja Tank. The NLC involved in coal mining activity will continuously shift the mine water outlet discharge point according to the excavation programmed by NLC authorities. Hence, the water discharge point cannot be focused at a single point even though NLC authorities assured to supply 6500GPM of mine storm water up to the year 2042 - 43. The DHG in his source sustainability report has reported that the discharge location will be moving 200m per year. The scheme startup for the base year is 2052. Hence, considering 2 years execution period 400m of intake pipe line was proposed to be taken up for immediate execution. Balance length of 8800m was proposed for future extension of intake pipe line which will be taken up as per the ground conditions as and when required. The intake pipeline was proposed with MS pipe of 1016mm and 406mm because of the same size used by the NLC. The mine water is continuously discharged using higher duty pumpset from the mine – II, which is at a depth of 80m below GL. The discharges water is proposed to be tapped with MS pipe line arrangements crossing the Garland channel maintained by NLC. The Garland channel is having its confluence into the Paravanar river. The WTP site is located North of the Paravanar River and East of the Garland Channel. The mine water will be received at the Valayamadevi Keel Water Treatment plant by tapping directly from the discharge outlet of mine. The collected water will be received in the raw water collection sump (Raw water Intake upto Raw water collection sump will under UFTP scope)

Brief Description of the Project

It is proposed to draw the source from the NLC mine – II as per the permission granted by the NLCIL, Neyveli for 6500GPM (41.40MLD). The raw water will be tapped from the discharge outlet point presently discharging into Mines Garland Channel and finally confluencing into Paravanar river. The WTP site is presently at a distance of 400m from the discharge outlet point. The discharge outlet points will be shifted as per the mine execution programmed by NLCIL. Accordingly, the raw water intake pipe has also need to be extended as per requirements. The raw water is proposed to be collected in an Raw water collection sump followed by water treatment plant using Ultra Filtration Membrane treatment. The Package – I scope includes tapping of Raw water from NLC discharge outlet points, collection into Raw water sump, full scale water treatment using UFTP with PVDP modules and delivering the product outlet water (confirmed for drinking water standards) into the clear water sump at a distance of 50-100m (Clear water Sump construction by others). All allied infra structures includes raw water intake from NLC mine discharge points, By pass arrangements, pre- treatment units, Iron removal units, Pressure filter units, UFTP treatment house, pump rooms, chemical rooms, administrative blocks, Master circuit control room, PLC automation, Electro mechanical, piping and instrumentation units as per plant requirements, internal roads, green belt arrangements, Landscaping and internal pathways for access to individual units, Full fledged Laboratory, security Room, Compound wall and chain link fencing requirements with RCC posts, waste water disposal into paravanar river at a distance of 100m. Obtaining plant approvals and clearances from other departments etc.,

Full Scale Water Treatment Plant with UFTP Method

The proposed treatment plant output capacity is to be 31.26 mld at Intermediate stage. The water recovery of raw water to product water is to be considered for fixing the plant sizing. If 90% water recovery is assumed the plant capacity need to be constructed for 34.50MLD($31.26 \times 1.10 = 34.38$ MLD). The WTP site is located in Keel Valayamadevi village, Bhuvanagiri Taluk, Cuddalore District at SF Nos 16/1,2,3&4 & 17/1,2,3,4,5&6 Tharisu Porambokku land (nearly 8 Hec, 63.5 Ares). The land will be measuring 315.80 & 167.800m on the Northern and Southern side and 327.6 & 399.00m on the Eastern and western side. The WTP land will be having its access on the Western side with the approach road maintained by NLCIL and linked to the Uyyakondaravi – Valayamadevi Panchayat road having its access to Cuddalore – Vridhachalam Main Road. The WTP site includes area for future expansion and chain link fencing to be provided for entire perimeter The access road and WTP land was given NOC by the NLCIL, Neyveli. The Land was resolved for WTP use by Keelvalayamadevi panchayat and land alienation proposal is

verified by the Thasildhar, Bhuvanagiri Taluk. The land alienation proposal will be finalized by the sub Collector, Chidambaram and awarded to TWAD Board by the District Collector, Cuddalore. The Construction of Treatment Plant using UFTP will be based on DBOOT system to deliver a product output water (confirming to drinking water standards) of 31.26MLD.

Design Process

The design of the Drinking Water Treatment Plant shall be in compliance with the requirements of Manual of Water supply and Treatment, Third Edition 1999 published by the expert committee of Central Public Health & Environmental Engineering Organisation, Govt. of India and relevant BIS codes of practice. The source of water for this Project is NLC mine storm water from Mine – II.

Bidders are to adopt UFTP technology with PVDP membranes having membrane life not less than 8 Years and demonstrate with relevant experience. However, the delivering required output water quality should be as specified in the Tender. Bidder must demonstrate experience in constructing and operating such system.

Waste water during water treatment shall be discharged in the nearby Paravanar river by gravity. The spot levels of WTP site including odai are uploaded. All the valves controls should be electrically actuated. The entire UFTP must be fully automated with PLC and manual operation for emergency purpose. The system housed in separate control room designed for plant requirements and having provision for addition of modules expansion for ultimate stage of 43.50MLD. $(39.43 \times 1.10 = 43.37 \text{MLD})$

The Designing, Building and Operation of Full Scale Water Treatment Plant to deliver product water of **31.26 MLD** as per the process described in the Annexure I and Water balance Diagram (Reference Purpose only) furnished in Annexure 2 with all allied civil works, supply, delivery and erection of all Electro mechanical, electrical instrumentation, Automation, piping facility, back washing & Air washing requirements, waste water disposals, chemical requirements and storage area etc., complete comprising Raw water Intake from NLC mines discharge outlet with bypass arrangements, RCC Raw water collection tank, Pumping station and pumping units to pre treatment units viz Cascade Aerator, Stilling Chamber with Aerated water channel, Aerated water collection sump, three layer Multi media Pressure filter with activated carbon, sand and Garnet, Chemical dosing system and feed water to UF membrane housing units, Back washing/ Air Washing pumping units , Clear water Distribution to Clear water Sump (Others scope) and Arrangement of disposal of waste water to Paravanar river, Annexure Building for accommodating

plant office Administration with File Record room and computer room with UPS backup, Master Circuit control control panels, Automation control room, Laboratory, Chemical housing & storage room, Pump rooms, security cum clock room and office, Required Ancillary building with Chlorine House for disinfection arrangements , Indoor and outdoor Lighting arrangements to all plant units and in the site, pipes and specials, power cable laying(buried and open), road crossing, emergency push button in all units including by pass arrangements, Power supply arrangements, providing Safety appliances, spares, tools and equipments, EOT/ HOT cranes, internal roads, Access path ways and side drains, Compound wall, chain link fencing with RCC post, Plant landscaping & Gardening , Construction of staff quarters, Internal Bath & Toilet facility for staff and workers with Septic tanks, furnishing of operation manual, completion plans etc. and commissioning of the entire plant and O&M for 5 years.

Annexure 1

The WTP is to be designed with 34959 m³/day for 90% water recovery of raw water to produce a minimum treated water of 31260 m³/day with 10% losses. The plant is to be designed with a provision that it can be augmented up to 43.500 MLD.

Infra structural Units

For Source

- 1.Raw water Intake pipe with Bypass arrangements(to be designed ultimate stage @ 43.50 MLD)
2. RCC Raw water collection sump with water meter.
3. Pumping station to pre treatment unit of WTP.

The WTP consists of the following process units:

1. Cascade Aerator
- 2.Stilling Chamber with Aerated water collection channel & Pump house.
3. Multimedia Pressure filter (Three layer with Activate Carbon, sand and Garnet)
4. Secondary collection tank & Pump house.
5. Chemical dosing and Membrane feed water pump house
6. Ultra filtration Membrane Filter house & Annexure Building.
7. PLC automation
8. Back wash / Air wash with Annexure Building
9. Laboratory Monitoring Room
- 10.Waster water disposal arrangement @ 100m into Paravanar River

11. Chlorine Disinfection arrangement with Annexure Building.
12. Clear water Disposal with water meter to Headworks clear water sump @ 100m
13. By- pass arrangements
14. Transformer Yard
15. Power supply arrangements
16. Service Water system with Pump room
17. Lighting arrangements for all units
18. Safety appliances, spares, tools and equipments
19. EOT/HOT cranes

Other Provisions in Treatment Plant Site (Detailed Estimate Available)

1. Internal Roads, Access Path ways and side Drains
2. Road Crossing culvert Drains
3. Front Compound wall & Chain Link Fencing with RCC post.
4. Staff Quarters with Bath & Toilet facility
5. Security cum Clock Room
6. Street lights
7. Landscaping & Gardening.

2. SPECIFICATIONS

II GENERAL SPECIFICATIONS

1. Scope of Work

Location and Detailed Unit Wise Specification

The source for the water supply is NLCIL, Neyveli Mine – II storm water source. The raw water will be discharged from the NLC mine – II into the Water Garland and its discharge raw water has to be tapped directed to the Raw water collection tank for Water treatment works located at Keel Valayamadevi Village. The raw water after full scale treatment is proposed using ultra filtration Membrane and will have to be pumped to the clear water sump (18Hr pumping) of Head works located at nearer to the Water Treatment work at Keelvalayamadevi Village. The required land is available for the construction of treatment plant is 8 Hectare, 63.5 Ares and the average ground level at the proposed treatment plant (+)18.90m.

The Treatment Plant should produce treated water conforming to the potable water standards indicated in clause 33 of this chapter.

2. General Outing of this Work

The water treatment plant shall have a capacity to treat 31.26 MLD. The contractor shall construct all civil works and install the complete plant including electrical and mechanical, PLC automation works etc.,. The plant may be designed for continuous operation of 18-20 Hours with view to ensure membrane life cycle and under economic ground conditions including preset back washing, plant maintenance, waste water disposal Multimedia filter maintenance etc.,

Detailed specifications for pre treatment units and Ultra filtration Membrane units

The scope of work includes Design & Engineering of civil, Mechanical, Electrical and Instrumentation, Construction of the Ultra Filtration membrane treatment plant with pre treatment section and allied infra structural facility and complete commissioning of plant to supply the product outlet water of 31.26MLd to the proposed clear water sump at TWAD Head works at Keelvalayamadevi Village. The raw water quality test report is enclosed for reference to estimate the design requirement of Ultra filtration treatment plant.

CONSTRUCTION OF UFTP.

The construction of UFTP involves complete design of all infra structural units involved with Civil structures of pre-treatment units and internal buildings, UF Membrane and housing infrastructure and all allied electro mechanical and instrumentation and required automation facility, internal piping and valve arrangements, Erection and commissioning of complete water treatment plant to supply the potable drinking water and product outlet quantity of 31.26 Mld for the allowable standards referred in IS 10500/2012 duly analyzed based on the raw water sample tested in TWAD.

a. Design, Engineering construction of civil works.

- The scope involves complete design of Ultra filtration treatment plant for its hydraulic design considering the back water wash and flushing of membranes etc.,
- Complete design of all civil infrastructural units required under pre-treatment section viz., Raw water collection tank to suit the capacity for 24 hours operation of UF plant with provision for suitable detention time, Pumpset and pumphouse, Cascade Aerator to suit the dissolved iron removal contained in the raw water. Aeration shall be of inducted atmospheric air and if required diffused air system shall be provided with provision for hypo chlorite dosing in the aerator unit.
- Followed by aeration, multimedia filtration (MMF) unit shall be capable to remove the particle size of 24 micron to less than 10. The filtration media shall be packed with layers of Anthracite, sand, garnet so as to enhanced the quality of filtered water and housed in Carbon steel container. Dedicated back wash pump shall be used and working on automated high differential pressure across the filter or after 24 hours of service, The operation shall be controlled by PLC/HMI system.
- All electro mechanical control systems shall be controlled and operated in a well spaced Master control system room. Other internal buildings for pumping units and machinery, water disinfection room, Chemical housing

room, Administration room, security room etc., shall be provided as per design requirements.

- The Ultra filtration treatment plant shall have internal lab unit to monitor and record the water quality status and submission of records on regular basis.
- Internal water supply and sanitation facility and emergency personal standing area shall be mandatory and provided as per plant requirements.
- The sub structure foundation design of all structures shall be as per the IS design requirements and based on the Geo Technical investigation Report. The trial pit details reveal all soil condition with a tentative SBC of 6 - 8KN/m²

b. DESIGN, ENGINEERING, SUPPLY, ERECTION AND COMMISSIONING OF MECHANICAL WORKS INCLUDING ULTRA FILTRATION.

The scope includes complete designing of ultra filtration membrane modules in suitable sectional skids with all internal electro-mechanical pumps and valve control systems functioning on PLC automation. Required back washing facility shall be maintained for the UF membranes to give washing in to and fro and on cross flow directions as required mixed with suitable chemical dosing to regularly maintain the membrane filter to standards and to get desirable product outlet water quality. The treated water recovery must not be less than 90%. The treated water shall be conveyed to the treated water storage tank i.e clear water tank at the head works.

- The UF membrane rows shall be set up and aligned in skids as per design requirements and entire UF membrane section housed in a well built indoor system. The UF membrane house shall be constructed in well ventilated and have access to natural lightning facility in all areas to have proper maintenance for day and night operations.
- All internal piping system shall have rigid support arrangements.
- Valve controls shall have access to well designed PLC automation and controlled monitoring facility to ensure satisfactory working of membrane units.

- All electro-mechanical pumping units shall be graded for energy efficient and installed as per design requirements.
- Required back washing tank, enhanced chemical washing tank and required pumping units shall be housed as per design requirements.
- Service cycle shall be followed by air assisted cleaning after a set interval time or based on the increased trans-membrane pressure. Oil and particulate free air plant shall be provided as per design requirements.
- The UF membrane unit inlet, product water outlet, Membrane washing, piping and valve controls, pressure monitoring units etc., complete shall be completely programmed to have access with PLC automation control systems and required instrumentation units shall be provided as per safety standards and designed for plant requirements.
- The UF permeate shall be collected in the RO feed tank for further treatment.
- The multi media filter back washing water and treated UF permeate water after membrane back washing shall be collected in wastewater collection tank as per design requirements and disposed safely into the Paravani river within a safe disposal distance of 100m.
- The UF membrane shall be of self encapsulated hollow fiber ultra filtration membrane module (Modified hydrophilic polyvinylidene fluoride (PVDF) material to offer high fiber strength and chemical resistance which operates under low transmembrane pressure in an outside – in – flow method).
- Conventional UF modules not recommended

c. SUPPLY AND INSTALLATION OF ELECTRICAL AND INSTRUMENTATION ITEMS.

The scope includes receiving TNEB electrical supply from the source grid point to the transformer yard installed with the plant site. The access to the transformer yard shall be as per CEIG & TANGEDCO requirements and the KW loading of transformer shall be based on the electrical energy requirements of all electro-mechanical units, internal and external plant lighting calculated with power factor of each units. All electrical, cabling, wire routing, earthing, power factor controller & surge control unit, Master control room, PLC and instrumentation items shall be well designed as per the plant requirements.

- The HT supply access grid from EB to the Transformer yard shall be located within the plant premises as per the CEIG & TANGEDCO requirements including yard maintenance as per IE rules.
- All electrical cable routes shall be indicated with cable routing indicator. HT cables laid within the plant premises shall be buried as per electrical cable laying procedure and cable tray shall be used wherever necessary for IE requirements and as per the approval accorded by CEIG
- Mater Circuit Control room shall have overall access of all electro-mechanical infrastructures and have synchronized electrical panel designed with power factor controller for UF treatment plant, allied pumping and electro mechanical requirements and as per CEIG approval with Earth fault relay systems.
- PLC and allied instrumentation panel shall be provided to automatically control the UF modules, MMF units etc.,

d. ERECTION AND COMMISSIONING OF COMPLETE WATER TREATMENT PLANT INCLUDING UF.

The scope included erection of all civil, Mechanical and electro mechanical units, PLC and instrumentation units, Multi media filtration and Ultra filtration membrane housing unit, piping and valve control units overall installation and working of all units as per design requirements from intake pipeline and upto the treated water storage tank to deliver a product outlet water of 31.26 Mld to the potable standards and sent upto the Clear Water sump constructed at same premises of Keelvalayamadevi Village within a distance reach of 100m.

3. Process Description

Cascade Aerator :

The raw water will be received at the WTP in the Cascade Aerator. The cascade Aerator shall be of R.C.C. M30 water fall cascade type aerator comprising 3 m height aeration, functioning, with equispaced circular trays respectively in 4 steps and collecting tray at bottom for treating 1457 Cum./hour (35Mld) of water by securing over inclined thin sheets and arresting turbulence by allowing water to pass through the steps adopting a surface loading of 0.015 Sqm/Cum/hour. Provision of hypo-chlorite dosing in collection tank shall be kept for disinfection. It will also help in oxidation of residual dissolved irons. Precipitates shall be separated from water in downstream filtration unit. The civil works includes fabrication and placing in position of grills for reinforcement, centering, shuttering, concreting, curing etc., including cost of cement and steel and cement painting two coats in Exterior surfaces etc complete. The pipe connections consists of supply, delivery and laying of 1000 mm M.S. pipe lined both sides of suitable length connecting Raw water and Aerator with 1000 mm dia controlling valve and necessary specials including earth work excavation, refilling etc.

Aerated Water Stilling tank :

R.C.C. (M30) Stilling Chamber shall be provided to hold the flow from Aerator with detention period of 60 seconds and liquid depth of 2.60 m and free board of 400mm. The civil works include fabrication and placing of grills in position centering, strutting, charges, curing etc., and cement painting 2 coats to the exterior surfaces and including cost of cement, steel, etc., complete and as per relevant standard specification.

Raw water Measuring Channel:

R.C.C. (M.30) Raw Water channel shall be suitably positioned with walkway slab and supported for conveying raw water from stilling chamber to the Distribution chamber for a length of 10m of size 2.00 m x 1.50 m liquid depth , 500 mm free board with walkway of width 1 m respectively and for flow measurement by providing copper 'V' Notch plate and Direct reading flow recorder of standard make synchronised with PLC, comprising integrators and automatic recorded flow measurement of minimum 5 mld and maximum 50 mld for use in conjunction with a weir. The instrument should be float operated with weather proof pedestal weir flow transmitters and incorporating electrical flow transmitting apparatus and all other accessories. The civil works include fabricating and placing of grills in position, centering, strutting, shuttering, concreting, curing

etc., complete including cost of cement and steel and also including provision of MS ladder with hand rails and colour washing two coats with cement paint for exterior surface, etc., complete. Water quality monitoring instruments such as pH, turbidity, TDS, Iron shall be installed with suitable arrangements such as sampling pumps and piping.

FILTRATION MEDIA :

The aerated water shall be filtered for removal of suspended particles & coagulants either using Filter beds or using Multi media filtration Units or any other method. The Filtration system used should reduce the load on the Ultra filtration Membrane, so as to have extended membrane life cycle not less than 8 years.

MULTI MEDIA FILTRATION :

Aerated water shall be fed to Multimedia filtration system for removal of Iron & other suspended particles. Coagulant & coagulant aid dosing system is provided at inlet for media filters to enhance the flocculation of precipitated particles. Filtration system consists of multimedia filter (MMF) constructed in carbon steel material to withstand high pressure and rust free unit. (Filter media for removal of Iron & other suspended particles. Viz., Katalox Light, Green Sand ,anthracite Coal and Garnet etc,) Required SDI value (Less than 30) may be achieved to ensure UF membrane life. Filtered water will be used for filter backwash and feed water will be used for final rinsing step during backwash cycle. Dedicated backwash pumps shall be used for MMF backwash.

Backwash is initiated automatically with PLC system, by high differential pressure across the filter or after 18 -20 hours of service, whichever is earlier. In case of emergency, the operator can initiate backwash manually through HMI system.

Filter backwash waste will be collected in backwash waste collection tank and filtered water from the MMF will be fed to the ultra filtration system.

ULTRA FILTRATION (UF) UNIT :**Membrane Parameter includes:**

Membrane Type : Outside In PVDF membrane with antifouling characteristic offering high mechanical strength, resistance to high chemicals, peroxides and chlorine tolerance with ability to handle high feed turbidity for a wide range of water treatment.

Operating Mode : Cross flow filtration (or) dead end filtration.

Designed Water flow : 40 – 90 L/sq.m/Hr @ 0.15Mpa, 25 deg C.

Max Operating Pressure : 0.2Mpa.

Max Trans membrane Pressure : 0.15Mpa.

Operating Temperature : 5 – 45 deg C.

Membrane Integrity Test : Certified with Pressure retention test.

The UF system shall comprise following components and equipment:

- UF skids (with 25% standby unit)
- UF Backwash & Chemical Enhanced backwash system
- Clean up system UF skids

The filtered water enters the UF module from the side bottom port. The filtration takes place through hollow fiber in outside to in configuration. The suspended impurities are retained outside the fiber lumen during filtration. The product water comes from the side top port and collected in the product water storage tank. Service cycle is followed by an air assisted cleaning after a set interval of time or based on the increased trans-membrane pressure.

The service cycle is followed by air scouring along with the feed flow. During this step product valve is closed and the waste water is taken from the reject side. The next step is to drain the modules to remove the impurities which have been removed after the air scouring. Air scouring is again started along with the feed flow subsequent to draining. A forward flush is done without air scouring as a next step. This completes the cleaning cycle and service cycle is resumed.

Chemical cleaning is done depending on the increased trans-membrane pressure or at a set time interval. During chemical cleaning, UF product water is mixed typically with Sodium Hypochlorite (with 200mg/l of free chlorine). This solution is passed from inside to outside flow direction. This is followed by a soaking period. Modules are flushed with the product water and chemical cleaning with acid is performed in a similar way subsequently. The pH of the cleaning water during CEB with acid is maintained around 2.

Oil and particulate free plant air at a pressure of < 2 bar shall be available to perform the regular and chemical cleaning process.

The complete process will be provided with a programmable logic controller to automatically control the UF modules backwash and Chemical enhanced backwash operations. Adequate instrumentation is provided for safety measures.

Part of UF permeate shall be collected in the RO feed tank for further treatment and rest shall be directly taken in to final treated water tank (by others). UF system usually operates at recovery of ~ 90%. The Backwash waste water will be collected in waste collection pit; further disposal by others.

Fully Automation by PLC Unit

The systems are fully automatic, controlled by a programmable logic controller (PLC) assisted by an electronic flow meter and pressure transducers. The PLC also provides full automation of acid, Air scouring and base backwash process, to maintain the UF modules clean and ready for operation.

Bye-Pass Arrangements

Supply, delivery, erecting, laying, jointing and testing of all pipes and specials and all other accessories for the bypass arrangements including earth work excavation and refilling the trenches etc. complete

Safety Appliances

Supply, delivery, erecting and testing of all safety appliances like fire extinguishers, lighting conductor, first aid box as per rules wherever necessary.

Spares

Supply, delivery and erection of spares required for piping and instrumentation, mechanical, electrical and electro mechanical equipments etc., for setting up of ultra filtration membrane and water treatment plant.

Tools and Test Equipment

Supply, delivery and erection of one complete set of special tools and test equipments. Erecting and fixing of tools and equipment in Boards or boxes for easy approach, handling and keeping safe custody of tools and test equipments for each unit of the plant.

Power Supply Arrangements

Supply, delivery and erection of floor mounting MV switch board as per IE rules with necessary incoming switches to receive supply from main switch board at Clear water pump house, outgoing switches of necessary quality and capacity to give power supply to all loads coming under Treatment plant with suitable capacitors, ammeters, volt meters and pilot lamps and cables etc. including starters for motors as per IE rules and preparing, submitting and getting CEIG's approval for electrical installation, drawings for the plant etc. complete. as required for complete installation of WTP.

Internal Roads

Laying of WBM road with bitumen top including side drains, cross drainage works etc. complete including path way linking to inter component of WTP.

Compound Wall

Providing Compound wall around the Treatment Plant Site.

Gardening

Providing adequate green belt , landscaping and gardening within WTP premises.

Staff quarters (1 No.)

Providing Staff quarters for accommodation of staffs within WTP premises.

Annexure 2**Hydraulic Water Balance & Demand calculation**

Qty of Raw water	34959m3/Day
For Aeration	34959m3/Day
For MMF Inlet	34959m3/Day
Back Waste Water in MMF(A)	720m3/Day
Balance for UF System	34239m3/Day
Back wash Waste water in UF(B)	2739m3/Day
Product water to clear water Sump	31500m3/Day
Effluent Disposal into Paravanar river(A+B)	3459m3/Day
Percentage Recovery to Raw Water	90 %
Percentage of Effluent Disposal	10 %

Note: Enclosed WBD calculations are provided for reference only. DBO Contractor, upon award, shall prepare and submit detailed hydraulic and process design calculations and structural designs for client review and approval.

Soil investigation results will be provided. Confirmatory testing and structural design to be furnished by the bidder for client review and approval.

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 Employer 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 portland 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 therefore 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 Fe500, 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.

- 1.4 The cement/ steel shall be tested in nearby accredited NABL laboratories of Polytechnic or Engineering College by the Employer. 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 (Casuarina 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 Employer.
- 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 latter 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 waste water 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

pipings, 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, which ever 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) underground 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. All soil available upto 10m depth as per trial bore test conducted. 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 upto 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. Pile integrity test must be conducted in random.

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], Bhuvanagiri Taluk 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 Employer 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 channelised 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. The contractor shall use steel scaffolding only.

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 50 mm for concrete facing/in contact with raw water and 40 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 employer.

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.

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 Employer.
- 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.
- 13.5 Neat finish wherever directed by the Engineer shall be done at no extra cost.
- 13.5.1 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, flaws, 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 Employer. 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:

Building	Storage	Room Type	Main Structural Construction	Plinth Height (mm)	Ceiling Height (mm)	Roof	Wall	Flooring	Doors / Windows	Plaster	Painting	Roof Water Proofing
Administration cum laboratory (60 sqm)	Ground Floor	-	RCC Framed	500	5000	RCC	Ext. mm)		Door	Ext.	Int.	
Ground Floor	Ground Floor	-	RCC Framed	500	5000	RCC	Int. (mm)		Window	Int.		
Foyer	-	-	RCC Framed	500	5000	RCC			Roll. shutter	Ceiling		
-												
500												
4500												
RCC												
230												
115												
Vitrified Tiles												
Teak												
Aluminum Glazed Powder Coated with vanishing blinds												
-												
20 mm thick In CM1:4												
12mm thick In CM :4												
6mm thick In CM1:3												
Luster Paint												
Cement Paint												
Luster Paint												
India Water Proofing on Brick Bat Coba or Equivalent												

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

			Building		
			Storage		
Passage			Room Type		Toilet
			Main Structural Construction		
			Plinth Height (mm)		
			Ceiling Height (mm)		
			Roof		
		Ext. (mm)	Wall		
		Int. (mm)			
Kota / Vitrified			Flooring		Glazed
Teak		Door	Doors / Windows		Syntax
Aluminum Glazed Powder Coated		Window			Aluminum Glazed louvers
		Roll. Shutter			
		Ext.	Plaster		
		Int.			
Luster Paint		Ceiling			Oil Paint
		Int.	Painting		
		Ext.			
Luster Paint		Ceiling			
			Roof Water Proofing		

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	IS: 2386 (part 4)	40 percent (max.) or
	Aggregate Impact Value	IS: 2386 (part4) or IS:5640	30 percent (max.)
2.	Combined Flakiness and Elongation indices	IS: 2386(part1)	30 percent (max.)

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.

Sieve Designation the IS sieve	Table 3: Grading requirements of aggregates for WMM Percent passing by weight passing
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 coarse and fine aggregates and filler shall produce a mixture to conform to the grading set for a table-6 below.

Table 6: Aggregate gradation for DBM

Sieve Designation	Percent passing by weight
37.5 mm	100
26.5 mm	90-100
13.2 mm	56-80
<u>4.75 mm</u>	<u>29-59</u>
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 sq.m. 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/sq.m 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) Granularsubbase	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 borrower 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 metres of soil.
- Plasticity Test [IS: 2720 (Part 5)]** :Each type to be tested, 2 test per 3000 cubic metres of soil.
- Density Test [IS: 2720 (Part-8)]** :Each soil type to be tested, 2 test per 3000 cubic metres 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 metres of soil.
- CBR Test on materials to be incorporated in the sub grade 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 metres 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)

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

S. N.	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

S. N.	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 MMC. 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 contactor, controlled by photocell/ clock switch and shall also have a manual by pass switch.

19.4 Luminaries 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. armored 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 armored cables. All wiring shall be coded with Red, Yellow, Blue & Black as per the phase used. If required, wiring can be done alternatively through armored 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 armored 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 50 mm

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

2. Testing for WaterTightness:

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 Employer.

V.SPECIFICATION FOR ELECTROMECHANICAL WORK (Water 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 raw water, sludge, chemicals, grit, waste water and other service fluids 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 gms/sq. m |
| b) | Fasteners | : | 300 gms/ 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 Electro Mechanical Equipments

1.9.1 Purpose & Scope:

- a. All Electro Mechanized units should be suitable for installation of water treatment plant adopting ultra Filtration Membrane Technology
- b. A complete fully automation electrical control system with PLC shall be supplied to totally ensure all working and process control of ultra filtration are operated with accurately designed programme for back washing, Chemical Washing, Air Scouring of each UF membrane modules.

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.

1.9.3.4 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 with in the scope of this specification and shall be provided by tenderer with out any extra price to purchaser.

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 then 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.

1.20 Chemical 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

1.22 Disinfection system**Chlorination System:****1.22.1 General**

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

Treated water 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 raw water 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 pendant 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 s 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	: Graphide 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 water 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 raw water 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 . All other water carrying pipes inside the plant premises shall be made of DI internally lined with SFRC lining. The treated and chlorinated water should be disposed off to the disposal site by closed RCC pipe or DI 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 water pipes. The pipe works for the plant involves procuring, supply, laying and jointing of suitable size electrically welded steel, cast iron, ductile iron, u PVC, RCC and PSCC pipes along with matching specials etc. as required. All yard piping inside the plant shall be cast iron or ductile 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/DI 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 coal` 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) conforming to IS 5382. The uPVC pipes shall be of minimum 4 kg / sqm 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

1.36 Ductile Iron Pipes

The DI pipes shall be centrifugally cast (spun) for Water and conforming to IS 8329-2000. The pipes used shall be both gasket joints and flanged joints. The minimum class of pipe to be used shall be class K-7 conforming to IS 8329. In general, pipes inside the buildings and below the structures shall be jointed as double-flanged pipes and those outside the building can be either EPDM gasket in accordance with IS 5382 and manufactured by the pipe manufacturer only. The pipes shall be supplied in standard lengths of 5.5m and 6.00m length with suitably rounded chamfered ends. Any change in the stipulated lengths will be approved by the Engineer's representative. The flanged joints shall confirm to the Clause 6.2 of IS 8329. The pipe supply will also include one rubber gasket for each flange.

1.36.1 Inspection and Testing:

The pipes shall be subjected to following tests for acceptance:

- (i) Visual and dimensional check as per clause 13 and 15 of IS 8329.
- (ii) Mechanical tests as per clause 10 of IS 8329.
- (iii) Hydrostatic test as per clause 11 of IS 8329.
- (iv) The test reports for the rubber gaskets shall be as per acceptance tests of the IS 5382 and in accordance to clause 3.8

The sampling shall be as per the provisions of the IS 8329.

1.36.2 Markings

All pipes shall be marked as per clause 18 of IS 8329 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 DI Pipes

The DI specials shall be manufactured and tested in accordance with IS 9523 or BS 4772. The mechanical test and hydrostatic test shall confirm to clause 9 and clause 10 respectively of IS 9523. The tolerances on dimensions shall be as per IS 9523. The manufacturer of the pipes shall supply the fittings.

1.36.5 Supply

All the DI 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.

1.37 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.
Tests	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 consists 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 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	M S as per IS 2062
Impeller	Cast Aluminium
Test	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 cleat 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:

	<i>Description</i>	<i>Quantity</i>
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.

	<i>Description</i>	<i>Quantity</i>
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 11 KV 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 11 KV Drop-Out Fuses

The 11 KV drop-out fit off fuses shall offer protection against short circuit and suitable for use in conjunction with 11 KV 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 11 KV 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 Combination of 11/22KV /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 Vermi 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, Earthfault
Overload protection	– adjustable current settings ariation 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 millie 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 IS 4237. The Sub-distribution Boards shall be equipped with rigidly fixed miniature circuitbreaker complying IS8828 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 case 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 110%
	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

S No	. 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 allpolypropylene 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 450 Volts	Measurement of panel board as per drawing quality of wiring provision of wire tag numbers brand name of equipment switch case which is provided is as per the procured from the approved vendors list.	Testing of operation closing and opening of switch gears relay functioning testing insulation testing	Type test certificates for 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 employer.

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 WATER TREATMENT PLANT

1. SCOPE OF WORK

The contractor shall operate and maintain the Water Treatment Plant, and all other allied works under this contract, for a period of **5 years**. Salient features of works are:

- 1) To Operate and maintain the water treatment plant adopting Ultra filtration membrane , all instruments and mechanical, electrical equipments, PLC etc., 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 and must ensure optimum membrane life not less than 8 years.
- 2) The contractor will monitor the performance of the water treatment plant; conduct the analysis of the inlet water 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 Employer. 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, 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 both in hot copies and soft copies in a server unit for future reference of the Employer and Engineer in Charge of the water treatment plant.

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 Employer 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 water 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 Employer mentioning qualification & experience.
- 10) The contractor will also be responsible to carry out day to day Maintenance of the rising main inside the WTP 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 Employer. 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 Water 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 Employer 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 out come 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 Employer.

The Employer will not be responsible for any accident /injury to the staff of the contractor. Further the Employer will not provide any insurance or 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 Employer.
- 13)** No accommodation / guesthouse / transportation facility will be provided by the to the contractor. Operation & maintenance staff will not be allowed any accommodation facility inside the plant premises. However for continuous operation of the plant and at the written permission of the Employer the staff quarters shall be used for official monitoring of the water treatment plant with Ultra filtration.
- 14)** The duration of the O&M shall be **60 months** from the date of successful commissioning of the WTP. The same can be extended for the further period if the Employer so desires.
- 15)** The contractor should employ all the staff at least one month prior to the final 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 Employer's instructions. Preparing data recording, correspondence work to EMPLOYER 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 EMPLOYER 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 EMPLOYER. This will be responsibility of contractor.
- 21)** Consumable items like rubber bush, graphite packing, rubber sheet, nut-bolts, material require for cleaning and house keeping etc. are to be brought by the contractor.
- 22)** (a) Electricity required for operation & maintenances of the plant will be provided by EMPLOYER. 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.

(a) Supply of Diesel will be provided by the Department as per requirement in case of power failure during O&M period only.
- 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 EMPLOYER 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 Electro Mechanical Equipments like Multimedia pressure filters, Ultra filtration units, PLC automation etc.,
- 28)** Contractor will have to maintain required Power Factor as per TNEB rules and regulations. In case 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 WTP.
- 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 WTP. 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 waster water, 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 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:
for quality of product water output as per **IS 10500:2012**
for consumption of chemicals
for PLC automation
for water recovery rate @ 90%
for Ultra filtration membrane life not less than 8years
- 35)** The contractor shall provide on job training to the Local body staff as per specifications.
- 36)** At the end of every 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 EMPLOYER, repair and re-condition all the electro 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 water 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.
- 39)** During adverse non operation period , the contractor shall run the plant for required hours towards safety of Ultra filtration membrane and give necessary chemical washing to avoid clogging of system once in 2 days.

1. OUTPUT AND OPERATIONAL GUARANTEES

The contractor is fully responsible for treating the Raw water (Mine discharge outlet) reaching at the Raw water collection sump. The performance of the contractor shall be treated as unsatisfactory if he fails to provide product output water to the drinking water standards said in the functional guarantee under Section 4 or does not maintain the guarantees listed in this clause excepting in force majeure condition or fails to fulfill other conditions of the contract.

2.1 Product water output standards

The contractor shall operate the Water Treatment Plant in such a way that the Product water quality attains the following parameters :-

Sl.No.	Functional Guarantee		Functional Guarantee value offered by the Bidder
	Qualitative parameters		
	(ie. In final treated effluent).		
1	Appearance		Clear
2	Color	pt.co. scale	5-25
3	Odor		Agreeable
4	Turbidity	NTU	1-5
5	Total dissolved solids	mg/l	500-2000
6	Electrical conductivity		--
7	pH		6.5 to 8.50
8	p-alkalinity as CaCO ₃	mg/l	--
9	Total alkalinity as CaCO ₃	mg/l	200-600
10	Total hardness as CaCO ₃	mg/l	200-600
11	Calcium as Ca	mg/l	75-200
12	Magnesium as Mg	mg/l	30-100
13	Iron as Fe	mg/l	0.3-1.00
14	Manganese	mg/l	0.1-0.3
15	Free ammonia as NH ₃	mg/l	0.5
16	Nitrite as NO ₂	mg/l	--
17	Nitrate as NO ₃	mg/l	45
18	Chloride as Cl	mg/l	250-1000
19	Fluoride as F	mg/l	1-1.5
20	Sulphate as SO ₄	mg/l	200-400
21	phosphate as PO ₄	mg/l	--
22	Tidy's test 4 hrs as O ₂	mg/l	--
23	Fecal coliform per 100 ml		Shall not be detectable in 100 ml sample
	Quantitative parameters		
	(ie. out-put of the Plant and Facility).		
	Plant output in MLD		31.26 mld

2.2 Waste water Disposal

The contractor shall operate the Water Treatment Plant such that the product water delivered will be at 90% recovery to the raw water and confirms the permissible drinking water quality. The volume of waste water produced after necessary water treatment process, does not exceed 10% of raw water input. The water generated from the WTP shall be disposed off into Paravanar river at a distance of 100m from WTP site premises designated by the Employer.

2.4 Chemical Requirements

All chemicals consumed to operate the Water Treatment Plant adopting Ultra filtration membrane and other facilities under this contract will be borne by the contractor.

3. Adverse Operating Condition

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

- a) If the raw water 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 Employer.
- 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 Employer.

3.1 Alternate Output Standards;'

The period of adverse condition is 30 days. The Contract shall continuously monitor the raw water input to attain the drinking water standards. If the raw water is not upto the standards, the water shall be discharge through bypass arrangement for safety of units.

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 EMPLOYER requirements, TNPCB & Other governing authorities. The TNPCB guidelines for Operation & maintenance of WTP 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:

If necessary, the contractor should get analysed / checked the Raw water as well as product water samples every month from TNPCB/ TWAD Board District Water testing Lab for drinking water standard parameters like Turbidity, TSS, PH, etc., The necessary testing charges are to be borne by the Contractor. The TNPCB/TWAD Vigilance testing charges for samples directly collected by TNPCB/TWAD 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**Water Treatment Plant**

Electrical Superintendent	2
Electrician grade - I / II	2
Fitter Grade II	2
Maintenance Assistant	2
Turn cock	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. Further requirement of staff for Ultra filtration/PLC operation requirement is to be considered.

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. The guidelines issued under Non engagement of manual scavenging may be followed.

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 EMPLOYER 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 fore casts, 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 raw water 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 WTP as per Factory Act/Safety Rules and during Pandemic situations directed by the GoTN. 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 EMPLOYER 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 EMPLOYER 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 and engaging female labour/ staff between 8.00PM to 8.00AM 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 EMPLOYER 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 water quantity and quality and waste water 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.
- Waste water 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 raw water 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 Cascade Aerator, Pumpset Automation, Ultra filtration Units, Pumps, Motors, 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 Employer. 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 waste water 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 waste water disinfected with chlorination should be by means of closed conduit (may be pressure line or Gravity line) made by RCC / DI/HDPE/CI or any RCC box channel.

The screened material, grit, physical impurities and the dried slit should be collected in trailers, trucks or tractor and the same should be disposed off at the site designated by the employer 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 raw water/ waste sludge 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 physical impurities, chemicals and other consumables 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 5 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 Employer 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 EMPLOYER Officials and this record shall be open for further inspection/checking by EMPLOYER and all other Government Agencies CPCB/TNPCB,CEIG 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 EMPLOYER. During 5 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 EMPLOYER 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 Water Treatment Plant.

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

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 EMPLOYER 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 5 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 Employer 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 Employer 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 product water, waste water 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 10 copies of draft O&M Manual to the EMPLOYER, 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 EMPLOYER, 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 EMPLOYER.
- g)** EMPLOYER 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 EMPLOYER, 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 Employer, prior to the start of O&M.
- h)** During the term of this Agreement, the contractor shall promptly notify EMPLOYER 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 Employer. In addition, during the term of this Agreement, EMPLOYER 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 EMPLOYER 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 EMPLOYER 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 Employer.
- The Contractor should repaint the plant including all civil structures, mechanical, electrical equipments/ units /structures as per the tender specifications
- After conducting Technical Audit of the WTP units by the Employer.

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 EMPLOYER. 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
Sulphateresisting 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
Drinking water standards	IS10500/2012 and amended from time to time.

3. Drawings

Attached Separately in Volume -3 (Drawing Volume)

- 1. Model General Arrangement Drawing of WTP for Ultra filtration Method.**
- 2. F.M.B Sketch of WTP site– SF NO. 16/1to4 & 17/1to 6 at Keelvalayamadevi in Bhuvanagiri Taluk.**
- 3. Water balance and Demand.**
- 4. Layout plan of WTP Site**

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)

District Profile :

Cuddalore District lies in the Geographical co-ordinates of 79° 51' 06" and 79° 52' 06" East Longitude and 11° 09' 00" and 11° 53' 00" North Latitude. This District is bounded by Bay of Bengal in the East and Villupuram District in the North. Cuddalore District is 200Km South of Chennai. Cuddalore Municipal Town is the administrative Head Quarters of Cuddalore District. The area of this district spanning to about 3703 Sq.Km with a total population of 26,05,914 as per 2011 Census .



The project area of the CWSS is to cover 6 Town Panchayats and 625 Rural habitations in Virudhachalam, Nallur and Mangalore Unions. Initially, the CWSS project is proposed with River Kollidam as Source. Later it was proposed to reutilize the mine water of the NLC mines. M/s NLC India Ltd., Neyveli. has also agreed and given consent to spare the mine – II water for this drinking water project. The CWSS Project was announced in the floor of the assembly during th Demand No.34. Based on the concurrence give by the GoTN, Necessary Preliminary investigation and detailed study was conducted for preparation of DPR. The CWSS is to cover 6 Town Panchayats and 625 rural habitations in Cuddalore District.

LOCATION OF KEELVALAYAMADEVI IN CUDDALORE DISTRICT



The rural and urban beneficiaries considered under this Project are detailed below.

Sl. No	Urban Beneficiaries	Rural Beneficiaries			
		Sl. No.	Name of union	No of VPs	No of habs
Cuddalore Dt					
1.	Thittakudi T.P	1.	Mangalore	62	191
2.	Pennadam T.P	2.	Nallur	62	233
3.	Mangalampettai T.P	3.	Virudhachalam	51	201
4.	Vadalur T.P				
5.	Kurijipadi T.P				
6.	Gangaikondan T.P				
			Grand Total	175	625

PROJECT AREA COVERAGE MAP WITH 6 TOWN PANCHAYATS & 625 RURAL HABITATIONS IN CUDDALORE DISTRICT

CUDDALORE DISTRICT MAP



POPULATION AND DEMAND:

The population forecast is prepared with the Census data for the last 5 decades and by adopting the empirical formulas

1. Arithmetical Increase Method,
2. Geometrical Increase Method,
3. Incremental Increase Method,
4. Line of Best fit Method,
5. Decadal Growth Rate Method

The population forecast is approved by the Chief Engineer, TWAD Board, Vellore Vide Lr.No.F.CWSS to Tittakudi/NLC/T4/CE/VLR/2019/dt.22.07.2019. Population is projected for 5.94 Lakhs(2022), 7.12 Lakhs(2037) and 8.43 Lakhs(2052).

After deducting the beneficiaries covered under existing TWAD owned CWSS, the final population is calculated for 5.61 Lakh, 6.72 Lakh & 7.96 Lakh for the Base year (2022), intermediate year (2037) & ultimate year (2052).

Since, ground (mine) water is proposed to be utilized, 18 hours of pumping was considered, as per the guidelines framed by the Board vide BP MS No 103/dt 31.10.2012.

Net clear water Demand calculated after deducting the existing sustainable supply of 85 lpcd for Town panchayats and 20 lpcd for rural & keeping the minimum flow in pipes as 10 lpm, transmission losses @ 10% works out to 23.92 mld, 31.26 mld & 39.43 mld for the present (2022), intermediate (2037) & ultimate (2052) stages respectively. Demand is calculated at the rate of 135 lpcd for Town Panchayats and 55 lpcd for rural habitations.

Sl. No.	Name of Beneficiary	Population			Net Requirement in MLD including 10% Transmission Losses		
		2022	2037	2052	2022	2037	2052
I.	Town Panchayats						
1.	Thittakudi	26559	32515	39818	1.46	2.35	3.43
2.	Pennadam	22324	26856	32308	1.23	1.90	2.71
3.	Mangalampettai	10984	13974	17719	0.60	1.05	1.60
4.	Vadalur	7391	8696	10000	0.41	0.60	0.79
5.	Kurijipadi	45391	53404	61417	2.50	3.69	4.88
6.	Gangaikondan	31556	37128	42699	1.74	2.56	3.39
	Sub Total	144205	172573	203961	7.94	12.15	16.80
II.	Rural (625 Habns)	413977	495709	557701	15.98	19.11	22.64
	Total	558182	668282	791662	23.92	31.26	39.43
	Add water treatment loss @ 5%				1.20	1.56	1.97
	Net source requirement in MLD				25.12	32.82	41.40
	Net source requirement in GPM				3842	5021	6333
	Source assured by NLC for 6500 GPM up to 2042-43						

WTP TO Tittakudi and 5 Town Panchayats and 625 Rural Habitations in Cuddalore District

Subsoil Properties of WTP at Keelvalayamadevi Village

SITE : SF NO. 16/1to4 & 17/1to6 of Extent 8 Hectare and 63.5Ares		
Depth Below G.L (in meters)	Soil Profile	Visual Description of Soil
0.30m		Top soils mixes with Vegetative and Non Vegetative waste
0.40m		All soils
0.80m		All Soil

Mile stones

S. No.	Description of Milestones	Time for Completion from the date of Receipt of LTC
1	Submission of layout, unit sizing, process design and drawings	1 Month
2	Mobilization to the site and establishment of field office and quality control laboratory	2 Month
3	Approval of designs and drawings	3 Month
4	Completion of civil works	12 Month
5	Completion of installation of Plant and equipment	18 Month
6	Completion of Trial Run of the Treatment Plant	24 Month
7	Completion of Commissioning and performance guarantee test and Operational Acceptance certificate by the Employer	24 Month
8	Completion of Commissioning and performance guarantee test and taking over by the Employer after completion of Maintenance of the Project (5 years)	84 Month

Note: Contractor shall submit a more detailed milestone / delivery plan based on PERT / CPM Calculations highlighting critical deliverables.

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 [. . . .insertdate. . . .], 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 Sub clause 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 Employer.

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 Employer's Home Office and the Site representatives of the Employer 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 Sub clause 39.2.1 of the General Conditions. We acknowledge that your agreement to the cost of preparing the Change Proposal, in accordance with GCC Sub clause 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]

6.2.5 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 approve the Change Order for the work specified in the Change Proposal (No. [number]), and agree to adjust the Contract Price, Time for Completion, and/or other conditions of the Contract in accordance with GCC Clause 39 of the General Conditions.

1. Title of Change: [Name]
2. Change Request No./Rev.: [Request number/revision]
3. Change Order No./Rev.: [Order number/revision]
4. Originator of Change: Employer: [Name] / Contractor: [Name]
5. Authorized Price:
Ref. No.: [Number] Date: [Date]
Foreign currency portion [Amount] plus Local currency portion [Amount]
6. Adjustment of Time for Completion
None Increase [Number] days Decrease [Number] days
7. Other effects, if any

Authorized by: _____
Employer

Date: _____

Accepted by: _____
Contractor

Date: _____

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 – 1 No Graduate in Civil Engineering/ Project Management/ Construction Management	15	10
2	Process Engineer – 1 No Graduate in Civil Engineering/ Environmental Engineering/ Public Health Engineering	10	5
3	Mechanical / Electrical Engineer – 1 No Graduate in Mechanical Engineering/ Electrical Engineering	10	5
4	Structural Engineer – 1 No Graduate in Structural Engineering/ Geotechnical Engineering	10	5
5	Instrumentation/PLC/SCADA Engineer – 1 No Graduate in Instrumentation Engineering / Electronics Engineering	10	5
6	Quality Control Engineer – 1 No Graduate Civil Engineer	10	5
7	Environmental Safeguard Officer – 1 No Graduate Environmental Science	5	3
8	Safety / Accident Prevention Officer – 1 No 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.