

**Design, Build and Commissioning of 7 MLD
Common Effluent Treatment Plant (CETP) and
0.5 MLD Package Sewage Treatment Plant (STP)
at DPIA on EPC basis with 4 years Operation and
Maintenance -Package B**

VOLUME 2

PART 1 GENERAL REQUIREMENTS

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Acronyms and Abbreviations

Abbreviations	
DPIA	Dighi Port Industrial Area
MITL	Maharashtra Industrial Township Limited
DMIC	Delhi Mumbai Industrial Corridor
NICDC	National Industrial Corridor Development Corporation
MIDC	Maharashtra Industrial Development Corporation
STP	Sewage Treatment Plant
CETP	Common Effluent Treatment Plant
WWTP	Wastewater Treatment Plant [STP and/or CETP]
MLD	Million Litres per day
MEICA	Mechanical, Electrical and Instrumentation Control and Automation
GA	General Arrangement
O&M	Operation and Maintenance
DLP	Defect Liability Period
CAPEX	Capital Expenditure
OPEX	Operational Expenditure
NPV	Net Present Value
FAT	Factory Acceptance Test
SAT	Site Acceptance Test
FDS	Functional Design Specification
RFI	Request for Inspection
GFC	Good For Construction
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
TSS	Total Suspended Solids
TDS	Total Dissolved Solids
VSS	Volatile Suspended Solids
MLSS	Mixed Liquor Suspended Solids
MLVSS	Mixed Liquor Volatile Suspended Solids
SVI	Sludge Volume Index
bCOD	Biodegradable Chemical Oxygen Demand
rbCOD	Readily Biodegradable Chemical Oxygen Demand
TKN	Total Kjeldahl Nitrogen
MLR	Mixed Liquor Recirculation
RAS	Return Activated Sludge
DO	Dissolved Oxygen
DG	Diesel Generator
UGSR	Under Ground Storage Reservoir
FRP	Fibre-Reinforced Plastic
N&E	North and East

MBR	Membrane Bio Reactor
ACF	Activated Carbon Filter
EOT	Electric Overhead Travelling
PLC	Programmable Logic Controller
SCADA	Supervisory Control and Data Acquisition
UPS	Uninterruptible Power Supply
GPRS	General Packet Radio Service
MCC	Motor Control Centre
QA/QC	Quality Assurance / Quality Control
QAP	Quality Assurance Plan
HV	High Voltage
LV	Low Voltage
AMF	Automatic Mains Failure
SPT	Standard Penetration Test
CCTV	Closed Circuit Television
CMMS	Computerized Maintenance Management System

1. PROJECT DESCRIPTION AND SCOPE OF WORKS

1.1 Project Requirements and Location to Site

The Sewage Treatment Plant and Common Effluent Treatment Plant are co-located in the project area. The area is 3.9 hectares.

1.2 Integration Requirement

The contractor's scope shall include integration of the treatment plants with other infrastructure components of Dighi Port Industrial Area (Parcel B).

Contractor shall coordinate with the other EPC package contractors/operators to ensure seamless integration of the treatment plant with the

- a) sewerage network for receiving the effluent/wastewater into the treatment plant
- b) transmission and distribution network for the delivery of product/treated/recycle water
- c) Optical Fibre Network for communication of the SCADA and other plant data to the Command and Control Centre
- d) MPCB approved the Common Hazardous Waste Treatment, Storage and Disposal Facility (CHWTSDf) for the disposal of hazardous waste generated in the CETP
- e) MPCB-approved non-hazardous/MSW waste disposal facility as approved by MITL
- f) Online Continuous Effluent Monitoring Systems (OCEMS) as per MPCB's requirements

1.3 Description of Works

The general description of works shall apply separately to each of the treatment plants viz., the Common Effluent Treatment Plant (CETP) and the Sewage Treatment Plant. For avoidance of doubt, it is expressly mentioned that each of the treatment plants shall be considered as an independent facility, designed as a separate unit without any common facilities, except where explicitly expressed.

The independent scope for each of the treatment plants (viz. the Common Effluent Treatment Plant (CETP) and the Sewage Treatment Plant) under this contract comprises of Data collection and studies, site development, Design, Engineering, Manufacture, Supply, Transportation to site, Storage, Construction, Installation/Erection, Testing, Commissioning, performance guarantee tests and putting into successful operation of the complete facility on EPC basis with 4 year O&M basis including all Civil, Structural and Architectural, Mechanical, Piping, Electrical, Control & Instrumentation and all infrastructural work covering lighting, drains, landscaping, plantation, all preparatory & temporary works to meet the entire scope of works for the plant capacity indicated in the process design requirements.

Each of the treatment plants shall comprise, but not be limited to, the following components:

- a) Process/treatment Units and Components as described in Volume 2, Part 1 [General Requirements] and Part 2 [Process Specifications] of this tender document
- b) All functional buildings, structures, equipment and other accessories and ancillaries related to process units
- c) Design and Construction of Buildings and Civil works, including process unit, pipeline systems/channels, internal roads, curbs, pavements, drainage systems etc.
- d) Complete Mechanical, Electrical, Instrumentation, Control and Automation (MEICA) systems, including supply, installation, testing and commissioning services
- e) Testing, trial runs and commissioning services for all systems, including a performance guarantee

The Contractor shall be fully responsible to ensure that the whole of the Works, including each individual component, is designed, and constructed in a manner so that the System as a whole operates as a fully integrated system with PLC and SCADA which is capable of achieving the required output in an efficient and economical manner, and to include all plant, equipment and accessories required for the safe and satisfactory operation of the facilities. To achieve this, the Contractor shall ensure that each individual component performs in a manner which is complementary to that of all other components. Any accessories which are not specifically mentioned in the specifications, but which are usual or necessary for completion of the Works and successful performance of the System and facilities shall be provided by the successful Bidder within the tendered cost.

The Contractor shall, to the maximum extent practical and feasible, endeavour to standardise on the manufacture and supply of plant and equipment so as to minimise the operation and maintenance requirements.

The Contractor shall ensure that his designs are "maintenance-friendly" and that all items of plant and equipment are designed and installed in a manner which will facilitate routine and periodic maintenance operations.

The Bidder shall include in its scope all the equipment, works and services necessary for complete, safe and reliable operation and maintenance of the facility in accordance with the terms of the Contract, even if certain works are not expressly stated in any part of the Tender Documents. Bidder's scope shall also include the interior works, including but not limited to false ceiling, flooring, lighting, ventilation, HVAC, and office furniture in each part of the building suited for the intended activity and purpose.

Throughout these Tender Documents, the terms "Bid" and "Tender" and their derivatives ("Bidder/Tenderer", "Bidding/ Tendering", etc.) are synonymous, and Day means calendar day of twenty-four (24) hours. Singular also means plural. "Bidder" or "Applicant" and "Bid" or "Application" for the purpose of interpretation of Instructions to Bidders shall mean the same. Any other term not defined herein should be interpreted in a manner as defined in the General Conditions of Contract. "MEICA" equipment shall mean Mechanical, Electrical, Instrumentation, Control and Automation equipment.

1.4 Detailed Project Scope of Works

The detailed scope of works shall include, but not be limited to following for approval from the Employer's Engineer

1. Site topographic survey and geotechnical investigations, soil testing as deemed necessary by the contractor
2. Setting out the works
3. Site development includes land clearing, planning utility routing, access roads, excavating, dewatering, grading, etc., in coordination with the infrastructure for water distribution systems.
4. Site Master Planning in accordance with the Development Control Regulations, byelaws, and provisions for future treatment plant units.
5. Architectural design and drawings for buildings, including the Administration and Control Building, Filter House, Blower House, Chemical Building, Maintenance Building, MCC, and Guard Room.
6. Landscape design and drawings.
7. Basic Engineering Package including Process and Hydraulic design with calculations, Equipment List and Datasheets
8. Preparation and submission of Process flow diagram, Process and Instrumentation Diagram, Hydraulic flow diagram, Site Layout, GA drawings, Piping Layout and Equipment Layouts for approval by the Employer's Engineer. Submission of detailed engineering submittals as per the tender requirements.
9. Design and detailed engineering of all process units, buildings, structures and equipment for approval by the Employer's Engineer.
10. Preparation of an integrated 3D BIM model.
11. All the statutory consents include but are not limited to Consent to Establish (CTE), Consent to Operate (CTO) and statutory compliances during construction and O&M period to ensure uninterrupted and continuous operation of the plant.
12. Design and Construction of all civil units/structures and building works.
13. Design, Erection and Commissioning of bypass lines
14. Design, engineering, procurement, manufacturing, shop fabrication, assembly, testing and inspection at supplier's works, packing, dispatch, shipping, delivery at Indian port/unloading at Indian port/delivery from Indian port to site in case of imported equipment and delivery/unloading at site for indigenous equipment, unloading and storing at site, successful completion of site acceptance test (SATs) of all Mechanical, Electrical, Instrumentation Control and Automation (MEICA) equipment, insurance up to time of takeover/hand over by Employer at the need of O&M period.

15. Erection of all MEICA items, including testing, commissioning, performance testing of process units, trial run for a period of one month, handing over of the full package, warranty, and defect liability period
16. One-month performance guarantee test to successfully demonstrate the guaranteed parameters for treated water and others (consumption of power, chemicals, etc.) after successful commissioning and stabilisation of the Water Treatment Plant.
17. Contractor will be responsible for the complete facility for four (4) years of operation and maintenance from the date of issue of the Completion Certificate and the successful completion of PGTR. The Operation and Maintenance period will commence upon the issue of the completion certificate, only in the case of deferred PGTR due to the non-availability of the raw water for treatment for reasons not attributable to the contractor.
18. Pumping systems for the conveyance/transmission of the treated water from the treated water tank to the service reservoir.
19. Safe disposal of treatment plant residuals, like but not limited to dewatered sludge.
20. Automation & Control - A PLC-based automation system with application software shall be provided. The treatment plant shall be capable of running in automatic mode with a redundant PLC/SCADA system. Complete automatic PLC/SCADA-based operation, including clarification, filtration, sludge dewatering, operation of blowers, disinfection process, chemical dosing, VFDs, limit switches and instrumentation in the plant. The automation system for the water treatment plant shall be designed to include a minimum of 20% spare capacity for each I/O module. Spare terminals shall be provided for at least 20% of the I/O points to ensure easy integration of additional field devices. All wiring and cabling infrastructure shall be designed to support the additional 20% I/O capacity, ensuring that spare I/O points are fully functional and ready for immediate use.
21. Ultrasonic level transmitter on all sumps/tanks. Flow meter in all lines, like but not limited to filter feed lines, treated water transfer pumps.
22. HMI Panel shall comprise of up-to-date standard PC with monitor, printer, mouse, RS-view, RS-links (gateway version), entire process and operator software with dynamic flow charts, pictures, screens, alarms, historical trends, reports, etc.
23. Digital energy meter along with CTs and protective switchgears on each MCC, which shall be connected on MODBUS communication with PLC to have all parameters like Voltage, current, Power Factor, active and reactive power.
24. Illumination of the entire CETP & STP laboratory with equipment and uninterrupted supply of reagents, chemicals and testing facilities.
25. Lay-down areas, warehouses, workshops with necessary equipment, tools and tackle for site construction, pre-fabrication purposes and for operation and maintenance.
26. Boundary wall with top barbed fencing as per the approved design for the required perimeter of the site with entry gates and security cabin.

27. Construction of Internal Roads, including connecting road to the site from the existing road to have a separate and independent entry to the plant/site.
28. Storm water drainage within battery limits and extension up to the nearest drain/point of disposal, drinking water & sanitation water system for operating & maintenance personnel, yard lighting, fencing, etc.
29. Drinking water, toilet, urinal and changing room facilities for the security staff and labourers.
30. Architectural 3D Model of the CETP & STP -The successful bidder shall have to provide an architectural model of the CETP & STP site as per the approved process design and process units depicting the picture of the post-completion stage of CETP & STP. The architectural model should be made in a suitable scale, depicting the master plan features and accommodated on a tabletop of size 3m x 3 m. The 3D model shall be placed at the place designated by the Employer/ Employer's Engineer. The 3D model shall be made using acrylic or any other approved durable material within 3 months of the date of issue of the work order.
31. Any other items of work which have not been specifically mentioned in specifications but are necessary for the plant as per engineering practice and safety norms, and operation and guaranteed performance of the entire plant shall be deemed to be included within scope of work of these specifications and shall be provided by the Contractor without any extra cost to the Employer.
32. The Contractor shall ensure that all designs and equipment for which he is responsible are safe. Nothing in this requirement shall remove the Contractors obligation from drawing the attention of the Employers Representative to any feature of the Works, which is not consistent with safety, or to prevent him making proposals for incorporating equipment or designs which would increase the safety of the site and plant.
33. The installation layout and system design shall not allow any item of plant to be positioned so that danger to operating personnel could arise during normal operation and maintenance. Attention should be paid to the position of pipes, air vents, electrical cables, and rotating machinery.
34. All rotating shafts, couplings, gears, flywheels, belt drives or other moving parts shall be fully guarded. Guards should be designed to provide ready access to bearings, grease points, thermometer sockets/instrument probes and other check points and to allow safe routine observation and servicing to be executed without the need to dismantle any part of their structure.

1.5 Design Life

The Plant components shall be designed and constructed to provide the minimum design life listed below for each component:

- Reinforced Concrete Structures : 50 years
- Other Concrete Structures : 30 years
- Steel Structures : 30 years

- Mechanical equipment : 20 years
- Electrical equipment : 20 years
- Control Panels : 20 years
- Instrumentation systems : 20 years

1.6 Design Process Requirements

The Contractor's design and engineering shall be supported by detailed calculations, process flow diagrams, and evidence of proven performance, such as operational data from reference installations, pilot studies, or validated performance literature. The efficacy of pollutant removal at each stage shall be demonstrated and traceable through mass balance or removal efficiency analysis.

In addition, the Contractor shall obtain and furnish vendor-supported performance guarantees and process warranties for all critical equipment and treatment modules, including chemical dosing systems, clarifiers, biological treatment process, MBR, RO, Thermal Evaporation system etc. All such documentation shall be subject to technical scrutiny and approval by the Employer's Engineer before procurement and implementation.

1.7 General Arrangement of Treatment Plant

The Contractor shall ensure that the whole of the works as installed are safe for use by the operation and maintenance staff, and by any other persons having access thereto.

The treatment plant shall be designed with a compact layout having vertical stacking of compatible units and equipment, ensuring minimal land footprint while maintaining full operational functionality, safety, and ease of maintenance. The design shall incorporate a modular approach, enabling phased implementation, ease of expansion, and simplified maintenance.

Permanent guardrails, electrical safety devices, thermal insulation, noise-suppression devices, written notices, safety colours, and the like shall be provided during the erection and operation of the plant. The equipment layouts shall provide easy and safe access to all operating devices, free from hazardous obstructions.

A continuous, unobstructed walkway at an appropriate elevation shall connect all process units, allowing seamless movement from the first to the last unit. Intermediate entry and exit points shall be provided on the walkway. Bridges shall be provided between successive elevated units and those requiring connectivity for the ease of operation. This Walkway shall be at least 1.2m wide, paved or tiled and shall have a hand railing, as required.

Nothing in this Specification shall remove the Contractor's obligation to draw the attention of the Employer's Representative to any feature of the Works, which is not consistent with safety, or prevent him from making proposals for incorporating equipment or designs which would increase the safety of plant equipment.

A set of special tools and tackles which are necessary or convenient for erection, commissioning, maintenance and overhauling of the equipment shall be supplied.

The tools shall be shipped in separate containers clearly marked with the name of equipment for which they are intended.

The following general rules but not limited to below shall be followed in arranging and Designing the Plant units:

- a) Sufficient room (not less than 3.0 m wide) shall be allowed between items of Plant and adjacent Plant or fixed structures to permit safe and convenient access for operation and maintenance; for provision of appropriate structure foundations. In case of the areas that require movement of heavy equipment for installation and replacement, sufficient access shall be provided to move heavy vehicles.
- b) An area adjacent to all mechanical plants shall be provided as a maintenance lay down area; fixed runways, lifting eyes or other means shall be provided to permit the removal of Plant Equipment that may logically be required to be removed during its normal operational life for maintenance or any other purpose.
- c) The Pumps should be designed for positive suction. Pumps shall generally comply with the requirements of codes and standards as cited in the tender documents. Pumps shall be so selected as to have a maximum capacity of not less than 125% of the rated capacity. Pump sets shall be suitable for the required duty conditions and shall be designed and constructed for 24-hour continuous duty at full load. The pumps shall be designed for continuous operation at any point of the head capacity curve between 25% and 125% of pump's rated flow without undue vibration or overheating.
- d) Areas where leakage is likely to occur whether in normal use or during maintenance, shall be provided with underground drain line or covered RCC drainage channels which shall direct spillage either to a suitable drain or to a sump from where it can be pumped to drain.
- e) Plant where necessary shall be provided with removable acoustic enclosure to limit the noise produced during normal operation to the limits detailed in the General Requirements.
- f) Plants shall be arranged, and the building shall be designed to permit the removal/relocation of Plant items. The Plant layout shall be such that no flooding/inundation is allowed even during heavy monsoon, and the units should always be accessible.
- g) All the units shall have drain valves. The drain valves of a diameter less than 250mm shall be manually operated and higher than 250mm shall be electrically operated. For the valves located below ground level extended spindle shall be provided for ease of operation.
- h) Equipment Bases: Steel base plate with proper corrosion restraint paint/protection shall be provided for all rotating equipment which is to be installed on a concrete base, unless otherwise specifically agreed to by the Employer's Representative. Each base plate shall support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units, shall have a raised lip all around, and shall have

threaded drain connections. Bases shall be appropriately painted for protection against corrosion.

- i) All motors shall have a run indication.
- j) Aeration blowers shall be located inside the blower room with necessary acoustic hoods complying with statutory and safety norms.
- k) Main control room housing PLC/SCADA shall be in such a manner so that entire WTP is preferably visible to the operator through glazed windows.
- l) Knife Gate valves shall be provided for sludge application.
- m) Doors, Windows, and Ventilators shall be of aluminum glazed type.
- n) EOT cranes shall be provided for Centrifuge Building, Blower room, etc. as required of adequate capacity (minimum 2 times the weight of the heaviest equipment).
- o) Adequate measures shall be taken to prevent dry running of the pump. Every sump and tank shall be provided with an ultrasonic level transmitter. The level of tanks and sumps shall be displayed on control room panel.
- p) Contractor shall design the plant in such a manner that the Vehicular approach shall be provided from entry and exit points of CETP up to the centrifuge building, Blower Room for execution and Operation and maintenance point of view.
- q) Flushing connections shall be provided for all sludge handling units and sludge lines.
- r) Access to platforms shall be by stairs/ ladders. Access shall be by stairway if unit requires frequent attention from operating personnel.
- s) Common delivery header and suction header of pumps (and blowers) shall be provided with a blind flange on one end.
- t) Sludge handling system with bracket making to be provided and storage area also be properly designed with flooring & roof.
- u) The whole area should have a well-designed Landscapes, tree plantations, Tiled pathways, Proper Safety hand railings at all Units, area lighting for the whole plant area and well-designed storm water drainage system.
- v) Chemical House including storage area, Testing Laboratory with all required equipment, testing chemicals/agents required for regular testing and testing kits etc.
- w) Chemical pipework shall be secured to racks or trays to be fixed to duct walls or walls of tanks and buildings as necessary. The method of securing the pipes to the racks shall be by clips or something similar, facilitating ease of removal in such a way that individual runs can be changed without dismantling adjacent pipes.
- x) All chemical pipes shall be colour banded and suitably labelled to enable individual lines to be identified throughout their run. Particular attention shall be paid to the layout of the chemical pipework, which shall be functional and neat in appearance. Generally, where pipework is installed in ducts, it shall be supported not less than 150 mm clear of the floor.

- y) When selecting materials for pipework, the Contractor shall consider the deteriorating effect of some of the synthetic materials due to the action of ultra-violet light. Where such materials are employed, they shall be shielded from direct sunlight. All the exposed MS piping should be Zinc Epoxy coated as base then painted 2 coats with approved colour to suit the type of carriage liquids

1.8 Workability and Maintenance

Facilities and equipment shall be arranged and spaced sufficiently to enable satisfactory operation and maintenance of the plant. Access around all equipment shall be provided, in accordance with Good Utility Practices, to allow effective inspection, maintenance and removal of equipment.

Aisleways adjacent to equipment and lay-down areas shall be sufficient to facilitate all aspects of major maintenance and Plant overhaul. General arrangement drawings shall be provided, clearly identifying the outline of all major Plant equipment, their weights and associated floor loading capacity and lay down location.

Space should be provided at the front and rear of the skid to allow the use of mobile equipment and access to pressure vessels for membrane replacement or leakages repairs.

Permanent lifting devices should be provided for maintenance of heavy equipment; they should be sized to lift the heaviest equipment in the said process unit.

The lay down areas for all major facilities shall have adequate space for direct heavy transport, as well as trailer access and direct mobile crane access. Platforms shall be provided around equipment as required for maintenance work, testing, inspection, and safe operation. Platforms where provided, shall be sized to facilitate safe ergonomic operation of manual valves and equipment between waist and shoulder level of an average height man. Those parts of the facility where maintenance activities will be performed shall be provided with permanent arrangements for slinging or handling during maintenance and overhaul.

All automatic valves and major equipment should be at ground level or accessible by permanent platforms. The marking and test specification of safe working load values on lifting equipment shall be in SI units.

All platforms to be visited on a daily basis shall be provided with stairways, except where a permanent access ladder is the only feasible means of access. All interior and exterior platforms gratings and/or checker plate shall be of GRP. Handrails shall be SS- 304 Schedule 10 made of 32NB pipes/tubes with top and intermediate rows of pipes running parallel to each other and the height of railing not less than 1100mm. The distance between 2 vertical posts shall not be more than 1.5 meters. The post shall also be of 32 NB.

Platforms shall be constructed using a suitable grade of GRP grating, to the relevant ISO, British Standards or ASME Standards and shall cater for the relevant loadings for maintenance. Generally, no frequently accessed platform shall be less than 1m wide and all platforms shall be extended up to the equipment, valves, and instrumentation that

they serve. All edges of floors, platforms and walkways shall be provided with curbs or kicking strips.

Sufficient space should be provided to ensure easy inspections and maintenance of all the equipment.

1.9 Plant Reliability Criteria

A part of the Works shall be deemed to have failed its test if:

- A single item of plant/ equipment fails more than twice during the test.
- More than four individual items/ equipment fail.

An item of Plant/equipment shall be deemed to have failed if manual intervention is required to restore the Plant/equipment to its fully operational state: i.e. the failure of a duty drive shall be considered as one failure, if the standby drive fails to start, that shall be considered as a second failure.

Any malfunction, non-response, or incorrect operation of control devices, safety interlocks, alarms, emergency stops, or any other protective systems shall also be considered as failure,

If the tests show that the specified treated water quality has not been reached, the Contractor shall submit his proposals for meeting the guarantees to the Engineer's Representative and shall carry out at his own expense whatever measures may be necessary to achieve the specified water quality.

Such measures may include improvements, alternations or additions to the plant and the contractor shall bear the whole cost of such electrical, mechanical, civil works or other changes. Tests will be repeated until the Engineer's representative is satisfied that the guarantees have been met.

1.10 Noise Limits

The Contractor shall ensure that the noise level generated by blowers, pumps, motors, or any other equipment installed in the treatment plant does not exceed 80 dB(A) at a distance of 1 meter from the equipment surface under any operating condition. Measurement shall be carried out in accordance with internationally recognized standards (such as ISO 3744 or equivalent).

The design of the equipment and any associated noise mitigation measures shall be considered and incorporated at the design stage to ensure compliance with the specified noise limits. The Contractor is responsible for selecting, designing, and providing equipment that meets these requirements prior to procurement and installation.

If, at any time, the noise level exceeds this limit, the Contractor shall promptly implement effective measures such as acoustic enclosures, silencers, vibration isolators, or any other means required to bring the noise level within the specified limit at no additional cost to the Employer.

Compliance with local environmental regulations and statutory noise limits is mandatory. Failure to adhere to this requirement shall be grounds for rejection of the equipment and may result in penalties or corrective action at the Contractor's risk and expense.

1.11 Order of Precedence

In case of discrepancy of process / mechanical / instrument /electrical/civil specifications within Vol 2 - Employer Requirements, the Process specification will supersede other discipline specifications.

1.12 Surveys, Topographical Survey and Soil Investigation Agency

It is the bidder's responsibility to carry out the site study and soil investigation at their own cost prior to bidding. The Bidder is required to verify the sub-soil strata including the CBR value by performing its own site investigation prior to developing the civil/structural design.

The successful bidder shall carry out a detailed geotechnical investigation and detailed design before starting works by the successful Bidder.

The geotechnical parameters necessary for the detailed foundation designs would depend on the findings of site-specific ground investigation.

The Contractor is required to confirm the topographical surveys and soil investigations before starting works.

The contractor should be ready with the qualified agencies he intends to use for the purpose and ensure that the work starts immediately upon award of work. The contractor shall conduct investigations as are normally necessary to ensure full and satisfactory designs and safety.

2. SCOPE OF WORKS FOR TRIAL RUN

The trial run and commissioning period shall be three months from the date of completion of construction works during which the contractor shall demonstrate satisfactory performance to the engineer.

The cost towards Contractor's Engineer and other operating personnel during the period of trial run as well as during O &M, along with cost of tools and spare parts, chemicals, electricity and other consumables which are required for operation and maintenance of the Plant and equipment during the commissioning and trial run period, shall be borne by the Contractor and shall be included in the tendered price. In the event that the plant or any of the facilities do not satisfactorily achieve the required performance standards during this period, the trial run period shall be extended until such time as the Contractor has satisfactorily rectified any deficiencies as may be necessary to satisfy the performance requirements. No additional compensation will be paid to the Contractor for such extension.

All type (as applicable), routine tests at manufacturer's works and acceptance tests shall be conducted, in the presence of Employer's representative or any agency (third party) agreed by the employer, on all the equipment's as per latest applicable standards without

any extra cost. Typical type test reports for other equipment's shall be submitted by the Contractor for approval by Employer.

All commissioning tests shall be carried out in the presence of Employer's representative and approval for the same shall be obtained before commissioning and installation. All instruments and accessories required for testing and commissioning of the equipment specified herein shall be provided by the Contractor at no extra cost to the Employer.

3. SCOPE OF WORKS FOR O & M

3.1 Defect Liability Period (DLP)

During the defect liability period, the Contractor shall be responsible to operate the Plant and all other allied works under this Contract for Twelve (12) Calendar months (one year) following successful completion of the Trial Run and Commissioning Period.

For this period, the scope of work shall include, but not be limited to the operation of the complete STP and CETP from the Receiving Chamber up to the treated effluent outfall chamber or up to receiving UGSRs.

The Contractor's Personnel shall be fully experienced in managing and operating all aspects of the plant and shall be fully responsible to monitor and ensure the successful performance of the Plant throughout the DLP.

All the routine operating cost for manpower and consumables (like chemicals, laboratory glassware, oil/lubricants, fuel etc.), transportation, disposal of treated effluent, ultimate disposal of sludge, disposal of screenings and grit, maintenance of Civil / Electrical / Mechanical / Pipeline / Automation, etc. shall be in the scope of the Contractor, but the cost of electricity shall be borne by the employer.

If during the Defect Liability Period any defect is found in the design, Engineering, materials and workmanship of the Site, Plant, Goods or Materials supplied or of the work executed by the Contractor, the Contractor shall promptly inform and in consultation and agreement with the Employer rectify, repair, replace or otherwise make good such defect as well as any damage to the Plant caused by such defect at its cost.

If the repair, replacement or making good is of such a character that it may affect the efficiency of the Plant or any part thereof, the Employer may give to the Contractor a notice requiring that tests of the defective part of the Plant shall be replaced or made by the Contractor immediately upon completion of such remedial work, whereupon the Contractor shall carry out such tests. The loss of time due to non- functioning of units will be to the Contractor's account and the DLP or O&M would stand extended to the extent of that time period.

If such part fails the tests, the Contractor shall carry out further repair, replacement or making good, as the case may be, until that part of the Plant passes such tests. The tests shall be agreed upon by the Employer.

If the New Facility or any part thereof cannot be used by reason of such defect or making good of such defect, the Defect Liability Period of the New Facility or such part, as the case may be, shall be extended by a period equal to the period during which the New

Facility or such part cannot be used by the Employer because of any of the aforesaid reasons.

3.2 Operation and Maintenance

Total Operation and Maintenance (O&M) period including one (1) year DLP shall be for five (5) years. After satisfactory completion of one (1) year defect liability period and issue of necessary certification from the engineer, the contractor shall carry out further O&M of the plant till the end of O&M period. All the cost for O&M of the new STP and CETP such as manpower, chemicals, consumables, spares, tools, transportation, disposal of treated effluent, screening, grit and sludge, maintenance of civil, electrical, mechanical and automation equipment's, etc. and other works as described above in different sections is in the scope of the contractor, but the cost of electricity shall be borne by the employer.

Other works included in the scope of O&M are as follows:

- i. Maintaining a record of all required process parameters with respect to the plant operation and the regular preventive and breakdown maintenance of all components, recommended maintenance.
- ii. Preparation of operation and maintenance manual for plant and equipment.
- iii. All civil, electrical, mechanical, instrumentation and control equipment's
- iv. Supply and operation & maintenance of one tractor with 3 no. tipping trolleys and one truck TATA 709, to be used during O & M
- v. The Contractors scope of work includes preventive maintenance, repairs and replacements if necessary and no extra payment other than whatever has been quoted in the financial bid will be entertained by the Employer.

Within his quoted cost, the contractor has to ensure that the following guarantees are maintained:

- i. Guarantee for quality of treated effluent;
- ii. Guarantee for consumption of chemicals;
- iii. Guarantee for consumption of power;
- iv. Guarantee for sludge generation;
- v. Guarantee for quality of treated sludge and odour;
- vi. Guarantee for automation system

The contractor shall, at no extra cost to the AITL, refurbish / repair & recondition all MEICA equipment in the concluding year of the O&M contract to a condition, so that they remain in running condition with regular preventive and recommended maintenance, including supply of all necessary spares that may be required to operate these equipment's for another 2 years. The list of necessary spares shall be drawn up depending upon the maintenance record log of equipment in the penultimate year of the O&M contract and the spares shall be supplied in the concluding year of the contract.

Apart from maintenance works mentioned above the contractor shall carryout painting of buildings and steel works at every 2 years interval, cleaning of storm water drains every year before rainy season, repair of potholes on roads as and when identified, cleaning and disinfections of water storage tanks at every 3 months interval and other day to day repairs.

For all other utilities not specifically mentioned here, a maintenance schedule shall be drawn as per standard practice and got approved by the Engineer. The approved maintenance schedule shall be followed during the O & M period.

3.3 Staffing Requirements

The Contractor shall provide all the necessary minimum operating staff and maintenance personnel to ensure the smooth operation and maintenance of the plant. The O&M staff shall have the following minimum number of dedicated personnel for the operation and maintenance of the CETP and STP:

Position	Min. Number	Desired Qualification
Plant cum HSE Manager	1	Bachelor's degree in environmental / chemical engineering with a minimum of 10 years work experience of a similar nature.
Chemist/Lab Technician	1	Bachelor's degree in chemistry with a minimum of 7 years work experience of a similar nature.
Process Engineer	1	Diploma in Environmental/Chemical Engineering with a minimum of 7 years' work experience of a similar nature.
Mechanical Engineer	1	Diploma in Mechanical Engineering with a minimum of 7 years' work experience of a similar nature.
E&I Engineer	1	Diploma in Electrical Engineering with a minimum of 7 years work experience of a similar nature.
Mechanical Fitter [#]	1/shift + 1 reliever [§]	ITI in Mechanical with a minimum of 5 years work experience of a similar nature.
Electrician	1/shift + 1 reliever [§]	ITI in Electrical with a minimum of 5 years' work experience of a similar nature.
Skilled Labour	1/shift + 1	12th pass with a minimum of 3 years work experience of a similar nature.

[#] The mechanical fitter shall be provided per process unit or for a group of process units based on the level of automation implemented in the plant and as approved by the Engineer-in-charge.

[§] Contractor to ensure the availability of a suitable reliever for the designated position and maintain continuity in operations 24x7 and 365 days a year.

The O&M staff shall also include a Computer operator, an office boy, Security Staff, a Gardener, Housekeeping staff etc.

The Contractor shall obtain the Engineer-in-charge's approval on the detailed proposed staffing schedule before the start of the O&M period for each of the sections of the Works. The schedule shall cover all categories of staff from the works superintendent to cleaners, including an adequate number of maintenance staff.

The staffing schedule for the O&M contract period shall be prepared to operate the Plant on a 24-hour-per-day basis with three equal 8-hour shifts.

4. TENDER AND ENGINEERING SUBMITTALS

4.1 Tender Submittals

The contractor shall furnish the following details as a part Annexure XIV as defined in Clause 5 [Submission of Bids] of Vol 1 Part 1 ITB

- Process Design Calculation (all process units sizes including odor calculation)
- Hydraulic Design Calculation
- Process flow diagram
- Process and Instrumentation diagram (P&ID)
- STP and CETP Phase 1 Layout
- Overall Layout indicating STP/CETP Phase 1 and Phase 2 units (Future phase process units should be located inside the plot)
- Hydraulic flow diagram
- Single Line Diagram
- PLC/SCADA Block diagram for STP/CETP

Note: The Technical Evaluation will be conducted based on the above bid submittals. The contractor has to submit all the above documents with the required details.

4.2 Engineering Submittals after Award of Contract

The Contractor shall submit the Design and Drawing in accordance with Clause 18 of Vol 1 – Part 4 [Conditions of Contract] and Clause 4.2, Clause 4.3 and Clause 4.4 of Volume 2 Part 1, and the 3D BIM Model in accordance with Clause 4.3 for approval by the Employer's Engineer.

Engineering Submittals shall be submitted by the contractor for approval from Employer's Engineer in two phases

- Basic Engineering designs i.e. Conceptual designs and drawings in conformity with tender specifications
- Detailed Engineering designs, drawings and BIM models

The Contractor's submittals shall include, but not be limited to, general and specific procedures for transmittal of submissions; processes for review and subsequent actions; a schedule of submissions and resubmissions; the construction schedule; coordination of drawings; insert and sleeve location drawings; reproduction of submitted drawings; samples; construction photographs.

4.2.1 Basic Engineering Designs and Drawings for Approval

Contractor shall submit the documents for Basic Engineering, followed by Detailed Engineering. The contractor shall submit detailed engineering designs and drawings after approval of the basic engineering designs and drawings, and shall inter alia comprise.

- Process Design Calculation (all process unit sizes including odor calculation)

- Hydraulic Design Calculation
- Process flow diagram
- Process and Instrumentation diagram (P&ID)
- STP and CETP Layout
- Hydraulic flow diagram
- Flow and Mass Balance diagram
- Process description
- Mechanical Equipment List
- Civil Unit List
- General Arrangement drawings (Plan & Section)
- Detailed Chemical Consumption Calculations (Daily/Monthly basis)
- Pipes, Valves and Penstock Schedule
- Electrical load list
- Single Line Diagram
- Sizing Calculations for Transformers and DG Set
- Plant Operational and Control Philosophy
- PLC/SCADA Block diagram for STP/CETP

4.2.2 Detailed Engineering Designs and Drawings for Approval

After approval of the basic engineering designs and drawings, the contractor shall submit detailed engineering designs and drawings and shall inter alia comprise of:

(a) Civil

- Foundation Recommendation including Bearing Capacity, Piling requirement, Pile Load Capacity, any soil improvement requirement, if applicable.
- Approximate Quantum of Civil and Structural works (Major Quantities)
- Civil general arrangement drawings of all structures
- Architecture designs and concepts for treatment units, buildings, landscaping, etc.;
- Plan and elevation of all buildings;
- Structural design calculations for all structures and buildings;
- Reinforcement drawings and Bar bending schedule;
- Standard drawings for Steel/FRP/Aluminum works e.g. Handrail , Ladder
- Transformer fencing;
- Design of roads;

- Plant storm water Drainage system;
- Water supply, Sewerage and Plumbing drawings for buildings;
- Drawing showing buried pipelines and other utilities along with N&E coordinates and offsets from permanent structures;
- Cable routes and Cable trenches;
- General arrangements and main sections of all plant areas;
- A description of building services provisions proposed for the Works

(b) Process and Hydraulics

- Detailed Hydraulic Calculations
- Detailed Hydraulic Flow Diagram
- Plan and L-section profile of pumping main
- Detailed Process Design Calculations
- Detailed Process flow diagram inclusive of mass balance
- Comprehensive P&ID including the details of pipeline sizes and materials, valve size and type, Equipment detail, instrumentation and identification of controlling PLC

(c) Mechanical

- Mechanical general arrangement drawings of all structures
- Detailed Mechanical Equipment List
- Major Equipment Specifications with supporting vendor brochures
- Detailed Piping schedule which includes the details of size, type, material, coating, lining, gauges/thickness and pressure rating
- Detailed Valve schedule which includes the details of size, type, material, pressure rating, operator/actuator type, Open/Close/Modulating type etc.
- Detailed Penstock schedule which includes the details of size, type, differential head, seating or non-seating, operator/actuator type, Open/Close/Modulating type etc.
- Outline Dimensional drawings and cross sectional drawings for the following items for STP and CETP, but not limited to:
 - Coarse Screens, Fine Screens and Ultra-Fine Screens
 - Screw Conveyor and Screenings Compactor
 - Vortex Grit Chamber Mechanism and Grit Washer/Classifier
 - Submersible Mixers and Guide rails
 - Pumps (Submersible, Centrifugal, Screw Pumps, Dosing pumps etc.)
 - Aeration Tank and MBR Blowers

- Fine Bubble Tubular Air diffusers
- Membrane Cassettes
- MBR Permeate cum Backwash pumps
- Activated Carbon Filter
- ACF Backwash pumps
- ACF Air scouring Blowers
- Thickener Mechanism
- Centrifuge
- Sludge Conveyor system and Hopper
- Chemical Dosing system
- Dosing Tanks
- Dosing Tank Agitators
- Flash Mixer, Flocculator and Primary Clarifier mechanism
- Manual and Motorized Penstocks
- Manual and Motorized Gate Valve
- Manual and Motorized Butterfly Valve
- Non Return Valve
- Knife Edged Gate Valve
- Dismantling Joints
- EOT Crane, Electrical Chain/Wire Hoist, Gantry Crane with electrical chain hoist and Manual Hoist
- Fixed Lifting Davit crane
- Pipe line sizes and materials
- Performance curves, Efficiency curves and Graphs for all pumps and blowers
- Catalogues for all electromechanical equipment's

(d) Electrical

I. Drawings:

- Electrical General Arrangement Drawings:
- Composite Single Line Diagram for electrical system for STP and CETP:
- Schematic drawings for each HV / LV switchboard;
- Internal and external general arrangement for each switchboard;
- Bill of quantities of each switch boards;

- Transformer schematic and general arrangement drawings;
- Cable block diagrams;
- Cable connection diagrams (or schedules);
- Cable routing/installation drawings;
- Foundation and fixing details drawings;
- Transformer enclosure drawings;
- Earthing system general arrangement drawing.
- Lighting drawings.

II. Schedules

- Cable Schedules;
- Load and Power consumption schedule;
- Junction Box schedule;
- Protection relay setting schedule

III. Calculations

- Transformer sizing;
- DG sizing;
- Fault level;
- Cable sizing;
- Coordinated protection study;
- Earthing calculations;
- Battery sizing;
- Lighting calculations.

Note:

1. Schematic drawings shall include a comprehensive schedule of the components used in each switchboard, MCC and control panel including details of the type, manufacturer and rating of each component.
2. The external arrangement of each switchboard, MCC and control panel shall show the arrangement of all components including details of panel section, switch and instrument labels.

(e) Control and Instrumentation

I. Drawings:

- Power supply distribution single line and schematics diagrams³ for each control panel;
- Internal and external general arrangement for each control panel (dimensional);

- Control panel wiring diagram, relay logic diagram along with terminal block details;
- System configuration and layout diagram along with bill of material, program listings, block logic diagram and control logic write up for PLC;
- UPS and battery sizing calculations;
- Control and instrumentation loop drawings;
- Catalogues for all instruments;
- Control and Instrumentation system configurations diagrams;
- Instrument installation detail drawing;
- Cable block diagrams;
- Cable routing/installation drawings;
- Foundation and fixing details and trenches drawings;
- Mimic general arrangement (full colour copies shall be provided);
- Loop Diagrams and Interconnection Diagrams.

II. Schedules:

- Cable schedule;
- Cable interconnection schedule;
- Control and instrumentation load schedule for each control panel;
- I/O schedule;
- Junction box schedule;
- Instrument schedule with tag nos.;
- Instrumentation, process control set point schedule;
- Instrument data sheets

III. Documentation:

- Functional design specification (FDS);
- Factory acceptance test document (FAT);
- Site Acceptance Test document (SAT).

Note:

1. Electrical control schematics, loop diagrams and schedules shall be of scale as directed by Engineer.

4.3 Submission of Documents and Drawings

The Contractor shall submit to the soft copies through the PMIS system and 3 sets of hard copies for each of the drawings and design calculations for the process and sizing of all components of the system including architectural, structural, mechanical, and electrical

and instrumentation equipment, supported by flow diagrams and general arrangement drawings for approval by Employer's Engineer.

The Employer's Engineer may require the Contractor to submit additional information for approval at the contractor's cost, if they are necessary to enable him to satisfy himself that the items are well designed, that they comply with the Tender Requirements and that they are suitable for their intended purpose. The construction documents shall form the agreed basis for the execution of the Works. If an approved drawing is revised, revised copies shall be submitted for approval as above and no such revised drawing shall be used for the purpose of contract until it has been approved in place of the earlier issue of the drawing.

The Employer shall arrange to send observations, if necessary, within 28 (Twenty-Eight) calendar days of submission of the design and drawings for modifications to the contractor. The contractor shall incorporate all necessary comments of the engineer in the above design and drawings, if any, and shall re-submit further 3 (three) copies each of the revised designs and drawings within 10 (ten) days for final approval of the Engineer. The contractor shall thereafter submit 3 (three) copies of each of the approved designs. The Engineer will return 2 (two) approved copies to the contractor and retain 2 (two) for the Engineer's office and field use.

If the submissions require more than one round of revision on account of incomplete compliance from contractor, the delay will be on account of the contractor. If new observations are given by the Engineer, the contractor will be entitled to take an additional 10 (ten) days period of compliance.

The Structural designs shall be submitted along with STAAD files (input and output) in soft as well as hard copies.

The Construction Documents are certified drawings submitted by the contractor to the Employer of Engineer during the course of the contract for approval. Construction documents shall be submitted in accordance with the timetable set down in the work programme.

The Construction drawings shall be submitted in A3/A1 sized drawing papers and to readable scale.

The Engineer will not permit construction to start on a part or section of the works unless construction documents for that part or section have been approved.

Draft As-Built Drawings and draft copies of the O&M Manuals shall be submitted to the Engineer for his approval at least 60 (sixty) calendar days prior to trial run of the plant.

The Final As-Built Drawings in soft as well as hard copies 3 sets shall be submitted prior to the issue of any taking over certificate.

The submission dates referred to above shall be the dates on which the drawings and documents are received by the Engineer.

4.4 BIM and CAD Requirements

4.4.1 General

4.4.1.1 Purpose

- a) The purpose of the 3D Building Information Modelling (BIM) requirements describes the use of computer-aided design (CAD), geographical information systems (GIS) and building information modelling (BIM) for the work under the Contract.
- b) These requirements shall be used as a reference for the Design & Build Contractor to develop a component-wise BIM Execution Plan (BEP).
- c) BEPs shall establish the methodology for managing the production, distribution and quality of the design information generated by CAD, GIS, and BIM systems, using a disciplined process for collaboration and a specified file and model naming policy.

4.4.1.2 Scope

- a) The Employer mandates the use of an advanced computer-based dynamic 3D BIM-model-driven approach for the detailed planning, design, engineering, Construction, and operation of the DPIA to allow simulation, visualisation and engineering analysis of all transportation, utility, building, civil works, and geospatial infrastructures.
- b) The Contractor shall develop and integrate a comprehensive 3D Building Information Model (BIM) of the Common Effluent Treatment Plant (CETP) as part of the city infrastructure model. The BIM shall include, but not be limited to, the following components:
 - a. Structural and Architectural Elements: All treatment units, including headworks, aeration tanks, MBR basins, blower rooms, MCCs, substations, sludge dewatering works, RO, ZLD, Pumping Stations, administrative buildings, and piping networks etc.
 - b. Utility Connectivity: Integration with the incoming sewer networks, Recycle water storage and pumping stations, stormwater connections, etc.
 - c. Access and Safety Infrastructure: Service roads, access platforms, fencing, lighting, and emergency response provisions.
 - d. Geospatial Coordination: Accurate geolocation and elevation data aligned with surrounding infrastructure and terrain.
 - e. Compatibility for the data integration related to asset management, maintenance planning, and future expansion through dynamic data linkage.
- c) All CETP and STP components shall be modelled in coordination with other city infrastructure systems to ensure spatial accuracy, clash detection, and operational efficiency. The BIM shall be delivered in a format compatible with the overall city infrastructure model and meet all applicable standards and specifications.

- d) 3D BIM modelling tools for infrastructure shall be used to develop and produce project models and simulations (e.g. in case of natural calamity etc.) as required for submittals.
- e) The 3D BIM infrastructure Information Models are to be used throughout the design, construction, and operational life cycle of the asset, including but not limited to system collision detections, Materials quantification, construction sequencing and carbon impact analysis.
- f) 3D BIM Model use shall be maximised for Project reviews, decision support, design analysis, and quality assurance during all phases of this program. The development of the 3D BIM Model should be developed in tandem with the design and detailed engineering. The final design and 3D BIM Model should always be submitted together.

The Contractor shall provide a minimum of one separate handheld electronic tablet of a minimum of 12 inches in size for the Contractor's utility engineer and the Employer's engineer as required for seamless execution and monitoring. The electronic tablet shall have adequate hardware and software configuration for displaying the BIM model during the site visit using the applicable viewer software. The electronic tablet shall be of a reputable make such as Apple, Samsung as approved by the Employer's Engineer.

4.4.1.3 The Contractor shall design the BIM workflow with constructional logic, fabrication and program as required by the Employer's Engineer. Engagement modalities for project management functions, including 4D/5D BIM requirements, are as below:

- a) The Contractor shall allocate a Project Coordinator who would be a single point of contact for the Employer's Engineer or his representative for monitoring and resolving concerns of the Client for the day-to-day progression of the project.
- b) Ensure that the BIM model follows guidelines mentioned in the BIM Execution Plan (BEP) for smooth implementation and execution, and that the quality of the BIM Model is up to the mark by checking the attributes, clashes etc. and providing a platform of BCF for communication between the project stakeholders.
- c) The BIM platform should allow the federation of BIM models from multiple sources and support colour-coding features on the BIM Model as per the conditions to evaluate.
- d) The Contractor shall create a Work Breakdown Structure (WBS) for its scope of work in the master project plan schedule period of completion for the project. A colour-coded view of the scheduled activities also shall be presented as per the conditions for evaluation.
- e) The Contractor shall create all the relationships between various activities to generate the Model-based critical path for the execution of the project within the stipulated time frame. This must be integrated with the BIM model for 4D/5D BIM.
- f) The Contractor must adopt an organized approach to divide the project into work packages and work locations. Location-based planning and management shall ensure that trade crews flow smoothly from prerequisite to successor tasks without interference and quantities by location for scheduling and procurement. Should submit the Line of Balance chart along with the Gannt charts for review.
- g) The contractor shall add attributes to the BIM model as and when needed during the construction phase as per the project requirements and submit for review on the BIM model.
- h) Ensure that the BIM model is accurate enough so that it can be used for quantification and scheduling purposes.
- i) The Contractor shall develop a Baseline Construction Schedule along with resources (material, manpower & machinery) integrated with the BIM model for 4D simulation.
- j) The contractor must present schedule comparison reports (eg; baseline vs actual) for review. Contractor shall monitor and report the progress on the BIM model using the handheld device at the site for reporting progress on the BIM model in real time.
- k) Delay analysis based on baseline vs actual schedule shall be represented on the BIM model. Colour-coded element breakdowns must be presented for visual analysis.
- l) BIM model-based monthly task look-ahead, contractor look-ahead, and critical path analysis shall be submitted for visual review along with the schedule reports.

- m) 3D/4D/5D BIM workflows should be carried out following integrated OpenBIM workflow and solutions like BEXEL Manager, Tilos, Primavera, and MS Project should be used and integrated.
- n) The Contractor shall be required to furnish key budget/ planned milestone billing details along with resources (manpower & machinery) planned to be deployed to the baseline program & being deployed on the project site from time to time, 5D BIM.
- o) Contractor shall submit Billing Quantities from the developed BIM model updated as per actual execution, along with the invoice.
- p) Contractor shall update in required frequencies the measurements or percentages of the work, work milestone status, any deviations in the quality or quantity (which will impact the bill book) and geo-located snapshot pictures of the actual construction progress and these documents must be uploaded to the respective elements in the BIM model.
- q) The Contractor shall update and revise their works schedule on the integrated master schedule, subject to directions & approval from the Employer's Engineer. Also, the BIM model along with the updated progress and quantity reports should be submitted along with every RA Bill submission.
- r) Should ensure that integration of BIM with other systems must be facilitated, depending on the Employer's requirements, if required.
- s) The contractor should also do a digital handover of the project, ensuring all the documents, such as equipment warranty, guarantees, quality documents, inspection documents, specifications, etc. are attached to the BIM Model at the elemental level.
- t) The schedule data (baseline start, baseline finish, actual start, actual finish etc), quantity data, and cost data (Man, Material, Machinery) data must be available in the BIM model at the elemental level on digital handover.
- u) Contractor should have an integrated open BIM Management platform instead of using multiple silo applications for delivering projects on BIM
- v) Contractor should link FM plans and entries for BIM elements. Also, manage FM contracts, activities and entries by adding information on Assignments, calendars, costs, FM plan range, recurrence patterns.
- w) Contractors should send notifications for FM plans and link FM contracts, plans and entries to the Documents management system.

4.4.2 BIM Modelling

4.4.2.1 Design Authoring Requirements

- a) Model Accuracy and Tolerances: Models will include all appropriate dimensioning as needed for design intent and assessment with the Level of Detail (LoD) and included model elements as approved by the Employer's Engineer.
- b) Modelling Units: The following units shall be used for developing modelling content. The relevant scale factors and adjustments shall be incorporated when federating models with dissimilar units:

4.4.3 BIM Functionalities

The contractor shall propose the BIM Execution Plan incorporating the below-mentioned functionalities for 4D/5D BIM Project management and Digital handover for review and approval by the Employer's Engineer.

Sl	Description
1	Interoperability (Share, exchange, gather, and process the same data in different environments) IFC file format supported (import, export and update IFC 2x3, IFC 4) & Bx3 IFC MVD import/export for Quantity take off and Schedule Sub-model IFC export by various rules Export custom properties to IFC BCF support IDS support bSDD service support Power BI integration (Reporting with BEXEL Viewer visuals) Collaboration management system Custom integration with ERP and other systems Custom database integration Support for a custom classification system Cobie support API and Add-in system Federated BIM models from multiple sources Custom report templates Knowledge base templates Access to advanced tutorials, free cost databases and demo models in different languages Autodesk Revit integration Autodesk Navisworks integration Export attribute sets back to authoring tools

	Unreal schedule exporter
2	Visualisation (A dynamic and immersive experience for exploring and understanding complex project details with clarity and precision.) Real-time model navigation Walk-mode Google Map integration Scenes and animations Level map Textures and mapping Measure distance tool
3	Model DATA Management (Systematically identify and address any inconsistencies to ensure a well-planned and controlled design process) Advanced data and meta-data management Automated data enrichment Property checker (IDS support) Colour coded element breakdowns Advanced element search and filtering Auto distribute elements Selection sets management Smart selection set Advanced reporting engine
4	Clash detection Clash detection and interference checking Containment analysis and relation enrichment Single or multiple clash grouping Import and set the custom clash matrix and rules Clash detection reports Export reports to xlsx/pdf/html/pbix Create, import and export BCF issues
5	Quantity take-off (Smart BIM-based QTO creation with automatic assignment of cost items and unit costs to model elements according to the specified rules.) Rapid model-based QTO Manage, generate and export custom QTO Instantly create BIM-based visual QTO reports Area Analysis
6	Document management (Integrated as-built project documentation provides a comprehensive overview of the project, preparing it for the Facility management phase.)

	Intelligent Document linking Link to BIM elements or group of elements Version control and document history Document management Add, replace, update, delete, search, preview, and download documents Organize documents by folder and subfolder structure Filter Documents by element selection Manage access rights on documents, folders and subfolders Document linking
7	Scheduling and planning (Use the advantages of software automation with a fully integrated intelligent planning process) Construction methodologies Intelligent LOB and flowline scheduling Smart automated scheduling Critical path method (CPM) and analysis (CPA) Smart mapping of model elements to schedule task Import/export schedules from various sources (e.g. Primavera, Microsoft Project) Gantt export to .pdf and .xlsx Schedule colouring by various rules Schedule Comparison
8	Construction simulation (Visualize construction schedule for clear and detailed project insights) Create and export 4D simulation Real-time construction simulation review Custom colour schemes for elements, tasks and resources Animation management (e.g. camera path, time interval, frame rate) Schedule task categorization (demolition/temporary/construction/neutral)
9	Schedule optimization (Fine-tune your construction schedule to achieve optimal results) Advanced analysis & optimization Resource allocation and levelling LOB and flowline analysis Smart task duration adjustment
10	BIM Based Cost estimation (Effective BIM cost management provides a comprehensive understanding of project costs, empowering project teams to make informed decisions and optimize project outcomes) Automated cost database creation Automated cost data mapping

	Create and export detailed budgets Create and export cost and resource database Integration of custom cost database Company cost databases Smart rules of measurement enrichment Custom Cost Properties Variable costs properties Group cost classification by various rules Preparation of tendering packages Non-BIM cost items integration
11	5D Project planning (By integrating time and cost information, visualising the construction sequence, optimising resource allocation and identifying impacts on the total project cost) Smart linking of model elements to cost items Element-based cost analysis Budgeting and Bill of quantities Smart automated 5D scheduling Productivity rates and resource planning Critical path method (CPM) and analysis (CPA) Import/export schedules from various sources (e.g. Primavera, Microsoft Project) Gantt export to .pdf and .xlsx 5D Schedule colouring by various rules 5D Schedule comparison
12	5D construction simulation (A comprehensive visual view, including both time and cost data, clearly visualizes how design and schedule decisions impact the overall project cost) Real-time construction simulation review Custom colour schemes for elements, tasks and resources Animation management (e.g. camera path, time interval, frame rate) 5D Schedule task categorization (demolition/temporary/construction/neutral)
13	Progress monitoring (A clear overview of the 4D/5D schedule, possible delays and cash flows during the project implementation ensures proactive decision-making and effective management) BCF/ CDE progress entry Selection sets progress entry Traditional quantity-based and element-based progress entry Import progress entry Automated schedule update according to progress input

	Look-ahead plans creation and analysis Monitor construction progress Resource monitoring Customizable monthly payment certificate
14	Integrated Reporting with Analytical platform like BEXEL Viewer or equivalent Detailed cost and schedule reports What-If analysis Planned vs actual analysis Earned value analysis Cash-flow monitoring Work breakdown structure reporting Executive reporting KPI tracking Look-ahead analysis Resource monitoring Schedule Comparison Cost Comparison Connect Data
15	AI Assistant Implementation of the AI Assistant empowers users with intelligent support throughout their BIM projects. Users should be able to use natural language prompts in the English language.
16	BCF Server Document Approval workflow Real-time communication through Chat like interface Add users as read-only observers, allowing them to comment but not modify issues or document approval Receive email notifications for every change sent to relevant Users Organize your issue repository with custom tags, defined by the administrator for any project stage or issue type Filter your issues by Type, Priority, Status, Deadline, Responsible Person or Pre- or Custom-defined Tag BCF clients for BEXEL Manager, Revit, Navisworks, ArchiCAD, and Civil 3D

4.4.4 Software Requirement (OpenBIM):

The following software shall be based on the latest available operating system and shall have the latest compatible version

Function	Software
x 3D BIM Modelling (for infrastructure, treatment plants)	Autodesk Civil 3D
	Bentley MX Road/ In Roads
x 3D Rail Infrastructure Modelling	Bentley Rail Track
x 3D BIM modelling for Buildings	Autodesk Revit
	AECOSim Building Designer
x Project Review and coordination 5D Schedule Simulation	Autodesk Navis Works Manage/BEXEL Build Collection/Equivalent
	Bentley Navigator
x 3D BIM and GIS integration/ coordination	Autodesk Infra Works
	Bentley Micro Station
Clash Detection	BEXEL Build Collection/Navisworks/Equivalent
Water Network Modelling	Bentley Water GEMS
Sewer Network Modelling	Bentley Sewer GEMS
Storm Network Modelling	Bentley Sewer GEMS/ Storm CAD
Structural Analysis	STAAD Pro
Drafting	AutoCAD
GIS	Bentley Micro Station
	ArcMap
Publishing Publish read only single file containing graphical and non-graphical attribute information for multi-discipline BIM models	I model Plug-in's. For Revit For Adobe (Reader)
3D/2D Models, Drawings and Maps	Autodesk DWG True View
Office	Microsoft Office and Power BI
Construction Management 4D BIM	BEXEL Build Collection/ Equivalent
Construction simulation	BEXEL Build Collection/ Equivalent
3D BIM Model Auditing	BEXEL Build Collection/ Equivalent
Location-based planning	BEXEL Build Collection/ Equivalent

4D BIM modelling	BEXEL Build Collection/ Equivalent
5D modelling at the elemental level	BEXEL Build Collection/ Equivalent
Generate BIM-based look-ahead plan	BEXEL Build Collection/ Equivalent
Progress Monitoring	BEXEL Build Collection/ Equivalent
Planned Vs Actual	BEXEL Build Collection/ Equivalent
BIM-Based Document Management	BEXEL Build Collection/ Equivalent

4.5 **As-Built Records**

The Contractor shall prepare, and keep up-to-date, a complete set of 'as-built' records of the execution of the Works, showing the exact "as-built" locations, sizes and details of the work as executed, with cross references to relevant specifications and data sheets. As-built records shall include all such drawings, schedules, documentation and calculations as necessary for the complete understanding of the designs, sizing and capacities of the structures and equipment's and operation and maintenance.

The 'As-Built' records shall consist of the fully up-dated versions of the approved Construction Documents incorporating any additional information which will assist the Employer in operating, maintaining and if necessary modifying or extending the works at a later date. These records should extend and supplement the information given in the Operating and Maintenance Manuals.

4.6 **Operation and Maintenance Manual**

The Contractor shall compile operation, maintenance and overhauling instructions for the whole of the Plant in the form of single volume document termed as Operation & Maintenance Manual. It should serve following main functions:

- I. As a text to be used for start-up training and plant start-up, safety aspects for the operators;
- II. To provide technical information about the plant and its equipment and controls, and provide plant staff with guidance regarding the operation of equipment and systems including start up, shutdown, and normal / alternative operations; and
- III. To provide assistance to the operating staff in continuing standard operating procedures after start up.
- IV. Manual shall also cover plant unit operation philosophy, instrumentation philosophy, operation control logic, abnormal operation conditions, routine checks and operations, recommended corrective action during process upset, etc.

It shall be aimed at the plant operators and be written in clear unambiguous text complete with drawings which must be sufficient for clarification of any issue.

The manual shall include design operating parameters such as unit efficiencies, operating criteria, suggested design or process control test ranges, etc.

The manual shall include the suggested “maintenance program”. By using this program the operating staff should be able to schedule, conduct and record all maintenance works as supplied by reputed vendors.

The manual shall include safety discussion including hazards of sewers, mechanical and electrical equipment, explosion, bacterial infections, chlorine, oxygen deficiencies, laboratory, etc. Safety relating to specific areas and equipment in the STP and CETP facility should be specifically covered and highlighted. The safety pre and post incidence management SOPs also should be developed for each unit.

The manual shall be enclosed within A4 (Text) and A3 (Drawings) ring binders having tough grease resistant covers suitable for use on site and designed to permit the easy removal and insertion of the contents. The front cover and spine of each volume shall show details of the project, Employer, Engineer and a volume title. A1 drawings shall generally be folded and enclose in A4 box files. Where A1 drawings accompany text they shall be folded and enclosed in an A4 plastic wallet, one wallet per drawing.

The contractor shall submit three hard copies of the O & M manual to the Engineer for approval at least 60 days before the start of trial run of the plant.

On approval from the Engineer and after incorporating the modifications suggested the contractor shall submit six sets in Hard and two sets in Soft (CD's) of approved O & M manual to the Engineer out of which one copy shall be kept at site always.

4.7 Amended O&M Manual

The amended manual shall be an updated manual that includes revisions based on experience gained from actual operation of the plant plus other issues brought up by the equipment manufacturers, safety precautions and Employer. The amended manual shall be prepared by the cooperative effort between the Employer and contractors operating staff. The amended material is reviewed by the Chief Operator or Plant Superintendent and that the signature of his is affixed on the first page of the manual.

If any modifications are made during the defect liability period, the contractor, within 30 days of completion of defect liability period shall submit three hard copies of amended O & M manual for approval of the Engineer. On approval from Engineer, the contractor shall submit six sets in Hard and two sets in soft (CDs) of the amended O & M manual to the Engineer out of which one set shall be kept at site always for reference of O & M staff and other purposes.

4.8 Monthly Progress Report and Construction Photographs

Monthly progress report shall include progress photographs for each work of construction taken from common viewpoints each month. Photographs shall show general extent of the works by both exterior and interior views. Each viewpoint will be selected and the number of monthly repetitive photographs taken from exactly the same viewpoint as decided by the Engineer.

The Contractor shall provide photographs of such portions of the works, in progress and completed, in three soft copies (CDs). Each photograph shall display date and time on it. Photographs shall be properly referenced and captioned to the approval of the Engineer.

5. QUALITY ASSURANCE

5.1 Policy

The Contractor shall apply the formal requirements of Quality Assurance to the design, supply, construction, testing and maintenance of the Works. This shall be achieved through the implementation of a Quality System compliant with the requirements of BS 5750 or an equivalent International Standard.

Positive commitment to Quality Assurance shall be expressed in a formal policy statement given in the Contractor's Quality Manual.

The Contractor policy and objective will be to establish Quality systems and provide to the Employer such evidence as is necessary to demonstrate the effective implementation of a Quality system. To enforce the Quality system the contractor shall afford reasonable availability of staff and documentation.

Construction Risk Workshop shall be arranged before commencement of works. It will be ensured that the Quality Control system of the complete project is made during design and planning stage.

The Contractor shall institute a Quality Assurance system to demonstrate compliance with the requirements of applicable codes and practices. Compliance with the Quality Assurance system shall not relieve the Contractor of his duties, obligations or responsibilities. The contractor shall prepare Quality Assurance and Quality Control (QA & QC) plan for the works and submit to Engineer for approval. The QA & QC plan so approved by the Engineer shall be subject to revision at all times during the contract period.

Details of all procedures and compliance documents shall be submitted to the Engineer for his information and approval before each design and execution stage is commenced. When any document is issued to the Engineer, it shall be accompanied by the signed Quality statements for such document. The Engineer shall be entitled to audit any aspect of the system and require corrective action to be taken. The Quality Assurance system and the audit of any aspect of system and necessary corrective action shall be at contractor's risk and cost.

5.2 Quality Assurance Plan

The implementation of the Quality System shall be through the establishment of a comprehensive Quality Assurance Plan issued to and approved by the Engineer. The instituted Quality Assurance system should ensure the quality and quantity continuously through properly designed monitoring systems / proformas for Test on materials, form work checkup, Bar bending schedule, pour card, post concreting checkups, daily progress report, labor / manpower deployed, quantity executed on periodic basis, observations thereof etc.

Quality Assurance plan shall include, but shall not be restricted to as noted herein.

- I. Management procedures adopted for placing the Quality Control plan in action during design, manufacturing, testing, procurement & supply, construction, fabrication, erection, trial run, O&M, etc.
- II. Procedures to control transmission of information across all interfaces both internally (that is, within the Contractor's Quality System) and externally. Those of the latter shall include all Statutory Bodies, Authorities and the Engineer.
- III. All material, plant and equipment intended to be used in the project and workmanship comply with specifications.
- IV. Provide samples of materials to be tested in required quantities at locations where testing is to be performed.
- V. When it is discovered on inspection that work is proceeding with incorrect materials or methods, ensure the corrections are immediately made and that improperly complete work is replaced on the Contractor's cost.
- VI. The Quality Assurance program, as approved by the engineer, shall provide inspection and testing of products during fabrication and installation as engineer may deem necessary to ensure that work is performed in compliance with the Contract.
- VII. The contractor shall engage, at no extra cost to the employer, third party independent professionals or firms or testing laboratories for inspection if required as per the applicable codes or specifications. All such engagements shall require prior approval of the engineer.
- VIII. Provision of inspection and testing instruments and devices and facilities required to ensure proper performance of Quality Assurance at the job site.
- IX. Certification by producer / manufacturer that specified products meet requirements of reference standards as specified in applicable codes / specification.
- X. Calibrate measuring and testing devices periodically against certified standard equipment. Calibration shall be verified by inspection firm.
- XI. Maintain continuity of Quality Assurance surveillance throughout fabrication of products and execution of work.
- XII. Submit details of Quality Assurance tests and methods inclusive of the specification.
- XIII. Perform inspection on a continuing basis as each part of the works commences and on a regular basis to ensure constant compliance with the requirements.
- XIV. Provide samples of materials to be tested in required quantities at locations where testing is performed.
- XV. Contractor's Quality Assurance representative at the site shall be responsible on receipt of items at the site for noting damage suffered by them during transit and for directing that they be rectified or replaced.

- XVI. When it is discovered on inspection that work is proceeding with incorrect materials or methods, ensure that corrections are immediately made and that improperly complete work is replaced.
- XVII. The Contractor shall impose Quality Assurance methods at the location of manufacture, fabrication and assembly of items to be incorporated in the works to ensure that they conform to requirements of the Contract Documents. This Quality Assurance shall not apply to proprietary catalog production products except as may be deemed necessary by the Contractor or as directed by the engineer.
- XVIII. Contractor shall provide notice to the engineer in writing at least 4 weeks in advance of packing of every batch of product components or assemblies so that the Employer or Employer's Consultants and their designated representatives may have opportunity at his / their choice of inspecting any such product components or assemblies prior to transportation at the cost of the bidder. The Contractor's Quality Assurance representative off-site shall be responsible for the release of items for transit to the job site.
- XIX. The Contractor shall be responsible for protecting and maintaining items on the site. No damage to equipment's and other materials shall take place during storage, erection, installation and maintenance.
- XX. All the field and site laboratory tests shall be carried out as per CPWD specifications. Minimum 10% of these field tests shall be got done from approved laboratory and all testing charges shall be borne by the contractor.
- XXI. Each delivery / lot of cement and steel shall be accompanied by manufacturer / producer test certificate conforming that the supplied cement and steel conforms to relevant specifications. These certificates shall be endorsed to the Engineer for his record.
- XXII. From each lot of Cement and steel samples shall be taken for carrying out mandatory test in accordance with latest CPWD specifications. These tests shall be got done from approved laboratory.
- XXIII. Water used in construction shall be tested in AITL approved laboratory and cost towards testing shall be borne by the contractor.
- XXIV. The Contractor shall furnish manufacturer's test certificates and technical literature for any admixture proposed for use. If directed, the admixture shall be tested at an approved laboratory.

5.3 Schedule of Quality Assurance Operations

The contractor shall provide the engineer with three copies of a schedule of Quality Assurance operations, both on-site and off-site, outlining the following:

- I. Quality Assurance organization.
- II. Qualifications of Quality Assurance personnel.
- III. Authority and responsibilities of each Quality Assurance person.

- IV. Schedule of inspections and tests with personnel assigned to each task and duration of each task.
- V. Schedule of required services to be provided by inspection and testing firms.
- VI. Testing methods.
- VII. Methods of performing and documenting Quality Assurance operations.

5.4 Quality Assurance reports and feedback

All Quality Control tests and inspections carried during the execution of contract shall be documented and submitted in the form of report in triplicate to the engineer.

The report shall state the purpose of tests performed, description of methods used, test results and observations made and personnel involved. Similarly, the inspection report shall certify that which item are defective, nature of defect and what corrective methods have been adopted.

If inspection and testing is carried out by an approved inspection and testing firm, certified copies of test reports obtained by the firm shall be annexed with the Quality Assurance report.

The system shall include for the reporting back, recording and incorporation into the system of deficiencies and remedial measures to correct them noted during the control of the project.

6. HEALTH, SAFETY AND ENVIRONMENT STANDARDS

The Contractor shall at all times maintain a safe system of working and working environment and shall comply with all enactments, regulations and working rules relating to safety, security, health and welfare of all persons who may be affected by his work. The Contractor shall have its' own dedicated Safety manager and team for regular monitoring of the safety aspects at the site.

Nothing which has been written into or omitted shall be taken to relieve the Contractor from his obligations under this clause. No clause in this Employer's Requirements shall prevent the Contractor from drawing the attention of the Employer's Representative to any feature of the Works which is not consistent with normal safety practices nor prevent him from putting forward proposals at any time which would increase the safety of the installations.

Not later than four weeks before work commences on the Site, the Contractor shall submit to the Employer's Representative his comprehensive proposals relating to the safety, health and welfare of all personnel on the Site.

The Contractor shall appoint a suitably qualified representative as Safety Officer who shall be responsible for the implementation of site safety procedures.

The proposals shall be appropriate for all grades of labour and personnel who will work on or visit the Site on behalf of the Employer, Employer's Representative or Contractor.

The Employer's Representative shall have the power to stop any activity or work in any area where there is a breach of the published site safety rules due to which health or life is put at risk.

The Contractor shall bring any violation of Site safety rules by others to the attention of the Employer's Representative in writing.

The Contractor shall provide at the Site such life-saving apparatus as may be appropriate and an adequate and easily accessible first aid outfit or such outfits as may be required by any government ordinances, factories acts, etc., published and subsequently amended from time to time.

The Contractor shall possess the valid electrical contractor's license of appropriate class from the concerned statutory bodies governing the area of work place. The Contractor shall fully comply with the relevant statutory rules and regulations and shall ensure safety of personnel and equipment. A prior approval from the Employer shall be sought before employing the electrical contractor. The Contractor shall be responsible for the electrical safety of all Plant supplied and installed. Whilst any equipment is being installed or tested, the Contractor shall ensure that all necessary precautions are taken to safeguard personnel working on site.

The Contractor shall ensure that the operations entailed in the construction of the Works do not cause annoyance to others working on the Site or to persons living adjacent to the Site.

7. WORK PROGRAMME

The contractor shall submit within 15 days of award of work, a work program pertaining to civil construction, procurement, supply, erection, installation, testing and commissioning of all equipment's in Primavera P6 software. The work program shall be reviewed on monthly basis by the Engineer. Any slippages, if occurred during the preceding month, shall be covered up by reallocating resources, putting depending activities on fast track, etc. and by applying other project management techniques. The contractor after taking into account these measures shall submit the revised work program to the Engineer for approval.

8. NOTICE OF OPERATIONS

The Contractor shall give full and complete written notice of all important operations to the Engineer sufficiently in advance to enable the Engineer to review such safety arrangements as the Engineer may consider necessary for inspection and for any other purpose. The Contractor shall not start any important operation without the written approval of the Engineer.

9. SURVEY AND INVESTIGATIONS

9.1 Topographical Survey

On award of the works and prior to commencement of any site works, the Contractor shall undertake a detailed topographical survey of the site and provide detailed digital

photographs of the Site. The Contractor shall arrange all survey and measuring instruments of every kind necessary for his own use in the execution of the Works. Topographical surveys shall be carried out by using Total station equipment. Bench marks and reference lines shall be established by the contractor with approval of the Engineer. The Contractor shall be responsible for checking of all levels and providing copies of the survey data to the Engineer.

On completion of the topographical survey work, a detailed layout plan showing various treatment units, L-sections of existing channels and other works will be prepared by the Contractor complete in all respect. The contractor shall also prepare a separate layout plan including location of site office, batching plant, go-down, steel yard, store, workshop etc., complete.

Layout of the plant shall be suitably arranged so as to allow space for future expansion (Phase 2), and fits within the space allotted and compatible with the existing infrastructural facilities, inlet and outlet pipe work/channels and nearby water bodies. Underground services requiring to be relocated in order to accommodate the proposed site layout shall be identified by the Contractor to alignments and marked on the survey layout with coordinates and offset distances from permanent structures.

Engineer will approve the layout plans prior to commencement of construction work.

9.2 Soil and Geotechnical Data

On finalization of the layout plan, the contractor in coordination with engineer will determine the locations of buildings / sewage retaining structures and conduct additional soil investigation to find out actual soil characteristics at the site. At least 3 boreholes, each of 20 m depth to be carried out for each structure having liquid depth of more than 5 m. The contractor shall perform SPT, Plate Load Test, monitor ground water levels and other tests as directed by engineer. The contractor shall submit the report to consultant and engineer for approval. In case there is a discrepancy between the two reports (preliminary investigations provided by employer and those carried out by contractor) lower of the values of the safe bearing capacity shall be considered for the design.

10. MATERIAL, CONSTRUCTION AND ERECTION OF PLANT

10.1 Material

The Engineer shall have the right at all times to inspect the sources of all materials. Such an inspection shall be arranged and the Engineer's approval obtained, prior to starting of construction and erection of the plant. Materials complying with codes/standards shall generally be used. Other materials may be used after approval of the Engineer and after establishing their performance suitability based on previous data, experience or tests. The Contractor shall request for inspection of all materials in an approved RFI form in at least 21 days in advance.

As soon as practicable after receiving the order to commence the Works, the Contractor shall inform the Engineer of the names of the suppliers from whom he proposes to obtain any materials but he shall not place any order without the approval of the Engineer which may be withheld until samples have been submitted and satisfactorily tested. The

Contractor shall thereafter keep the Engineer informed of orders for and delivery dates of all materials.

All materials cement, aggregate, water, admixtures, structural steel and steel for reinforcement shall be of best quality and subject to mandatory test. These tests shall be got done from any approved laboratory or as directed by Engineer. The cost of samples, packing & transportation etc. shall be borne by the contractor. However, testing charges for all materials except cement, steel and water will be reimbursed to the contractor at actual on verification of proof submitted. If the test results are not in compliance with the Specifications and the Standards, the testing charges shall be borne by the contractor.

Each delivery / lot of cement and steel shall be accompanied by manufacturer / producer certificate conforming that the supplied cement and steel conforms to relevant specifications. These certificates shall be endorsed to the Engineer for his record. From each lot sample shall also be taken and got tested. Cost of such tests shall be borne by the contractor. In case the test results indicate that the cement and steel arranged by the contractor does not conform to standards specified, the whole lot shall be rejected and material removed from the site by the Contractor at his cost within a week's time after written orders from the Engineer.

All materials which do not conform to the Employer's Requirements/ BIS specifications shall be rejected.

10.2 Pipe Material and Type of Valve

The design requirements for Pipe material and Valve type common for CETP are provided in table below:

Table 10-1 Pipe Material and Valve Type Specification

S No	Application	Pipe Material	Valve Type
1	Raw sewage / Industrial wastewater	HDPE of PE100 PN6 up to 225mm and DWC SN8 pipe for sizes above 200mm	Gate valve
2	Treated effluent	HDPE for pipe sizes 110 mm to 250 mm DI for pipe sizes 300 mm and above	Butterfly valve
3	Encasing Material for Road Crossing	RCC NP4	
4	Sludge	GRP / SS 304	Gate valve
5	Thickened and Dewatered Sludge	SS 304	Knife-edged gate valve
6	Grit Line	SS 304	Gate valve
7	Air pipe	SS 316 / SS 316 L	Butterfly valve

8	Chemical	Polymer: SS 316; Alum: uPVC; NaOCl: PVC	Ball valve / Diaphragm valve
9	Odour	GRP	Butterfly valve

10.3 General Specifications for Motor

The design requirements for Motor common for STP and CETP are provided in Table 10-2.

Table 10-2 Motor Specification

Description	Values	Unit
Motor Design Temperature	50	Deg C
Power supply	415 V/ 3 Ph / 50 Hz	
Enclosure (above water)	IP 55	
Enclosure for submerged installation	IP 68	
Insulation Class	Class F	

10.4 Construction and Erection of Plant

Construction and Erection of Plant shall be phased in such a manner as not to obstruct the work being done by other contractors.

Plant shall be erected in a neat and workmanlike manner on the foundations and at the locations shown on the approved drawings. Unless otherwise directed by the Engineer, the Contractor shall adhere strictly to the aforesaid drawings.

The Contractor shall be responsible for setting up and erecting the Plant to the line and level required and shall ensure that all Plant is securely held and remains in correct alignment before, during and after grouting-in.

Any damage caused by the Contractor during the course of erection to new or existing plant or building or any part thereto, the Contractor shall at his own cost, make good, repair or replace the damage, promptly and effectively to the entire satisfaction of the Engineer.

The Employer shall appoint an Employer's Engineer for Construction Supervision of the Works under this Contract. The agency as directed by the Employer shall be responsible for regular monitoring and inspection of Contractor's progress of works and Quality Control on behalf of the Employer.

11. PACKING AND PROTECTION DURING TRANSPORTATION

Materials shall be transported, handled and stored in such a manner as to prevent deterioration, damage or contamination, failing which such damaged materials will be rejected and shall not be used on any part of the Works under this contract.

Before any equipment/ material is dispatched from a manufacturer's factory, it shall be adequately protected and packed to ensure that it is delivered to the Site safely and without any damage. The methods employed for protection and packing must be suitable for withstanding the conditions which may be experienced during shipment, delivery to the Site and prolonged periods of storage in the open, whether the items are shipped in packing cases, crates, or only partially protected according to their nature.

Bright parts and bearing surfaces shall be protected from corrosion by applying a rust preventive lacquer, high melting point grease or similar temporary protection. A sufficient quantity of solvent shall be supplied with the plant to enable this coating to be removed on the Site.

All machined flanges and other mating surfaces shall be protected by means of wood templates. The bolts for securing these templates shall not be reused in the final installation.

No one crate or package shall contain items of Plant intended for incorporation in more than one part of the Works.

All items of Plant shall be clearly marked for identification against the packing list, which shall be placed in a waterproof envelope inside every packing case or crate.

Every packing case and crate shall be indelibly marked to show its weight, serial number, top and bottom, shipping marks and handling instructions or sling marks.

Electrical Plant shall be enclosed in sealed airtight packages with dehydrating material, before being placed in packing cases on shock-absorbent material and secured by means of battens.

12. SPARE PARTS

The Contractor shall provide separate priced lists of spare parts, special tools and Plant spare parts required for operation of the Works as detailed in the Contract.

The Engineer shall provide comments on the spares lists, special tools list and Plant spare parts list and discuss with the Contractor any omissions or additions required to the lists. The agreed lists of emergency spare parts and special tools shall be finalised before approval of the relevant submittals.

The Contractor shall procure all of the emergency spare parts and special tools in accordance with the finalised list and deliver them to the Site before the start of the Tests on Completion and any special tools that shall be required for commissioning. The Contractor shall be responsible for replenishing the spare parts and special tools that have been used or are damaged during the Tests on Completion. The emergency spare parts and special tools shall become the property of the Employer when the Taking-Over Certificate is issued.

The spares shall comprise an adequate stock of the parts likely to be needed as routine replacements, together with any major items or components which it may be desirable to hold in order to facilitate or expedite timely repair.

Spare parts shall be new and shall be packed separately in packages or containers designed to preserve the spares from the effects of long-term storage under the ambient

conditions specified. Any items that cannot be packed in this way must be protected from corrosion by applying temporary protective coatings and shielded from mechanical damage. All spares shall be clearly labelled with brief descriptions and part numbers.

The Contractor may use spare parts maintained in the stock to replace failed parts during the entire contract period. However, the Contractor shall be responsible for replacing those parts used with identical parts at no cost to the Employer.

Spare parts to be supplied under this contract shall be interchangeable where possible within the treatment plants constructed under this contract and shall be adequate for a period of two (2) years after handing over the plant to the Employer.

13. SPECIAL TOOLS AND APPLIANCES

The Contractor shall supply two complete sets of the special tools, lifting tackle, access equipment (ladders, scaffolding, etc.) and greasing equipment necessary for the maintenance, repair, testing and overhaul of the Plant.

The tools and tackle shall not be used for the erection of the Plant except when the Engineer may call upon the Contractor to demonstrate their use.

The Contractor will be permitted to utilise the overhead gantry cranes supplied under this Contract for the purposes of installing the equipment in his supply. On completion of the installation, the contractor shall make good of any damage or worn-out components, if any, caused to the crane during its use.

All special tools and test equipment necessary for overhauling the Plant and testing its performance shall be included and mounted in suitably designed cabinets with lockable doors. Racks and clips shall be provided for individual items with outline markings and labels to show where any equipment is missing.

14. PRELIMINARY SITE WORKS

14.1 Site Clearance

The Contractor shall clear the site to the extent required by the Employer's Representative for checking the setting-out. Clearance of the site shall also include clearing of plants, bushes, rubbish, slush, demolition and removal of all articles, objects and obstructions which are expressly required to be cleared. The Contractor shall not clear the site of any existing structure without the prior written instruction of the Employer's Representative.

The Contractor shall ensure that the parts of the site to be occupied by the proposed Permanent Works are clear, and shall maintain the remainder of the site as may be required for access and temporary works areas required for the project.

The Contractor shall remove the material arising from such clearance and dispose of it in a manner and at a location, to the approval of the Employer's Representative.

14.2 Temporary Works

Temporary works include site office, labor hutments and sanitary facilities, Go-down for storage of construction materials, field laboratory for carrying out material and other Quality Control tests, approach roads and diversions, etc.

Not less than 30 days before commencing any portion of the Works, the Contractor shall submit to the Engineer for his approval, comprehensive drawings and calculations for all Temporary Works which the Contractor proposes for the construction of that part of the Works. Notwithstanding the approval by the Engineer of any design for the Temporary Works, the Contractor shall be entirely responsible for their safety, efficiency, security and maintenance and for all obligations and risks in regard to such Temporary Works specified or implied in the Contract.

14.3 Labor Hutment and Camp

The Contractor shall construct and maintain to the Employer's Representative's satisfaction a camp to provide living accommodation for all his staff and operatives who have no other local accommodation. The Contractor's camp shall be located close to but not on the Site itself and at a location approved by the Employer's Representative.

Responsibility for providing all services to the living quarters and compliance with all sanitary laws and other laws and regulations shall be borne by the Contractor. Security and the fencing of these areas shall be the responsibility of the Contractor.

14.4 Water Supply during Construction

The Contractor shall make his own arrangements for water supply for construction as well as for drinking purposes during the entire construction period and shall ensure that the quality of water remains suitable for the purpose for which it is intended. Water shall be tested in the AITL's/any recognized third party laboratory. The frequency shall be once every three months.

14.5 Toilet, Latrines, Washing Facilities and Wastewater Disposal

Throughout the period of construction of the Works, the Contractor shall provide, maintain and cleanse suitable and sufficient latrines and washing facilities for use by his employees. He shall ensure that his employees do not foul the Site and use the latrines. Where practicable, the latrines shall be connected to the nearest sewer, or if this is not practicable, the Contractor shall provide an adequately sized septic tank.

After completion of works, the latrines and washing facilities shall be removed and the surface reinstated to the satisfaction of the Employer's Representative.

The provision for disposal of waste from the Administrative Building cum Laboratory Building, Control Building, etc. shall be made by the Contractor connecting to the nearest Manhole of the particular sewer.

14.6 Electricity for Contractor's Use on Site

The Contractor shall be responsible for the provision and distribution of an electrical supply for the purpose of constructing the Works. If a temporary electric connection is required from the Power Distribution Company during the construction period, the contractor shall take up the matter at his level; however, the Employer may facilitate this process by issuing a recommendation letter to the Power Distribution Company.

The installation shall comply with all the relevant regulations, Indian Standards and Codes of Practice, and Health and Safety requirements, etc. The Contractor must take all precautions to ensure that his installation is safe and that injury to personnel or damage to plant and buildings is avoided. The Contractor shall be fully responsible for all safety aspects.

The Contractor shall test the temporary site distribution system every 3 months for compliance with the relevant standards.

14.7 Site Laboratory

The contractor shall establish and equip the field laboratory with equipment for performing the following tests and any other tests as required to be carried out at the site during execution of works:

- I. Tests on aggregates - Grain size distribution / Sieve analysis, Silt content, specific gravity, bulk density, crushing strength and impact value;
- II. Tests on concrete – Slump, consistency and cube strength;
- III. Test on bricks – Dimensions, compressive strength, water absorption and efflorescence.

14.8 Approach Roads

The contractor shall make temporary approach roads for accessing the different areas of the sites for staff and vehicles. The Contractor shall be responsible for establishing and maintaining the temporary road.

14.9 Go-down / Shed for storing construction material and equipment

An area and/or building on the Site for use by the Contractor for safe and proper storage of equipment and materials prior to erection and construction will be subject to the approval of the Employer's Representative. Preparation of the Go-down, stacking and storage of materials shall also comply with specifications.

The Go-down shall be of such capacity so that a stock of 3000 bags could be maintained at all times. For extra safety during the monsoon, the stack shall be completely enclosed by a waterproofing membrane, such as polyethene, which shall close on the top of the stack.

The Contractor shall provide all facilities for the safe and proper storage of Plant, as recommended by the manufacturers, with particular consideration being given to temperature, rain/floods, and Sunlight, wind and ground conditions. The Contractor shall

remain responsible to the Employer for the care and insurance of the Plant, and the provisions of this Clause shall not relieve the Contractor of any of his liabilities under the Contract.

Stored Plant items shall be laid out by the Contractor to facilitate their retrieval for use in the programmed order. Stacked Plant items shall be protected from damage by spacers on load-distributing supports and shall be safely arranged. No metalwork shall be stored directly on the ground. Steel reinforcement and structural steel shall be stacked and stored so as to prevent deterioration and corrosion. Bars of different classifications, sizes and lengths shall be stored separately to facilitate issues in such sizes and lengths.

Small Plant items shall be held in suitable bins, boxes or racks and be clearly labelled.

Items of Plant shall be handled and stored so that they are not subjected to excessive stresses, so that protective coatings are not damaged.

The Contractor shall comply with the manufacturer's package and plant markings concerning the use and location of lifting slings, chains and hooks.

14.10 Temporary Site Office

Within 60 days of start of work the Contractor shall make the site office in approximately 80 sq. m area for the use of Employer. The site office shall have following features:

- I. Two rooms for Engineers and representatives and one meeting room;
- II. Air conditioners of required capacities;
- III. One common toilet and one each attached to the Engineers' and meeting room;
- IV. The site office shall be equipped with the necessary furniture as directed by the Engineer.
- V. Multipurpose printer (Copy, Fax, Laser Print, Scan) - 1 No.;
- VI. One Desktop Computer of approved configuration installed with required operating software and UPS;
- VII. Internet connection;
- VIII. All required internal water supply, sanitary, electricity fittings, etc;
- IX. Drinking water arrangement;
- X. Daily upkeep of the office;
- XI. One orderly staff

The location and layout of the site office shall be approved by the Engineer before providing the same.

14.11 Maintenance of Existing Facilities

14.11.1 Construction Site

The Contractor shall maintain the site, equipment and provide related services until expiry of the Contract period or until such time as the aforementioned facilities are removed, with the permission of the Employer's Representative.

During the construction period, the contractor shall barricade the construction site and display necessary warning and Safety signs for the movement of vehicles and the safety of the operators, labour and staff deployed at the proposed site.

14.11.2 Areas Outside the Site

In the event of the Contractor making use of any special or temporary way leave or accommodation acquired by him or any tip for the disposal of surplus materials, or any borrow pit or quarry, he shall obtain the written consent of the owner, occupier or authority having charge of the land in which such way leave, accommodation or tip is situated and shall make a record agreed by the owner, occupier or authority as aforesaid of the condition of the surface of that land before entering thereon.

In such case, the land in which such way leave or accommodation is situated shall be deemed to be part of the Site. On completion of the works at site, the Contractor shall reinstate the area to its original condition to the satisfaction of the Employer's Representative.

For the purposes of this Clause, 'accommodation' shall be deemed to include housing, offices, workshops, warehouses, go-downs and storage areas.

14.11.3 Refuse Disposal

Refuse and rubbish of every kind shall be removed from the Site and disposed of by the Contractor at his own expense, frequently and regularly to keep the Site in an approved wholesome, hygienic and tidy condition to the satisfaction of the Employer's Representative.

15. EMPLOYER'S ENGINEER ASSISTANCE AND HIS REPRESENTATIVE

The Employer's Engineer shall have the right at all times to inspect all operations, including the sources of materials, procurement, layout and storage of materials, the concrete batching and mixing equipment and the Quality Control system.

The Contractor shall provide all necessary assistance to the Employer's Representative and his staff in carrying out their duties of checking, inspecting, measuring the Works and shall also provide standards, manuals and applicable IS codes. The Contractor shall provide chainmen, staff men, office attendants and labourers as may be needed from time to time by the Employer's Representative.

The Contractor shall provide for the Employer's Representative and his staff, consultants and their staff and visitors such protective clothing, safety helmets, gas masks and rubber boots of suitable sizes, hand lamps and the like as may be reasonably required by them.

The Contractor shall permit the Employer and the Employer's Representative and any person authorised by the Employer or the Employer's Representative, including workmen of the Employer, other contractors or utility undertakings, access for the purposes of the Contract to all areas of the Site and to any additional accommodation or temporary way leave for the duration of the Contract period.

16. CERTIFICATION ON COMPLETION

On completion of the Works, the Contractor shall clear any temporary works areas and temporary access roads and reinstate the areas to their original condition and to the satisfaction of the Employer's Representative.

After completion of installation work, the Contractor shall arrange for inspection and obtain approval from the concerned statutory bodies. Any fees that are to be paid to such statutory bodies for testing, inspection or calibration shall be paid by the Contractor. Any modification/revision in the equipment/installation of equipment as required by the statutory bodies shall be carried out by the Contractor. All such costs/fees for revisions/modifications shall be deemed to be included in the prices of supply, installation, testing and commissioning of equipment as quoted by the Contractor.

Any changes from the approved drawings to suit site conditions, suggested by the Employer, shall be incorporated in the final drawings by the Contractor. All test reports shall be properly maintained by the Contractor, duly approved by the statutory bodies and shall be handed over to the Employer after completion of the job.

17. INSPECTION, TESTING AND COMMISSIONING

17.1 Inspection and Testing During Manufacture

17.1.1 General

- a) All inspection and testing shall be carried out in accordance with the specification and in the absence of a specification relevant Indian Standard or an internationally approved equivalent standard. After the award of the contract, the contractor shall furnish a QA/QC plan for approval by the Employer. QA/QC plan shall include testing for incoming supply of raw materials and bought out items, stage inspections and tests on finished products at the manufacturer's works/appropriate testing station. QA/QC plan shall clearly indicate tests which are intended to be witnessed by the Contractor alone and those by both Contractor and Employer.
- b) The inspection and tests schedule shall be as follows
 - I. Manufacture tests
 - II. Acceptance inspection/Quantity checking
 - III. Install/Site Inspection

- IV. Site Acceptance Test
 - V. Tests on Completion
 - VI. Process Wet tests (by raw sewage)
 - VII. Operation tests (Tests after completion)
 - VIII. Complete Performance Tests of the plant after O&M period (Before plant handing over)
 - IX. Tests furnished as per IS code/manufacturer QAP
- c) The Contractor shall carry out at the place of manufacture tests of the Plant /Equipment at any part of the Works as per the approved QAP.
 - d) The Employer and/or duly authorised and designated representative(s) shall be entitled to attend the aforesaid inspection and/or tests.
 - e) The Employer and his duly authorised representative shall have access to the Contractor's premises at all times to inspect and examine the material and workmanship of the mechanical and electrical plant and equipment during its manufacture there. If part of the plant and equipment is being manufactured on other premises, the Contractor shall obtain permission for the Employer or his duly authorised representative to inspect as if the plant and equipment was manufactured on the Contractor's own premises. Testing (including testing for chemical analysis and physical properties) shall be carried out by the Contractor and certificates submitted to the Engineer, who will have the right to witness or inspect the above-mentioned inspection/testing at any stage desired by him. Where inspection or testing is to be carried out at a subcontractor's works, a representative of the Contractor shall be present.
 - f) Contractor shall provide test procedure, pre-factory test results, and calculation sheet, photo in advance and provide all of the test result with necessary documents, including its data and photo to show the Engineer that the test is carried out in proper condition and its test results. Construction material shall be tested by the contractor at the approved laboratory.
 - g) The procedure for the testing and inspection to be carried out during or following the manufacture of the materials to ensure the quality and workmanship of the materials and to further ensure that they conform to the Contract in whatever place they are specified shall be as described below.
 - I. The Contractor shall give the Employer at least 28 clear days' notice in writing of the date and the place at which any plant or equipment will be ready for inspection/testing as provided in the Contract. Prior to notice, contractor should submit pre factory test results. The Employer or his duly authorised representative shall thereupon at his discretion notify the Contractor of his intention either to release such part of the plant and equipment upon receipt of works tests certificates or of his intention to inspect. The employer shall then give notice in writing to the Contractor, and attend at the place so named the said plant and equipment which will be ready for inspection and/or testing. As and when any plant shall

have passed the tests referred to in this section, the Engineer shall issue to the Contractor a notification to that effect after obtaining clearance from the Consultants.

- II. The Contractor shall forward to the Employer 6 duly certified copies of the test certificates along with characteristics performance curves / tables if any for all equipment obtaining dispatch clearance from the consultants/Engineer.
- III. If the Engineer (s) fails to attend the inspection and/or test, or if it is agreed between the parties that the Engineer (s) shall not do so, then the Contractor may proceed with the inspection and/or test in the absence of the Engineer and provide the Employer with a certified report of the results as per (ii) above.
- IV. If any materials or any part of the works fails to pass any inspection / test, the Contractor shall either rectify or replace such materials or part of the works and shall repeat the inspection and/or test upon giving a notice as per (i) above. Any fault or shortcoming found during any inspection or test shall be rectified to the satisfaction of the Engineer before proceeding with further inspection of that item. Any circuit previously tested, which may have been affected by the rectification work, shall be re-tested.
- V. Where the plant and equipment is a composite unit of several individual pieces manufactured in different places, it shall be assembled and tested as one complete working unit, at the manufacturer's works.
- VI. Neither the execution of an inspection test of materials or any part of the works, nor the attendance by the Engineer (s), nor the issue of any test certificate pursuant to (iii) above shall relieve the Contractor from his responsibilities under the Contract.
- VII. The test equipment, meters, instruments etc., used for testing shall be calibrated at recognised test laboratories at regular intervals and valid certificate shall be made available to the Engineers at the time of testing. The calibrating instrument used as standards shall be traceable to National/International standards. Calibrating certificates or test instruments shall be produced from a recognised/Laboratory for the Engineer's consent in advance of testing and if necessary instruments shall be recalibrated or substituted before the commencement of the test.
- VIII. Items of plant or control systems not covered by standards shall be tested in accordance with the details and program in conformity as per good Engineering Practices and as agreed between the Engineer and Contractor's Representative. If such materials or works are found to be defective or not conforming to the Contract requirement due to the fault of the Contractor or his sub-contractors the Contractor shall defray all the

expenses of such inspection and/or test and of satisfactory reconstruction.

- IX. Tests shall also be carried out such that due consideration is given to the Site conditions under which the equipment is required to function. The test certificates shall give all details of such tests.
- X. The Contractor shall establish and submit a detailed procedure for the inspection of materials or any part of the works to the Employer for approval within the date indicated in the Programme Details. The detailed procedure shall indicate or specify, without limitation, the following:
- Applicable code, standard and regulations.
 - Fabrication sequence flow chart indicating tests and inspection points.
 - Detailed tests and inspection method, indicating the measuring apparatus to be used, items to be measured, calculation formula, etc.
 - Acceptance criteria.
 - Test report forms and required code certificates and data records.
 - Method of sampling, if any sampling test to be conducted.
 - Contractor's or Employer's witness points.
- XI. The Contractor shall not pack for shipment any part of the Plant until he has obtained from the Employer or his authorised representative his written approval to the release of such part for shipment after any tests required by the Contract have been completed to the Employer's satisfaction.
- XII. The following Inspection and Testing procedures shall be carried out for the equipment as per approved QAP.

The detailed procedure shall indicate or specify, without limitation, the following:

- Raw Material
- Visual Inspection/ Appearance.
- Chemical and Mechanical property tests
- Dimension Checking
- Dynamic balancing for all rotating parts
- Scale inspection
- Hydrostatic / Leak testing for all pressure parts, Pneumatic Leak Test wherever applicable

- Repair procedure.
 - Operation check
 - Procedure Qualification Record (PQR); Welding Procedure Qualification (WPQ) and Welders Qualification Report (WQR)
 - Material Test
 - Assembly/Connection
 - Documentation
- h) The Contractor shall maintain proper identification of all materials used, along with reports for all internal / stage inspection work carried out, based on the specific job requirement and or based on the datasheets /drawings/ specifications.
- i) The expenses incurred during inspection shall include, but not be limited to all travelling, boarding, lodging and out-of-pocket expenses.
- I. The Contractor shall be responsible for-all expenses incurred by the Engineer or person/s nominated by the Engineer in attending inspection and tests of Plant carried out during manufacture within India and abroad. Normally two or three persons from Employer side will witness the Inspection and testing along with the contractor's representative.
 - II. Cost of inspection when material or any part of the facilities is not ready at the time specified by the Contractor for inspection or when re-inspection is necessitated by prior rejection shall also be borne by the Contractor.
- j) Witnessed testing will normally be waived on standard types of equipment such as small motors made by approved manufacturers, individual standardised instruments, small mass produced components used in the manufacture of Plant items, small bore pipework and fittings, minor installation materials and low voltage cable. In order to remove doubt this shall not relieve the Contractor of his obligation under the Contract to ensure that all Plant is tested at the manufacturer's works prior to delivery to Site.
- k) As a reference and guide to the Contractor the Employer reserves the right to witness testing of the following but not limited to the following Plant items:
- I. Mechanical:**
 - All process equipment;
 - Mechanical bar screen, Mechanical Step screen and Mechanical Drum Screen;
 - Vortex Grit Mechanism;
 - Flash Mixers and Flocculators;
 - Clarifier and Thickener bridges, drives and sludge/scum mechanisms;

- Weirs;
- Fine Bubble Air diffuser systems;
- Process Air Blowers;
- Membrane Cassettes and Membrane systems;
- Permeate cum backwash systems and CIP systems;
- Mixers, Agitators, pumps and blowers including their motors;
- Storage tanks;
- Pressure vessels;
- Chemical dosing systems complete with dosing tanks, dosing pumps and related accessories;
- Chlorination system;
- Centrifuge;
- Polymer Dosing system;
- EOT crane, Electrical/Manual Hoists, Lifting Davit Crane;
- Valves, Penstocks and actuators;
- Expansion/Dismantling Joints;
- Piping & other fittings.

II. Electrical:

- Transformers;
- 11 KV metal enclosed switchboards and switch gears;
- 415 V metal enclosed switch gears (PCC) / MCC;
- 415 V Power Capacitor and control panel;
- Diesel Generator with AMF Control Panel;
- Battery, battery charger and DC distribution board;
- Variable Frequency Drives;
- Non segregated Bus Duct;
- Power and Control Cables;
- Lighting System

III. Instrumentation and Control:

- Level Measuring Instruments;
- Temperature Measuring Instruments;
- Flow Measuring Instruments;
- Pressure Measuring Instruments;

- All online analysers as per process requirement;
 - Auto samplers;
 - Instrumentation and Control Cables;
 - Programmable Logic Controller;
 - SCADA/ HMI System;
 - Uninterruptible Power Supply System;
 - Wireless GPRS gateway testing;
 - FAT and SAT for complete ICA system
- l) All destructively tested samples shall be replaced with new.
- m) The Employer/ his representative reserves the right to be present during the testing and inspection of all plant items.

17.2 Factory Acceptance Test (FAT) Document

Two (2) Months prior to commencement of inspection of each Plant item, the Contractor shall supply a Factory Acceptance Test (FAT) Document for approval. The FAT Plan shall provide comprehensive details of the tests to be carried out, the purpose of each test, the equipment to be used in carrying out the test and the methods to be adopted in carrying out the tests. The FAT shall provide space within the documentation for results of the tests to be added and for each test and for the FAT as a whole to be signed off by the Contractor and the Engineer. On completion of the tests the Contractor shall provide four copies of all test certificates, curves etc. for the inspected Plant item.

Where witness tests are not required the test certificates and curves etc. shall be forwarded to the Engineer within two weeks of the tests being completed.

The Contractor shall not deliver Plant to Site without the Engineer's approval in writing. This permission will not be given unless amongst other things a valid Contractors test certificate and completed FAT document for the item of Plant concerned is in the possession of the Engineer.

17.3 Inspection and Testing Programme

The Contractor shall submit to the Engineer not later than Two (2) Months prior to the commencement of the first inspection and test during manufacture a programme detailing the inspection dates for all Plant.

Those items of Plant that the Engineer has specifically identified for witness testing test shall be highlighted in the programme.

The Contractor shall keep the Engineer informed of any changes to the programme.

The Engineer shall not be requested to inspect an item of Plant until the Contractor has satisfied himself that the equipment meets all requirements of the Employer's Requirements.

The Contractor shall inform the Engineer in writing at least 21 days in advance regarding readiness for carrying out inspection of equipment/material etc. at manufacturer's works or at places of inspection.

The programme for inspection shall be finalised by the Engineer after the receipt of the above. In case inspection cannot be carried out due to non-readiness of equipment/material etc. a subsequent date shall be finalised for carrying out the inspection in which event all expenses incurred by the Engineer for such visits shall be recovered from the Contractor. In case equipment/material etc. is found not to comply with the specification, dates for re-inspection shall be finalised and expenses incurred by the

Engineer for such visits shall also be recovered from the Contractor. Contractor's Representatives shall essentially be present during all inspections. The following information shall be given in the inspection call letter mentioned above:

- Name of manufacturer/supplier;
- Address of place where inspection is to be carried out;
- Proposed date/s and equipment to be inspected;
- Name/s of contact personnel at manufacturer's/ supplier/s works with their telephone and fax numbers.
- Name of Contractor's Representative who will be present during the inspection.
- Confirmation that internal testing has been completed.
- Testing Procedure with relevant codes and standards.

The Contractor shall provide all the necessary instruments to carry out the tests after assembly. All instruments used for such tests shall be calibrated and certified by and approved by an independent testing authority not more than six month prior to the tests in which they are used. Calibration certificates for instruments used for such tests shall be produced for the approval of the Engineer and if necessary, instruments shall be recalibrated before the commencement of the tests.

No material shall be delivered to the Site without inspection having been carried out or waived in writing by the Engineer.

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

17.4 Manufacturer's Works Acceptance Tests on Mechanical Equipment

The Contractor shall carry out further specified tests (but not limited to) as follows in addition to any tests stated or implied by the foregoing sections of this clause.

Pump

Manufacturer's standard test certificates will be acceptable for small centrifugal pumps rated for powers of 25 kW or less.

All other pumps shall be tested individually in accordance with the relevant international standard. Site conditions shall be simulated as near as possible including the NPSH condition. Pumps shall be tested with their own prime movers. Where it is impractical to include the full length of the connecting shaft, the Contractor shall state the allowances to be made for the losses incurred by its omission and shall demonstrate the accuracy of the allowances to the satisfaction of the Engineer.

Each centrifugal pump shall be tested on the manufacturer's premises individually, in accordance with the provisions of BS EN ISO 9906:2000 with clean, cold water.

Each and every rotating part/assembly/sub-assembly shall be dynamically balanced as per grade G6.3 of ISO 1940/1 - 1986.

Each pump shall be tested at its guaranteed duty point and over its full working range from its closed valve condition to 20% in excess of the specified quantity at minimum head. Tests shall provide information for performance curves to be drawn for: head/quantity, efficiency/quantity, power absorbed/quantity and net positive suction head/quantity.

Pump casings shall be subject to a pressure test at 2.0 times the pressure obtained with the delivery valve closed. The positive suction head shall be taken into account in determining this pressure.

Performance characteristics of motors used during testing shall be furnished prior to commencement of tests.

In addition to confirming the hydraulic performance of the pump set as specified, the test shall demonstrate that vibration is within the specified limits and that the mechanical performance is satisfactory. However, for the purpose of the Performance Guarantee, noise and vibration levels shall be demonstrated at site to be within acceptable limits

Valve

Type test certificates will be acceptable for valves sized 300 mm diameter or less.

All valve bodies shall be hydraulically tested closed ended to (minimum) 1.5 times the rated pressure and at rated pressure for seat as specified in Table 5 and 6 of IS: 14846.

Satisfactory operation of manual/motorised and pneumatic actuators with valves shall be demonstrated.

Butterfly valves' body and disk with rubber seats shall be tested to the pressures and duration as specified under IS: 13905.

Penstock

Check for smoothness of operation and integrity of seal. Leakage tests shall also be carried out as per appropriate standard. Satisfactory manual and motorised operation of penstocks shall be demonstrated.

Pipe Work

The inspection and testing of all pipework shall be carried out in accordance with the appropriate standards approved by the Engineer.

Cranes & Hoist

Cranes shall be completely assembled and tested for all operations in accordance with the relevant international standard. Internal Test certificates shall be furnished.

Hoists and lifting equipment shall be assembled and tested at the place of manufacture in accordance with IS 3938.

Each and every rotating part/assembly/sub-assembly shall be dynamically balanced as per grade G16 of ISO 1940/1 - 1986.

Compressors and Blowers

Tests shall be carried out in accordance with the relevant international standard. All compressors and blowers shall be tested with their ancillaries to confirm design performance particularly in respect of flow and pressure. The test shall demonstrate that vibration and noise are within the specified limits and that the pressure relief valve operates correctly.

Air receiver shall be tested in accordance with the relevant section of B.S. 5169.

All pressure vessels shall be inspected and hydro water tightness tested.

Diffusers

- Visual inspection to ensure compliance with specifications and the drawings;
- Standard Oxygen Transfer Efficiency (SOTE).

Sludge Dewatering Equipment

- Visual inspection to ensure compliance with specification and drawings;
- Material of construction;
- Functional tests.

Screens

- Visual inspection (bar spacing, laminate thickness) to ensure compliance with specifications and drawings;
- Material of construction;
- Energy consumption;
- Function test (test run).

Process Plant Items

All process plant items shall be tested to ensure they meet the Employer's Requirements for quality of workmanship, construction and performance.

Ventilation System

The ventilation fans shall be tested at manufacturer's works to verify the design flow and pressure.

Internal test certificates shall be furnished.

MCC

The Contractor shall carry out the type tests defined in BS 5486 as follows:

- Verification of the temperature rise limits;
- Verification of the dielectric properties;
- Verification of the short circuit strength;
- Verification of the continuity of the protective circuit;
- Verification of the clearances and creepage distances;
- Verification of the mechanical operation;
- Verification of the degree of protection;
- Checking of protective measures, including primary or secondary injection testing and checking the continuity of the protective circuit.

17.5 Inspection at Site

During erection of the Plant the Engineer will inspect the installation from time to time in the presence of the Contractor's Supervisor to establish conformity with the requirements of the Specification. Any deviations found shall be corrected as instructed by the Engineer.

17.6 Plant Protection on Site

Factory finished plant shall be adequately protected both before and during installation against damage to finished surfaces, fitted components, and the ingress of dust. It may be necessary for structural finishing operations to be carried out in the vicinity of installed plant before it is taken over and the Contractor shall take this into consideration in complying with the requirement of this clause.

17.7 Delivery, Unloading and storing at Site

The Contractor shall be responsible for checking all material delivered to Site and shall keep the Engineer's representative fully informed of the state of deliveries. The Contractor shall carry out, at his cost, all instructions of Engineer or his representative for proper unloading. Preservation, maintenance, storage and security of materials delivered of Site until he fulfils all his obligations under the Contract.

Prior to dispatch, the equipment shall be adequately protected by painting or by other approved means for the whole period of transit, storage and erection, against corrosion and incidental damage, including the effects of vermin, sunlight rain, high temperatures and humid atmospheres. The Contractor shall be responsible for the plant being so packed and/or protected as to ensure that it reaches the Site intact and undamaged. The plant shall be packed to withstand rough handling in transit and all packages shall be suitable for storage including possible delays in transit.

The Contractor shall be deemed to have included in the schedule of prices for all materials and packing cases necessary for the safe package, conveyance and delivery and storage of the plant with all protective and preservation measures.

Cases containing rubber, rings, bolts and other small items shall not normally weigh more than 50 Kg gross per case. No one package or bundle shall contain items of plant intended

for incorporation in more than one section of the Works. All items of plant shall be clearly marked for identification against the packing list.

Eye bolts, lifting hooks and other small be provided for lifting the boxes, crates and packages. Every crate or package shall contain a packing list in a waterproof envelope.

All crates, packages, etc. shall be clearly marked with a waterproof material to show the weight and where the slings should be attached and shall also have an indelible identification mark relating them to the packing lists. Packing cases shall be non-returnable. Contractor shall have to clear the Site including packing material.

Electrical equipment shall be enclosed in sealed air tight package with hygroscopic material, before being placed in packing cases on shock absorbent materials and secured by means of battens.

A duplicate copy of the packing list shall be sent by post to the Engineer's representative at site.

The Contractor shall erect and maintain on the Site any temporary storage facility as required and approved by the Engineer. The Contractor shall have to pay rent as finalized by the Engineer if area the Employer Provides, depending upon availability.

Multiple handling and movement of material during storage and retrieval shall be avoided.

For all temporary structures, drawings to be prepared and approved by Employer's Engineer.

17.8 Erection Staff

The Contractor shall provide at least two approved senior working erectors to supervise the erection of all Plant in the Contract.

The Contractor shall also provide sufficient erectors skilled in electrical, mechanical and instrument engineering, with such skilled, semi-skilled and unskilled labour as are necessary to ensure completion of the various sections of the Contract in the time required. The Contractor shall not remove any supervisory staff or labour from the site without the prior approval of the Engineer. The Contractor shall make all the necessary arrangements to ensure that sufficient plant has been or is about to be delivered to site, so that there shall be no delay to the start of erection.

It shall be the responsibility of the Contractor to obtain necessary License/Authorization/Permit for work from the Licensing Boards of the Locality/State where the work is to be carried out. The persons deputed by the Contractor's firm should also hold valid permits issued or recognized by the Licensing Board of the Locality/State where the work is to be carried out.

17.9 Site Acceptance Test Document

Two (2) months days prior to commencement of Tests on Completion the Contractor shall supply a Site Acceptance Test (SAT) Document for approval.

The SAT Plan shall provide comprehensive details of the tests to be carried out, the purpose of each test, duration of test, tolerance limits, the equipment to be used in carrying out the test and the methods to be adopted in carrying out the tests. The SAT shall provide space within the documentation for results of the tests to be added and for each test and for the SAT as a whole to be signed off by the Contractor and the Engineer.

The SAT shall categories tests as follows:

- Pre Commissioning Checks
- Dry Tests;
- Wet Tests
 - Hydraulic tests;
 - Process tests (Manual and Automatic).
- Initial Performance Tests

Dry tests are those tests carried out without process fluid being present.

Wet tests are those tests carried out with raw water or treated water in order to prove the hydraulic capability of the Works. Process wet tests are those tests carried out with raw water as the feed stock to prove the process capability of the various equipment and Works.

Initial performance tests are carried out after Dry and Wet tests to check the performance of the complete process of the plant as a whole. Both water treatment processes and wastewater treatment processes shall be tested. The tests are described in detail below.

All dry tests and wet tests shall comply with relevant approved International standard / code.

It shall be assumed that the co-operation of other contractors in the carrying out of Tests on Completion will not be unreasonably withheld.

17.10 Tests on Completion

The purpose of Tests on Completion shall be to demonstrate and confirm that the Works can fulfil all the mechanical, electrical and process requirements of the Specification. This includes all commissioning and initial performance tests.

Prior to the commencement of Tests on Completion the Contractor shall submit for approval the following:

- Site Acceptance Test Documents;
- As-Built Drawings;
- Operation and Maintenance Manuals.

Tests on Completion shall not be commenced until the aforementioned documents are approved. The initial stocks of oil, grease, electrolyte generator fuel oil, chemicals etc. necessary for Tests shall be kept ready and to be provided by the Contractor.

The costs of chemicals, power, spare parts and any other ancillaries used for the Tests shall be met by the Contractor.

Vibration/noise level tests shall be carried out at site which will form basis for acceptance of the equipment. If the Contractor is not in a position to meet the requirements given below as per ISO 10816 – 1995, the equipment may either be rejected or the Contractor shall carry out all necessary modifications to keep vibrations within the acceptable limits specified.

Pre-Commissioning Checks and Dry Test Requirements:

As a minimum requirement the following dry tests shall be carried out as a general requirement:

- A general inspection to check for correct assembly and quality of workmanship;
- A check on the presence of lubricant, cooling medium, electrolyte, etc.
- A check on adequacy and security of Plant fixing arrangements;
- A general check to ensure that all covers, access ladders, water proofing, guard railings etc. are in place;
- A check on damp-proofing, rust-proofing and vermin-proofing and particularly the sealing of apertures between building structures, chambers etc. and the outside;

As a minimum requirement the following dry tests shall be carried out on the mechanical systems:

- Carry out preliminary running checks as far is permitted by circumstances in order to ensure smooth operation of Plant.
- Automatic START/STOP and flow control of membrane trains using SCADA.
- Manual flow control of the membrane train using SCADA interface (workstation) and PLC.
- Automatic backwashing at various time intervals.
- Automatic shutoff and alarm for various failure modes for each membrane train and for entire
- Membrane Equipment System.
- START and STOP of any membrane air system.
- Membrane integrity test system.
- Determination of clean water permeability of each membrane train and temperature correction of the clean water permeability for each train.
- Operation of systems for maintenance and recovery cleans.
- Bubble point testing of the membrane modules.
- Monitoring and recovery of operating data.
- Proper operation of the fine screening system.
- Proper operation of the blower, pump and mixer systems.

- Monitoring and control from remote workstation.
- Automatic switchover from normal power to emergency power, and emergency power to normal power.
- All control functions, both at local system and remote workstation.
- Operation of all monitoring instruments.

Commissioning Checks and Wet Test Requirements:

Wet tests shall be carried out on completion of dry tests and shall comply with relevant approved engineering international standard / code. Raw water or treated water (if available) shall be used for hydraulic wet tests. The purpose of the tests is to prove as far as is practical the hydraulic performance of the Works. In order to demonstrate this the Contractor shall ensure that each part of the Works is hydraulically loaded to its rated throughput (including a period of overload if required in order to demonstrate compliance with the Employer's requirements) for a continuous stable operating period of not less 48 hours.

In order to ensure a sufficient supply of raw water to carry out these tests the Contractor shall provide facilities for the disposal off Site in an approved manner. In order to remove doubt the following tests inter alia shall be carried out:

- pressure testing of all piped systems laid direct in ground in accordance with the relevant standards;
- fill all structures and check for leaks;
- filling of all storage vessels to check for leaks and distortion;
- running of all pumped systems in order to check for:
 - correct functionality;
 - absence of leaks;
 - correct running temperatures
 - smoothness of running and the absence of undue vibration or stress;
 - Check drive running currents.
- carry out calibration of instruments where appropriate;
- carry out valving, diversions etc. to fully hydraulically load (or where there is a requirement to withstand an over load to overload) each process element;
- manual operation and automatic commissioning tests of all the equipment and protection systems
- alarm initiation
- Demonstrate correct functionality of electrical, control and instrumentation systems.
- Verification of conformance to specified or guaranteed performance as far as is practical at the initial loading.

The Contractor shall simulate where practical the conditions that will prevail when operating as a process in order to demonstrate the correct functionality of process control loops etc.

During these tests a check on the performance of Plant shall be made, as far as site facilities will allow, to compare its site performance with the factory test data and to identify any constraints on performance due to site conditions.

Safety Audit

After satisfactory completion of hydraulic wet tests and prior to introduction of process fluid to the plant a safety audit shall be carried out to ensure compliance with the necessary requirement for safety and for operation of the plant. The safety audit shall be documented. The safety audit document shall be approved by the Engineer prior to commencement of Plant commissioning.

17.11 Process Wet Tests with Raw Sewage

On approval by the Engineer the Contractor shall carry out process wet tests.

Raw Sewage shall be used as the main feed stock for process wet test. These tests shall be carried out to demonstrate the process performance of the Works. In order to demonstrate this, the Contractor shall ensure that each part of the Works is loaded to its rated throughput (including a period of overload if required in order to demonstrate compliance with the Employer's Requirements) for a continuous stable operating period of not less than 48 hours. If necessary, Contractor shall create design loading conditions for testing purposes by testing fewer than the total number of installed units of process tanks or equipment at a time. In such cases, multiple tests shall be conducted to ensure that all installed units are tested.

The Contractor shall provide all required facilities for the disposal off Site in an approved manner.

The following tests inter alia shall be carried out:

- 1) Check for leaks on vessels, structures, pumps and pipe work
- 2) Running of all pumped systems in order to check for
 - Correct functionality.
 - Absence of leaks.
 - Correct running temperatures.
 - Smoothness of running and the absence of undue vibration or stress.
 - Check drive running currents where the solution pumped is different from that pumped during hydraulic wet tests.
- 3) Carry out calibration of instruments
- 4) Carry out valve operation, diversions etc. to fully hydraulically load each process element (or where there is a requirement to withstand an over load), overload each process element.

- 5) Demonstrate correct functionality of electrical, control and instrumentation systems not checked during dry or hydraulic wet tests or which may have changed as a result of the different operating conditions now prevailing

On completion of the tests on the various parts of the works the Contractor shall run the plant as a whole in order to demonstrate the full functionality and performance of the Works at various throughput rates for a continuous period of not less than 30 days.

During the various process tests the Contractor shall perform sampling and analysis of all the process streams (locations) and parameters listed in the "Sampling/Analysis Locations and Frequencies" table provided in the "Tests after Completion" Section below. The frequencies listed in this table shall be followed for the Tests after completion. However, for the Process Wet Tests performed as part of the Tests On Completion, the sampling frequency for all locations and all parameters shall not be less than once every hour. The Contractor shall demonstrate to the Engineer that the Works is functioning in accordance with the Employer's Requirements. Each sample shall comprise two 1 litre (minimum) quantities and shall be labelled to identify the contents were taken and time and date. The flow recorded at the time of sampling shall also be indicated in the log book or record. One sample shall be used by the Contractor for his analysis; the other shall be handed over to the Engineer.

The Engineer reserves the right to take additional samples and to carry out his own tests or to check the correctness of samples taken by the Contractor.

The Engineer shall be given reasonable access to the premises where analysis is taking place in order to check on working practices and the procedures being adopted.

17.12 Effluent Quality Criteria for passing the Tests on Completion

The Works shall be considered to have achieved the required effluent quality standards for passing Tests On Completion if all samples taken during a 15 day continuous operational period comply with the criteria set down for passing the Tests After Completion. This includes criteria relating to the reliability of the plant.

The Effluent quality Tests On Completion shall not be commenced until all tests associated with the civil/building, electrical and mechanical works and individual process tests have been completed to the satisfaction of the Engineer.

17.13 Co-operation with other Contractors in the Execution of their Tests

The Contractor shall coordinate with other Contractors, where required, assist other contractors in carrying out their tests on completion and or tests after completion.

17.14 Tests after Completion

17.14.1 General

On successful completion of "Test on Completion" the Contractor shall carry out over a period of time not exceeding three months two separate 15 days operational tests. These tests shall be used to prove the operation of the Works at varying flows and with varying

raw sewage quality. During these tests effluent produced by the works will be entering the disposal system.

The total time for carrying out the tests shall not be less than three calendar months. One of the tests for each part shall be carried out in a period of high raw sewage BOD and suspended solids.

On commencement of each 15-Days test the Employer shall allocate a continuous period of not greater than 30 days to complete the test. Any failure to perform during the 30 days period shall restart the '15 day clock'. If the part of the Works fails to pass the test in the 30 days period the test shall be deemed as a failure and the Contractor shall carry out any necessary remedial work to the satisfaction of the Engineer before the Contractor restarts the test.

During the tests the Contractor shall take samples to demonstrate that the part of the Works is performing in accordance with the Employer's Requirements. The procedure for taking the samples shall follow the pattern adopted for Test on Completion. Samples shall be taken at locations and intervals detailed below. The results of the Tests after Completion shall be compared and evaluated by the Employer and Contractor.

The Contractor will not be held responsible for interruptions to the sewage treatment process as a result of Grid power failures (unless as a result of a Plant failure) interruptions in the raw Sewage supply etc. which are out of his control. However, the Contractor shall be required to demonstrate that the Works can cope with these inevitable interruptions in an orderly fashion and recover to a normal operational state with the minimum of manual intervention.

All consumables except power needed for operation of the Works shall be provided by the Contractor.

The Contractor shall provide all facilities and equipment not supplied under the contract and which are deemed necessary for the Contractor to carry out and monitor the Tests after Completion.

17.14.2 Sampling and Analysis

Sampling and analysis shall be performed to measure the parameters indicated in the table below, at the locations and frequencies indicated in the table. In case of multiple units (Such as multiple aeration basins or clarifiers), the indicated sampling and analyses shall be performed for each individual module.

Table 17-1 STP Sampling/Analysis Locations and Frequencies

Sample Location and Parameters to be measured	Frequency	Sampling Method
STP Effluent (Outlet of Chlorine Contact Tank): All parameters specified under the Treated Sewage Effluent Limits, sub-section of Volume 2, Part 2, Section 2.3	Daily	Flow-weighted 24-hour composite
Dewatered Sludge: All parameters specified under the Sludge Generation and Dewatered Sludge	Daily	Composite of samples from each container or

requirements, sub-section of Volume 2, Part 2, Section 2.4		vehicle filled during the day
Odor: All parameters specified under the treated odor quality, sub-section of Volume 2, Part 2, Section 2.5	Daily	Composite of air samples measured at the discharge of 2 nd stage OCU stack
Raw Sewage Influent, STP Effluent, MLR, RAS, Waste activated sludge (WAS), Thickened Sludge, Dewatering Influent, Odor Control Unit influent, Plant Recycles: Flow	Continuous	Continuous Instantaneous flow from recorder
Raw Sewage Influent, Secondary Effluent and Filter effluent: TSS, VSS, Temperature, pH and TDS	Daily	Flow-weighted 24-hour composite
Raw Sewage Influent and Secondary Effluent: BOD, COD, TKN, Ammonia Nitrogen, Nitrate-N, Nitrite-N, Total Phosphorus, Soluble Phosphorus and Alkalinity	3 times per week	Flow-weighted 24-hour composite
Aeration/MBR Basins: MLSS, MLVSS, Temperature, SVI	Daily	Grab
Bioreactor zone profiles (Anoxic and Aeration): Ammonia Nitrogen, Nitrate-N, Nitrite-N, Total Phosphorus, Soluble Phosphorus, DO, bCOD and rbCOD	3 times per week	Grab
RAS, WAS, Thickened Sludge, Dewatered Sludge: TSS, VSS	Daily	Grab
Chemicals/ Scum/Screenings/Grit: Specific Weight, volume, weight, chemical consumption	3 times per week	Grab

Table 17-2 CETP Sampling/Analysis Locations and Frequencies

Sample Location and Parameters to be measured	Frequency	Sampling Method
CETP Effluent (Outlet of Chlorine Contact Tank): All parameters specified under the CETP Treated Effluent Limits, sub-section of Volume 2, Part 2, Section 3.3	Daily	Flow-weighted 24-hour composite
Dewatered Sludge: All parameters specified under the Sludge Generation and Dewatered Sludge requirements, sub-section of Volume 2, Part 2, Section 3.4	Daily	Composite of samples from each container or vehicle filled during the day
Odor: All parameters specified under the treated odor quality, sub-section of Volume 2, Part 2, Section 3.5	Daily	Composite of air samples measured at the discharge of 2 nd stage OCU stack
Raw Industrial Influent, Equalization Tank Outlet, CETP Effluent, MLR, RAS, Waste activated sludge	Continuous	Continuous Instantaneous

(WAS), Thickened Sludge, Dewatering Influent, Odor Control Unit influent, Plant Recycles: Flow		flow from recorder
Raw Sewage Influent, Primary Effluent and Secondary Effluent: TSS, VSS, Temperature, pH and TDS	Daily	Flow-weighted 24-hour composite
Raw Sewage Influent, Primary Effluent and Secondary Effluent: Heavy metals, BOD, COD, TKN, Ammonia Nitrogen, Nitrate-N, Nitrite-N, Total Phosphorus, Soluble Phosphorus and Alkalinity	3 times per week	Flow-weighted 24-hour composite
Aeration/MBR Basins: MLSS, MLVSS, Temperature, SVI	Daily	Grab
Bioreactor zone profiles (Pre-anoxic, Aeration and Post-anoxic): Ammonia Nitrogen, Nitrate-N, Nitrite-N, Total Phosphorus, Soluble Phosphorus, DO, bCOD and rbCOD	3 times per week	Grab
RAS, WAS, Thickened Sludge, Dewatered Sludge: TSS, VSS	Daily	Grab
Chemicals/ Scum/Screenings/Grit: Specific Weight, volume, weight, chemical consumption	3 times per week	Grab

All costs associated with the taking and analysis of samples shall be met by the Contractor. The analysis shall be carried out by certified laboratory approved by the Engineer, and shall be performed in strict compliance with appropriate analytical methods published in Indian Standards, or in "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, or as published by the US Environmental Protection Agency. The Contractor shall submit to the Engineer a comprehensive report of the above sampling and analysis, including details of each analytical test as well as a summary of all the data and results in a Microsoft Excel spreadsheet.

17.14.3 Criteria for Passing the Test After Completion

Treated Effluent, Dewatered Sludge and Odor Quality Criteria:

The works shall be deemed to have met the Treated Effluent, Dewatered Sludge and Treated Odor Quality Criteria if:

- I. at least 95 percent of the plant effluent samples described above meet the requirements specified under the "Effluent Quality Requirements" sub-section of Volume 2, Part 2, Section 2.3 (STP) and Volume 2, Part 2, Section 3.3 (CETP)
- II. at least 95 percent of the dewatered sludge samples described above meet the requirements specified under the "Dewatered Sludge Quality Requirements" sub-section of Volume 2, Part 2, Section 2.4 (STP) and Volume 2, Part 2, Section 3.4 (CETP), and

- III. at least 95 percent of the Odor samples described above meet the requirements specified under the "Treated Odor Quality Requirements" sub-section of Volume 2, Part 2, Section 2.5 (STP) and Volume 2, Part 2, Section 3.5 (CETP)

Operational Cost Criteria:

The plants shall have fulfilled the operating cost criteria if the operating costs determined during the Tests After completion are in agreement with or less than those detailed in the Contractor's Functional Guarantee or an amount of liquidated damages are agreed by the Contractor and the Engineer to compensate for any short fall in performance up to an agreed maximum amount if stated.

Plant Reliability Criteria:

A part of the Works shall be deemed to have failed its test if:

- I. A single item of Plant/ equipment fails more than twice during the test.
- II. More than four individual Plant items/ equipment fail.

An item of Plant / equipment shall be deemed to have failed if manual intervention is required in order to restore the Plant / equipment to its fully operational state: i.e. the failure of a duty drive will be considered as one failure, if the standby drive fails to start that will be considered as a second failure.

17.15 Performance Certificate

The conditions for issuance of a Performance Certificate shall inter alia comprise:

- I. The completion of the three months operation of the Works (Tests after Completion) to the satisfaction of the Engineer.
- II. The O & M Manuals have been updated following one year's operational experience and approved by the Engineer.
- III. All defects identified prior to Taking Over and defects identified during one year operation of the Works have been rectified.
- IV. All Tests "After Completion" have been completed to the satisfaction of the Engineer.
- V. All training detailed in the Employer's Requirements has been completed.

18. TRAINING TO AITL

18.1 General

The Contractor shall provide comprehensive training for the different categories of the Employers operation and maintenance staff. Training shall fall into two main types which are 'off the job' and 'on the job'. Off the job training shall take place in the class room and on the job training shall be carried out on the running plant(s).

18.2 Off The Job Training

The Contractor shall prepare formal training documentation for distribution to the trainees. Visual aids shall be used to illustrate the points being made and to make the training programme interesting and enjoyable for the participants.

The off the job training shall comprise the following:

Off the Job Training Programme for all Trainees:

To provide training:

- on the simple physical-chemical and biological process principles involved in the operation of the Works;
- regarding basic features of the electro-mechanical and instrumentation equipment to be installed
- health and safety;
- plant safety procedures;
- On the use of the local and central HMIs.

Off the Job Process Training Programme for Operators:

To provide training:

- on the operation of individual items of plant and sections of the Works including automatic operation and manual operation;
- on the day to day operation of the Works and procedures;
- on a comprehensive list of 'what if' scenarios dealing with the actions to be taken in the event of potential process problems, alarms, plant failures, overflows, power failures etc.;
- on first line mechanical maintenance;
- safe work practices;
- on safety procedures to be followed in operating, maintaining, and cleaning the plant;
- Special procedures to be followed in the event of chlorine leak.

Off the Job Training Programme for Electrical Maintenance Staff:

To provide training:

- on the configuration, construction and operation of the electrical Plant;
- on the electrical maintenance requirements of the Works;
- on the switching and safety procedures to be followed;
- safe methods of working;
- On fault finding and repair procedures.

Off the Job Training Programme for Control and Instrumentation (ICA)

Maintenance Staff: Refer to the following section 18.6

Off the Job Training Programme for Mechanical Maintenance Staff:

To provide training:

- on the routine mechanical maintenance requirements of the Works;
- on lubrication requirements of the Works;
- on fault finding, repair and overhaul procedures;
- Safe methods of working.

Off the Job Training Programme for Waste Water Treatment Management Staff:

To provide training:

- sewage treatment process management techniques;
- Waste Water Treatment Plant cost management;
- Waste Water Treatment Plant laboratory management;
- safe methods of work general;
- On safety procedures to be followed in operating, maintaining and cleaning the plant.

18.3 On The Job Training

The Contractor shall utilize the Operation and Maintenance Manuals as the primary training aid in carrying out the on the job training. Shortcomings, omissions and errors identified in the O & M Manuals during the training shall be rectified prior to final acceptance of the O & M Manuals.

On the Job Training Programme for all Trainees:

To provide training:

- Plant familiarization tour;
- on the use of the local and central HMIs;
- Health and Safety;
- Identify areas where special safety precautions are necessary.

On the Job Process Training Programme for Operators:

To provide training:

- under operational conditions on the operation of individual items of plant and sections of the Works including automatic operation and manual operation;
- illustrate by example the day to day operation of the Works and procedures;
- illustrate by example the actions to be taken in the event of potential process problems, alarms, plant failures overflows, power failures etc. (as identified in the 'what if' scenario off the job training);
- illustrate by example the first line mechanical maintenance;
- illustrate by example safety procedures to be followed in operation, maintenance and cleaning of the Works.

On the Job Training Programme for Electrical Maintenance Staff:

To provide training:

- carry out detail tour of the electrical plant;
- illustrate by example the operation of the electrical Plant;
- illustrate by example the electrical isolation and maintenance procedures;
- illustrate by example fault finding and repair procedures;
- illustrate by example switching and safety procedures to be followed;
- illustrate by example safe systems of work.

On the Job Training Programme for Mechanical Maintenance Staff:

To provide training:

- illustrate by example the routine mechanical maintenance requirements of the Works;
- illustrate by example lubrication procedures;
- illustrate by example fault finding, repair and overhaul procedures.
- illustrate by example safe systems of work.

18.4 Training Programme

Off the job training shall be carried out prior to Handing back of the Works or any section of the Works.

Off the Job training shall be carried out prior to On the Job training. On the Job training shall be completed as a condition for acceptance of the Works following completion of the Tests after Completion.

The Contractor shall provide a training plan for each category of staff. The training plan shall detail the content and duration of each course. The training plan shall be submitted for the approval of the Engineer at least 120 days prior to the commencement of the Tests on Completion. The duration of training offered for each category of staff shall not be less than that detailed in the following table.

Table 18-1 Duration of Training

Category of Staff	Off the Job (minimum days duration for each course)	On the Job (minimum days duration for each course)
All staff	1	1
Operator	3	5
Electrical technician/electrician	2	2
Control/instrument technician	10	5
Mechanical technician/fitter	2	2
WWTP management	3	(see note)

Note: It is assumed that WWTP managers on the job training will be continuous throughout 12 months in a calendar year when the plant(s) is operated by the Contractor. The training day shall be assumed to be not less than 8 (eight) hours split into two sessions. The Contractor shall provide facilities for training which shall include inter alia the training rooms/locations, tables and chairs, projectors, white/black boards, training aids etc.

Where trainees of a given category can all be released from their Works operational duties simultaneously they may be trained together. Where this is not possible the Contractor shall repeat the complete course for those who could not attend.

18.5 Training Personnel

The Contractor shall provide suitably qualified trainers to carry out the off the job and on the job training.

The trainers are to be experienced in Waste Water Treatment Plant management, operation and maintenance in their relevant discipline and in the training of skilled and unskilled staff.

The Contractor shall submit the curriculum vitae of the trainer nominee's to the Engineer for approval 120 days prior to the commencement of the Tests on Completion. The training expert shall be fluent in English and Hindi Languages or the Contractor shall provide the services of an interpreter during the training periods.

18.6 Instrumentation, Control & Automation Training requirements

The Contractor/ system supplier shall conduct training courses for personnel selected by the Employer. Training shall be conducted by personnel employed by the Contractor/ system supplier familiar with the system supplied and who have experience and training in developing and implementing instructional courses.

The contractor shall arrange training for personnel of the Employer for 5 days before the conduction of the completion test of the Facility.

The entire cost of the complete training programme, including reasonable per diem expenses to cover meals, lodging, transport and similar expenses for all the Employer's personnel and the consultants attending the training program, shall be the borne by the Contractor/ system supplier and shall be included in the contract price.

The Contractor shall submit information on the training programme for approval, prior to shipment of the equipment. This submittal shall include a course outline; time required, course schedule, sample workbook and instructor qualification information for each level.

The Contractor/ system supplier shall make a workbook on each course available to every person taking the courses listed herein. The workbook shall be of sufficient detail so that, at a later date, a trainee could review in detail the major topics of the course.

The training times shall be scheduled by the Employer in advance with the Contractor/ system supplier so as not to disrupt the Employer's ability to operate the plant.

18.7 Operations and Maintenance Training

Training shall be provided for ten (10) of the Employer's personnel at the Contractor/ system supplier facility on operations and maintenance of all system components separately for the WWTP. The training program shall be divided into two segments and shall consist of at least 5 (five) working days, each of 8 (eight) hours duration.

The maintenance training program shall be developed for personnel that have electronics maintenance and repair experience and a general knowledge of computer systems, but shall not assume any familiarity with the specific hardware furnished. As a minimum, the following subjects shall be covered:

- System Architecture and Layout
- Hardware Components
- Module Switch Settings (Configuration Switches)
- I/O Modules
- Power Supplies
- Data Highway:
- Programmer connection
- IOP programming and diagnostic techniques
- Battery replacement and recharging
- PC and workstation familiarization and maintenance:
- Troubleshooting
- Disassembly
- Cleaning
- Component Replacement
- Re-assembly
- The operation training programme shall include the following topics:
- Power-up, bootstrapping and shutdown of all hardware devices
- Interpretation of all standard displays
- Appropriate actions for software and hardware error occurrences
- Use of operator interface displays and keyboards
- Use of printer including replenishment of supplies
- Manual data entries
- Creation and editing of graphic operator display screens.
- Loading of any required software into the system
- Data base creation and editing.

19. OPERATION AND MAINTENANCE

19.1 Operation

19.1.1 General

The Contractor shall from the date for commencement of the Operation and Maintenance until expiry of the Operation Period carry out the Operation in strict accordance with the Registered/Approved Design, the Contractor's Plan and the programme consented to by the Employer and the provisions of the Contract. The Contractor shall provide all necessary Plant, and equipment to ensure the safe and secure Operation of the Facility. The scope of work for the Operation shall include the following:

- Liaise with the Employer and other stakeholders;
- Implement quality system and environmental management system in accordance with ISO 9001 and ISO 14001;
- Operation of all systems associated with the Facilities and disposal of residue from the operation.
- Prepare records and reports;
- Keep the Facility in clean, hygienic, tidy and safe conditions;
- Sustain and maintain condition of landscape establishment;
- Implement security control of the Facility;
- Carry out tests and laboratory analysis;
- Carry out preventive and corrective maintenance;
- Carry out audits, Performance Tests, Condition Surveys and Residual Life Assessments;
- Carry out overhaul, renewal and replacement of Plant;
- Carry out refurbishment of buildings, structures and civil works;
- Review and update the Contractor's Plan;
- Prepare submissions to the Employer and/ or the Employer's Representative, utility companies, government departments and authorities;
- Obtain and renew licences, permits and certificates necessary to operate the Facility;
- Conduct trainings for Contractor's staff and Employer's staff;
- Handing over back the Facility to the Employer and the follow-on contractor at the end of the Operation Period;
- All other activities set out in the Specification;
- All other liabilities, obligations set forth and reasonably implied in the Contract; and
- Handle and resolve complaints of public in relation to the operation of the Facility;

The Contractor shall operate the Facility in full compliance with the Environmental Performance Requirements and Operational Performance Requirements as specified in

the Specification. In the event that the Employer certifies non-compliances with these requirements under the Conditions of Contract, the payment of the Operation Fees shall be reduced or penalty will be applied, without prejudice to other provisions in the Contract, in accordance with the Conditions of Contract. Non-compliance points are allocated as specified.

The Contractor shall apply for and maintain all licences, permits and certificates necessary for the Operation of the Facility. Whenever there is alteration or modification of requirements of the said licences, permits or certificates, the Contractor shall propose the necessary changes to the Registered Design, the programme and/or relevant parts of the Contractor's Plan for the Employer's consent.

The Contractor shall supervise and control the actions of all Plant, and personnel on the Site to ensure the safe and secure Operation of the Facility. The Contractor shall maintain all areas in a clean and orderly condition at all times and shall ensure the correct and proper operation and handling of all equipment and materials. In particular, the Contractor shall comply with the approved operation and maintenance procedures for all plants and equipment and shall ensure that the safety systems are fully operative at all times.

19.1.2 Site Usage

Without the prior written consent of the Employer, the Contractor shall not erect nor bring on to the Site any additional structures, plants, equipment, materials or accommodation, other than those in the Registered Design or Contractor's Plans consented to by the Employer.

Without the instruction of the Employer, the Contractor shall not use the Facility, including but not limited to all Plant for any activities other than for the Operation under provisions of the Contract.

19.1.3 Condition of the Facility

During the Operation Period, the Contractor shall carry out maintenance, repair, rehabilitation and replacement work to ensure safe and effective operation of the Facility. The specific requirements are provided in the Specification.

On the expiry of the Operation Period, the Facility shall be handed back to the Employer in a good and fully serviceable condition suitable for the immediate and continual use by the Employer, his agents or the follow-on contractor in accordance with the Conditions of Contract and the Specification.

The colour of any paintwork and external finishes of buildings and structures, including any architectural finishes or the Registered Design shall not be changed without the prior consent in writing of the Employer's Representative. The Contractor shall inspect all paintwork and external finishes of buildings and structures at least once every 2 years for Mechanical Works and 5 years for Civil Works and shall carry out repainting or remedial works as necessary to the consent of the Employer's Representative.

19.1.4 The Contractor's Plan

The requirements for the Contractor's Plan are specified in the Specification. The following plans in the Contractor's Plan are relevant to the Operation:-

- Plant Management Plan;
- Human Resources Plan;
- Operation Plan;
- Asset Management Plan;
- Handing Over Plan;
- Environmental Management and Quality Plan; and
- Safety and Health Plan

The Contractor shall review, update and submit if necessary, plans (a) to (e) above annually during the Operation Period. In case there is no change to the previous plan(s), the Contractor shall declare such status in writing to the Employer instead of submitting the same plan(s).

The Contractor shall review, update and submit if necessary, the plans (f) to (g) above at monthly intervals during the Operation Period. In case there is no change to the previous plan(s), the Contractor shall declare such status in writing to the Employer instead of submitting the same plan(s).

If the Employer is of the opinion that any of the plans does not meet the requirements of the Contract, the Contractor shall revise or update the relevant plans and submit to the Employer for consent within 7 days of the date of notice served by the Employer.

19.1.5 Health and Safety

The Contractor shall be responsible for the adequate stability and safety of all work and operations connected with the execution of the Operation and the safety and health of all persons on the Site.

The Contractor shall take all reasonable measures necessary to ensure that all facilities within the Site are safely secured during typhoons and all other inclement weather conditions. The measures taken shall prevent facilities from causing damage to the Plant, and all persons on the Site.

The Contractor shall ensure that the Facility is adequately lit at all times, the level of illumination of each part of the Facility being consistent with the safe and effective functioning of that part of the Facility and for security purposes. The Contractor shall provide emergency lighting in accordance with the Specification.

The Contractor shall maintain the fire services installations at the Facility for fire detection and firefighting. Fire services installations shall be approved by the MIDC Fire Services Department as appropriate.

The Contractor shall display guidelines on personnel health precautions to be taken by all employees and users of the Facility, including those guidelines concerned with the risk of Leptospirosis (Weils Disease) at locations agreed by the Employer's Representative.

The Contractor shall develop and implement a Safety and Health Plan. The Contractor shall review and update the Safety and Health Plan in accordance with the Specification. For the avoidance of doubt, the Safety and Health Plan shall take into account of construction work associated with maintenance of the Facility.

The Contractor shall develop site specific safety training for all personnel as specified in the Specification.

The Contractor shall keep records on all safety and health matters. Such records shall be updated daily and be available at all time for inspection by the Employer's Representative. The safety and health records shall include as a minimum the following information:-

- A record of all employees on the Site;
- Dates and times of employees and staff having completed site orientation/safety training courses/drill exercises;
- List of safety and health equipment issued and maintenance records;
- Safety and health inspections carried out under the supervision of the Safety Manager;
- Safety and health instructions issued to employees and staff;
- Safety and health incidents/accidents and actions taken; and
- Safety and health prosecutions, non-compliances or observations notified by the Employer's Representative, Ministry of Labour and Employment or other authorities, and actions taken.

The Contractor shall formulate and implement strategies to promote good air quality and prevent indoor air pollution problems for buildings or any part of the building which is totally enclosed and served with mechanical ventilation and air conditioning system for human comfort, such as the offices, control rooms, and all indoor locations accessed by operation personnel.

The Contractor shall conduct fire and emergency drills at least 4 times each year during the Operation Period in enabling his staff and all personnel working in the Facility to familiarize with the proper response to fire incidents and emergency situations. The drill plans shall be included in the Operation Plan for consent and the drill records shall be submitted to the Employer's Representative.

First aid kits shall be provided and maintained by the Contractor throughout the Operation Period.

19.1.6 Environmental Management and Quality Assurance

The Contractor shall be responsible for taking mitigation measures to reduce environmental impacts and nuisances arising from the Operation of the Facility.

The Contractor shall implement an Environmental Management System in accordance with the requirements of ISO 14001 and develop a comprehensive Environmental Management Plan. The Contractor shall review and update the Environmental Management Plan when appropriate.

The Contractor shall maintain proper function of the ventilation for the whole operation to prevent any leakage of objectionable odour.

The Contractor shall implement a Quality Assurance System in accordance with the requirements of ISO 9000 and develop a comprehensive Quality Plan. The Contractor shall review and update the Quality Plan in from time to time and when appropriate.

19.1.7 **Cleanliness**

The Contractor shall all the times keep the Site and the Facility in a clean, tidy and hygienic condition to ensure that efficient operation of the Facility is maintained and appropriate environmental standards are complied with during the Operation Period.

The Contractor shall clean litter and debris from surface water drainage channels on a regular and frequent basis. If features are found that are preventing the adequate performance of the surface water management system or which may develop to an extent so that the performance requirements of the system are no longer adhered to, appropriate remedial work shall be carried out.

In addition to regular cleaning, the Contractor shall carry out thorough cleaning at least once per month of all indoor carpets to ensure free of deep seated dirt, stains and soils, with wet / steam carpet cleaning method.

The Contractor shall clean and wash the streets of the Facility at least once a day. The area to be washed and cleansed is hereinafter referred to as "the streets". "The streets" means internal roads of the plant and all adjacent footways and verges within the Facility. The Contractor shall take necessary measures to avoid spillage/leakage of sludge, water, wastewater, chemicals, fuels or other waste within the Site. Any spillage/leakage occurred shall be confined and cleaned immediately. The Contractor shall conduct a thorough check and clean-up at the end of the opening hours on each working day.

19.1.8 **Landscape Establishment**

The Contractor shall sustain and maintain in healthy, attractive and safe condition for all trees, shrubs, groundcovers, annuals, perennials and turf within the Site established in accordance with the Registered Design. The Contractor shall also clean-up and dispose of all clippings, pruning, etc., generated in the process.

The following items of work are general descriptions for guidance only and shall not be construed as a complete detailed list of all operations to be performed:-

- Maintain all landscape plant materials;
- Control and eliminate weeds in mulched areas, turf areas, planting beds, and inert materials;
- Control and eliminate pests; and
- Mow and edge turf.

The Contractor shall be responsible for the maintenance of landscape of the STP and CETP that is not limited to irrigation and watering of the grass land inside the boundary of the Plot 51.

19.1.9 Good Relations

The Contractor shall take all necessary and reasonable actions to preserve good relations with stakeholders, neighbors, statutory authorities and bodies and to avoid impairing any amenities by the behavior and actions of his employees, by the use of Plant, or by air or water pollution, or otherwise.

The Contractor shall immediately correct any nuisance such as dust, odor, waste or the like caused by receiving and treatment of Sludge and by transfer of ash and residue.

19.1.10 Security

The Contractor shall provide security services to meet the following objectives:

- To prevent damage, vandalism and the like to the Facility;
- To prevent unauthorized removal of any part of the Facility;
- To prevent unauthorized entry to the Facility;
- To prevent unauthorized parking within the Facility;
- To prevent unauthorized use of the Facility; and
- To provide first aid in an emergency in the Facility.

The Contractor shall provide security services on a 24-hour basis throughout the Operation Period.

Before and after opening hours of the Facility, the Contractor shall provide security personnel to patrol the Facility, and provide a gate control service at the main entrance to the Facility.

Outside the opening hours of Facility, the security personnel shall observe the CCTV monitors in the guard house at the main entrance to the Facility with the CCTV cameras trained on, but not limited to:

- peripheral areas along the Site boundary;
- Open tanks including aeration tanks, primary sedimentation tanks and secondary clarifiers,
- entrances to buildings and office area;

Any malfunctioning of security and safety installations (including CCTV cameras) and procedures shall be logged and remedied promptly and the Contractor shall ensure that security and safety are not materially compromised at any time. Where necessary, interim provisions shall be implemented

Security and safety installations and procedures shall be reviewed and updated at regular intervals during the Operation Period to take advantage of technological improvements and comply with prevailing good practice.

Regular tests, inspections and maintenance of the fire alarm system, and the fire services installations in line with industry standards and statutory requirements shall be carried out. Any malfunctioning shall be logged and remedied promptly.

The Contractor shall arrange the issue of passes to his employees for the Operation of the Facility, and persons authorized by the Employer for the admission to the Site and the Facility, and in such event any person who fails to show his pass on demand to any duly authorized person shall be refused admission. Incidents of unauthorized entry shall be reported to the Employer's Representative promptly.

The Contractor shall not allow and shall prevent any persons, other than his employees, agents for the Operation of Facility, and persons authorized by the Employer, from entering the Site and the Facility. For the avoidance of doubt, no visitor shall be allowed without prior permission of the Employer's Representative.

The Contractor shall maintain a record showing the names identity document numbers of all his employees or persons authorized by the Employer to whom passes have been issued. An updated record shall be available at all times for the Employer's inspection. The Contractor shall ensure that any pass issued must be returned and invalidated on the cessation of the bearer's employment, or as directed by the Employer's Representative, and in any case on the issue of the Handover Certificate.

19.2 Facility Operation

19.2.1 Operation Plan

The Contractor shall submit a draft Operation Plan to the Employer's Representative for certification. The draft Operation Plan shall be developed based on and shall not differ in any material respect from the Outline Operation Plan submitted by the Contractor. The Operation Plan shall include, but shall not be restricted to, the following sections:

General Matters:

- Overall plan for operation and maintenance of the Facility with due consideration on the reliability of performance, flexibility to cope with variability, diligence to maintain tidiness and cleanliness, capability to respond to emergency situations and effectiveness to handle complaints and to meet the Environmental Performance Requirements and Operational Performance Requirements;
- Provision of spare parts and special tools with quantity and particulars throughout the Operation Period for effective and uninterrupted operation of the Facility;
- Plan for maintaining good communication and relationship with neighbors and stakeholders; and
- Measures to enhance and sustain the good image of the Facility and the public acceptance.

Operation and Maintenance:

- Sampling and testing methodologies in determining physical, chemical and biological characteristics of influent and effluent of the Facility;
- Identification, elimination and mitigation of safety and health risks associated with the Operation of the Facility;

- Means and flow of communication among field staff, staff at control rooms and truck drivers for sludge disposal;
- Inventory control of consumables such as fuel, sand and various types of chemicals, dangerous goods and hazardous materials;
- Safe and proper storage and transfer of various types of materials and chemicals, dangerous goods and hazardous materials to assure the continuous operation of the Facility, the compliance with statutory requirements and avoidance of environmental nuisance;
- Upkeep of the CMMS to ensure availability of reliable on-line and archived data to satisfy operational needs as well as for assessment of the Contractor's compliance with contract requirements;
- Maintenance management plans for every system, building and infrastructure of the Facility;
- Preventative maintenance programmes;
- Procedures to handle corrective maintenance;
- Precautionary measures and arrangements for inclement weathers;
- Procedures to record and handle complaints;
- Arrangements for Employer's Audits;
- Operational arrangements related to Performance Tests;
- Operational arrangements related to Condition Surveys and Residual Life Assessments; and
- Procedures to prepare and submit routine records and reports to the Employer and the Employer's Representative.

Operational Performance and Environmental Performance Monitoring:

- Procedures, plans and actions to achieve compliance with the contract requirements in respect of Operational Performance and Environmental Performance and compliance of all conditions stipulated in the Project Environmental Clearance order.;
- Setting of appropriate triggering levels for early action against potential non-compliance with the contract requirements in respect of Operational Performance and Environmental Performance;
- Procedures, plans and actions to avoid non-compliance with the contract requirements in respect of Operational Performance and Environmental Performance; and
- Procedures and actions to rectify non-compliance with the contract requirements in respect of Operational Performance and Environmental Performance.

Operational Contingency Plan:

- Identification of potential problems that may cause disruptions to operation and assessment of potential impacts;

- Measures to handle identified potential problems and prevent disruptions to operation;
- Measures to handle emergency situations that may cause disruptions to operation and even shutdown of the Facility;
- Estimation of the duration of shutdown due to various disruption incidents;
- Procedures to handle unauthorized entry to the Facility;
- Precautions and procedures to resume operation after removal of the emergency situations; and
- Fire and emergency drill plans.

Information Technology System:

- Arrangements for ensuring data security and integrity, and prevention of unauthorized alteration;
- Arrangements for data recovery in dealing with accidental loss of essential operational data;
- Arrangements for allowing flexibility of the computer database to store and process data upon introduction of new technologies and data management system; and
- Provision of access to the Employer and the Employer's Representative in the specific parameter of operation.

Environmental Considerations:

- Assessment of water impacts arising from the Operation of the Facility;
- Assessment of noise impacts arising from the Operation of the Facility;
- Assessment of ecological impacts arising from the Operation of the Facility;
- Assessment of waste management arising from the Operation of the Facility;
- Assessment of rodent and insect control arising from the Operation of the Facility; and
- Assessment of other potential nuisances and environmental impacts arising from the Operation of the Facility.

The Contractor shall obtain the Employer's consent and State Environmental agency or Pollution Control Board on the certified draft Operation Plan, which will then be construed as the Operation Plan. The Contractor shall review and update the Operation Plan annually.

The Contractor shall update or amend the Operation Plan whenever the need to do so becomes apparent, which may include but not limited to the following:-

- a change ordered by the Employer, in accordance with the Conditions of Contract;
- any new or emerging technologies, techniques, practices and methods related to the Operation of the Facility that is more efficient or effective;

- any change in the procedures and arrangement of the treatment process as a result of liaison with the Drainage Services Department;
- any change required due to additions, amendments to current enactment, regulations, bye-laws or rules, or new enactments, regulations, bye-laws or rules made during the continuance of the Operation.

The Contractor shall submit the updated Operation Plan for the Employer's consent in a timely manner so as not to interfere the Operation. Submission of revision or update shall not relieve the Contractor from any of his liability or obligation under the Contract.

Throughout the Operation Period, the Contractor shall operate the Facility wholly in accordance with the currently consented Operation Plan.

19.2.2 Opening Hours of the Facility for Sludge Reception

The Facility shall run 24 hours every day and 365 days each year continuously under normal operation. It is the obligation of the Contractor to maintain the system operation safely with redundant backup despite failure occurs on non-critical systems.

All activities on the Site likely to produce any noise shall be subject to the requirements of the latest Noise Pollution (Control and Regulation) Rules with respect to the Operation.

19.2.3 Contractor's Resources

Organization Structure

The Contractor shall develop and implement a Human Resources Plan to manage the Facility considering the 24X7 operations in 3 shifts. The information shall include:

- Description of human resources plan, strategy and monitoring mechanism;
- Organization structure, bureaucracy and line of reporting;
- Position description, qualification and, responsibility and authority; and
- Succession planning of key positions.

The number of personnel below is regarded as minimum for both STP and CETP;

Table 19-1 Operator Personnel

Personnel	Min Nos. per day	Qualification	Minimum Experience	Main task
Plant Manager/ Engineer In charge	1	BE (Civil/ Chemical/ Env)	10 years	Manage and co-ordinate the operation activities to achieve satisfactory operation of the Facility
Engineer (Mechanical)	1	BE (Mech)	5 years	Responsible for daily O&M, process units, mechanical equipment of the WWTP and data collection.
Engineer (Electrical)	1	BE (Elec)	5 years	Responsible for daily O&M, electrical equipment of the WWTP and data collection.
Engineer (Inst &	1	BE (Inst)	5 years	Responsible for daily O&M,

SCADA)				Instrumentation equipment of the WWTP and data collection.
Engineer (Civil)	1	BE (Civil)	5 years	Responsible for daily maintenance of civil works
Operators / Shift in charge	6	ITI	5 years	Execution of specific tasks as indicated by the Engineer (Mech) and (E&I) for operating the different installation of WWTP.
SCADA Operators	2	ITI	5 years	Responsible for Operation & maintenance of SCADA system.
Electrician	3	ITI	5 years	Responsible for maintenance of electrical equipment.
Fitter(Mech.)	3	ITI	5 years	Responsible for maintenance of mechanical equipment.
Health and safety officer	1	Diploma in H&S	5 years	Responsible for H&S of plant and staff.
Chemist	1	(M.Sc. Chem/ Env)	5 years	Daily analysis of samples of WWTP and fixing of chlorine doses and sludge withdrawal
Lab technician	2	BSc/Diploma	5 years	To assist the chemist in daily analysis of samples.
Helper/Non Skilled labor	12	NA	NA	Assistance to operators & fitters for maintenance of plant
Security Guards	3	NA	NA	Plant safety
Cleaner/Sweeper	2	NA	NA	Plant cleaning, assistance in removal of screenings/grit/sludge etc.
Gardener	1	NA	NA	To maintain the garden / Landscaping of the plant

19.2.4 Manning Level

The Facility shall be manned 24 hours every day with adequate number of the Contractor's staff as may be necessary to ensure the safe and effective Operation of the Facility in compliance with the Contract. The Contractor shall determine the required manning level of each shift of operation and arrangement during emergencies and inclement weather conditions for the Employer's consent. The manning level shall be maintained at all times as that set out in the Human Resources Plan.

The Contractor shall at all times provide sufficient personnel to enable the fulfillment of all Operational Performance Requirements and Environmental Performance Requirements in accordance with the Specification, including the provision of sufficient staffing and equipment to handle any emergencies such that Operational Performance Requirements and Environmental Performance Requirements are maintained.

The Contractor shall appoint an Operation Manager to be responsible for managing the Operation of the Facility. This manager shall be suitably qualified and experienced and shall have experience of managing similar facilities elsewhere. The Contractor shall refer to the Specification for detailed qualification requirements of the Operation Manager. A

detailed curriculum vita of the Operation Manager shall be provided to the Employer for approval prior to the commencement of the Operation of the Facility.

19.2.5 **Operation and Maintenance Manual**

The Contractor shall prepare standard operation and maintenance procedures for the Facility.

The Contractor shall update the standard operation and maintenance procedures on an ongoing basis to reflect any changes to the Facility of newly introduced regulations and standards.

The Contractor shall prepare the Operation and Maintenance Manuals for the Facility, in a format to be agreed by the Employer. The scope of the manual for all the major equipment and systems of the treatment works should include the following:

- Introduction
- Permits and Standards,
- Description, Operation and Control of Wastewater Treatment Facilities
- Description, operation and Control of Sludge Handling Facilities
- Personnel
- Sampling and Laboratory Analysis
- Records and Reporting
- Maintenance
- Emergency Operation and Response Program
- Safety
- Utilities

The Contractor shall ensure that the Operation and Maintenance Manuals are comprehensive and cover all Plants of the Facility. The Operation and Maintenance Manuals shall have detailed descriptions of operation and maintenance procedures supplemented by updated drawings, figures, graphs, photographs and manufacturers' literatures.

A draft set of the Operation and Maintenance Manuals shall be submitted to the Employer's Representative for certification and subsequently to the Employer for consent at least 60 days before the Plant Commissioning.

Upon receiving certification and consent of the draft Operation and Maintenance Manuals, the Contractor shall update the Operation and Maintenance Manuals on an ongoing basis to reflect changes of the facilities, changes of work safety or other related regulations and standards.

19.2.6 **Traffic Control**

The Contractor shall be responsible for the control of all traffic within the Site.

The Contractor shall be responsible for the implementation of the traffic management within the Site. The Contractor shall provide assistance to and coordinate all the works required by other departments and authorities to implement the traffic arrangement.

The Contractor shall erect and maintain in good conditions traffic control and warning signs inside the Facility. Traffic signs and road markings shall be in accordance with the Specification and local safety regulation related.

19.2.7 Handling and Disposal of Wastewater Treatment byproducts

The Contractor shall operate and maintain a system for handling and disposal of by-products from the treatment, including solid waste, screenings, grit and sludge and other residue. When disposals of these by-products are necessary, the Contractor shall transport the by-products from the Facility to a proper landfill site, or other sites as directed by the Employer.

The requirements for handling and disposal of the by-products shall include but not be limited to the following:

- The Contractor shall carry out pre-treatment of the by-products before disposal, when necessary, to comply with the requirement to be accepted for landfill.
- Provision of sufficient vehicles throughout the Operation Period to transport the by-products from the Facility to the landfill site for disposal;
- Maintenance and repair of the vehicles in good and clean conditions for operation;
- Provision of sufficient containers for the storage and transport of the by-products from the Facility to the landfill site. These containers shall be non-combustible, able to withstand accidental impact, provided with covers/lids that can be securely locked during transport.

The Contractor shall obtain from the landfill site operator records of weight of the by-products disposed of at the landfill site for every trip.

All costs related to handling and disposal of the by-products, including but not limited to license application, transportation, tests and treatment shall be borne by the Contractor and deemed to be included in the Operation Fees.

19.2.8 Onsite Communications

The Contractor shall manage and maintain computer facilities and telemetry connections between the Facility and the Employer's on-site and off-site offices as specified in the Specification.

The Contractor shall manage and maintain telephone and facsimile services to the Facility and for the use of the Employer's Representative.

The Contractor shall establish communication links and provide proper equipment for communication between field staff, staff at control rooms, and truck drivers for operation and by-product disposal.

Prior to using any radio-communications on the Site, the Contractor shall have to obtain necessary licences granted by the Wireless Planning and Coordination Wing and all relevant bodies and authorities.

19.2.9 **Inventory Control**

Throughout the Operation Period, the Contractor shall provide and maintain special tools and spare parts in accordance with the Registered Design and sufficient for 2 years operation. The Contractor shall also maintain stock level of all consumables as required in the Specification or otherwise consented to by the Employer, to ensure continuous operation of the Facility. The required stock levels shall take into consideration reliability of sources and supply interruptions, for example, due to inclement weather.

The target stock levels to meet the requirements the Specification shall be set out in the Operation Plan. The quantity or amount of each item required to meet the target stock level shall be entered in the Computerized Maintenance Management System (CMMS) for monitoring.

The current stock levels shall either be updated on-line by monitoring signals of the SCADA system (e.g. level of chemical tanks) or by manual input to the CMMS at a reasonable frequency with reference to the respective consumption rates, but in any case not fewer than once per week. All delivery of spare parts and consumables shall be recorded as appropriate.

The Contractor shall develop and implement an appropriate inventory control system and work procedures such that stock levels of spare parts and consumables shall be updated in the CMMS and appropriate record files immediately at the time the spare parts and consumables are retrieved from the store. In general, the method and frequency of updating shall be stated in the Operation Plan for the Employer's consent.

The Contractor shall carry out inventory checks in every six months. The inventory checks shall be scheduled to avoid disturbance to the Operation and a one-week advance notice shall be served to the Employer's Representative. The Employer may, at his discretion, attend any of these inventory checks.

19.2.10 **Chemicals, Dangerous Goods and Hazardous materials**

The Contractor shall provide and maintain storage of chemicals, dangerous goods and hazardous materials required for the Operation. Dangerous Goods means any of the goods or substances to which the Dangerous Goods Ordinance applies.

The Contractor shall include in his Operation Plan a detailed list all chemicals, dangerous goods and hazardous materials to be used in the Operation with inventory control programme, safety plan and procedures for handling and storage.

The Contractor shall maintain appropriate stock levels to allow continuous and efficient Operation of the Facility but the quantity stored in the Facility shall not exceed the regulatory limits.

All chemicals, dangerous goods and hazardous materials shall be packed in containers of suitable design and construction so as to prevent leakage, spillage or escape of the

contents under normal conditions of handling, storage and transportation, and shall comply with relevant statutory and the requirements of MIDC Fire Services Department.

Storage areas of chemicals, dangerous goods and hazardous materials, including any room, cupboard, cabinet or bin, should display a hazard warning panel, notice or marking at or near the entrances or opening of the storage area and such panel, notice or marking should:

- be indicated in English and Hindi;
- be securely attached to or worked in vertical plane of the storage structure;
- be weather resistant and rigid;
- be kept clean and free from obstruction; and
- meet statutory and MIDC Fire Services Departments requirements where appropriate.

19.2.11 Break down and Emergencies

The Contractor shall notify the Employer's Representative in advance in writing of all shutdowns and interruptions to any part of the Operation. Provided that in the event of an emergency shutdown or any emergency action at the Site, the Contractor shall forthwith give notice by telephone and as soon as practicable thereafter give notice in writing to the Employer's Representative and specify the probable cause, effect and extent of such emergency.

Without limiting the Contractor's obligations and responsibilities under the other provisions of the Contract, the Contractor shall provide from time to time all temporary arrangements and contingency provisions necessary or as may be provided in the Contract to maintain the Operation during the maintenance, overhaul, renewal, breakdown, Performance Tests, Condition Surveys and subsequent repair of any part of the Facility, without limitation to the generality of the foregoing:-

- The Contractor shall not be permitted to suspend the Operation by reason of any such event;
- The Contractor shall make available at all times such workers, Plant as provided in the Contract for the execution of emergency works to the Facility;
- If by any reason of any accident or failure of other event occurring which, in the opinion of the Employer's Representative requires the emergency works to be executed or services to be performed, the Employer's Representative may give to the Contractor an order verbally in the first instance, to be followed by an proper letter instruction within 1 days of the issue by the Employer's Representative of the verbal order. The Contractor shall upon receipt of the verbal order immediately execute the works or perform the services with due diligence as instructed in the verbal order.

19.2.12 Emergency Procedures

The Contractor shall prepare an Operational Contingency Plan as part of the Operation Plan. This shall state the non-routine operational procedures to be adopted during emergencies, and shall include at least the following:-

- Fire;
- Vehicle breakdown and accidents;
- Facility closure;
- Procedure to handle excessive incoming sewage due to rain storm or infiltration;
- Floods;
- Inclement weather conditions;
- Power outage;
- Spillage of chemicals;
- Labor disputes; and
- Others.

The Operational Contingency Plan shall be submitted to all relevant authorities including but not limited to the Employer's Representative for comment and submitted to the Employer for approval. The Contractor shall review and update the Operational Contingency Plan regularly or when considered necessary by the Employer.

19.2.13 **Employer's Audit**

Unless otherwise specified, an Employer's Audit of the Facility operations shall be carried out, on a yearly basis, jointly by the Contractor and the Employer's Representative and shall include, without limitation, inspection and audit of the following:-

- Influent/Effluent quantities and characteristic;
- General plant and equipment conditions;
- Spare parts conditions;
- Storage of chemicals, dangerous goods and hazardous materials;
- Storage of consumables;
- Conditions of security and safety installations;
- Site Cleanliness and Housekeeping;
- Odor;
- Noise;
- Lighting;
- Surface water;
- Dust;
- Vermin/insect;
- Site Diary and Safety and Health Records;
- Operational records and data including SCADA and CMMS database;
- Manning levels

The observations and findings of the Employer's Audit, among the observations and findings identified from the routine inspection carried out by the Employer's Representative, shall be used to determine non-compliance with the Environmental Performance Requirements and the Operational Performance Requirements as specified in the Specification. In such case, the Employer will notify the Contractor as soon as is practicable specifying his observation of non-compliance in accordance with the Conditions of Contract.

On the basis of the Employer's Audit the Contractor shall be required to remedy any part of the Operation that is not in accordance with the requirements of the Contract.

Nothing in relation to the Employer's Audit shall relieve the Contractor of his obligations, liabilities and responsibilities and shall not constitute any admission on the part of the Employer that any such obligations, liabilities and responsibilities have been complied with.

The Employer's Representative will advise the Contractor of the date and time of the Employer's Audit. The Contractor's Operation Manager and Safety Manager shall be present during the Employer's Audits.

19.2.14 **Unscheduled Audit**

From time to time, the Employer shall send an audit team comprising the Employer's employees and/or the Employer's agents to carry out on-site detailed monitoring of every aspect of the operation and maintenance of the Facility. The Employer will give the Contractor 7 days' notice (the notice should be kept to the minimum) of commencement of the said audit. The Contractor shall make provisions to assist the Employer's audit team to monitor the operation and maintenance.

These shall include without limitation the following:

- To provide detailed operational and maintenance procedures and records within 3 days of being requested by the Employer in writing;
- To provide on the spot verbal explanation of operational and maintenance matters when asked;
- To provide responses to questions raised by the said team on the operation and maintenance of the Facility; and
- To provide comments within 14 days of receipt of report(s) produced by the said team regarding the operation and maintenance of the Facility.

19.3 **Facility Maintenance**

19.3.1 **General**

The Contractor shall carry out corrective and preventive maintenance for the Facility in accordance with the maintenance management plans in the consented Operation Plan to ensure the facilities and equipment perform to the specific standards.

The Contractor shall ensure on a continuing basis that at all times his maintenance procedures are sufficient so that:

- The Facility operates on a continuous basis in compliance with all stipulated performance requirements;
- The Facility is maintained to achieve its full designed working life; and
- The condition of the Facility at the expiry of the Operation Period enables it to meet its residual design life requirements as set out in the Specification.

All elements of the Facility shall be maintained at regular and frequent intervals so that their performance requirements are met.

The system of planned maintenance shall include the maintenance of adequate records.

Maintenance shall be carried out in a safe manner following the procedures for ensuring the safety of operatives including but not limited to a "permit-to-work" system, the correct use of lifting equipment and the isolation of Plant.

All elements of the Facility shall be regularly and frequently cleaned, checked for damage, and repairs made as appropriate. The frequency of cleaning and checking shall be proposed by the Contractor for agreement with the Employer's Representative.

The cost of maintenance, including remedial works identified in the Performance Tests and Condition Surveys, shall be deemed to be included in the Operation Fees.

The Contractor shall complete remedial works identified in the Performance Tests and Condition Surveys in the manner and within the time allowed in accordance with the Conditions of Contract. If the Contractor fails to complete the remedial works to the satisfaction of the Employer's Representative within the specified time, the Employer is empowered to instruct the remedial works to be carried out by other contractors and deduct the costs for such instruction from any payments due to the Contractor.

The Contractor shall make and maintain detailed records of all Facility maintenance work, which shall remain available for inspection by the Employer's Representative within 24 hours' notice.

In accordance with the Specification, the records of Facility maintenance work shall be submitted by the Contractor to the Employer's Representative on a monthly basis, and will be made available for inspection by Contractor bidding for any follow-on contract.

The Contractor shall maintain the Facility wholly in accordance with the requirements of the Contract and the approved maintenance management plans in the Operation Plan. If the Contractor identifies any possible alternative method of maintenance that may be more efficient he shall notify the Employer accordingly. If any such change to the method is acceptable to the Employer it will be implemented in accordance with the relevant provisions of the Contract.

19.3.2 Preventive and Corrective Maintenance

The Contractor shall be responsible throughout the Operation Period for the maintenance of the Facility and parts thereof including all preventive maintenance, overhaul, repairs, rehabilitation, renewal and replacement of Plant which at all times shall be maintained in good functional conditions and to perform in accordance with the Specification.

The Contractor shall develop and implement specific preventive maintenance programmes for every system, equipment, building and infrastructure of the Facility with the objective of maximizing their availabilities as well as minimizing any unscheduled maintenance or emergency shutdown.

The scope and frequency of preventive maintenance shall meet the manufacturer's recommendations, as a minimum, and shall be adjusted with reference to conditions identified in the previous preventive maintenance and any repair carried out recently.

The preventive maintenance programmes shall be incorporated into the Operation Plan and updated whenever necessary in accordance with the Specification. The same shall be entered into the CMMS in accordance with the Specification for generation of work orders and for monitoring.

For the avoidance of doubt, the replaced items or parts upon maintenance or repair shall be regarded as the property of the Contractor and at his disposal and/or removal off-site away of these items shall be made known to the Employer's Representative.

Scheduling of preventive maintenance which requires system or equipment shutdown shall ensure that the ability of remaining system or equipment can meet the Operational Performance Requirements and Environmental Performance Requirements.

The Contractor shall effect all necessary or appropriate maintenance with due diligence and expedition. Conditions of the Facility shall be proactively managed with defects rectified within a time frame agreed to by the Employer's Representative. The Contractor shall rectify any defects identified by the Employer's Representative in accordance with the Conditions of Contract.

Preventive maintenance, corrective maintenance and the subsequent repairs, renewal or replacement work shall be carried out in a safe manner, including the adoption of the appropriate safe work procedures stated in the Safety and Health Plan.

The Contractor shall pay particular attention to the setup and use of temporary equipment / works such as mobile lifting equipment, mobile access platforms, scaffolding, platforms and ladders, etc. All relevant guidelines, Code of Practices and statutory requirements shall be strictly followed.

19.3.3 Maintenance Management

The CMMS shall include functions for the creation and upkeep of work orders and maintenance records. The database shall include the following information:

- Preventive maintenance programmes of systems, equipment, building and infrastructure of the Facility, which are used to generate work orders for preventive maintenance automatically;
- Logs off system or equipment fault / breakdown and automatic generation of work orders for corrective maintenance;
- Date of inspection / maintenance (preventive or corrective) carried out;
- Names and positions of Contractor's staff carried out the inspection / maintenance;

- Logs off manual alterations of any operations records, etc.;
- Details of inspection / maintenance carried out including:-
 - Causes of maintenance
 - Maintenance procedures
 - Special gears / equipment used
 - Spare parts used
 - Status of Warranties of Equipment and updation
 - Equipment / parts replaced
 - Any follow-up actions / recommendations (e.g. change of operational procedures, etc.)

The CMMS shall have functions to organize, sort and filter the maintenance records in the database as required and perform statistical analysis and generate reports for performance monitoring.

The CMMS database shall be archived on a monthly basis. One electronic copy of the entire database shall be stored on the Site for retrieval as necessary. Another backup copy shall be passed to the Employer's Representative.

19.3.4 Calibration of Instruments and Measuring Equipment

The Contractor shall maintain accuracy and reliability of all measurement facilities throughout the Operation Period to enable correct and effective monitoring and control of the Facility.

The Contractor shall be responsible for the calibration and re-calibration as necessary of all measurement facilities. All calibration work shall be carried out so as not to delay or disrupt the Operation. Calibration frequency shall not be less than that recommended by the manufacturers of the instruments or measuring equipment and in any case no longer than 12-month intervals. For the avoidance of doubt, all costs associated with any agreed calibration shall be deemed to be borne by the Contractor and included in the Operation Fees.

The calibration shall be carried out by an accredited testing and calibration organization consented to by the Employer's Representative. The results of calibration shall be made available to the Employer's Representative.

19.3.5 Special Tools and Spare Parts

During the Operation Period, the Contractor shall provide and maintain special tools and spare parts in accordance with the Registered/approved Design.

The storage of special tools and inventory of spare parts shall be recorded and monitored in accordance with the Specification.

At the expiry of the Operation Period, the Contractor shall handover to the Employer all special tools and spare parts in accordance with the Registered Design. The stock level of spare parts shall be sufficient for 2 years operation from the date of Handover Certificate.

19.4 Records and Reporting

19.4.1 Archiving the SCADA and CMMS Data

The Contractor shall maintain all operation and maintenance records, including the SCADA and CMMS data, throughout the Operation Period in a safe and secure manner. No record shall be discarded without prior consent of the Employer. Any amendment to the records shall only be made in accordance with proper checking and authorization procedures, which shall be included as part of the Operation Plan submitted to the Employer for consent.

The Employer's Representative shall be allowed to check the abovementioned data and records described at any time.

As far as possible, all records shall be kept electronically utilizing the Contractor's Site computer facilities with backup security. If the computer facilities fail, then appropriate paper records shall be produced and filed.

The records shall be filed electronically and the electronic files shall be submitted to the Employer and/ or the Employer's Representative upon request. Copies of any paper record shall also be submitted at the same time. The Contractor shall submit formats of electronic and paper records to the Employer for consent.

For the purpose of retrieving SCADA and CMMS data under this Clause, the Contractor shall provide and maintain workstations at the Employer's offices, including an on-site office and an off-site office, the location of which shall be determined by the Employer. The requirements of these workstations shall be in accordance with the Specification. The workstations shall be complete with all necessary hardware and software. All cost, including for the avoidance of doubt application and subscription fees for licences and communication services, are deemed to be included in the fixed Operation Fees.

19.4.2 Site Diary

The Contractor shall maintain a Site Diary which shall include, as a minimum, the following information on a daily basis:

- Date and weather;
- Operation hours;
- Labor on the Site;
- Flow and quality records of influent and effluent;
- Disposal records of treatment by-products;
- Accidents and incidents;
- Instructions to the Contractor;
- Comments by the Contractor;
- Complaints received and action taken;
- Authorized visitors to the Site

The exact scope, form and layout of the Site Diary shall be agreed with the Employer from time to time.

The Site Diary shall be in a printed proforma completed with one original and three copies:

- Employer (Original);
- Employer's Representative;
- Contractor;
- File copy.

The Site Diary shall be checked and signed by authorized personnel of the Contractor in accordance with the consented Operation Plan. The completed Site Diary shall be made available to Employer's Representative for inspection not later than noon time on the following day.

The Contractor shall keep appropriate records of all personnel employed at the Site. These records shall be available for inspection by the Employer's Representative at any reasonable time. These records shall be kept available for inspection throughout the Operation Period.

The Contractor shall retain at the Facility a Construction Site Safety Manual or approved equivalent. All accidents occurring to personnel during the Operation Period shall be recorded and reported to the Employer's Representative within two hours of the occurrences of the accidents.

19.4.3 **Safety and Health Records**

The Contractor shall keep records on all safety and health matters as specified in the Specification and update such records daily for inspection by the Employer's Representative.

19.4.4 **Monthly Report**

The Contractor shall provide and present details, in the form of Monthly Reports, of operational data and information in relation to the Operation of the Facility to the Employer in a systematic and concise manner. Monthly Reports shall be submitted in duplicate to the Employer and the Employer's Representative by the 14th day of the month following the month to which the report relates. Typical required information and data shall include, but not be limited to the following:-

Project Management:

- An updated organization chart which includes details such as number of employees in the Facility by trades;
- Change of staffing;
- Summary of visits to the Facility;
- Performance Tests or Condition Surveys carried out and scheduled in the following month;

- Meetings held with the Employer, and other related authorities, etc.;
- Scheduled meeting in the following month; and
- Quantity and quality of influent and effluent, and a summary of problems encountered during the month.

Energy Consumption Data:

- Summary of energy consumption (fuel and electricity) of the Facility,;

Inventory and Consumables Data:

- Quantities of chemicals, reagents, fuel and spare parts consumed;
- Stock level of chemicals, reagents, fuel and spare parts;
- A list of current suppliers for chemicals, reagents and additives and their contact details;
- Delivery records of all consumables.

Environmental Monitoring Data:

- Records and document concerning the disposal of treatment by- products.

Maintenance Records:

- Summary of all preventive and corrective maintenance, plant alteration, renewal and replacement activities with descriptions, photos and drawings as appropriate;
- Summary of the CMMS database for ongoing maintenance / repair work carried forward to the next month;
- Summary generated from CMMS database for backlog of outstanding preventive maintenance work orders for 30 days and more (counting from the CMMS preset work order completion date), with reasons of delay and measures taken / plan to rectify;
- Summary generated from CMMS database for backlog of outstanding corrective maintenance work orders for 3 days and more, with reasons of delay and measures taken / plan to rectify; and
- Programme showing the scheduled maintenance (including planned and ongoing) work in the following month.

Incident Report:

- Covering injury of any staff or members of the public / fire / property damage, etc. and their corresponding statistical analysis;
- Covering any fatal incidents of any staff or members of the public;
- Details of incidents and recommendation on prevention of re-occurrence;
- Comparison with relevant statistics in the past; and
- Safety and security issues.

Complaint Record:

- Detailed account of each complaint including complainant, time, nature, issue of complaint and action taken; and
- Statistical analysis of all complaint records.

The Contractor shall supplement and present any additional operational data and information, in form of Monthly Reports or in ad-hoc manner, as requested by the Employer's Representative from time to time.

Details of report formats shall be approved by the Employer.

19.4.5 **Annual Report**

The Contractor shall submit Annual Reports to the Employer and the Employer's Representative before the last day of the anniversary month following the year to which the report relates.

- summaries of quantities and characteristics of sewage received and treated at the Facility during the reporting year;
- overall performance of the Facility with highlights on non-compliance with Operational Performance and Environmental Performance Requirements;
- summary of expiry dates for licences, permits and certificates for the Operation;
- summary of major equipment breakdown, repair, overhaul, renewal, replacement, modification, Performance Tests, Condition Surveys carried out, with CMMS reports;
- summary of incidents related to safety and health, environmental issues, security and complaints;
- scheduled maintenance, overhaul, renewal, replacement, modification of major plant and equipment, Performance Tests and Condition Surveys in the forthcoming 12 months;
- list of Changes ordered by the Employer, with details and status;
- summary of payments of Operation Fees; and
- records of the Contractor's financial performance including audited accounts with balance sheets and profit/loss statements.

Details of report formats shall be approved by the Employer.

19.4.6 **Monthly Environmental Monitoring Report**

The Contractor shall submit Monthly Environmental Monitoring Reports to the Employer and the Employer's Representative by the 14th day of the month following the month to which the report relates. Typical required information and data shall include, but not be limited to the following:-

- results of environmental monitoring undertaken during the reporting period;
- actions and mitigation measures adopted or to be adopted to redress unacceptable, consequential or unanticipated environmental impacts, together with an assessment of their likely effectiveness;

- comparison with both statutory and contractual compliance limits; and
- details of response in the event of any omissions or failures.

Details of report formats shall be approved by the Employer.

19.4.7 **Annual Environmental Audit Report**

The Contractor shall submit Annual Environmental Audit Reports to the Employer and the Employer's Representative before the last day of the anniversary month following the year to which the report relates.

The Annual Environmental Audit Report shall include review on environmental monitoring data and operational data obtained in the reporting year, with particular reference to the effectiveness of mitigation measures identified in the previous Environmental Monitoring/Audit Reports and measures that the Contractor proposes to adopt in overcoming any shortcoming.

19.5 **Asset Management**

19.5.1 **General**

The Contractor shall submit a draft Asset Management Plan to the Independent Representative for certification. The draft Asset Management Plan shall be developed based on and shall not differ in any material respect from the Outline Asset Management Plan submitted by the Contractor. The Asset Management Plan shall include, but shall not be restricted to, the following sections:-

- a) Asset Overview
 - classification and registry of assets of the Facility;
 - significance of assets to the performance of the Facility;
 - dependencies between the assets;
 - asset management strategy
- b) Performance and Standards
 - design lives of Plant, buildings and structures;
 - benchmarks, standards and guidelines adopted for Performance Tests, Condition Surveys and Residual Life Assessments
- c) Asset Performance Monitoring
 - plans, scopes, arrangements and reporting for Condition Surveys and Residual Life Assessments in accordance with the Specification;
 - plans, scopes, arrangements and reporting for Performance Tests in accordance with of the Specification;
- d) Asset Remediation Plans
 - Refer Section 19.5.2

The Contractor shall obtain the Employer's consent on the certified draft Asset Management Plan, which will then be construed as the Asset Management Plan. The Contractor shall review and update the Asset Management Plan annually.

The Contractor shall carry out all corrective and preventive maintenance programmes for the Facility in accordance with the consented Operation Plan and Asset Management Plan.

The Contractor shall carry out or cause to be carried out repair, replacement and rehabilitation of the Facility and the Site as required for the ongoing operation of the Facility in accordance with the design performance and standards.

The Contractor shall note that all reports prepared by the Contractor under this Specification will be made available for inspection by the Contractor for any follow-on contracts.

All costs associated with works and services pursuant to this Specification shall be borne by the Contractor and deemed to be included in the Operation Fees.

19.5.2 **Asset Remediation Plan**

The Contractor shall develop and implement asset remediation plans which shall include, as a minimum, the following:-

- schedules for overhaul and replacement of Plant;
- schedules for refurbishment and renewal of buildings and structures;
- planned actions to bring or keep the assets above their minimum conditions required under the Contract;
- criteria for acquisition and disposal of assets; and
- means and arrangements to demonstrate to the Employer that the Plant, buildings and structures have the respective residual lives specified in the Specification at the expiry of the Operation Period;

If the design life of any Plant, buildings or structures stated in the Asset Management Plan or otherwise established during Residual Life Assessments in accordance with the Specification expires during the Operation Period, the Contractor shall before such expiry renew, rehabilitate or replace such Plant, buildings or structures. The cost of such renewal, rehabilitation or replacement shall be deemed to be included in the Operation Fees provided that with respect to the design life of any Plant, buildings or structures which is due to expire but which Plant, buildings or structures still performs safely and efficiently and in accordance with the Contract requirements, the Contractor may at the option of the Employer's Representative defer such renewal, rehabilitation or replacement so long as the said performance continues but the Contractor shall in any event complete the said renewal, rehabilitation or replacement before expiry of the Operation Period.

19.5.3 **Condition Surveys**

The Contractor shall engage with the Employer's Representative to carry out Condition Surveys of the Facility in the presence of the Contractor or the Employer's

Representative. The survey shall be carried out in the seventh month of the 3rd year of the Operation Period, unless otherwise consented to by the Employer.

The scope of the Condition Survey shall include:

- Inspection and auditing of manuals, schedules, reports, SCADA and CMMS records for compliance;
- Visual inspection of all components, including Plant, buildings and structures for state of maintenance and repairs;
- Inspection of performance records and performance evaluation of the plant and equipment in operating condition;
- Witness testing of the plant and equipment in operating condition, including the Performance Tests specified in the Specification;
- Based on the above information, forming a view as to the general operation and maintenance condition of the Plant, buildings and structures, with due regard to their service hours and/or age; and
- Making recommendation on enhancement of the operation and maintenance of the Facility, where applicable.

The Contractor shall compile and submit a condition survey plan to the Employer for approval at least 45 days prior to commencement of the Condition Survey. The condition survey plan shall be prepared in consultation with the Contractor to ensure uninterrupted Operation of the Facility. The condition survey plan shall include the following information, as a minimum:

- a programme showing the systems, equipment, structures, etc. which are included in the Condition Survey;
- detailed descriptions of precautionary measures, methodologies, procedures, timing for the inspections, audits, measurements or tests to be carried out on each survey item;
- effect on normal operation of the Facility including any reduction in redundancy or standby capacity, with mitigation measures or temporary arrangements clearly stated;
- any safety, health and environmental related issues;
- details of any temporary work for the Condition Survey; and
- contingency plan for emergency situations that may arise during the Condition Survey.

The Condition Survey shall not commence until the condition survey plan have been approved to by the Employer. The entire condition survey shall be completed within 1 calendar month.

The Contractor shall prepare and submit to the Employer and the Employer's Representative, a detailed condition survey report within 28 days of the completion of the Condition Survey. The report shall include:-

- methodologies and findings of the survey;
- identification of any damage or defects;

- recommendation of rectification work required to satisfy requirements of the Contract; and
- recommendation of enhancement to the operation and maintenance of the Facility.

In the event that the Employer considers, as a result of the Condition Survey and the Residual Life Assessment specified in the Specification, if appropriate, that any part or parts of the Facility require repair, maintenance, rectification or replacement to satisfy the requirements of the Contract, the Employer will serve notice under the Conditions of Contract on the Contractor of the work necessary to be carried out. The Contractor shall ensure that all such repair, maintenance, rectification or replacement are completed within reasonable time and in any case not more than 90 days after receipt of the Employer's notice, unless otherwise consented to by the Employer.

Prior to the handing over of the Facility, the Contractor shall conduct an End-of- Contract Condition Survey as specified in the Specification.

The Condition Surveys in the 3rd year of the Operation Period shall include the Residual Life Assessment as specified in the Specification.

For the avoidance of doubt, all costs associated with the carrying out and reporting of the Condition Surveys shall be borne by the Contractor deemed to be included in the Operation Fees.

19.5.4 Residual Life Assessments

The Condition Survey in the 3rd year of the Operation Period and the End-of Contract Condition Survey (5th Year) shall include a Residual Life Assessment. The Residual Life Assessment shall be carried out as part of the Condition Surveys by the Independent Surveyor.

The Residual Life Assessment shall benchmark the Facility against relevant international standards / guidelines, and performance of similar facilities on a worldwide basis.

The Contractor shall include a separate section in the survey report specified in the Specification for the Residual Life Assessment, to record the following:-

- Residual life assessment methodology;
- Standards, guidelines and references adopted;
- Detailed descriptions of assessment carried out;
- Findings of assessment; and
- Recommendation of work required for the upkeep of the Facility in satisfactory conditions.

19.5.5 End of Contract Condition Survey

All requirements for Condition Surveys specified in the Specification and those for Residual Life Assessments specified in the Specification shall apply to the End-of- Contract Condition Survey unless otherwise specified.

The End-of-Contract Condition Survey shall be carried out at least 6 months but not more than 9 months prior to the expiry of the Operation Period to verify conditions of the Facility and ascertain the residual life of the Facility.

For the avoidance of doubt, the End-of-Contract Condition Survey shall include a Residual Life Assessment as specified in the Specification.

As part of the End-of-Contract Condition Survey, the Contractor shall carry out tests and provide all necessary assistance to the Employers' Representative to determine whether the Facility to be handed over to the Employer is in good and serviceable condition suitable for continual use and meets the residual life requirements as specified in the Specification.

The Contractor shall compile and submit an End-of-Contract Condition Survey Plan to the Employer for consent at least 60 days prior to commencement of the End-of-Contract Condition Survey. The plan shall include tests and inspections requested by the Employer.

The Contractor shall prepare and submit to the Employer, and the Employer's Representative, a detailed End-of-Contract Condition Survey report within 28 days of the completion of the End-of-Contract Condition Survey. The report shall include recommendation of work required to meet the residual life requirements specified in the Specification

In the event that the Employer considers, as a result of the End-of-Contract Condition Survey, that any part or parts of the Facility require repair, maintenance, rectification or replacement to satisfy the requirements of the Contract, the Employer will serve notice under the Conditions of Contract on the Contractor for the work necessary and the work that becomes necessary during the remainder of the Contract to be carried out and completed to the satisfaction of the Employer no later than 60 days prior to the expiry of the Operation Period. In the interpretation of the End-of-Contract Condition Survey, the Employer will have due regard for the obligation under this Contract on the Contractor to fully maintain the Facility that is to be handed over to the Employer in good and serviceable condition suitable for continual use to the performance requirements of the Facility.

If in the opinion of the Employer, the Contractor has failed to carry out any work to hand over the Facility in good and serviceable condition to the Employer for continual use at the expiry of the Operation Period, the Employer may order such defects to be made good and deduct the Costs from any payments due to the Contractor from this or any other contract the Contractor may have with the Employer.

After the remedial works carried out according to the notice served by the Employer after the End-of-Contract Condition Survey, the Contractor shall carry out joint inspections with the Employer's Representative on the plant and equipment that has been maintained or replaced, including all necessary tests to demonstrate that the requirements of the Contract have been met.

20. HANDING OVER

20.1 Handback Plan

The Contractor shall submit a draft Handback Plan with complete punch list of assets to the Employer's Representative for certification. The draft Handback Plan shall be developed based on and shall not differ in any material respect from the Outline Handback Plan submitted by the Contractor. The Handback Plan shall include, as a minimum, the following:

- a) Plans to transfer the Facility to the Employer or the follow-on contractor;
- b) Transition plans with respect to the Contractor's Personnel including a plan for transition of the operators to the Employer or the follow-on contractor;
- c) A proposed process for the transfer of all Contract Records to the Employer;
- d) Plans to transfer operations and maintenance functions to the Employer or the follow-on contractor, and
- e) A 3-month programme to train staff of the Employer and/or Employer's agents in all aspect of the Operation and Maintenance of the Facility

The Contractor shall obtain the Employer's consent on the certified draft Handback Plan, which will then be construed as the Handback Plan. The Contractor shall review and update the Handback Plan every year.

No later than 6 months prior to the expiry of the Operation Period the Contractor shall carry out training in the Handback Plan. All costs and expenses associated with the training of Employee's staff shall be borne by the Contractor and included in the Operation Fee.

20.2 Pre-Handover Procedures

The Contractor shall take all reasonable steps and co-operate fully with the Employer and any follow-on contractor so that any continuation of the operation is achieved with minimum disruption and so as to prevent or mitigate any inconvenience or risk to health and safety of the employees of the Employer and members of public.

The Contractor shall use reasonable endeavors to assist the Employer in the preparation for, and conduct of, a fair and competitive bidding process for any follow-on contract. In particular, the Contractor, shall make available to the Employer any information, and assist in the verification of any information as the Employer reasonably requires in connection with the bidding process

All the information provided by the Contractor to the Employer shall be true and correct in all material respects and will not be misleading, by omission or otherwise.

The Contactor shall make available at least 18 months prior to the expiry of the Operation Period, full details of the operation and maintenance documentation and records of the Facility for the entire Operation Period to date so that these can be made available for inspection by Contractor for any follow-on contact.

The report of the End-of-Contract Condition Survey and records of the subsequent maintenance and replacement works (if any) will be made available for inspection by Contractor for any follow-on contract.

20.3 Handing over on Completion

To ensure smooth transition of the Operation from the Contractor to the follow-on contractor, the Contractor shall co-operate fully with the follow-on contractor from the date of his appointment to allow the follow-on contractor's staff to train and work alongside the Contractor's own operatives before the expiry of the Operation Period to gain familiarity in the provision of the Operation.

20.4 Completion Documents

Completion (Handing over) documents shall include on a minimum 3 sets of soft copies and 3 sets of hard copies. The hard copies shall be spiral bounded clearly indicating the version/revision submitted. All the contents shall be indexed. The contents of completion documents shall be clearly legible and shall include original manufacturer's literature on a minimum, and incorporate any changes as per site conditions.

The comprehensive updated operation and maintenance manuals (six sets) shall be submitted at the end of the operation and maintenance period.

20.5 As-Built Drawings

Revised As-built drawings based on all modifications during O&M Period shall be submitted at the end of O&M period. It shall include all drawings of treatment units (plan and all necessary sections), utility and ancillary buildings, site layout of treatment plant and pumping stations, drawing of pump house, layout of pumps and all other mechanical equipment and piping, all electrical drawings like Single Line Diagrams, Schematic Diagrams, Control Circuits Equipment Layout, Cable Layout & Cable Schedules, Earthing Layouts and all ICA Drawings like P&ID; System configuration diagram (PLC & SCADA architecture), Instrument installation drawings, Instrument cable schedule, and cable layouts. Six sets of the revised as-built drawings shall be submitted in hardcopies and softcopies (editable form).

20.6 Completion Certificate for O&M Contract

The Contractor on completion of O&M period will request the Employer for a joint inspection of the Plant, after ensuring that all the Plant equipment's are in good handing over condition and all the requirements/documents as specified in this contract are also ready for handing over.

Based on above request a Joint Inspection with Engineer shall be arranged by the Contractor to assess the condition of civil structure, mechanical, electrical and instrumentation equipment and First Joint Inspection Report, for various required remedial actions, repair actions, replacement actions, tests etc. shall be prepared.

The Contractor shall attend to all points of Joint Inspection Report, by carrying out all such remedial/repair/replacement actions, tests at his own cost, and after attending, will confirm the same to the Employer.

On receipt of the confirmation, Second Joint Inspection shall be arranged by the Contractor, for certification of completeness of remedial work, as well as condition of all civil works to its original appearance.

The Contractor shall submit the entire required documents to Employer for review and comments. The Contractor shall resubmit the documents incorporating the comments.

The Employer shall issue the Completion Certificate of the O&M Contract to the Contractor within 30 days of acceptance of Second Joint Inspection Report, subject to the above documents and obligation are met by the Contractor before 90 days prior to handing over of the plant.