बृहन्मुंबई महानगरपालिका
Municipal Corporation of Greater Mumbai




Mithi River Water Quality Improvement Project

Package3: Dry Weather Flow Interception at Tidal Outfalls (including Gate Pumps), Transfer Sewer, Training of River (Retaining wall and Service Road), Beautification including Promenades and Allied Works from Prem Nagar outfall, Kurla to Mahim Causeway.

Design Build Operate

Contract Volume 2
Employer's Requirements

MUNICIPAL CORPORATION OF GREATER MUMBAI

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Volume 2 – Employer's Requirements

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1 INTRODUCTION

This volume describes the Employer's Specific Requirements for the Mithi River Water Quality Improvement project Package - 3 **"Dry Weather Flow Interception at Tidal Outfalls (including Gate Pumps), Transfer Sewer, Training of River (Retaining wall and Service Road), Beautification including Promenades and Allied Works from Prem Nagar outfall, Kurla to Mahim Causeway".** Design, Build and Operate (DBO) Contract. The Contract includes the Design-Build of the Works and the Operation Service.

The general technical specifications are included in Volumes 2A, 2B, 2C & 2E and describe the general requirements of the general technical, mechanical, electrical and Gate Pump works. Operation & Maintenance of pumping station is included in Volume 2F. Contract Drawings are included in Volume 2D and Background Information is included in Volume 5. By reference in this clause, Volumes 2A, 2B, 2C, 2D,2E , 2F and 5 form part of the Employer's Requirements.

If there is a conflict between the specific requirements of this Volume 2 and the General Technical Specifications in Volumes 2A, 2B,2C, 2E and 2F the Contract Drawings in Volume 2D, and the Background Information in Volume 5, then the specific requirements ofthis Volume 2 shall take precedence in accordance with Clause 1.5 of the Conditions of Contract.

The terms of the Contract are based upon the FIDIC Conditions of Contract for Design, Build and Operate Projects (The Gold Book).

1.1 Background to Scheme

1.1.1 Mithi River

The Mithi River runs 17.8 kilometres through densely populated residential and industrial areas. Except during the monsoon, the river is a non-perennial water body and carries only sewage and industrial effluent during the rest of the year.

1.2 Delivery Approach

MCGM had appointed the Consultant, M/s. Frischmann Prabhu (I) Pvt. Ltd. to suggest Short Term & Long Term measures for Mithi River Water Quality Improvement. After survey &study the Consultant had proposed Short Term Works and Long Term Works in 4 different packages to divert Dry Weather Flow of about 285 MLD discharging into Mithi River to Municipal Sewer system.

Package III (from CST bridge to Mahim Causeway including Vakola River), works are located in tidal influence zone. It includes training of river (Construction of Retaining Wall & Service Road), Pumping Stations, Interceptions &Diversion works for diverting Dry Weather Flow (DWF)of various outfalls / nallas into nearby existing Municipal Sewer networks along with Gate Pumps, Beautification including Promenades & allied works.

It comprises of Sewer line work (7.61km), Retaining Wall (7.490 km), Service Roads (6.421 km), 28 nos. of Interceptors, 26 nos. of Gate Pumps, 3 nos. of Sewage Pumping Stations and 8.850 kms of beautification of river including Promenades with their O&M for 10 years.

All Tidal Outfall currently entering the Mithi River from South-west portion Bandra, Mahim Sion link road, Dharavi road south and LBS road will be intercepted and transferred to existing sewage treatment plants by connecting it into nearby existing sewers. Wherever possible the intercepted sewage is transferred by gravity sewer else throughpumping.

1.3 Objectives of the Contract

The main objectives of this DBO Contract for Contract Package 3are:
Table 1-1Contract Objectives

No.	Objective
	Through the Employer's (MCGM's) Delivery Strategy which sets out four Contract Packages, the overall aim is to curb the pollution load of the Mithi River. Specific Package 3Contract objectives are as follows:
1.	Package III (from CST bridge to Mahim Causeway including Vakola River), works are located in tidal influence zone. It includes training of river (Construction of Retaining Wall & Service Road), Pumping Stations, Interceptions &Diversion works for diverting Dry Weather Flow (DWF)of various outfalls / nallas into nearby existing Municipal Sewer networks along with Gate Pumps, Beautification including Promenades & allied works.
2.	Undertake all work in a safe manner, minimizing health and safety risk to all involved or affected by the project.
3.	Comply with all relevant environmental regulations and legislation throughout the construction and operation of the Contract.
4.	Complete the Build phase of the Contract by December 2023
5.	Operation and maintenance of the interception&transfer facilities, Sewage Pumping station and storm water pumping station (Gate pumps) for a period of10 years following the Design-Build Period, including disposal of screenings produced.
6.	Hand back the Works to the Employer in a well maintained, operating condition at the end of the Contract.

1.4 Description of the Works

1.4.1 Dry Weather Flow Interception /Transfer

The general principle for this element of the Contract Package is to intercept the DWF at the identified DWF ingress locations to the Mithi River for conveyance to the STP through nearby existing sewers -for treatment. This shall be achieved through the construction of interception chambers, gravity sewers, manholes, vent shafts, pumping stations, rising mains, break pressure chambers (balancing chamber).

To intercept the total DWF, the proposed DWF interceptor needs to be located at or near the Tidal outfall point. As such, tidal influence and associated seawater intrusion will significantly affect the effectiveness of the DWF interceptor system / Gate pump. A tidal barrier is therefore required to prevent seawater intrusion during the operation of the DWF interceptor.

Also, A bypass culvert may be provided if, required, to allow emergency discharge of floodwater or in case of failure of the operation of tidal barrier.

1.4.2 Storm water pumping station (Gate Pumps)

In order to tackle the flood like situation in the low lying areas, mainly situated along the banks of Mithi River in the tidal portion i.e. between Mahim causeway and Airport box culvert, the work of installation of gate pumps, integrating with dry weather flow interception, is proposed in Package - III tender.

1.4.3 SummaryServices

The Works includes training of river (Construction of Retaining Wall & Service Road), Pumping Stations, Interceptions &Diversion works for diverting Dry Weather Flow (DWF)of various outfalls / nallas into nearby existing Municipal Sewer networks along with Gate Pumps, Beautification including Promenades & allied works.

2 SITEINFORMATION

The following tables identify information about area downstream of CST Bridge to Mahim Bay (Tidal outfalls only).

2.1 Area 4 Catchment Downstream of CST Bridge to MahimBay

Table 2-1Site Information

No	Item	Details
1.	General	Refer to Contract Drawings in Volume 2D which identify the existing DWF and storm water flow ingress locations into the Mithi River. These have been designated for interception and transfer to nearby existing sewers under thisContract.
2.	Flow Measurement	Refer to Volume 5for the maximum average DWF / instantaneous peak flow rates from an hourly flow measurement survey held over a 3-day dry weather period in Oct / Nov 2017 for some of the existing DWF ingress locations. Refer to Volume 2E for design discharge capacity of gate pumps. The Contractor shall not rely on this information and shall ensure that any critical measurements, locations, or the suchlike are verified on site.
3.	Geotechnical Information	Borehole logs and data analysis have been made available by the Employer from the contract to construct the river encroachment / training wall along the length of the Mithi River. Refer to Volume 5 fordetails. The Contractor shall not rely on this information and shall ensure that any critical measurements, locations, or the suchlike are verified on site.
4.	Contract Drawings	Refer to Volume 2D for the drawings onto which relevant details of Retaining wall, Service road, Sewer lines, Sewage pumping station, Storm water Pumping station (Gate Pumps) and Promenade Work. The Contractor shall not rely on this information and shall ensure that any critical measurements, locations, or the suchlike are verified on site.
5.	Existing Services	No information is provided on the extent of existing above or below ground services near the designated DWF ingress locations, nor along the proposed transfer routes to the nearby existing sewers.
6.	Site Difficulties	The tenderer is advise to visit the site of work so as to ascertain the scope of work required for effective execution of work & also to ascertain the difficulties of access / approach road, traffic restrictions, tidal conditions, utilities, encroachments, etc.

3 WORKSINFORMATION

Contract specific information for the Works is scheduled as follows:

3.1 DWF Interception /Transfer

Table 3-1 Works Information for DWF Interception / Transfer

No	Item	Details
1	Scope of Work	The Works shall include but not be limited to the design, construction, operation and maintenance of training of river (Construction of Retaining Wall & Service Road), Pumping Stations, Interceptions & Diversion works for diverting Dry Weather Flow (DWF) of various outfalls / nallas into nearby existing Municipal Sewer networks along with Gate Pumps, Beautification including Promenades & allied works. • DWF Interception Chambers. These shall intercept all DWF during the dry season, and a proportion of DWF during the wet season when the DWF will be diluted by storm flow. The interception chamber / shall be designed and constructed to ensure there are no spills to the river during the dry season diurnalcycle. The DWF interceptors shall have the necessary screening arrangement and Mechanical Tidal Gate arrangement; • GravitySewers; • Sewage Pumping Stations(PS); • RisingMains; • Break Pressure Chambers;and • Manholes, Vent Shafts etc. • Construction of Retaining Wall and Service Road • Beautification including Promenades and Allied Works • Storm Water Pumping Stations. These pumping stations shall have screening arrangement and pumps attached with Flood Gates.
		Refer to Contract Drawings in Volume 2D for the above scope of work, which has been developed to a feasibility level of design. The DBO Contractor shall undertake all outline and detailed design for the Works. Co-ordinates of some of the DWF ingress locations are identified in the flow measurement data in Volume 5.
2	Engineering Services	The Works shall include but not be limited to the design, specification, procurement, supply, construction, commissioning, testing, operation, and maintenance of a fully functioning DWF interception and transfer system which is fit-for-purpose. All necessary engineering services shall be provided to ensure the DWF interception, and transfer system remains fit-for-purpose over the duration of the DBOContract.

3	Flows	The Contractor shall be responsible for conveyance of flows from the DWF interception chambers into the existing nearby sewers as proposed in Drawings in Volume2D.
4	Provision of Service Infrastructure	The Contractor shall be responsible for any temporary relocation required for the affected slum hutment inhabitants. The Contractor shall be responsible for all service connections to the DWF interception chambers (if required), and the pumping stations required for construction of the Works. The Contractor shall be responsible for the connection, and continued provision of all necessary services (e.g. electricity, water, telecommunications, etc.) to the DWF interception, and transfer system site for the Design-Build Period, and for provision of the Operation Service. The Contractor shall be responsible for the payment of all such services for the entire Contract Period.

4 CONTRACTOR'S DOCUMENTS

4.1 General

The Contractor shall submit the Contractor's Documents to the Employer's Representative in accordance with Clause 5.2 of the Conditions of Contract and more particularly as required in this Section. All Contractor submissions referred to in the Employer's Requirements shall be deemed to be part of the Contractor's Documents as defined in the Conditions of Contract.

4.2 Format of Contractor's Documents

The Contractor shall submit three paper copies and one copy in electronic format (unless otherwise stated) of each drawing or document required to be submitted. The Contractor shall mark incomplete areas of drawings "hold". Any revisions to drawings or documents shall be clearly highlighted by the Contractor. The Contractor shall note drawing amendments in the title box and mark amendments with a triangle containing the revision number. Amendments to documents shall either be redlined/struck out or marked in themargin.

Drawings shall all have a similar title block which shall include the name of the designer, the Contractor and the Employer, the name of the Contract, a unique description of the content and a unique reference number complying with a formalised numbering system. The title block shall be such that the whole title block is visible including space for amendment information when folded to A4 size.

Process and instrumentation diagrams (P&IDs) shall show in symbolic form the process plant and systems of measurement, control and automation.

Documents shall be in Microsoft Office format or equivalent approved by the Employer's Representative. Programmes shall be in the latest version of Primavera or MS Project. Drawings shall be in AutoCAD or compatible equivalent.

4.3 Programme and Project Execution Plan

4.3.1 Programme

The Contractor shall submit a programme within the times specified in Section 5, in accordance with Clause 8.3 of the Conditions of Contract and clearly indicate the strategic milestones, periods for delivery of Plant and Materials to Site, periods for construction, erection, testing and commissioning.

Key milestones to be identified shall include as a minimum:

- Finalisation of all licenses and consents for the construction of theWorks;
- Completion ofdesign;
- Construction of treatment plantunits
- Ordering and importation of major equipment;
- Tests on Completion of Design-Build;and
- Issue of CommissioningCertificate.

In addition the programme shall:

- Show fully the Contractor's programme for submission of Contractor's Documents for review by the Employer's Representative. It shall show adequate time for review by the Employer's Representative (minimum of 28 days) and other review bodies according to the volume and complexity of the data presented in eachsubmission;
- Be in accordance with the Employer'sRequirements;
- Include as an appendix, a schedule of intended submissions showing clearly the content of each submission and its relationship to construction activities in sufficient detail for its significance and status to beunderstood;
- Show subcontracts to beplaced;
- Show critical path and float;and
- Include as an appendix the resources required for eachtask.

4.3.2 Project Execution Plan

The Contractor shall submit to the Employer's Representative within the time specified for the programme, his proposals for project control during the Design-Build Period. They shall clearly set out the Contractor's intentions and procedures for controlling and managing the project including areas suchas:

- Costcontrol;
- Documentcontrol;
- Progress control;
- Changemanagement;
- Specificationdeviations;
- Paymentprofiling;
- Contractualissues;
- Schedule oftesting;
- Site management manpower and labour (health &safety);
- Plant and equipmentcontrol;
- Detailed Subcontractstrategy;
- Detailed Subcontractmethodology;
- Quality Plans;and
- Reporting andreviewing.

These shall all be addressed in a Project Execution Plan which provides the detailed framework, with scope for being revised/supplemented as work progresses.

4.3.3 Failure to Provide Programme and Project Execution Plan

If the Contractor fails to provide a programme or project execution plan within the timescale specified, or to provide a satisfactory improved or revised programme or project execution plan with a period of two weeks from being requested to do so by the Employer's Representative, the Employer's Representative shall be entitled to reject all further Contractor's Documents and to instruct the Contractor to cease any or all of the Works on Site until they are provided. In such an event the Contractor shall notbe

entitled to an extension of Time for Completion of Design-Build or additional payment as a result of any delay incurred as a result of the Employer's Representative's instructions.

4.4 Design Stage Documents

4.4.1 General

Design documentation shall be submitted to the Employer's Representative in two distinct stages comprising a draft Contractor's design report and a final Contractor's design report. The proposed content of the two reports is set out below. The Contractor shall submit his proposals for submission of design details to the Employer's Representative, which shall be in accordance with thesesections.

Design details shall be submitted in a co-ordinated succession of drawings, calculations and reports. They shall be in distinct packages having been finished and been checked by the Contractor's design reviewers and approved by the Contractor's Representative.

Subcontractor's documents shall be submitted with a clear statement to show that they have been approved by the Contractor. Documents, including Subcontract enquiries or tenders shall not be submitted as a means of getting them checked by the Employer's Representative.

Typical details for submission of design stage Contractor's Documents are contained in Appendix A.

4.4.2 Contractor's Draft Design Report

This report shall be submitted by the Contractor to the Employer's Representative in a clear and logical format, sectionalised for each significant element of the Works. The report shall as a minimum include the following elements:

1. Fully dimensioned general arrangement drawings for the tidal dry weather flow interception facility, foundations, screen units, access road, utility routes and general constructiondetails;
2. Process and instrumentation diagrams(P&IDs);
3. Power single linediagrams;
4. Process data sheets to define design criteria, installed capacities and loading rates of principal items of plant and equipment. Drawings to show physical sizes and layouts of plant andequipment;
5. Operation and control philosophyreport;
6. Draft works operatingstrategy;
7. Draft user requirement specification for softwaresystems;
8. Load testschedules;
9. Instrumentschedule;
10. I/O schedule for each Motor Control Centre(MCC);
11. Instrumentation/Process Control systemarchitecture;
12. Instrumentlist;
13. Equipment electrical controlschematics;
14. Structural calculations for the structural components of theWorks;
15. Cut and fill balance and hard and soft landscapingproposals;

16. Site drainagedetails;
17. Architectural elevations and perspectivesections;
18. Building materials and finishesschedule;
19. Materials handlingprocedures;
20. Pipe work and ductinglayout;
21. Cable and wiringlayout;
22. Hazardous area classificationdetails;
23. Access and maintenanceproposals;
24. Standbyphilosophy;
25. Statement detailing measures to protect Site fromflooding;
26. Geotechnical interpretativestatement;
27. Safety and healthreport;
28. Disposal of unwanted materialsoffsite;
29. Design and layout of earthing and lightning protectionsystem;
30. Design and layout of lightingsystem;
31. Surveillance system design and networkarchitecture;
32. Beautification civil/landscaping worksdesign;
33. Unit sizingcalculations
34. Pump Head loss calculations
35. Head loss calculations in screenand
36. Any other details/data/design required as per the proposedtechnology.

4.4.3 Final Contractor's Design Report

This report shall include any amendments to the draft report and inter-alia the following elements:

1. Geotechnical interpretivereport;
2. Calculations for earthworks andfoundations;
3. Structural calculations of all components of theworks;
4. Finishes layout for all internal and externalfinishes;
5. Screen design, screens control, design of flow modulated penstock piping and instrumentationdiagrams;
6. Control Schematics drawing for flow modulated penstock control and pumping stations;;
7. General arrangement drawing of instrument and control panels fully dimensioned in plan and elevation views, showing foundation and fixing details, access doors, clearances, cable-entry positions, weight and lifting arrangement;
8. Layout drawings of panel fasciasshowing instruments, controls and details of alllabels;
9. Layout drawings of panel interior showing equipment, terminal blocks and cableways;
10. Fully dimensioned and co-ordinated general layouts of mechanical, electrical, lighting and building servicesequipment;

11. Civil calculations and reinforcement drawings for all reinforced concretestructures;
12. Final craneage/ layout (including clear description of how individual items of plant are to be handled, lay-down area and loadingprocedure);
13. Air duct layout and sections;
14. Electrical loadschedules;
15. Electrical single linediagrams;
16. Cable routing diagrams andschedules;
17. Fireand security alarm system schematics and layout with designcalculation;
18. Pipe work layout diagrams including all valves andpenstocks;
19. Longitudinal pipelinesections;
20. Routing diagrams forservices;
21. Zonal and hazardous areasclassification;
22. External works detailed layout including roads, lighting,drainage;
23. I/O list, alarm list, cable and junction boxschedule;
24. Instrument hook updrawings;
25. Loop schematics and interconnection wiringdiagram;
26. Instrument data sheet, Instrument test and calibrationreport;
27. Instrument operation and maintenancemanual;
28. Equipment schedule;and
29. Hazard and riskassessment.

4.5 Construction StageDocuments

Construction or fabrication of any element of the Works and delivery or installation of Plant and Materials shall not commence until relevant Contractor's Documents have been submitted and the review has been completed by the Employer's Representative. Relevant Contractor's Documents shall includeinter-alia:

1. All required approval andconsents;
2. Approved Construction Environmental Management Plan(CEMP);
3. An integrated earthworks balance calculation for the whole of theWorks;
4. An assessment of the existing ground water table and the measures proposed to ensure no deleterious effect onsame;
5. Construction methodstatements;
6. Specifications;
7. Final designcalculations;
8. Detailed constructiondrawings;
9. Materials, equipment and instruments approvaldocuments;
10. Schedules;
11. Inspection and testprocedures;
12. Inspection and testcertificates;
13. Safety certificates;

14. Proof load tests;and
15. Performancecurves.

4.6 Plant and Equipment Documents

Plant shall not be delivered to Site until relevant Contractor's Documents have been submitted and the review has been completed by the Employer's Representative. Relevant Contractor's Documents shall include inter alia:

1. Drawings of Plant andequipment;
2. Schedules of Plant andequipment;
3. Plant and equipment handling and installation methodstatements;
4. Test and inspection methodstatement;
5. Test and inspection certificates;
6. Performancecurves;
7. Safetycertificates;
8. Certificate for equipment to be used in potentially hazardous atmospheres (where relevant);
9. Proof load tests for all liftingequipment;
10. Plant delivery documents;and
11. Vesting certificates (when equipment is to be placed into store and payment certified by the Employer'sRepresentative).

4.7 Control System Development

Within the time scale detailed in the programme, the Contractor shall submit a control system functional design specification for review by the Employer's Representative.

The control system design by The Contractor shall consider modulating penstock for flow control purpose where the flow through the intercepted pipeline shall not exceed the DWF within the accuracy of +/- 5%. The modulation of penstock control shall consider the frequent repositioning and utilise only a proportion of the full stroke to allow only DWF through the interceptorpipeline.

The indicative general arrangement is as per the general arrangement drawings in Vol 2D for screen, flow modulated penstock andflowmeter.

4.8 Tests on Completion of Design-Build documents

The Tests on Completion of Design-Build shall not commence until relevant Contractor's Documents have been submitted and consent to commence tests has been granted by the Employer's Representative. Relevant Contractor's Documents shall include inter-alia:

1. Site installation, inspection and testcertificates;
2. Tests on Completion of Design-Build method statement andprogramme;
3. Final Contractor's designreport;
4. Draft Operation & MaintenancePlan;
5. Test schedules and performance dataschedules;
6. Plant inventory and datasheets;

7. Operation and Maintenance Manuals;and
8. Populated asset managementdatabase.

4.9 As-built Documents

The Contractor shall prepare and submit as-built documents including drawings and records during the Design-Build Period and shall submit them to the Employer's Representative following completion of each part of the Works, and within the periods stated in the Contract or as otherwise agreed with the Employer's Representative.

As-built documents shall constitute a permanent record of the Works as completed or executed.

As-built documents shall consist of final versions of those Contractor's Documents as are necessary to fully record the design and construction of the Works, incorporating any additional information that will assist the operator of the facility. They shall include inter alia:

1. The final version of the designcalculations;
2. Key construction records andtests;
3. Final versions of all drawings prepared during the Design-BuildPeriod;
4. Final versions of thespecifications;
5. Quality control records forMaterials;
6. Assetsheets;
7. Borehole records and soil test reports;
8. Survey records;and
9. Any information requested to be provided in the form of as-built records elsewhere in the Employer'sRequirements.

Final approved as-built drawings shall consist of three copies on CD/DVD in AutoCAD and pdf formats, plus three A1 and three A3 printed and durable copies.

4.10 Operation and Maintenance Manuals

The Contractor shall submit three hard copies of the Draft Operation and Maintenance manuals for review and approval of the Employer's Representative. Comments if any by the Employer's Representative shall be incorporated by the Contractor and six (6) hard copies and three (3) soft copies on CD of the approved final version shall be submitted by theContractor.

4.11 Progress Photographs

A weekly progress report with photographs of the Design-Build shall include 24 photographs of the Site based activities and six other photographs as required by the Employer's Representative. The photographs shall be submitted (along with the labour and plant returns) weekly by the Contractor to the Employer's Representative and shall be dated and labelled, mounted in albums, and accompanied by digital files.

The Contractor shall arrange to have the progress photographs taken by a person acceptable to the Employer's Representative during the course of the Design-Build. The Contractor shall submit the entire set of photographs as 150mm x 100mm colour proofs from which the Employer's Representative will select progress photographs. The Contractor shall supply up to 10 suitably annotated prints not less than 250mm x 200mm

from the selected proofs, each week, as required. These photographs shall also be dated and labelled and presented in separatealbums.

All negatives, prints, and electronic versions shall be the property of the Employer and shall not be supplied to any other persons without the authority of the Employer's Representative.

4.12 Monthly Progress Reports during Design-BuildPeriod

The Contractor shall prepare and submit monthly progress reports at least one week in advance of the monthly site meetings described in Section 4.28 of Volume 2A16.28. In addition to the requirements identified in Clause 4.21 of the Conditions of Contract, each monthly report shall:

- Provide the Employer with information reasonably required to assess the progress of the construction and commissioning of the Works;and
- Highlight current and potential future issues that may hinderprogress.

Each monthly report shall include, as aminimum:

- Asummary;
- Project summary data including the planned date for the commencement of the Operation Service Period (as amended by any approved extensions of Time for Completion ofDesign-Build);
- Labour resource data including a histogram of the actual and projected workforce on Site;and
- A progressupdate.

Progress updates within each monthly report shall include:

- Reference to the up-to-date constructionprogramme;
- Progress against key milestones and keydates;
- A commentary on areas that are behind programme and details of measures being taken to mitigatedelays;
- An update on any proposed changes to theContract;
- An update on the submission and review of Contractor'sdocuments;
- Progress in obtaining all necessary approvals orpermits;
- The health and safety record (including accidentrecords);
- An update on toolboxtalks;
- Environmental records (including records of complaints, breaches of permit conditions and other environmental incidents, such as spillages onSite);
- Details of any security incidents and changes to the Contractor's securitymeasures;
- Details of any public relations incidents oractivity;
- Records of labourutilised and Contractor's plant and equipment onSite;
- Copies of quality assurance documents, test results and certificates ofMaterials;
- Details of the projected and actual payment profiles and estimated future expenditure in quarterlyperiods.

5 QUALITY MANAGEMENT SYSTEM

5.1 General

The Contract requires the Works to be executed and completed to a uniformly high quality, to provide a treatment facility that is reliable, economic in operation with ease of maintenance for the design life specified. The Contractor shall be responsible for providing and operating his own quality control and checking procedures that shall be demonstrably independent of those actually responsible for design and construction.

The Contractor shall institute, maintain and operate for the Contract Period a Quality Management System complying with ISO 9001 as appropriate (accreditation is not a requirement) or other equal and approved equivalent standard and of the Contract, for the purpose of ensuring and demonstrating that all aspects of the Works and all other matters for which the Contractor is responsible under the Contract are carried out in conformity with the relevant provisions of theContract.

The Contractor shall make a condition in each and every Subcontract and order for Plant, Materials and services including design services whereby Subcontractors and suppliers shall institute maintain and operate for the Design-Build Period a Quality Management System complying with ISO 9001 as appropriate (accreditation is not a requirement) or other equal and approved equivalent standard and of the Contract for the purpose of ensuring and demonstrating the services or goods provided conform with the relevant provisions of this Contract. Any such subcontractor or supplier can achieve compliance with the other provisions of this sub-clause by adopting and operating under the Quality Management System and the Quality Plan as referred to elsewhere within this section. The Contractor shall make a condition within each and every Subcontract to provide for the Employer's Representative's access to facilities of a standard sufficient to enable him to take such actions as he may consider necessary under thisSection.

Subject to the other requirements of the Contract, the Contractor shall submit to the Employer's Representative for review his Quality Management System and his Quality Plan within the times stated.

The Contractor shall comply with the Quality Plan referred to in this section and shall ensure that:

- The designer complies with the Quality Plan in respect of the design supervision of the Works;and
- The Contractor's Subcontractors and suppliers comply with the Quality Plan referred to within thisSection.

Where the Quality Plan refers to, relies on, or incorporates any quality manual or procedure or method statement, then such quality manual or procedure or method statement, or the relevant parts thereof, shall be submitted by the Contractor to the Employer's Representative at the time that the Quality Plan is submitted in accordance with this section. The Employer may require the amendment of any such quality manual or procedure or method statement to the extent necessary to enable the Quality Plan to satisfy the requirements of this Section.

The Contractor shall employ, for the duration of the Contract, a Contract Quality Manager who shall have no other management role under this Contract. The appointment of the Contract Quality Manager shall be subject to approval by the Employer's Representative.

Without limitation to the foregoing the Contract Quality Manager shall be required to:

- Ensure the effective operation of the Quality Management System and the Quality Plan;
- Audit the Quality Management System and the Quality Plan at regular intervals and report the findings of such audit to the Employer'sRepresentative;
- Review the Quality Management System and Quality Plan at intervals to ensure their continued suitability and effectiveness;and
- Liaise with the Employer's Representative on all matters relating to quality management.

Without limitation to any other provision of this Contract, where required by the Employer, any representative of the Employer may carry out audits of the Quality Management System (including without limitation the Quality Plan and any quality manuals and procedures) at approximate intervals of 3 months and may carry out periodic monitoring, spot checks and auditing of the Quality Management System and QualityPlan.

The Employer's Representative reserves the right to audit, without prior notice, the quality of Works and the Contractor's Quality Management System to verify compliance with the specified quality requirements. The Contractor shall render every assistance and provide free and unhindered assistance to the Employer's Representative or any person authorised by him to carry out any suchaudit.

All materials and workmanship shall be of the respective kinds described in theContractandinaccordancewiththeEmployer'sRequirementsortheEmployer's Representative's Instructions and shall be subjected to the samples and tests required or reasonably implied by the terms of the Contract and set out in the method statements, or which may be ordered by the Employer's Representative.

The acceptance by the Employer's Representative of any part of the Quality Plan and the giving of his consent to the procedures, proposals, records and certificates contained therein shall not be construed as approval by the Employer's Representative that the Works or any part of them have been constructed or manufactured in accordance with theContract.

The application of a Quality Management System by the Contractor shall in no way affect either the Contractor's other obligations or the powers and duties of the Employer or Employer's Representative under the terms of the Contract.

5.2 Principal Requirements of the QualityPlan

The Contractor shall institute, maintain and operate a Quality Management System in accordance with the provisions of this section. The Quality Management System shall be as described in a written 'Quality Plan' that shall be submitted by the Contractor to the Employer's Representative. The principal requirements that apply to the Quality Plan are set out below. The Quality Plan shall be deemed to be part of the Contractor's Documents.The Quality Plan shall cover but not be limited to the following items:

i) Contractor's organisation and management of theContract;

ii) Contractor's control ofdesign;

iii) Contractor's method statements and procedures for theWorks;

iv) Contractor's supervision of theWorks;

v) Contractor's quality control for the construction of theWorks;

vi) Contractor's quality control for the Operation Service;and

vii) Sub-contractor's or supplier's QualityPlans.

The Quality Plan shall show quality hold points where no further works or activity shall proceed without the written approval of the designated person identified in the related quality procedure, method statement or works instruction and quality witness points where no further works or activity shall proceed without the designated person being given the appropriate notice to visually inspect such works or activity as set out in the related quality procedure, method statement or works instruction.

The Quality Plan shall contain, or incorporate by reference, documents which contain requirements to produce quality records which shall include inter alia documents which demonstrate the achievement by the Contractor of the Contract requirements such as:

- Office and sitelogs;
- Records of visits to any location or party in connection with theWorks;
- Office and site testresults;
- Records ofverification;
- Records of all supervision and witnessing with results carried out by the Contractor; and
- All certificates and statements required by the Contract in respect of theWorks.

Such records shall identify inter alia all design changes to products and specifications and verification and traceability of all processes in connection with the design of the Works.

The Quality Plan shall be demonstrated to be capable of controlling, indexing and cross-referencing records of all drawings, designs, specifications, documents, test results, certificates and construction documents which have relevance to the Works. The Quality Plan shall be auditable and be subject to review by the Employer.

5.3 Employer's Representative's Monitoring of the Contractor'sPerformance

The Contractor shall take due cognizance of any reports from the Employer's Representative and action them and integrate them into the Contractor's working quality procedures, method statements or works instructions.

5.4 Particular Requirements of the Quality Plan

The Quality Plan shall conform with but not be limited to the requirements shown as follows:

5.4.1 Contractor's Organization and Management of the Contract

This part of the Quality Plan for the Contractor's organisation and management of the Contract shall include but not be limited to:

i) The definition of the Contract and itsdocumentation;

ii) The organizationof the Contract including the line of command and communication links between all the parties involved in the Contract in the form of annotatedchart(s);

iii) The names, roles, responsibilities, curriculum vitae and authority of principals and key personnel involved in the design, construction, operation and maintenance of the Contract. These will include, where appropriate, the roles undertaken by the project director, contracts manager, site agent/Contractor's projectmanager,

operatives, technicians, analysts, Subcontractors, Contract Quality Manager, representative for environmental protection, general foreman, foremen, engineers, quantity surveyor, safety officer, Contractor's and Designer's supervisor(s) for the Works, Designer's team leader(s) and Site representative(s), checker's team leader(s), Contractor's and Designer's health and safety co-ordinators and any other principal party involved in theWorks;

iv) Documented procedures for the control of consultations, liaison and meetings with third parties including the police, statutory bodies, undertakers and any other companies;

v) The identification of the Contractor's staff responsible for overseeing and co-ordinating each major activity including design, design checks, safety audits and all Subcontractactivities;

vi) Documented procedures for the control of Subcontracts which must include theassessment of the Subcontractor's quality assurance and quality control capabilities, the identification and implementation of additional controls needed on such Subcontractors to fulfil the Contractor's obligations in respect of this section and theContract;

vii) Documented procedures for the control of all documentation including inter alia documentation which has to be provided by the Contractor to the Employer's Representative or theEmployer;

viii) A programme for submission of designs, associated documentation, method statements and QualityPlan;

ix) The Quality Plans for Subcontractors and suppliers of work, Plant and Materials which are the subject of quality managementschemes;

x) Documented procedures and method statements for the preparation, review and adjustment of programmes for the effective progression and completion of the Works in accordance with the other provisions of the Contract and the recording of same;

xi) Documented procedures and method statements for the control and approval of purchases ofMaterials;

xii) Documented procedures and method statements for the control of off-Site activities;

xiii) Documented procedures for the regular review and recording by the Contractor which demonstrates that the Works meet the requirements of theContract;

xiv) Documented procedures for the control of personnel selection which demonstrate that such personnel have appropriate skill and experience for undertaking their appointedrole;

xv) Documented procedures for the management review/audits to monitor and demonstrate control over the implementation of the QualityPlan;

xvi) Documented procedures for the quality control of the Operation Service;and

xvii) Any other relevant item which may during the Contract be brought to the attention of the Contractor by the Employer's Representative.

5.4.2 Contractor's Control of Design

This part of the Quality Plan for the design shall include but not be limited to the provisionof:

i) The names and curricula of the key personnel who carry out thedesign;

ii) Documented procedures and method statements for ensuring compliance with the Employer's Requirements;

iii) Documented procedures for the review of the design including the frequency of and personnel responsible for suchreviews;

iv) A description of arrangements for the checking of the design and liaison with the checker;

v) A description of arrangements for the interface with supervision of the Works;and

vi) Any other relevant item which may during the Contract be brought to the attention of the Contractor by the Employer's Representative.

5.4.3 Contractor's Method Statements and Procedures for the Works

This part of the Quality Plan for the Contractor's method statements and procedures for the Works shall include but not be limited to:

i) The names and curricula vitae of the key personnel who will carry out the management;

ii) A list of Subcontractors to be employed on theWorks;

iii) A list of the quality procedures and method statements to beprovided;

iv) Identification of specialist activities and personnel to be employed carrying out such activities;

v) Arrangements for quality control of purchased Plant andMaterials;

vi) Arrangements for quality control of all Plant and Materials sourced on or offsite;

vii) Detailed written method statements for each major activity whether such activities are directly controlled by the Contractor orSubcontracted;

viii) The written method statements shall identify quality hold points and witness points and invoke for allactivities:

a) Work instructions;

b) Quality controlprocedures;

c) Compliance testing/inspection arrangements;and

d) Work acceptanceprocedure.

Method statements shall inter alia describe each stage of the construction, including the layout of the Works and of the Operation Service. The method statements shall also identify the Plant and Materials to be used in the Works, Temporary Works, safety measures, working space considerations, and where appropriate the requirements for skilled labour and/or special supervision and similar. Method statements shall show how the proposed operations ensure that impacts are restricted to the best possible environmental option and shall include contingency plans and environmental procedures to minimise damage caused by accidents, spillages or other unforeseen events. The method statements shall include procedures for notifying the public or statutory bodies and authorised authorities.

The Contractor shall state where work is subject to environmental requirements, for example, temperature, noise and dust control, working hours, traffic conditions, vehicle routings, screening and the like.

The Contractor shall identify 'hold points' at stages of work where checks are necessary before continuing. The authority for release of the 'hold points' shall also be identified by the Contractor in the method statements.

The Contractor shall identify 'witness points' at stages of work where such witness points are required. Such witness points shall include Employer's Representative's witness points. The Contractor shall state in the method statements the notice required to be given to personnel carrying out such witnessing.

i) The identification of the relevant procedures in the Contractor's own Quality Management System. Procedures invoked by method statements shall include procedures from the quality controls required by the Contractor's construction quality control:

   a) The control, identification and traceability ofmaterials;

   b) Procedures for the prevention of inadvertent use, installation or covering up of non-conforming work;and

   c) Any other corporate and/or contract specific work instructions to beapplied.

ii) Schedules of tests and inspectionsproposed.

iii) Any other relevant item which may during the Contract be brought to the attention of the Contractor by the Employer's Representative.

5.4.4 Contractor's Supervision of the Works

This part of the Quality Plan for the supervision of the Works shall include but not be limited to:

i) The names and curricula vitae of all personnel to be employed in the supervision of theWorks;

ii) A description of arrangements for the interface with procedures and method statements in respect of the construction of theWorks;

iii) A description of the interface with procedures fordesign;

iv) Arrangements for liaison and meetings with interestedparties;

v) Arrangements for the control of personnel selection which shall be based on consideration of skill, care, diligence and experiencequalities;

vi) A statement of the Contractor's (and his designer's) responsibility to supervise the Works including the duty to supervise the construction, completion and testing of theWorks;

vii) Documented procedures for undertaking the supervision of the Worksdetailing:

   a) The stages of work when the inspection(s) is to beundertaken;

   b) The personnel carrying out theinspection(s);

   c) The frequency ofinspection(s);

   d) The procedures to be followed when detailing with non-conforming works;and

   e) The recording ofinspection(s)

viii) Documented procedures for the review of the extent and frequency ofsupervision;

ix) Documented procedures for the issuing of constructioncertificates;

x) Documented procedures for document control including the receipt, control and retention of alldocuments;

xi) Documented procedures for reporting progress and the identification of problems; and

xii) Documentedproceduresfortheobservationofsampling,testingandthereporting

of results of testing; and

xiii) Any other relevant item which may during the Contract be brought to the attention of the Contractor by the Employer's Representative.

5.4.5 Contractor's Quality Control for the Construction of the Works

This part of the Quality Plan for the Contractor's quality control for construction of the Works shall include but not be limited to:

i) A statement of the Contractor's organisation for quality control and shall identifythe:

   a) Responsibility for the initiation and updating of the QualityPlan;

   b) Responsibility for the adequacy of the quality recordsproduced.

ii) Documented procedures for the arrangements for "receiving" and "in-process" testing;

iii) Documented procedures for the control of testlaboratories;

iv) Documented procedures for the control of test, measuring and inspectionequipment;

v) Documented procedures for document control and shall include their identification, traceability requirements, control of document issues and their status. Documents recording the verification, review, approval, release and amendment of the Works shall similarly becontrolled;

vi) Documented procedures for monitoring and recording the inspection, test and approval status of the construction/installed work including the identification of "hold points";

vii) Documented procedures for tests and inspections for the purpose of the Contractor certifying that prior to covering up, each part of the Works is complete and conforms to the Contract. The procedures shall identify the proforma and/or database to be used for recording the inspection and test results, and the proforma to be used for recording the certification of compliance of all items of the Works by authorised key personnel. The Contractor shall identify each submissionseparately;

viii) Documented procedures for the review of work submitted for review but not accepted as conforming to the Contract. These procedures shall include options for identification of non-conforming work and proposals for reworking and remedialwork;

ix) Documented procedures for the collation of qualityrecords;

x) Documented procedures for inspection and testing of Plant, Materials and equipment;and

xi) Any other relevant item which may during the Contract be brought to the attention of the Contractor by the Employer'sRepresentative.

5.4.6 The Contractor's Quality Control for the OperationService

This part of the Quality Plan for the Contractor's operation and maintenance quality control for the Works shall include but not be limited to:

i) A statement of the Contractor's organisation for quality control and shall identifythe:

   a) Responsibility for the initiation and updating of the QualityPlan;

   b) Responsibility for the adequacy of the quality recordsproduced;

ii) Documented procedures for the control of testlaboratories;

iii) Documented procedures for the control of test, measuring and inspectionequipment;

iv) Documented procedures for identifying the procurement of Plant conforming to the design requirements and for ensuring the continued performance to thesestandards;

v) Documented procedures for identifying the introduction of new legislation, standards, Laws and regulations and theirimplementation;

vi) Documented procedures for document control and shall include their identification, traceability requirements, control of document issues and their status. Documents recording the verification, review, approval, release and amendment of the Works shall similarly becontrolled;

vii) Documented procedures for the review of work submitted for review but not accepted as conforming to the Contract. These procedures shall include options for identification of non-conforming work and proposals for reworking and remedialwork;

viii) Documented procedures for the collation of quality records;and

ix) Documented procedures for inspection and testing of Plant, Materials, equipment and any other relevant item which may be brought to the attention of the Contractor by the Employer'sRepresentative.

5.4.7 Subcontractor's or Supplier's Quality Plans

The Quality Plan for Subcontractors (including suppliers of Plant and Material) shall include but not be limited to:

i) A definition of the product or service which is to beprovided;

ii) Annotated chart(s) showing the organisation structure of the Subcontractor describing the line of command and stating the name of the senior manager responsible for the contracted work and the name of the Subcontractor's on-site management representative. The Subcontractor shall provide contact addresses, telephone numbers and the like. This must address all activities, including those which have been sub-let. The Subcontractor shall provide names of any suppliers involved in theproduction;

iii) The identification of the relevant parts of the Subcontractor's Quality Management System relevant to the product or service beingprovided;

iv) Documented procedures for the control of personnel selection (at Works and on Site), including special requirements for skilled personnel for example; certification of welders, training of operatives, experience requirements and the like. The Subcontractors shall provide evidence that the training and experience requirements given in the appropriate Quality Management System are beingmet;

v) Documented procedures for the receipt and examination of certificates of conformity and test results for purchasedproducts;

vi) Documented procedures for product identification and traceability. Each piece or bundle of delivered product shall be indelibly marked and where appropriate, the lot identification shall be included on eachpackage;

vii) Documented procedures for handling, storage, packaging and delivery to Site and storage and handling on site, including instructions for repair of damaged products where appropriate;and

viii) Documented procedures for compiling records which shall include documents to demonstrate the achievement of the requirement standard for example; site logs, record of visits, records of verification, review and release, certificates of conformity and records of all design modifications to products andspecifications.

5.5 Monitoring during the Operation Service Period

The Contractor shall develop monitoring and sampling plans as part of the Contractor's Quality Plan for the Operation Service. These plans shall be implemented to ensure that all required analyses and reports are completed fully and accurately to exacting specifications, following standard methods and procedures, in a timely manner and in support of other performance requirements of the contract.

The plans shall clearly distinguish between the monitoring required to meet regulatory requirements and the monitoring required to meet the Contract requirements. The plans shall include:

- A list of all parameters to be monitored as part of these plans. These plans shall include a schedule of the proposed monitoring quality control requirements, describing which parameters will be monitored on a daily, weekly, biweekly and monthly basis;
- A laboratory manual, which shall describe the Contractor's approach to attaining the highest standards of laboratory performance. The manual must outline the methods for each test to be performed. The plan shall identify which tests will be conducted in-house and those to be performed by Contract laboratories. All laboratories performing tests shall be subject to approval by the Employer's Representative. In addition, the laboratory manual shall specify the type and model of all equipment to be used in performing all tests by theContractor;
- Minimum experience and qualifications of individuals or Contract laboratories performing testingservices;
- A description of analysis techniques that will be implemented to ensure that all regulations and standards are met. The plan must provide examples of any tools such as flow charts, check sheets or any other data presentation and evaluation techniques that will be utilised;and
- A description of all calibration techniques, quality control procedures, including those to be utilised for all equipment used for testing and measuring different parameters within the treatment process and at the in-house laboratory and Contract laboratories. The description shall address the calibration practices, including the frequency and accuracy requirements. The calibration procedures shall consider intermediate spot and cross checks, in addition to the scheduled formal calibration checks.

5.6 Submission of Quality Plan

Sections of the Quality Plan as far as they relate to the Design-Build Period, shall be submitted by the Contractor to the Employer's Representative for his approval within the date stated for the submission of the Quality Plan, the remaining sections being provided as soon as practicable thereafter.

Sections of the Quality Plan as far as they relate to the Operation Service Period, shall be submitted by the Contractor to the Employer's Representative for his approval within the date stated for the submission of the Quality Plan, the remaining sections being provided as soon as practicablethereafter.

The Contractor shall submit the remaining parts of the Quality Plan to the Employer's Representative for review at least two weeks prior to commencement of any associated work or activity and to the programme included.

5.7 Review of Nominated Laboratory

A Nominated Laboratory shall mean one or more laboratories located on Site or off Site and used for the purpose of undertaking all tests for acceptance, compliance or payment purposes, nominated by the Contractor. A Nominated Laboratory shall be nationally accredited (NABL) or internationally accredited (ISO 9000, NAMAS or similar INAB standard) for all tests that are to be undertaken. The Contractor shall ensure that the accreditation is maintained throughout the Operation Service Period. The Nominated Laboratories shall operate to ISO 17025.

At least one month prior to any testing or analysis at the proposed laboratories the Contractor shall inform the Employer's Representative of his intended Nominated Laboratories and which tests are to be undertaken in each of the Nominated Laboratories. This may be more than one laboratory. The Contractor shall carry out an assessment of the Nominated Laboratories to ensure that they are accredited. The Contractor shall provide an assessment report to the Employer's Representative for review.

The Nominated Laboratories shall be subject to the approval of the Employer's Representative, which approval shall not be unreasonably withheld.

The sampling gathering and testing protocol(s) shall be based on or equal to the latest edition of APHA/AWWA/WEF Standard Methods for the Examination of Water and Wastewater. The accredited testing laboratory shall be fully conversant with these methods.

6 HEALTH, SAFETY AND ENVIRONMENT

The Contractor shall comply at all times during the Contract with all relevant Indian health, safety and environmental legislation, and all amendments thereto and also IS 18001:2007 Occupational Health and Safety (OH&S) management system.

This standard prescribes requirements for an OH&S management system, to enable an organisation to formulate a policy and objectives, taking into account legislative requirements and information about significant hazards and risks, which the organisation can control and over which it can be expected to have an influence, to protect its employees and others, whose health and safety may be affected by the activities of the organisation.

The Contractor shall immediately notify the Employer's Representative or, in his absence, the Employer, if any accident occurs whether on or off the Site in connection with the Works which results in any injury to any person whether directly concerned with the Site or a third party. Such notification may initially be verbal and shall be followed by a written report within 24 hours of theaccident.

6.1 CEMP

The Contractor shall be responsible for preparing the Construction Environmental Management Plan (CEMP) and obtaining the approval of the relevant authority. The Contractor shall be responsible for implementing the approved CEMP.

6.2 Safe Systems of Work

The Contractor shall be responsible for all safety systems on site. Throughout theDesign-Build and Operation Service the Contractor shall:

- At all times maintain a safe system of working 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 hiswork;
- Ensure that only persons who are properly trained for their duties are employed, that the correct tools and procedures are used and that adequate personal protective equipment is provided to all persons who may be affected by thework;
- Carry out toolbox talks for all Contractor's Personnel at least once perweek;
- Erect suitable warning signs, barriers, etc. as necessary for the activity which is being carried out – the Contractor shall maintain such signs, barriers, etc. for the duration of such activities; and
- Submit to the Employer, no later than 28 days before work commences on the Site, his Health and Safety Plan containing comprehensive proposals relating to the management of health, safety and welfare of all his personnel on the Site and all persons who may be affected by hiswork.

The Contractor shall be responsible for the safety of all of his personnel and other persons directly or indirectly employed for the Works and shall take all measures necessary to ensure their safety. In particular such measures shall include the following:

i) Provision of proper safety and emergency plans and regulations; fire, gas and electric shock precautions, stretchers and first aid box together with rescue facilities generally for each place ofworking;

ii) Provision of appropriate and effective safety work gear, including certified safety helmets and certified work boots for all personnel includingthe Employer's

Representative and each of his staff and any authorised visitors to the Site (see further data in Section 16.36 and Appendix C of the Employer's Requirements);

iii) Safe control of the water table, including provision of ample standby generating and pumping plant to maintain dry conditions;

iv) Provision and maintenance of suitable lighting to provide adequate illumination of works with appropriate spares and standby equipment;

v) Provision and maintenance of safe, sound mechanical equipment, each item of plant having an up-to-date testing certificate;

vi) Provision and maintenance of safe, sound ropes, slings, pulleys and other lifting tackle, each appliance having an up-to-date testing certificate, where appropriate;

vii) Provision of notices on weather-proof boards measuring 1.25m x 1.5m in size, written in bold letters in English, Marathi and Hindi to be erected on existing footpaths and at points of access likely to be used by the public, which shall warn the public of the existence of the Works. These notices shall be in addition to any statutory requirements demanded of the Contractor;

viii) Suitable scaffolds shall be provided for workmen for all activities that cannot be safely executed from the ground, or from solid construction except such short period work as can be done safely from ladders. When a ladder is used, an extra person shall be engaged for holding the ladder and if the ladder is used for carrying materials as well, suitable footholds and handholds shall be provided on the ladder and the ladder shall be given an inclination not steeper than ¼ to 1 (¼ horizontal and 1vertical);

ix) Scaffolding or staging more than 3.25m above the ground or floor, swung or suspended from an overhead support, or erected with stationary support, shall have a guard rail properly attached, bolted, braced and otherwise secured at least 1 metre above the floor or platform of such scaffolding or staging and extending along the entire length of the outside and ends thereof with only such openings as may be necessary for the delivery of materials. Such scaffolding or staging shall be so fastened as to prevent it from swaying from the building or structure;

x) Working platforms, gangways and stairways shall be so constructed that they do not sag unduly or unequally, and if the height of a platform or stairway is more than 3.25 metres above ground level or floor level, it shall be closely boarded, have adequate width and be suitably fenced;

xi) Every opening in the floor of a building or in a working platform shall be provided with suitable means to prevent fall of persons or materials by providing suitable fencing or railing with a minimum height of 1.2 meter;

xii) Safe means of access shall be provided to all working platforms and other working areas. Every ladder shall be securely fixed. No portable single ladder shall be over 3 metres in length;

xiii) All scaffolds, ladders and other safety devices shall be maintained in a safe condition and no scaffold, ladder or equipment shall be altered or removed while it is in use.

xiv) The Contractor shall take adequate precautions to prevent danger from electrical equipment.

xv) No material on the Site shall be so stacked or placed as to cause danger or inconvenience to any person or the public;

xvi) Excavation and trenching: All trenches 1.5 metres or more in depth shall be considered confined spaces and shall at all times be supplied with at least one

ladder every 30 metres, or fraction thereof. Ladders shall be extended from the bottom of trenches to at least 1 metre above the surface of the ground. Sides of a trench which is 1.5 metres or more in depth shall be stepped back to give suitable slope, or securely held by timber bracing, to avoid the danger of sides collapsing. Excavated material shall not be placed within 1.5 metres of the edge of a trench, or half of the depth of the trench, whichever is more. Cutting shall be done from top to bottom. Under no circumstances shall undermining or undercutting be done.

xvii) Demolition: Before any demolition work is commenced and also during the process of thework:

a) All roads and open areas adjacent to the work site shall either be closed or suitably protected;

b) No electric cable or apparatus which is liable to be a source of danger other than a cable or apparatus being used by an operator shall remain electrically charged;

c) The Contractor shall take all practical steps to prevent danger to persons employed from risk of fire or explosion, and the Contractor shall ensure that no part of a building shall be so overloaded with debris or materials as to render itunsafe.

xviii) All necessary personal safety equipment shall be provided by the Contractor for use by persons employed on the Site and maintained in a condition suitable for immediate use, and the Contractor shall take adequate steps to ensure proper use of equipment by thoseconcerned:

a) Workers employed on mixing asphaltic material, cement and lime mortars / concrete shall be provided with protective footwear, gloves andgoggles;

b) Those engaged in handling any material which is injurious to eyes shall be provided with protectivegoggles;

c) Those engaged in welding works shall be provided with welder's protective eye-shields;

d) Stone breakers shall be provided with protective goggles and protective clothing and seated at sufficiently safeintervals;

e) Those working with loud machinery or near loud activities shall be provided with appropriate ear protection such as earmuffs;

f) When workers are employed in sewers and manholes, which are in use, the Contractor shall ensure that manhole covers are opened and manholes are ventilated by mechanical means for at least one hour before workers are allowed entry. Gas detection devices shall be used to ensure the atmosphere inside the sewer or manhole is safe before man entry is allowed. Manholes so opened shall be cordoned off with suitable railing and provided with warning signals or boards to prevent accident topublic.

xix) When work is done near any place where there is a risk of drowning, all necessary equipment shall be provided by the Contractor and kept ready for use and all necessary steps taken for prompt rescue of any person in danger and adequate provision made for prompt first aid treatment of all injuries likely to be sustained during the course of thework;

xx) Use of hoisting machines and tackle including their attachments, anchorage, and supports shall conform to thefollowing:

a) These shall be of good mechanical construction, sound materialand

adequate strength and free from patent defects and the Contractor shall keep same in good repair and in good working order;

b) Every rope used in hoisting or lowering materials or as a means of suspension shall be of durable quality and adequate strength, and free from patentdefects;

c) Every crane driver or hoisting appliance operator shall be properly qualified and no person under the age of 21 years shall be in charge of any hoisting machine including any scaffold winch or giving signals to theoperator;

d) In the case of every hoisting machine and of every chain ring hook, shackle, swivel and pulley block used in hoisting or lowering or as a means of suspension, safe working load shall be ascertained by the Contractor by adequate means. Every hoisting machine and all gear referred to above shall be plainly marked with safe working load by the Contractor. In case of a hoisting machine having a variable safe working load, each safe working load and the conditions under which it is applicable shall be clearly indicated by the Contractor. No part of any machine or of any gear referred to above in this paragraph shall be loaded beyond safe working load except for the purpose oftesting;

e) The Contractor shall notify safe working load of each machine to the Employer's Representative whenever he brings it toSite.

xxi) Motors, gearing, transmission, electric wiring and other dangerous parts of hoisting appliances shall be provided with efficient safeguards. Hoisting appliances shall be provided with such means as will reduce to the minimum risk of accidental descent of load. Adequate precautions shall be taken to reduce to the minimum risk of any part of a suspended load becoming accidentally displaced. When workers are employed on electrical installations which are already energised, insulating mats, wearing apparel such as gloves, sleeves and boots, as may be necessary, shall be provided. Workers shall not wear any rings, watches or carry keys or other material which are good conductors ofelectricity;

xxii) Adequate washing facilities shall be provided at or near places ofwork;

xxiii) These safety provisions shall be brought to the notice of all concerned by display on a notice board at a prominent place at the work spot. Persons responsible for ensuring compliance with the safety provisions shall be named therein by the Contractor;

xxiv) To ensure effective enforcement of the rules and regulations relating to safety precautions, arrangements made by the Contractor shall be open to inspection by the Employer's Representative and any safety inspectionofficer.

Notwithstanding the above provisions, the Contractor is not exempted from the requirements of any other Laws in force.

The Contractor shall submit to the Employer's Representative for review detailed proposals under (i) above in conjunction with detailed construction and installation method statements for each element of work to be undertaken. When accepted by the Employer's Representative, and before the work is started, the Contractor shall distribute copies in English or in other language as appropriate to all his employees and to the Employer'sRepresentative.

The Contractor shall ensure that all his employees are fully conversant with the plans and regulations and the Contractor shall enforce the rule that any employee committing a serious breach of such plans and regulations shall be instantly dismissed and shall not be re-employed.

6.3 Lead in Paint

Paint or other products containing lead shall not be used.

6.4 First Aid and Life-Saving Apparatus

The Contractor shall provide on the Site such life-saving apparatus as may be appropriate and shall provide, equip and maintain at the Site of the Works first aid boxes as directed and shall be subject to approval by the Employer's Representative for the use of his own as well as Employer's Personnel onSite.

In addition, the Contractor shall instruct an adequate number of persons permanently employed at the Site in the use of the apparatus and equipment, and the Contractor shall make known the persons so designated to all employees by posting their names and designations in a prominent position on Site.

The Contractor shall advise the Employer of measures to be taken in the event of a serious accident.

The Contractor shall post a list of emergency telephone numbers (including ambulance) at several locations onSite.

6.5 Electrical Safety

While any electrical equipment is being installed or tested, the Contractor shall ensure that all necessary precautions are taken to safeguard personnel working on Site. If necessary, this shall include fencing off areas that are considered to pose a risk, and erecting warning notices.

The Contractor shall ensure that the installation of electrical equipment is carried out by suitably trained competent personnel and that the work is carried out in a safe manner. No electrical cables shall be laid across rebar. No joints or repairs shall be made to cables except by suitably trained competent personnel using appropriate protective equipment. All power sockets used on the Site shall be protected by a residual current device.

The Contractor shall be responsible for the operation on the Site of a permit to work system during the period of electrical equipment installation and testing. This system shall regulate the installation, the energising and the use of electrical Plant installed and the method of workadopted.

6.6 Asbestos

The Contractor shall not use any product that contains crocidolite (blue asbestos). Prior to use of any asbestos materials, whether in permanent works or temporary works, the Contractor shall submit to the Employer's Representative for review evidence that his insurance policies provide appropriate cover for the use of asbestos. The Contractor shall notify the Employer's Representative of the presence of asbestos on site throughout the entire Contract Period, including the Operation Service Period. When handling any asbestos materials, he shall comply with all appropriate national and internationally accepted regulations and codes of practice relating to the handling and disposal ofasbestos.

6.7 Supply of Potable Water and Sanitation Facilities

The Contractor shall, having regard to local conditions, provide on the Site an adequate supply of fresh and chlorinated potable water suitable for drinking and other water for the

use of the Contractor's staff on a daily basis. The Contractor shall also provide sanitation facilities for his staff employed on the site for the duration of the Contract.

6.8 Measures against Insect and Pest Nuisance

The Contractor shall at all times take the necessary precautions to protect the Contractor's staff employed on the Site from insect and pest nuisance, and to reduce their danger to health. The Contractor shall comply with all the regulations of the local health authorities, including use of appropriate insecticide.

6.9 Measures against Sunburn and Heat Exhaustion

The Contractor shall at all times take the necessary precautions to protect the Contractor's staff employed on the Site from sunburn and heat exhaustion, including provision of adequate breaks.

6.10 Alcoholic Liquor or BannedSubstances

The Contractor shall not allow alcoholic liquor or banned substances on site. The Contractor shall not import, sell, give, barter or otherwise dispose of any alcoholic liquor or drugs, or permit or allow importation, sale, gift, barter or disposal thereto by Contractor's staff.

6.11 Arms and Ammunition

The Contractor shall not allow arms or ammunition of any kind on the site. The Contractor shall not give, barter, or otherwise dispose of, to any person, any arms or ammunition of any kind, or allow Contractor's staff to doso.

6.12 Festivals and Religious Customs

The Contractor shall respect the Country's recognised festivals and religious or other customs. As a minimum, the statutory/mandatory holidays as declared by the Central and State governments shall be adhered to by theContractor.

6.13 Employment Records of Workers

The Contractor shall keep complete and accurate records of the employment of labour at the Site. The records shall include the names, ages, genders, hours worked and wages paid to all workers. The Contractor shall summarise these records on a monthly basis and submit to the Employer's Representative, and the Contractor shall make these records available for inspection during normal working hours. The Contractor shall include these records in the details to be submitted by the Contractor under Clause 6.10 of the Conditions ofContract.

6.14 Repatriation of Labour

The Contractor shall be responsible for the return of persons (recruited and employed for the purpose of or in connection with the Contract) to the place from where they were recruited or to their domicile and shall maintain such persons in a suitable manner until they shall have left the Site or, in the case of persons who are not nationals of and have been recruited from outside India, shall have left India.

6.15 Epidemics

In the event of any outbreak of illness of an epidemic nature, the Contractor shall comply with and carry out such regulations, orders and requirements as may be made by the Government, or the local medical or sanitary authorities, for the purpose of dealing with and overcoming the same.

6.16 Burial or Cremation of the Dead

The Contractor shall make all necessary arrangements for the transport, to any place as required for burial or cremation, of any of his expatriate employees or members of their families who may die in India. The Contractor shall also be responsible to the extent required by the local regulations, for making any arrangements with regard to burial or cremation or any of his local employed who may die while engaged upon the Works.

6.17 MCGM Health Department Guidelines

The Contractor shall keep a check on the health of all labour / employees as per MCGM Health Department Guidelines, including the appointment of a MBBS doctor to carry out regular checks at the site.

7 KEY PROGRAMME REQUIREMENTS AND STAFFING

The Contractor is required to complete each of the following activities, items of work or stages in the performance of the Contract in full in accordance with the Contract by the date or within the period specified for each such activity or item or stage in the table below. Week numbers refer to weeks after the Commencement Date unless otherwise stated. Other submissions as specified in the Contract shall be required in addition to the key submissions identified below.

7.1 Design-Build

Table 7-1 Key programme requirements during design and build

No.	Activity/Item of Work/Stage	Date or period by which item is to becompleted
1.	Submission of programme in accordance with Clause 8.3 of Conditions of Contract	As per Clause 8.3 of the Conditions of Contract
2.	Submission of project execution plan	Within 28 days of receipt of Notice of Commencement Date
3.	Submission of controlled copy of Quality Management System	Within 28 days of receipt of Notice of Commencement Date
4.	Submission of Health and Safety Plan	No later than 28 days before commencement of Works onSite
5.	General method statement	No later than 28 days before commencement of Works onSite
6.	Submission of Quality Plan for Design-Build	By end of week 4
7.	Submission of draft Contractor's design report(s)	By end of week 24
8.	Submission of HAZOP recommendations	By end of week 24
9.	Submission of all licenses, consents, clearances, NoCs, etc. required for commencement of Construction Work	By end of week 24
10	Submission of final Contractor's designreport(s)	By end of week 36
11	Submission of construction stage documents (excluding method statement)	No later than four weeks prior to commencement of that element
12	Submission of construction and installation methodstatements	No later than four weeks prior to commencement of that element
13	Submission of plant delivery documents	No later than three weeks prior to commencement of thatelement
14	Submission of Testing Plan and Testing Programme in accordance with the requirements of Section 14 of the Employer's Requirements	No later than 6 months prior to commencement of the Tests on Completion ofDesign-Build

No.	Activity/Item of Work/Stage	Date or period by which item is to becompleted
15	As-built documents submission of asset sheets	No later than 3 weeks prior to commencement of the Tests on Completion ofDesign-Build
16	Draft Operation and Maintenance Plan and Asset Management Database	No later than 8 weeks prior to commencement of Tests on Completion of Design-Build
17	Draft Final Operation and Maintenance Plan and Asset Management Database	No later than 3 weeks prior to the date for commencement of Tests on Completion of Design-Build
18	Nomination of Dry Weather Flow Interception Facility Manager/Pumping StationManager	No later than 6 months before the anticipated date for commencement of the Commissioning
19	Commencement of Tests on Completion of Design-Build (Process Commissioning)	No later than 2 months before the date for completion of the Design-Build
20	Commencement of Tests on Completion of Design-Build (Plant Proving Period)	No later than 6 weeks before the date for completion of the Design-Build
21	Submission of Quality Plan for OperationService	
22	Final approved as-built documents	No later than the date set out for the commencement of the Plant Proving Period or 28 days after completion of the commencement of the Commissioning whichever is theearlier
23	Final Operation and Maintenance Plan and Asset Management Database	
24	Final Operation and Maintenance Manual	
25	Time for Completion of Design-Build	As stated in the Particular Conditions Part A - ContractData

7.2 Design Review by Employer's Representative

The Contractor's final detailed design shall be completed within 30 weeks on a pro-rata basis from the Notice of Commencement. The design review team of the Employer's Representative will be available to carry out design review during this 30 weeks period.

If the Contractor is late in submission of either the draft or final designs for review, or proposes changes to a reviewed design such that additional design reviews are required, the cost of such reviews shall be borne by the Contractor.

7.3 OperationService

Table 7-2 Programme during Operation Service

No.	Activity / Item of Work / Stage	Date or period by which item is to be completed
1.	Full implementation of the O&M Plan	No later than the date set out in the Commissioning Certificate in accordance with General Conditions Sub-Clause 11.7, or 28 days after Completion of the Tests on Completion of Design-Build whichever is the earlier
2.	Service Delivery Review Report	Initial review report within one month of the date set out in the Commissioning Certificate in accordance with General Conditions Clause 11.7 and subsequent reviews every 3 months thereafter with a complete review annually
3.	Update of the O&M Plan	At least every 3 months and when required to meet recommendations of the Service Delivery Review Reports
4.	Submission of draft O&MManuals	Within 3 months of the date set out in the Commissioning Certificate in accordance with General Conditions Clause 11.7
5.	Submission of final O&M Manuals	Within 6 months of the date set out in the Commissioning Certificate in accordance with General Conditions Clause 11.7
6.	Update of O&M Manuals	At intervals of no more than 12 months

7.4 Key Staff

7.4.1 Contractor's Representative

The Contractor's Representative shall be experienced in the construction of large infrastructure projects. He shall meet or exceed the following parameters:

- 15 years' relevant experience;
- 3 years' experience specifically in construction of sewer networks and sewage or storm water pumping stations;and
- Bachelor Degree in Engineering.

7.4.2 Project Manager

The Project Manager shall be experienced in the construction of large infrastructure projects. He shall meet or exceed the following parameters:

- 20 years' relevant experience;
- Bachelor Degree in Engineering.

7.4.3 Deputy Project Manager

The Deputy Manager shall be experienced in the construction of large infrastructure projects. He shall meet or exceed the following parameters:

- 12 years' relevant experience;
- Bachelor Degree in Engineering.

7.4.4 Project / Site Engineer

- 5 years' relevant experience if Bachelor Degree in Engineering ;

OR

- 10 years' relevant experience if Diploma in Engineering ;

7.4.5 Quality Engineer

The Quality Engineer shall be experienced in the construction of large infrastructure projects. He shall meet or exceed the following parameters:

- 8 years' relevant experience;
- Bachelor Degree in Engineering.

7.4.6 Surveyor

The Surveyor shall be experienced in the construction of large infrastructure projects. He shall meet or exceed the following parameters:

- 8 years' relevant experience;
- Diploma in Engineering.

7.4.7 Project planning / Billing Engineer

The Project planning / Billing Engineer shall be experienced in the construction of large infrastructure projects. He shall meet or exceed the following parameters:

- 6 years' relevant experience;
- Bachelor Degree in Engineering.

7.4.8 Surveillance Specialist / Electrical Works Supervisor

The Surveillance Specialist / Electrical Works Supervisor shall be experienced in the construction, operation and maintenance of surveillance / electrical works. He shall meet or exceed the following parameters:

- 10 years' relevantexperience;
- 3 years' experience in planning, construction, operation, and maintenance of surveillance works;and
- Bachelor Degree, or Diploma, in Electrical Engineering, Electronics, or other relevant field.

8 GENERAL DESIGN

8.1 Codes andStandards

The Works shall be designed, manufactured, constructed, tested and operated in accordance with the following standards and codes of practice. In the event of differences between the standards or codes of practice, the more stringent shall apply. In the event of any conflict, the standards or codes of practice shall be interpreted in the order of precedence givenbelow:

1. As specified in this Contract, should there be any conflict within the Contract documents, Volume 2 – Employer's Requirements will take precedence over the specifications in Volumes 2A, 2B,2C and 2E;
2. For Plant and Materials, they shall comply with those standards of the country of manufacture which are relevant to the item concerned, in addition to the standards cited in the general technical specifications; and
3. Relevant standards and codes of practice ofIndia.

If the Contractor determines there are conflicting requirements, the more stringent shall apply. However, the Employer's Representative reserves the right to make the final decision on the matter.

Each item of equipment, Plant and Materials shall comply with those standards of the country of manufacture which are relevant to the item concerned. The Contractor shall also ensure that each item of equipment, Plant and Materials comply in all respects with the standards cited in the general technical specifications.

For items which have not been specified in either Indian codes/standards or in this Contract, the Contractor shall ensure the following standards are met:

a) European codes of practice, such as those Euro norms which are codes ofpractice; and

b) International Electro technical Commission (IEC) and International Organisation for Standardization (ISO) of codes ofpractice.

Where the requirements of the standards cited in the general technical specifications are more stringent in any respect than the requirements of the standards of the country of manufacture and, in the opinion of the Contractor, the proposed manufacturer cannot reasonably meet these more stringent requirements, the Contractor shall submit to the Employer's Representative for approval a list of all the deviations from the standards cited in the Contract.

If requested to do so by the Employer's Representative, the Contractor shall submit to the Employer's Representative at least one copy of each code of practice, standard, and reference work which is referred to in the general technical specifications or elsewhere in the Contract or proposed by the Contractor. All such documents shall be in the language stated in the Contract Data in accordance with Clause 1.4 of the Conditions ofContract.

The Employer's Representative reserves the right to reject any Plant or Materials manufactured to a different standard which he considers to be unacceptable.

References in these documents to standards shall be deemed to be to their equivalent current standard in the event that they have been withdrawn or new more applicable standards are in force.

Only proven technologies shall be incorporated in the Works. The Contractor may only incorporate new technology in the works subject to his being able to demonstrate each of the following to the Employer:

- The new technology is permitted by the Laws ofIndia;
- The new technology has a proven track record (of similar size andapplication);
- Application of the new technology will not be detrimental to the life of and the safe, environmentally sound, reliable, cost efficient and correct operation of theWorks;
- Incorporation of new technology in part of the Works will not result in any undesirable incompatibility or monopoly;and
- Application of the new technology will yield benefits to the operation and maintenance of the Works, for example by reducing operating & maintenance costs, providing more user-friendly operation, enhancing the automatic collection and storage of data relating to the operation and maintenance of the Works,etc.

8.2 Design Life

Unless stated otherwise in the Employer's Requirements, the Contractor shall design the Works such that the design life shall be a minimum of:

Table 8-1 Design Life

Item	Minimum Design Life (Years)
Civil engineering and building works (including underground services and pipes)	50
External pipework and valves	50
Roads	25
Mechanical - internal pipework and valves	25
Mechanical – rotating machinery and complex equipment	13
Mechanical – Gate Pumps, Actuator, etc.	15
Electrical – cables	25
Electrical - HT electrical, transformers & switchgear	20
Electrical - LT electrical, switchgear	13
Instrumentation	7

All Plant, Materials, and equipment utilised in the Works shall be new. No existing Plant, Materials, buildings or equipment from the facility or element of the existing facility shall be reinstalled or re-used in the final Works. The Contractor shall look for opportunities to design the Works with a longer design life than those listed above for equipment that is paid for by the Employer through the Asset Replacement Expenditure. The Contractor shall provide the necessary information to allow the Employer to decide if the asset with a longer useful life should be used to replace the existing asset based on cost factors such as immediate cost and future operating/maintenancecosts.

8.3 Units of Measurement

All correspondence, drawings, data sheets, calculations, labels, nameplates, field instruments etc. shall be expressed in metric SI units where such unit exists.

8.4 Plant Access and Maintainability

For ease of operation and maintenance, the arrangement of new, refurbished and

upgraded parts of the Works shall include access:

- to all items such as valve operating handles, gauges, sample points, etc. to which access is needed during normaloperation;
- for maintenance, including suitable lay downareas;
- for the removal of equipment without disturbing adjacent equipment and to enable the equipment to be loaded on to a vehicle;and
- for visual inspections, except in the case of buriedpipelines.

The Contractor shall ensure that all working areas have adequate access, lifting equipment, lighting, air-conditioning, heating and ventilation.

All plant, equipment housings etc. which may be handled during the course of normal operations or maintenance, shall be provided with the following facilities:

Table 8-2 Lifting Limits

Range of Weight (W) of Object to be Lifted			**Required Facility**
N/A	W	≤ 25kg	No special arrangements required
25kg <	W	≤ 35kg	Arrange for two-man lifting
35kg <	W	≤500kg	Provision of suitably rated lifting equipment
500 kg<	W	≤1 tonne	Provision of suitably rated lifting beam with manual chain block
1 tonne<	W	≤ 2 tonnes	Provision of suitably rated overhead crane with manual chain block and manual travel
2 tonnes<	W	N/A	Provision of suitably rated overhead crane with electric lift and electric travel

Each building which houses process equipment shall include provision for that equipment to be lifted by a hoist/crane and extended beam system such that the equipment is hoisted within the building and easily moved outdoors (on the same hoisting system) and can be lowered directly onto or raised directly from a transport vehicle.

Where it is necessary for the regular delivery of chemicals, fuel, skips etc. into a building and/or for the collection of skips, screenings, ash, bag filter residue etc., each loading/unloading area shall incorporate a covered canopy structure adjacent to the access door. The access door may be either an electrically operated roller shutter door or a two-leaf outward opening door, both designed to suit the hoisting system. Where it is necessary for large vehicles to enter a building regularly, the building shall be arranged so that each vehicle can drive through the building without the need to reverse inside the building. It shall be possible to close both the vehicle entrance and exit doors while the vehicle is being loaded or off-loaded inside thebuilding.

A pedestrian access door shall be provided adjacent to each vehicle access door. Vehicular routes within buildings shall be clearly marked and:

- Process equipment, pipes, cables, etc. shall not be located within 1 metre of a marked vehicularroute;
- Appropriate physical protection shall be provided for equipment, pipes, cables, etc. located close to a vehicle access route to minimise the risk of damage;and
- Thereshallbeamarkedpedestrianaccessroutenotlessthan1metrewide

Along side each vehicular route.

8.5 Drawings

Refer also to Section 4 in relation to Contractor's Documents.

The Contractor shall provide all drawings with dimensions in metric units.

The Contractor shall use ISO standard size sheets only. All electrical drawings shall include a key legend of symbols and references used.

All drawings issued by the Contractor shall have a common title block bearing the name of the Employer and the Contractor and shall include the name of the Subcontractor or supplier where appropriate.

8.6 Climatic Conditions

The Contractor shall ensure the Works are suitable for continuous operation in all climatic conditions likely to be encountered at the Site. The Contractor shall ensure all Plant and Materials located outside are suitable for a temperature range of at least 10ºC below the minimum to 10ºC above the maximum temperatures recorded in the area by the meteorological service. As a minimum the Contractor shall ensure that all Plant and Materials are suitable for thefollowing:

- Temperature: 0 ^{O}C to + 50^{O}C;
- Humidity: 100% (including enclosures);and
- Saline / coastalconditions.

8.7 Asset Register

During the design of the Works, the Contractor shall develop a numbering system for each item of Plant and Materials that will be compatible with his proposed Operation and Maintenance Plan and his proposed Asset Management Database.

The Contractor shall apply the numbering system to the method of physically identifying each item and to the referencing on the drawings and in the ICA design.

The Contractor shall submit the format of asset sheets to be included in the Operation and Maintenance Manual and Asset Management Database to the Employer's Representative for review.

8.8 Labels

All signs, notices, on-site instructions, name-plates, monitors etc. at the Works shall be in both Marathi and English.

All Plant items shall be fitted with a rating plate, which contains as a minimum, manufacturer's name, type reference, serial number, date of manufacture and rating of machine or Plant item.

All Plant items shall be fitted with a unique name plate bearing the individual plant reference for the Plant item e.g. 'Screen Motor No. 2'. In the case of removable Plant items, the name plate shall be fitted alongside the item.

In addition, each item of Plant and equipment shall carry an asset number label which may be electronic to comply with the requirements of the Operation and Maintenance Plan to be developed.

Name plates and rating plates shall be either traffolyte (black letters on white label) or 316 stainless steel labels stamped with black lettering. The lettering shall be of a size

suitable for the application but shall not in any case be less than 6mm high. All labels shall be visible from an operator access way.

Each switchboard, motor control centre, ICA panel, pump, valve, etc. and any other item of Plant and equipment shall be fitted with an identification label with letters not less than 12mm high. Additionally, each individual switch shall have an identification label at both the back and front of the unit, where applicable. These labels shall carry the unambiguous switch name and number, in letters not less than 8mm high, which will denote the service or Plant items which they control.

Fuse or MCB sizes and circuit numbers must be clearly indicated adjacent to each device to facilitate identification andreplacement.

Where more than one power supply is connected to a distribution board or plant item, clear indication of the danger must be given and the voltage between phases shall be made obvious by the Contractor

All cables shall be clearly labelled so that their source, destination, and function can be identified.

All labelling or types of labelling shall be subject to approval by the Employer's Representative before installation.

All pipe work above ground shall be labelled with contents and flow direction. Pipe work of diameter less than 50mm may have tags or clamped signs unless it is less than 1.0m in length where labelling shall not be necessary.

All storage tanks shall be labelled with contents and volume. Letters shall be of a size suitable for the application but shall not be less than 100mm high. Labels shall be painted at 90 degree intervals at a suitableelevation.

8.9 Hazardous Area Classification

As part of the Contractor's design, the Contractor shall carry out a risk assessment of the possibility of the existence of potentially explosive atmospheres during the operation of the Works by means of a Hazardous Areas Classification.

All zonal classification and Plant and Materials shall be in accordance with BS EN 60079 and IECE x 60079 series of standards.

Plant shall be of an approved type and be "Ex" rated according to the Hazardous Areas Classification as necessary.

8.10 HAZOP Studies

The Contractor shall carry out a hazard and operability (HAZOP) study for the Works at an appropriate stage in the design. Modifications to the Contractor's design or construction that are required as a result of the HAZOP shall be implemented by theContractor.

The HAZOP shall be carried out in accordance with the Indian Standard - *HAZARD IDENTIFICATION AND RISK ANALYSIS - CODE OF PRACTICE IS15656:2006.*

The Contractor shall appoint from his staff the chairman and the secretary for the HAZOP meetings subject to agreement with the Employer's Representative. Other members of the Contractor's staff familiar with the details of the Contractor's design shall attend the HAZOP meetings, as appropriate. These HAZOP meetings shall be held in Mumbai and the Employer's Representative shall be given adequate notice to attend themeeting.

The following shall be included in the studies:

- The design, including all process and instrumentation diagrams, all single line diagrams, plant layout drawings, pipeline drawings and block diagrams for the control system;and
- An ICA design appraisal including the controlphilosophy.

During the HAZOP study, the following topics shall be considered as a minimum:

- Disaster resilience as per the requirements of Disaster Management Act 2005 as modified;
- Adequacy of the vehicle and personnel access to plant, plant rooms, switch rooms, control rooms etc. together with the means of escape – safety aspects such as confined spaces, areas where high noise levels are expected,etc.;
- Facilities for transferringscreenings;
- Impact of various climaticconditions;
- Facilities for removing items of plant formaintenance;
- Safety facilities such as safety showers, fire alarmsetc.;
- Operation of the Permanent Works under normalconditions;
- Impact of abnormal conditions such as high or low temperature, pressure or flow on the operation of the PermanentWorks;
- The impact of an electricity supply failure, etc. on the operation of the Permanent Works;and
- Other topics as determined by the HAZOP studyteam.

The HAZOP meetings shall be conducted in a systematic manner and the outcomes shall be recorded by the secretary. A two-stage approach shall be used. The first stage will be carried out at the stage when process and instrumentation diagrams are available and the results shall then be used to further develop the design. The second stage will review both the process and instrumentation final diagrams and the ICA systems to ensure that the overall system design provides adequate operationalsecurity.

Following the HAZOP meetings, the Contractor shall consider each of the hazards which have been identified and assign to it:

- Likelihood of occurrence, i.e. high, medium or low;and
- Severity of the consequences when the hazard does arise i.e. severe, medium or low.
- From these two factors, the overall risk associated with each hazard shall be determined by the Contractor.
- Following this risk assessment, the Contractor shall recommend the action which is to be taken in relation to each hazard. The Contractor shall submit these recommendations to the Employer’s Representative forreview.

9 APPROVALS AND LICENSES

9.1 Environmental Impact Assessment

The Contractor shall undertake an Environmental Impact Assessment to support the application wherever needed.

9.2 Licenses

The Operating Licence signed as part of this Contract allows the Contractor to operate the Works on behalf of the Employer.

The Tenderer shall provide compliance as per Environmental Clearance from MOEF, No. 11-49/2007-IA-III Dated 28th January 2008 which is incorporated into the details contained in AppendixB.

The Employer has consent from the Maharashtra Pollution Control Board (MPCB) in relation to the discharge of treated effluent.

The requirements of the Environmental Management Plan (EMP) issued by the National Environmental Engineering Research Institute (NEERI) have been incorporated into the Employer's Requirements.

The Contractor shall be responsible for obtaining all consents, permits, licenses and approvals/clearances (including pending, re-validation and renewals) required for the project. The Contractor shall also allow sufficient time for the necessary procedures in his programme. Any delays associated with obtaining any licenses, permits, and consents shall be the responsibility of theContractor.

The Contractor shall carry out the Operation Service in accordance with all consents, permits, licenses and approvals required.

Appendix F contains a sample list of procedures for general construction works. The Contractor is cautioned that Appendix F is not an exhaustive list. The Contractor shall be required to identify all other licenses or approvals required.

The Contractor shall submit to the Employer in advance a list of licenses, permits and consents required for the Contract and the Employer shall determine which of these shall be in the name of the Employer. However, the Contractor shall bear all costs associated with the licenses, permits and consents.

Licenses required to undertake the Works will include, but not be limited to, the following:

Table 9-1 Schedule of Licenses

Sr. No.	Item	Authorising Body	Details
1	Environmental Clearance	MOEF	The Contractor shall comply with the environmental clearance which the Employer has obtained fromMOEF.
2	Environmental Management Plan (EMP)	State Expert Appraisal Committee (SEAC), Maharashtra	The likely requirements of the EMP have been incorporated into the Employer's Requirements. The Contractor shall obtain the EMP with support from the Employer.

Sr. No.	Item	Authorising Body	Details
3	General	Various	The Contractor shall be responsible for obtaining all consents, permits, licenses and approvals/clearances (including pending, re-validation and renewals) required for the project. The Contractor shall allow sufficient time for the necessary procedures in his programme. Any delays associated with obtaining any licenses, permits, and consents shall be the responsibility of the Contractor. Appendix F contains a sample list of procedures for general construction works. The Contractor is cautioned that Appendix F is not an exhaustive list. The Contractor shall be required to identify all other licenses or approvalsrequired.
4	Operating License		The Operating Licence signed as part of this Contract allows the Contractor to operate the Works on behalf of theEmployer.
5	Operation Service	Various	The Contractor shall carry out the Operation Service in accordance with all consents, permits, licenses and approvals required. In case, during period of operation and maintenance any additional permits, consents clearances etc. are required due to change in government laws, policy etc., the Contractor shall obtain the same at no extra cost to theEmployer.

10 PROCESS DESIGN

10.1 General

10.1.1 General Design Requirements

The Contractor is responsible for the design and construction of the Works and for the subsequent provision of the Operation Services in accordance with the Contract. The Contractor shall select the type, number, sequence and configuration of process units needed to achieve the tidal dry weather flow interception and transfer. The Contractor's design of the Works shall be in accordance with the Employer's Requirements and all other requirements of the Contract. The Works shall be capable of conveying and treating the maximum flows and loads specified in Appendix B1 of the Employer's Requirements to the standardsspecified.

The Works shall have capacity to convey through the interception processes to the outfall the Pass Forward Flow (PFF) specified in Appendix B1 of the Employer's Requirements without overflow. The Contractor shall determine the diurnal variation and other variation factors and take consideration of these in hisdesign.

The Contractor shall not stop or reduce the delivery of flows from the sewerage network to the Tidal Dry Weather Flow Interception Facility or to the sewage pumping stations. The Contractor shall not discharge any flows through an emergency bypass, except in an emergency and with the express permission of the Employer for each overflowevent.

The estimated current Dry Weather Flow as given in Volume 5, may change during the Operation Service. The Contractor's design shall accommodate variations in plant loading during the Operation Service Period. The Contractor shall make no limiting assumptions in relation to the timing and rate of any increase in flow and loading and shall not infer any linear increase in the loading to theWorks.

The Employer does not guarantee the wastewater flows and loads which will be delivered to the Tidal Dry Weather Flow Interception Facility or to the sewage pumping stations. Flows and loads may be lower than the current estimated flows andloading.

As far as possible, the Contractor shall minimise the use of proprietary equipment or processes which will require inputs from third parties throughout the Operation Service Period.

The process units shall be selected based on minimum process design parameters given in this section. All tenderers shall complete and return the schedule of design parameters with their tenders – no departure from the minimum design parameters shall be accepted without written approval from the Employer.

Table 10-1 Key Process Parameters–

Process Unit	Minimum Design Parameter (at PFF)
Type of Gate in Pump Gate	Roller
Sealing method in pump gate	4 way sealing
Minimum Number of Pumps in any SWPS	2
Type of pumps in SWPS	Submersible horizontal axial flow
Number of starts / Stops in an Hour (SWPS)	4
Screen Size	75 mm

10.1.2 Stand by Requirements

The Contractor shall design the Works such that each stage of the process includes appropriate standby capacity and bypass arrangements. The Works shall be designed such that at Peak Daily Flow any individual unit can be taken out of service for planned maintenance work without breaching the specified performance requirements.

All mechanical and electrical plant (Except Screening Plant at Tidal Dry Weather Flow Interception Facility) shall be arranged in duty/standby configurations with automated rotation of duty to ensure even wear and automated changeover to standby units in the event of plant failure. Standby plant shall be of the same type and capacity as the duty plant. The following table gives the minimum standby capacity requirement versus the number of duty plant units.

Table 10-2 Minimum Standby Requirements

No of duty units	Minimum standby (%)
1	100
2	50
3	33
>3	25

For all process units, tanks and containers, the Contractor shall build in facilities for draining down and bypassing without the need for portable equipment, except for emergency provision. The Contractor shall automate draining down where appropriate, and shall make allowance in the treatment stages for return of liquors generated during draining down and cleaning of the works.

10.1.3 Bypass Requirements

The Contractor shall provide an emergency bypass channel or pipe for the whole of the Works capable of handling the required Pass Forward Flow (PFF). The emergency bypass shall lead from a designed emergency overflow at the Inlet Chamber to the Outfall and include connections from key points in the process such that in the event of a blockage or complete process failure, could continue to be discharged to the receiving watercourse without overspill and consequent damage to the Works.

Access points to the bypass (i.e. designed overflow points in the Works) shall include devices to record overflow events, which shall be logged in the PLC & local data logging system.

10.1.4 Influent Characteristics

The characteristics of wastewater Influent arriving at dry weather flow interception facility are typically influenced by contributions from domestic sewage, industrial effluent, storm water and tidal water infiltration to the collection system. Tidal infiltration can create elevated chloride and sulphate concentrations in the wastewater. The Contractor shall ensure that the process design and materials used in the construction of the Works are appropriate to the quality of the Influent.

There is no septicity control upstream within the catchment. Therefore, the Contractor shall design the Works taking into account that the wastewater Influent may be septic and consider / provide suitable treatment of septicity to protect the treatment processes and prevent generation of malodours. The Contractor shall provide protective coatings to protect structures and equipment from corrosion due to the presence of hydrogen

sulphide gas, including in openstructures.

10.1.5 Design Standards

The Contractor shall design the Works based on best international practice and shall ensure that treatment processes provided are based upon technically proven processes.

In addition to the Indian (CPHEEO) Manual 2013 on Sewerage and Sewage Treatment, it is expected that the best international practice, standards and guidelines shall be based on, as a minimum, the latest editions of thefollowing:

1) Design;
   - Manual of British Practice in Water PollutionControl;
   - British – Water Research Centre(WRc);
   - EuropeanStandards;
   - USA- Environmental ProtectionAgency;
   - USA-Water Environmental Federation Manuals ofpractice;
   - USA-“10 States” Standards of WastewaterFacilities;
   - Ministry of the Environment for Design Guidelines for Sewage Works (Ontario, Canada);and
   - Wastewater Treatment and Re-use - Metcalf &Eddy;
2) Area Classification and VentilationRequirements;
   - USA National Fire Protection AgencyNo.820;
   - Manuals of British Practice;and
   - EuropeanStandards;
3) Operation &Maintenance;
   - Manual of BritishPractice;
   - EuropeanStandards;
   - USA Environmental Protection Agency - Considerations for Preparation of Operation and Maintenance Manuals;and
   - USA Water Environment Federation manuals ofPractice;
4) Laboratory TestingProtocol;
   - APHA/AWWA/WEF Standard Methods for the Examination of Water and Wastewater.

If the Contractor determines that there are conflicting requirements, the more stringent shall apply. However, the Employer’s Representative reserves the right to make the final decision on the matter.

10.1.6 Process Requirements

The following main treatment processes are envisaged in the Contractor's design of the Works:

- Pumpingsystem;
- Flowmeasurement;
- Inletchamber;
- Preliminary treatment (screeningremoval);
- Storage and disposal of all wastes includingscreenings.

The Works at the Sewage Pumping Stations, Storm Water Pumping Station (Gate Pumps)and dry weather flow interception facilityshall also include, but not be limited to, the items listed below:

a) dry weather flow interceptionfacilities;

- Transfer of flows via open flow channels and undergroundconduits;
- Flow measurement at locations in accordance with Section10.19;
- All ancillary mechanical and electrical installations associated with the main dry weather flow interceptionprocesses;
- Suitable and appropriate lifting equipment for maintenance andoperation;
- Potential septicity treatment (ifrequired);
- Facilities for collection of bags, skips and containers, wherevernecessary;
- PLC, local data logger and alarmequipment;
- Provision of electricity, water and other utilities and services to theSite;
- Cabling and all electrical installation equipment andmaterials;
- Process control, monitoring andinstrumentation;
- Provision of spareparts.

All on-site civil engineering works associated with the wastewater and sludge treatment facility including:

- Administrationbuildings;
- Access and siteroads;
- Landscaping and planting of theSite;
- Site drainage, run-off and internal buildingdrainage;
- Security systems including guardhouse, CCTV, fencing and accessgates;

b) OperationService;

- Operation and maintenance of the Works by the Contractor for a period of 10 (Ten)Years.

10.1.7 Site Layout Restrictions

Refer to the Employer's Requirements for any site layout restrictions.

10.1.8 Existing Influent Data

Refer to Volume 5.

10.2 Incoming Influent

Refer to the Employer's Requirements for conveyance details of the incoming Influent to the Works.

10.3 Inlet Chamber

The Contractor shall provide an inlet chamber to receive incoming flow. This shall be designed for the Pass Forward Flow (PFF) plus any waste streams (centrate, washwater etc.) to be returned to the head of the Works. The inlet chamber shall be covered and be provided with forced ventilation for the extraction of foul gas from thechamber.

The Works include for the provision of Storm Water and Sewage Pumping Stations.

There shall be an Emergency Overflow (EO) upstream of the IPS designed to automatically and continuously operate in the event that there is a failure of the main electrical power supply to the Works or in the unlikely event that flows in excess of the PFF arrive at the Works. The level of this EO shall be constructed to prevent backwater surcharging of the inlet sewer system. The EO shall preferably be of a fixed adjustable longitudinal weir type and shall also incorporate a device (at the discharge) to prevent reverse flows.

The EO shall also incorporate a fixed coarse trash rack/screen (with 75 mm spacings) capable of handling 100% of the PFF to prevent debris or gross solids entering the emergency overflow pipe. The Contractor shall provide a monitoring system on the overflow to identify in real time if any flows discharge through the overflow.

The PS shall be provided with inlet screening equipment suitable for open channel type flow. The Contractor shall provide a minimum of two mechanised coarse multi rake bar screens with Auto-Jam Removal System (20 mm spacings) each suitable for 100% of the PFF designed to remove debris from the wastewater that would otherwise affect pumpingperformance.

The Contractor shall design the Works from the inlet sewer immediately within the site to the emergency overflow discharge point with a capacity not less than the PFF. The Contractor shall connect to the incoming sewer at the inlet pumping station. The incoming sewer within the Site boundary shall be the responsibility of the Contractor. Invert levels shall be verified by theContractor.

The Contractor shall design the proposed PS such that the pumped rate matches, in as far as is possible, the rate of inflow to the pumping station wet well. If this is achieved by maintaining a fixed control water level within the wet well, the pump control system shall include the optional facility to draw down the water level to pump at a lower level on a timed basis during low flow conditions, to reduce the accumulation of floating material, scum, solids and screenings.

The wet well shape may be circular or rectangular. The wet well shall have two compartments with an interconnecting Sluice Upward Opening Thimble Gate. Pumps designed for average flow shall be provided with Variable Frequency Drive (VFD) arrangement. The wet well shall have a maximum operating depth of 2 m and the pump submergence depth shall be a minimum 1.5 m (minimum difference between the two set points for the level sensors shall be 300mm).The wet well shall have a minimum of 300 mm freeboard. The wet well operating volume shall have a minimum of 5 minutes retention time at PFF.

10.4 Preliminary Treatment

10.4.1 Screening

The Contractor shall provide mechanically operated, front-raked screening equipment suitable for open channel type flow.

The Contractor shall provide a sufficient number of appropriately sized units operating in parallel to meet the Flows and Loads specified in Appendix B1 of the Employer's Requirements.

The Contractor shall provide a means of isolating each screen with motorised penstocks in upstream and Stop log in downstream capable of manual operation.

Screens shall have clear openings not less than 75mm for interceptors. Design velocity through the apertures shall not exceed 1.5 m/s at PFF.

Screens shall be equipped with an automatic cleaning system to prevent blockage. The Contractor shall ensure that the screen cleaning system can be operated intermittently and be controlled by both an adjustable timed cycle and a pre-set differential head across the screen using ultrasonic level sensors. The screens shall be equipped with multiple rakes such that the maximum time between raking any point on the screen is 20 seconds in fair season and 10 seconds duringmonsoon.

The Contractor shall select the screens and screening handling equipment from suppliers with a proven track record for thisapplication.

Thecapacityofthescreeningstreatment plant shall beadequate totreat thepeak screenings loads, which may occur following a storm. The Contractor shall demonstrate that this has been taken into account in the design of the screenings handling system.

The Contractor shall be responsible for the transport and disposal of screenings to a legal, licenced landfill site.

The Contractor shall remove screenings from the Site in sealed bags / containers designed to ensure no release of odours or liquid to the environment along the route to the disposal location.

The Contractor shall make provision for storage of empty screenings containers / bags on the Site. These containers shall be thoroughly clean and odourfree

10.5 Ventilation

Forced ventilation shall be provided in pumping station, minimum Air Changed Per Hour shall be 12.

Each blower stage in the ventilation systems shall be supported by a standby, with automatic starting of the standby unit at failure of a duty machine.

To limit power consumption and minimise the risk of noise nuisance, the velocity of the air through the ventilation ducting shall not exceed 12m/s.

The ducting shall be manufactured from suitably corrosion resistant material. Galvanised steel will not be acceptable.

Mechanical and natural ventilation rates shall take into account any requirements arising from the conclusions of the hazardous areas classification.

Ventilation design shall provide for the dissipation of heat generated by electrical equipment.

10.6 Hydraulic Design

10.6.1 General

The principal hydraulic design requirements applicable to the Works are that:

- All aspects of the hydraulic design shall be based on sound principles and good common engineering practice typical for municipal engineeredworks;
- The Sewage Pumping Station and Dry Weather Flow Interception Facility and all parts thereof shall be capable of passing the required wastewaterflows;
- The Storm Water Pumping Station Facility and all parts thereof shall be capable of passing the required storm waterflows;
- The flows shall be evenly distributed between the numbers of streams and process units in operation for all flowconditions;
- Suspended sediment entering the facility shall be kept in suspension and transported through the facility by the flow as far as the treatment unit where it is to be removed or separated from the main wastewater flow;and
- The hydraulic design shall comply, where applicable with relevant international standards.

10.6.2 Design Flows

Hydraulic design flows throughout the facility shall take full account of recycled and returned flows. The hydraulic design calculations shall demonstrate the proper functioning of the facility if any one of the process units were to be out of service for maintenance at the Peak Flow during dry weather and PFF.

Where the applicable control structures are sited downstream of the chamber or other location where the division of flows occurs, the intervening channels, culverts and pipes shall, as far as practicable, be functionally identical in terms of conduit dimensions, lengths, bend angles, etc. so as not to impair the even division of flow.

Hydraulic calculations shall be based on the Colebrook-White or Hazen-Williams formulae for pipe, and the Manning equation for open channel, flow. The hydraulic design calculations shall show clearly the methods of calculation and analysis used, including all assumptions made. The calculations shall include a hydraulic profile and full details of the depths, velocities, water surface or pressure head elevations, energy (or total head) elevations and (for open channels or closed conduits flowing partially full) Froude numbers throughout theDWFIF, Sewage Pumping Station and Storm Water Pumping Station.

All parts of the Works shall be designed with allowances for the most adverse combinations of anticipated maximum and minimum settlements or other movements of the structures concerned. In particular, the minimum freeboard in hydraulic structures shall include an appropriate allowance for anticipated settlement.

10.6.3 Pipelines and Culverts

Hydraulic design calculations for pipes and culverts flowing full shall include profiles of the static head and total energy elevations in relation to the soffit of the conduit. No designs shall cause, assume or require the occurrence of sub-atmospheric pressures within any conduit. All pipe and culvert intakes shall be designed to reduce airvortices.

10.6.4 Channels

The Manning Formula or similar shall be used for the design of open channels and shall, except where expressly permitted otherwise, be designed for sub-critical flow, with a Froude number no higher than 0.5.

Channels collecting flows from weirs along one or both sides of the channel shall be designed and analysed taking account of both friction losses and losses due to mixing of the incoming flow. The modified ‘Camp’ formulae may be used for headloss calculation for ‘staged flows’ in effluent launders with weirs.

10.6.5 Control and other Hydraulic Structures

As far as practicable, sharp crested weirs with free discharge shall be used and shall be designed with standard profiles for which flow characteristics are readily available, so that their hydraulic performance can be predicted reliably from reputable hydraulictexts.

Sharp-crested weirs shall include adequate provision for maintaining atmospheric pressures beneath the nappe.

Flumes shall be designed with the appropriate approach distance and the discharge shall be designed to be free flowing (not drowned) with the appropriate maximum submergence. Flumes shall be designed to work under all hydraulic flow conditions from minimum to maximum.

10.6.6 Penstocks

Penstocks in channels shall be designed so that, when fully open, there is no encroachment on the cross-sectional area of the maximum flow depth.

10.6.7 Hydraulic Gradient

The hydraulic gradient shall be calculated according to the following criteria:

a) The roughness coefficient ‘C’ or ‘K’ shall be as per common engineering practice (pipes and channels), the pipe manufacturer’s guidelines, taking into account whether the use is for wastewater or surfacewater;

b) A freeboard of at least 25 mm shall be provided to upstream weir crests under maximum flow conditions when one stream is isolated, and at least 100 mm shallbe provided under full flow with all streamsoperational;

c) The ADWF hydraulic gradient shall be calculated assuming one stream ofprocess plant is offline, and weir levels set accordingly;and

d) Self-cleansing velocities shall be achieved in all pipes and channels as appropriate at least two times perday.

11 CIVIL DESIGN

11.1 General

This section of the Employer's Requirements sets out the particular requirements for the civil engineering works, building works and site services for the Works required by the Contract unless stated otherwise elsewhere in the Contract.

11.2 Design Requirements

In designing the Works, the Contractor shall comply with the following requirements:

- The Works shall utilise a minimum area within the Site, consistent with safe and reliable operation andmaintenance;
- Means of access and egress for personnel above and below ground shall comply with safe and reliable procedures and all Indianregulations;
- Ensure design is consistent with relevant national and local legislation, guidelines andpolicies;
- All pipelines, ducts, mains and services shall be provided with flexible joints able to accommodate the differential movement that may occur between buildings and the surroundingsoil;
- All pipelines, ducts, mains and services shall be provided with surface access chambers (including pipeline puddle flanges, dismantling couplings or adapters and rocker pipes) at bends over 30 degrees and at all connections including valves and metres;
- Buildings shall be designed in accordance with the current edition of the National Building Code of India / relevant latest editions of IS codes / any other latest standards, codes, IRCsetc.;
- All walkways, stairways and platforms shall have 1.2m clear spacing between the handrails.

11.3 Site Works

Site works shall include:

- Demolition of all existing unused structures (above ground & to a depth of 1m below finished groundlevel);
- Road works, grading, landscaping etc. as required to prepare for the newworks;
- Provision of temporary roads, grading etc. as required to construct the new works; and
- Provision of final grading, new site road works with under base(s) and asphalt topping suitable for class AA loadingcondition.

11.4 Loadings

All buildings / structures shall be designed to withstand loads from; wind loads, earth pressures, seismic loads, water pressures, surcharges due to temporary or permanent conditions; dead load and imposed load in combination to comply with the relevant design codes andstandards.

Wind loadings on structures shall be calculated in accordance with IS: 875 (Part 3).

The effects of air temperatures and fluctuations in air temperature shall be taken into account in the designs.

Earth and water pressures shall be determined by the Contractor and shall take into account the prevailing site conditions and the proposed construction methods.

The possibility and consequences of explosions shall be investigated during HAZOP studies and the design shall take account of this risk.

Surcharge loads adjacent to basement walls of not less than10kN/m^2shall be allowed for in addition to fill loads. The Contractor shall further design for any surcharges exceeding this figure occasioned by his proposed method of construction or operation.

Dead loads shall be assessed by the Contractor using the proposed sizes and material densities.

Loads from overhead cranes comprise dead loads from crane bridges, gantry beams and hoists, live loads based on crane safe working loads and an allowance for dynamic effects. These loads shall be factored using the appropriate loadfactors.

Similarly, plant dead and live loads shall be assessed including an allowance for pipe thrusts and dynamic effects in the design of base slabs and roof slabs. Plant loading shall not be taken into account in determining the factor of safety againstflotation.

All loads used in the design, including those of mechanical and electrical plant shall be clearly indicated in the design calculations, which are to be included with in the Contractor's Documents.

11.5 Earthworks, Ground Improvements and Foundations

The Contractor shall be wholly responsible for developing his approach to any earthworks, ground improvements or foundations for structures and shall remain fully liable for the selection, design, construction and performance of these aspects.

Prior to commencing earthworks, ground improvements or foundation works, the Contractor shall submit the geotechnical interpretive report, calculations for earthworks and foundations and a detailed construction method statement and programme relating to this work.

All excavated and surplus material on site shall be disposed by way of transportation as directed by Engg In Charge at the cost of contractor. No additional payment will be done to contractor.

11.6 Dry Weather Flow InterceptionStructures

All dry weather flow interception structures (channels, chambers etc.) and foundations shall be constructed using cast-in-place reinforced concrete.

All interior faces of walls, exposed roofs of structures of above and below grade and exterior surfaces above finished grade shall have a smooth form finish in accordance with ACI 301 Surface Finish 3.0(SF-3):

1. Patch voids larger than 10mm wide or 10mmdeep;
2. Remove projections larger than3mm;
3. Patch tie holes;and
4. Provide surface tolerance Class A in accordance with ACI117.

All exterior walls below finished grade and other surfaces shall have an unworked finish free from substantial voids, honeycombing or other large blemishes, unless otherwise specified.

The external visible surfaces shall be painted.

All dry weather flow interception structures (channels, chambers, etc.) shall be water tight withoutleaks.

Cement and chemical materials to be utilized in the concrete make-up shall be suitable for final use with wastewater and its potential aggressive conditions.

All dry weather flow interception structure wall and slab thicknesses shall be designed to suit the load conditions, geographical conditions, geotechnical conditions and in any case not be less than 300 mm inthickness.

Where a dry weather flow interceptor is an integral part of an adjoining dry structure, the interior of the dry structure must be protected by waterproofing the interior surface area of the process tank wall/slab adjacent to that dry structure to a distance of 2 m beyond the limits of the adjoining dry area. Waterproofing shall be for Service ConditionD.

11.7 Administration Facilities

11.8 Building Works andFinishes

11.8.1 Architectural Design

Externally the buildings shall be visually aesthetically pleasing with clean and simple lines demonstrating a high quality and sensitivity to the local setting. The Contractor shall ensure that a similar high standard of architectural and landscaping is provided in his design.

The design approach for buildings and structures shall be to achieve a safe, functional and durable facility. Materials and their colours for external surfaces shall be selected for their visual qualities and proven durability to withstand all the local climatic conditions likely to be experienced, ease of maintenance and reasonable cost. The civil engineering and building works design shall provide working conditions and facilities entirely suitable for the Work that are conducive to its efficient operation and to ensure that maintenance during the life of the Works is minimised.

Local materials shall be used when possible with regards to quality and reasonable cost.

Effective methods of rainwater disposal shall be provided so that no roof or overhang water is left to run down the face of the building. Effective drip stops shall be incorporated in all overhangingelements.

11.8.2 Materials

The design and selection of materials for all buildings shall be guided by the need to ensure that various elements have long, trouble free operational lives and that the requirements for building maintenance are reduced to a minimum.

Steelwork: Internal steelwork shall have a protection system in line with the requirements of ISO 12944. The protection system shall be suitable for a frequently damp and wet interior and shall have a life to first maintenance of 15 years ormore.

External steelwork shall be either stainless steel, aluminium or have a protection system with a life to first maintenance of 10 years or more.

All galvanising shall be undertaken after the manufacture of the steelwork.

Windows*:* Where provided, windows shall be consistent with ensuring maximum security.

Floors: Floor slabs shall be designed to cater for plant loading together with basic floor live loading.

Suspended floor slabs shall, in addition to the above, be designed to carry all dead loads, including the ceiling loads, floor finishes etc. asapplicable.

Ground slabs shall be cast in situ concrete with a minimum thickness of 300 mm.

Doors: All external personnel doors shall be heavy duty and security duty.

Roller shutter and roller panel doors shall be electrically operated and of aluminium construction with plastic / protective coating.

11.8.3 Internal Finishes

Internally, buildings shall be functional and smart in appearance and be based on a colourco-ordinated design to include all plant and materials.

The Contractor shall ensure that all areas of walls, floors and ceilings are provided with protective finishes suitable for normal operating conditions with a minimum durability of 10 years to first maintenance unless otherwise stated. When selecting materials, the Contractor shall consider the environment in which these are to be used, the substances to which they will be exposed and the need to protect any equipment installed in the vicinity. The Contractor shall ensure that the materials selected provide a safe working environment for the Operations staff and are in accordance with all relevant health and safety regulations.

In all areas where any liquid or sludge spillage may occur, the Contractor shall ensure that the floor is screeded and finished to provide drainage into the nearest suitable site drainage collection system. The Contractor shall also seal the screed to prevent liquids percolating through to the structural concrete beneath. The Contractor shall ensure that the materials provide a non-slip surface under all conditions.

Detailing shall allow for ease of replacement of panels that might become damaged and hidden structural panels shall be adequately protected.

11.8.4 General requirements for Areas to be Finished

The following are the minimum standards for finishes:

Table 11-1Schedule of Internal Finishes

Location	Walls	Floor	Ceiling	Skirtings/Architraves
Offices/ reception area /control rooms	Fair faced block work with awipe downpaint finish	PVC floor sheeting	Wipe down paint finish or wipedown suspended ceilings	PVC skirting
Store rooms/ Switch room/ Workshop building	Fair faced block work with a wipe down paint finish	Power floated concrete or granolithic screed with anti-dusting hardener/ sealant	Wipe down paint finish or wipe down suspended ceilings	None required

Location	Walls	Floor	Ceiling	Skirtings/Architraves
Toilets /sinks /showers	Textured plastic spray generally and ceramic tiles to shower cubicles and sink surrounds	Ceramic tiles	Suspended ceiling to incorporate wipe down finish	Ceramic tile skirting
Vehicle access areas		Sealed screed to protect structural integrity of floors, slabs to be protected in the event of oil, petrol or chemical spillages		

11.8.5 External Finishes of Buildings

The external finishesof thepumping stations andother buildings shall have asa minimum either:

- Plastered/rendered finish which shall bepainted.

11.9 External Works

Roads and footpaths shall be suitable for their intended use and as a minimum, shall be designed to the design standards set out in the following requirements.

11.9.1 Dry Weather Flow Interception Facility Roads and Hardstanding Areas

Geometric design of roads, junctions, turning circles etc. shall be in accordance with national guidelines. They shall be designed to provide an adequate number of lay-bys, turning areas, parking spaces etc. to enable screening removal vehicle and other vehicles to discharge or pick up without causing obstructions to others. Hardstanding areas for skips shall be of concrete construction. Junction radii shall be a minimum of 10 m.

Carriageway widths shall be adequate to accommodate all vehicles required to operate and maintain the Works and shall provide adequate manoeuvrability in accordance with accepted guidelines. Generally, this shall be a minimumof5 m width. All internal roads shall have adequate turning circles at bends and junctions to allow easy vehicular movement of the type and size of vehicles and loads anticipated to use the site.

Road drainage shall be provided. The roads shall be laid to falls and have adequate capacity to be free draining. Roads shall be sealed and paved to prevent soil loss.

Off road parking shall be provided for operational staff cars, maintenance vehicles etc. as determined by the Contractor but with a minimum space for atleast2vehicles at the dry weather flow interceptionfacility.

Footpaths of minimum 1.5 m width shall be provided around all buildings and to all areas where equipmentis provided.

11.9.2 Gates, Fencing and Guardhouse

Permanent fencing and gates to the Site shall be provided.

The Contractor shall construct new permanent, anti-intruder palisade fences of minimum height 2.75m around the whole of the Site to delineate the Site from all other areas.

The Contractor shall construct an appropriate new guardhouse and access gate with appropriate facilities for twoguardsmen.

The guardhouse shall be equippedwith:

Telephone linked to the security control room.

CCTV camera linked to the centralised security system.

11.10 Site Drainage

Land scaped and unpaved areas shall be finished and graded such that there are no undrained low spots or areas liable to ponding. Surface water shall be directed to a drainage system.

Surface water from the access road and dry weather flow interception facility area shall be drained to a drainage system. The Contractor shall ensure that only uncontaminated surface water and rain to the surface water system. Surface water pipe work shall be designed by the Contractor using a rainfallintensityof100mm/hr with no surcharging of any pipe work. The Contractor shall obtain consent from the Storm Water and Drain Department for the discharge of the stormwater.

All road and hard standing areas with potential for contamination, wash waters and works drainage shall be contained and returned upstream of the screens.

11.11 Services to theSite

11.11.1 General

The Contractor shall be responsible for provision of all services necessary for the Design Build and Operation Service of the Works. For clarity, the Contractor shall be responsible for the connection and continued provision of all necessary services (electricity, water, telecommunications etc.) to the Site for the Design-Build Period, including commissioning and for the provision of the Operation Service. The Contractor shall be responsible for the payment of all such service providers for such services for the entire Contract Period. The Contractor shall not assume that any connection can be made from the existing services being provided to thesite.

The Contractor shall advise the Employer's Representative in writing of all arrangements made with public or private utilities and provide copies of all correspondence between themselves. The Contractor shall give the Employer's Representative adequate notice of all meetings with the utility representatives so that he Employer's Representative may attend. The Contractor shall minute all such meetings and provide the Employer's Representative with copies.

Procedures shall be developed to cater for planned maintenance and for emergency failure of services, such that the performance standards are met even in the event of suchoutages.

The Contractor shall determine on Site the exact position of all existing services that may

affect or be affected by the Works prior to carrying out his design. He shall submit all details gathered to the Employer's Representative.

11.11.2 Electricity Supply Cable Ducts

The Contractor shall provide the electricity supply to the dry weather flow interception facility Site, which shall follow the route of the main entrance to the Site. Any new supply shall be underground within the Site and be in suitably sized ducts. The minimum duct size shall be 150mm diameter. The route of the electricity supply shall be agreed between the Employer's Representative, supply authority, planning authority, and Contractor. Where a looped supply or two supplies are proposed, they shall be separated by a minimum 2,500mm.

The Contractor shall provide a means to connect an emergency source of power sufficient to operate the facility's essential service during a complete power failure of the electricity supplies. The Contractor's design shall demonstrate how this is to be achieved. The facility shall be capable of safe shut-down of all non-essential services and of safe start-up upon restoration of power. The Contractor shall develop procedures and demonstrate how these would be carried out in a safemanner.

The Contractor shall meet all of the supply authority charges relating to the Site from the Commencement Date.

11.11.3 Potable Water

The Contractor shall provide a potable water supply to the Site. Where existing public water mains are believed to be present, this information is contained in the Background Information. Wherever possible, the supply to the dry weather flow interception facility shall be brought along the verge of the access road or entranceway to the Site. The pipe shall be sized fort heflow required.

The Contractor shall be billed at industrial water rates. The Contractor is encouraged to minimise clean water usage at the facility.

11.11.4 Telephone Supply

The Contractor shall provide a suitable number of and specification for telephone cables. The route of the telephone cables shall follow the line of the access road.

11.11.5 Spare Ducting

The Contractor shall provide two spare150 mm dia ducts along the route of the access road to the Site, withdraw pits suitably spaced for the drawing of control cables in the future.

11.11.6 Water Supply for Fire-Fighting

The Contractor shall supply suitable firefighting facilities to meet the requirements of the Chief Fire Officer, MCGM. The facilities shall use potable water from a fire water storage tank and comprise:

- At least one electrical and one diesel and one jockey pumpset;
- A pressurised ringmain;
- Hydrants;
- Hoses;and
- Nozzles.

11.12 Reinforced Concrete

Reinforced concrete shall comply with Section 17 of Volume 2A, General Civil Specification.

Due to the severity of exposure of the site (high chlorides, high sulphates), the Contractor shall design suitable concrete mixes for the exposures anticipated. However, the Contractor's mix designs shall meet the following minimum concrete specification for all liquid retaining structures, structures in contact with water (including groundwater), superstructures of all buildings and tanks, load bearing members andfoundations:

Table 11-2 Minimum concrete requirements

Minimum Grade of Concrete:	M–35
Cementitious Materials:	OPC or PPC (Cementitious material can be used with prior approval)
Minimum Cementitious Content (kg/m^3):	400
Maximum Water Cement Ratio:	0.4
Minimum nominal cover to reinforcement	50 mm unless otherwise specified
Maximum Shrinkage Rate:	0.04%

Super plasticiser shall be provided where necessary to ensure necessary workability and wet curing is required.

The following are the minimum grades of concrete which shall be used for particular non-structural application:

M – 20: Pavements.
M – 15: Plinth protection work, mud mat below foundations, plinth beams, drains, trenches, pits etc.

Reinforcing bars shall be of minimum grade Fe 500 D Corrosion Resistant Steel (CRS) conforming to IS 1786.

The design of RCC structures shall be carried out by the ultimate limit state or the working stress method as per the provisions of IS 456. Concrete exposure shall be considered as severe for the purposes of the depth of cover to reinforcement.

Concrete tanks and other liquid retaining structures shall be designed either as un-cracked sections in accordance with the recommendation of IS 3370 or using limit state design for reinforced concrete in accordance with IS 3370 with a design crack width of 0.1mm. The design shall also take into account cracking due to shrinkage, the amount, size and spacing of reinforcement shall be adequate for strength and serviceability for shrinkage effects.

RCC walls shall include reinforcement on both faces for sections of 200mm or more, even if not required from a structural design consideration.

All concrete in liquid retaining structures shall include cement additives conforming to IS: 9103 to ensure a dense and watertight finished structure.

The following minimum structural thicknesses shall be used:

Table 11-3 Minimum section thicknesses- NOT USED

~~***Elements***~~	~~***MinimumThickness***~~
~~Suspended RCC floors / slabs / walkways~~	~~300 mm~~
~~Ground slab-on-grade~~	~~300 mm~~

~~***Elements***~~	~~***MinimumThickness***~~
~~Water retaining slabs/ walls~~	~~300 mm~~
~~Cable/ pipe trenches/ underground pits and base slabs~~	~~100 mm~~
~~All footings and raft foundations~~	~~300 mm~~
~~Parapets~~	~~100 mm~~
~~Sunshades~~	~~75 mm (at edge)~~
~~Pre-cast louvers~~	~~50 mm~~
~~Pre-cast trench cover slabs / floor slabs~~	~~75 mm~~
~~Paving~~	~~150 mm~~
~~Basement walls and base slab~~	~~300 mm~~
~~From the fire resistance perspective, the minimum thickness of reinforced concrete members shall be as per Figure 1 or Table 16A of IS 456.~~	

*Refer to Minimum Thickness given in table unless otherwise specified

Note that these are the general minimum thicknesses employed. Structural elements shall be designed in accordance with the loads to be imposed.

All steel reinforcement shall be Fe 500 D CRS. All steel shall be procured from “original producers” who manufacture billets from iron ores and roll the billets to produce steel confirming to IS 1786. No re-rolled material shall be accepted. If instructed by the Employer’s Representative, the Contractor shall submit the manufacturer’s test certificates for the steel. Random tests on steel supplied by the Contractor may be performed by the Employer as per relevant Indian Standards. Each steel bar shall be identified by the number duly moulded on the bar itself.

11.13 Liners to Concrete Material

Due to the potential for H_2S corrosion in wastewater containing structures, all concrete surfaces above the minimum working liquid level in the following structures shall be lined with HDPE / Polyurea / Epoxy coat when formed:

- All covered manholes /chambers;

11.14 Design Requirements for Concrete

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

All blinding and levelling concrete shall be a minimum 100 mm thick in concrete grade M15.

In general, reinforcement for buildings and sewage treatment units shall be HYSD-CRS (Corrosion Resistant Steel) of Grade Fe 500D. All physical and chemical properties of this Fe 500D grade steel shall conform to IS: 1786-2008. Welded wire fabric shall conform to IS: 1566 as shown or specified on the drawing. The CRS (corrosion resistant steel) index shall be at least 1.35 when tested for Salt Spray test as per ‘ASTM B 117’ – 2009 test procedure for 120 hours when compared with the Fe 500D normal reinforcement bars and with same bar diameter. All test results (including physical and chemical properties and salt spray tests) shall be produced for the respective bar diameter for each consignment of steel delivered at site and at a frequency of every 20 metric tonnes.

Minimum cover of reinforcement:

- Raft foundation: 75 mm (bottom), 50 mm (side &top).

Minimum cover of reinforcement for liquid retaining structures shall be as follows unless stated otherwise:

- walls - face in contact with earth: 60mm;
- walls - face in contact with water: 60mm;
- base slab in contact with water: 60 mm;and
- base slab in contact with soil: 60mm.

As per I.S. 455, the slag constituent shall be not less than 25 percent nor more than 65 percent of the Portland slag cement.

11.15 Design Philosophy

The following details shall be included in the general design philosophy:

- Design philosophy for Liquid Retaining Structures with various boundary conditions as applicable;
- Design philosophy forbuildings;
- Design philosophy for allstructures;
- Material properties (grade, strength, unit weight etc.), development lengths, lap/splice lengths, anchorage lengths under tension and compression, clear cover, water proofing specifications, legend usedetc.;
- Reinforcement detail showing the development length at column/footing intersection, column and roof beam intersections, walls and base slab intersections; walls and cover slab intersections;
- Detailing of the reinforcement for columns, beams, beam/column intersection, footing/column intersection, and slabs as per relevant code provisions/requirements depending upon the assumptions made in the design asapplicable;
- Reinforcement detail for cut-outs in slabs and walls with maximum size ofcut-outs;
- Reinforcement detail at top of RCC trench walls showing edge/seatingangles;
- Pouring sequence of concrete and standard details for construction joints, expansion joints, contraction joints etc.;and
- Details of manholes to be placed in thetank.

11.15.1 Design Loadings

All buildings and structures shall be designed to resist the worst combination of the following loads/stresses under test and working conditions; these include dead load, live load, wind load, seismic load, stresses due to temperature changes, shrinkage and creep in materials and dynamicloads:

Dead Load

This shall comprise all permanent construction including walls, floors, roofs, partitions, stairways, fixed service equipment and other items of machinery. In estimating the loads of process equipment all fixtures and attached piping shall be included but excluding contents.

In general, dead loads shall be as per I.S. 875 Part (I). However, the following minimum loads shall be considered in design of structures:

Table 11-4 Material densities

(i)	Weight of water	10.0 kN/m^3
(ii)	Weight of soil (irrespective of strata available at site and type of soil used for filling etc.). However, for checking stability against uplift, actual weight of soil as determined by field test shall be considered	20.0 kN/m^3
(iii)	Weight of concrete	24.0 kN/m^3
(iv)	Weight of reinforced concrete	25.0 kN/m^3
(v)	Weight of brickwork (exclusive of plaster)	20.0 N/m^2 per mm thickness of brickwork
(vi)	Weight of solid concrete block work (exclusive of plaster)	24.0 N/m^2 per mm thickness of block work
(vii)	Weight of plaster to masonry surface	18.0 N/m^2 per mm thickness
(viii)	Weight of granolithic terrazzo finish or rendering screed etc.	24.0 N/m^2 per mm thickness
(ix)	Weight of MS chequered plates	78.5 N/m^2 per mm thickness of plates

LiveLoad

Live Load (LL) shall include superimposed loads due to the use/occupancy of the structure/building not including dead, wind or earthquake load. Live loads shall be in general as per I.S. 875 Part (II). However, the following minimum live loads shall be considered in the design of structures:

i) Live load on roofs: 1.5kN/m^2;
ii) Live load on floors supporting equipment such as pumps, valves,blowers, compressors etc.: 10.0kN/m^2;
iii) Live load on all other floors, walkways, stairways and platforms: 5.0kN/m^2;
iv) Live load on toilet areas: 2.0 kN/m^2;and
v) Live load surcharge for structures (retaining walls):1.2 m height ofsoil.

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

Wind Load

Wind loads shall be as per I.S. 875 Part (III).

Earthquake Load

Seismic forces shall be as per I.S. 1893.

Dynamic Load

Dynamic loads due to working of plant items such as pumps, blowers, compressors, switch gears, travelling cranes etc. shall be considered in the design of structures.

Vehicular Wheel Load

For any structure or pipeline below the roads, Class A loading of IRC 6 shall be considered.

Joints

Movement joints such as expansion joints, complete contraction joints, partial contraction joints and sliding joints shall be designed to suit the structure. However, contraction joints shall be provided at specified locations spaced not more than 7.5 m in both right-angle directions for walls andrafts.

Expansion joints of suitable gap at suitable intervals not greater than 30 m shall be provided in walls, floors and roof slabs of liquid retaining structures.

Construction joints shall be provided at right angles to the general direction of the member. The locations of construction joints shall be decided on convenience of construction. To avoid segregation of concrete in walls, horizontal construction joints shall normally be provided at every 2m height. PVC water stops of 150 mm width shall be used for walls and 230 mm width for baseslabs.

11.15.2 Detailed Design Calculations &Submission

Complete detailed design calculations of foundations and superstructures together with general arrangement drawings and explanatory sketches shall be submitted by the Contractor to the Engineer. Separate design calculations for foundations or superstructures submitted independent of each other shall be deemed to be incomplete and will not be accepted by the Engineer. The following calculations and drawings shall be submitted:

- One (1) copy of a Compact Disc (CD) containing electronic files relevant to the structure's modelling, analysis and design calculations (Microsoft Excel, Staad Pro, etc.). Files submitted shall be in editable format;and
- Print copy (6 copies) of the contents as submitted in theCD;

Construction Issue Drawings

- One (1) copy of a CD containing AutoCAD files (civil general arrangement, structural dimensions and reinforcement details) pertaining to the structure. Files submitted shall be in editableformat;
- Print copy (6 copies) of the contents as submitted in the CD. Prints shall be submitted on A1 size sheets as a minimum or A0 size sheets when required by the Employer;
- Bar-bending schedule indicating the number, shape and size of the reinforcing bars shall be submitted as part of the reinforcementdetails;
- Detailed drawings showing the location, number and depth of inserts shall be included for any structural steel /metal inserts in the structure such as rungs, bolted connections for ladders/railingsetc.;
- Location of construction joints and pour sequence shall be included on the drawing for base slabs, walls and top slabs;and
- Revised drawings shall be submitted by clouding at the location with the latest revision number and show the history of revisions in a table format immediately above the titleblock.

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

11.15.3 Design Criteria for Underground Liquid Retaining Structures

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

- Liquid depth up to full height of wall: No relief due to soil pressure from outside shall beconsidered;
- Structure empty (i.e. empty of liquid, any material etc.): Full earth pressure and surcharge pressure wherever applicable shall beconsidered;
- If water table exists, earth pressure shall be considered for submerged soilconditions with reference to the geotechnicalrecommendation;
- Partition wall between dry sump and wet sump shall be designed for full liquid depth up to full height of wall;and
- Partition wall between two compartments shall be designed as one compartment empty and otherfull.

Structures shall be designed for uplift in empty conditions with the water table as indicated in geotechnical report and a minimum factor of 1.2 shall be provided against uplift or flotation, by considering 0.9 times the characteristic dead load. The external ground water table shall be assumed to be at ground level and the structure empty. Uplift shall be resisted by dead weight with a factor of safety of 1.2. Ground anchors and pressure relief valves as a means of dealing with uplift are not permissible.

Walls shall be designed under operating conditions to resist earthquake forces from earth pressure mobilisation and dynamic water loads (hydrodynamic impulsive pressure).

For general retaining walls and largesized tanks where the walls are designed as retaining walls, a sliding check shall also be performed along with overturning checks

Overturning: The stability of a structure as a whole against overturning shall be ensured so that the restoring moment shall be not less than the sum of 1.2 times the maximum overturning moment due to the characteristic dead load and 1.4 times the maximum overturning moment due to the characteristic imposed loads. In cases where dead load provides the restoring moment, only 0.9 times the characteristic dead load shall be considered. Restoring moment due to imposed loads shall be ignored.

Sliding: The structure shall have a factor against sliding of not less than 1.4 under the most adverse combination of the applied characteristic forces. In this case only 0.9 times the characteristic dead load shall be taken into account.

As a design consideration to control cracks, the general requirements of IS 3370: 2009 & (Annexure F) IS: 456- 2000 shall be followed, All liquid retaining structures shall be designed based on the serviceability crack width limit state (i.e. 0.2 mm crack width) and other limit state requirements to ensure an adequate degree of safety and serviceability.

In case of large and deep underground tanks such as wet wells, analysis can be carried out by Finite Element Method using STAAD.Pro V8i or other equivalent software predominantly used and accepted in the industry.

11.16 Foundation

The minimum depth of foundations for all structures, equipment, buildings and frame foundations and load bearing walls shall be as per IS 1904 but in any case, shall not be less than 1.0 m in the original soil.

Maximum safe bearing capacity of soil strata shall be taken as determined by the Contractor through his own independent investigations. Geotechnical reports of proposed sites covered under the Contract are provided in Volume 5. These maybe

used by Contractor as part of, in addition to, or in lieu of such investigations at his own risk.

Care shall be taken to avoid the foundations of adjacent buildings or structure foundations, either existing or not within the scope of this Contract. Suitable adjustments in depth, location and sizes may have to be made depending on site conditions. No extra claims for such adjustments shall be accepted by the Employer.

Special attention is drawn to danger of uplift being caused by the ground water table. All underground structural slabs shall be designed for uplift forces due to ground water pressure.

EGL (existing ground level) and FGL (finished ground level) shall be marked on all drawings showing foundation/sub-structure details and related design documents.

Machine/static equipment foundations shall be separated from adjoining parts of buildings, other foundations and floor/pavement slabs. Joints at floor/pavement slabs shall be suitably sealed.

Foundations and structures for machines subject to vibrations shall be proportioned so that the amplitude and frequency of the foundation/structure are within the permissible limits as per relevant BIS codes (or as required by the machine vendor).

Machine foundations shall be designed and detailed as per IS: 2974. All appendages to such foundations shall be reinforced suitably to ensure integral action.

For lightly and medium loaded plant structure foundations in swampy / waterlogged areas, ground improvements shall be considered in compliance with the relevant Geotechnical Investigation Report recommendations as applicable. In this respect, the Contractor shall enlist the services of an experienced and specialised agency for all related design aspects, considerations, equipment specifications and implementation methodology etc.

11.17 Design Requirements

Reinforcement bars and structural steel shall be procured only from primary steel producers with Integrated Steel such as TATA / SAIL / RINL / JSW using iron ore as the basic raw material and having in-house iron making facilities followed by production of liquid steel and crude steel with in-house rolling, adopting BF-BOF route or DRI-EAF technology as per Ministry of Steel guidelines. No re-rolled material/secondary steel will be accepted or allowed for any structural works.

Only primary steel producer firms with integrated steel plant in single premises are eligible.

There shall be a certificate issued by the Ministry of Steel for the primary steel producer and integrated steel plant having infrastructure in single premises for producing sponge iron, billet and TMT reinforcement bars using iron ore as base material.

The steel manufacturing company shall have latest ISO accreditation for Quality Management System.

The minimum amount of reinforcement in each of the two directions at right angles within each surface zone shall be provided as per clause 8.1 of IS 3370 (Part 2):2009. Definition of surface zones is clearly shown in Figure 1 and Figure 2 of IS 3370 (Part 2): 2009. For slabs, minimum of 10 mm dia bars shall be used to avoid any deformation of lesser diameter bars under loads prior toconstruction.

All buildings shall have a minimum 1 meter wide, 100 mm thick plinth protection paving in M15 grade concrete or stone slabs/tiles. All plinth protection shall be supported on well compactedstrata.

All pipes and ducts laid below the structural plinth and road works shall be surrounded with concrete of grade M15 having minimum 150 mm thick concrete or D/4 (D = outer dia. of pipe) thickness whichever is thegreater.

Use of pressure relief valves to reduce uplift pressure due to ground water table shall not be allowed.

Detailing of the reinforcement shall be considered as per latest Indian codes of practice and special publications as applicable.

A sliding layer or slip layer shall be provided between sub-base and structural slab (raft). Polythene sheets of 500 microns shall be provided as sliding layer as per IS specification.

Water tightness testing of water retaining structures shall be undertaken in accordance with IS: 3370, (Part I) - 2009. The depth of water for testing shall be up to the soffit of the covering slab.

11.18 Standards

Materials and workmanship shall comply with the relevant Indian Standards (with amendments) current on the date of submission of the tender.

Where the relevant standard provides for the furnishing of a certificate to the Engineer, at his request, stating that the materials supplied comply in all respects with the standard, the Contractor shall obtain the certificate and forward it to the Engineer.

All standards, specifications, codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions.

In case of discrepancy between the Specification and the Standards referred to herein, the Specification shall govern.

11.19 General Arrangement of Interceptor

The following general guidelines shall be followed in the preparation of general arrangement of Interceptor:

Sufficient room shall be allowed between items of Interceptor or fixed structures to permit safe and convenient access for operation and maintenance

An area adjacent to all mechanical Plant shall be provided as maintenance lay down area.

Fixed runways, lifting eyes or other means shall be provided to permit the removal of Plant that may be required to be removed during the course of its normal operational life for maintenance or any other purpose;

Areas where leakage is likely to occur, whether in normal use or during maintenance, shall be provided with covered drainage channels which shall direct spillage either to a suitable plant drain or to a sump from where it can be pumped to plant drain.

11.19.1 Orientation

The works shall be laid out within the confines of the Site to interface to the existing infrastructure of roadways and inlet and outlet pipe work. Underground services requiring relocation to accommodate the proposed site layout shall, with the approval of the Engineer, be relocated by the Contractor.

11.20 Buildings and Structures

All building and structure works shall comply with the following unless otherwise specified:

All external walls and internal partition walls shall be in brick work with common burnt clay F.P.S. (non modular) bricks of class designation 7.5 in cement mortar 1:4.

All internal walls shall be 200mm thick except for toilets. Toilet partition walls shall be in 100 mm thick solid concrete block.

Finishes to concrete liquid retaining structures shall be:

F1 – external surfaces, buried;

F2 – external surfaces exposed and up to 300 mm below ground level; and

F2 – internal surfaces.

Finishes to other concrete structures shall be:

F1 – buried;

F1 – exposed, where plastering is specified; and

F2 – exposed.

All internal masonry and ceiling surfaces finish shall have 12 mm thick plain faced cement plaster in cement mortar (1:4) with neat cement finish on top. Over this, one coat of primer and two coats of plastic emulsion paint of approved quality and shade shall be provided.

All external masonry and concrete with rough board finish shall have 20 mm thick sand faced cement plaster in two coats; base coat 12 mm thick in cement mortar 1:4 and finishing coat 8 mm thick in cement mortar 1:4. Waterproofing compound of approved make and quality shall be added to the cement mortar in proportions as specified by the manufacturer.

All external surfaces above ground level shall have one coat of primer and two coats of waterproof cement based paint of approved quality and shade. A coat of silicone water repellent paint shall also be applied thereon. Toilet areas, walls and ceilings shall have one coat of primer and two coats of plastic emulsion paint.

All staircases shall have 25 mm thick chequered mosaic tiles for treads and 25 mm thick plain mosaic tiles for risers of approved make and shade and half tile skirting set in cement mortar in 1:4 to give an overall thickness of 50 mm. All concrete stairs shall have aluminium nosing over 2 mm thick rubber strip of width same as nosing for the full length of the tread. Nosing shall be fixed with countersunk screws.

Stairways shall be provided to permit access between different levels within buildings. Staircaseshallbeminimum1200mmwide, minimum tread=250mm, maximum riser = 175 mm and maximum 15 number of steps per flight unless specified otherwise. Staircases in general shall not be steeper than 40°. Staircases having space constraints may be steeper than 40°.The maximum vertical run for a single flight of stairs shall be 3.0 m.

All roof tops and overhead tanks shall be made accessible with ladder provision. Vertical step ladders fitted with landing point extensions will be permitted where considered appropriate by the Engineer to access areas not frequently visited.

Steel staircases shall be constructed of standard channel stringers with M.S. grating treads 25 mm thick with non-skid nosing. Steel Ladders shall be minimum 600 mm wide and shall not exceed 6 m of straight run. The ladders shall be painted with epoxy paint.

All handrailing shall be provided in stainless steel SS-304 L (Schedule 40) with 48.3 OD to suit the saline environment.

The minimum height of handrailing shall be 1.2 m and maximum spacing of verticals shall be 1.2 m. Number of horizontal rails shall be 3 (1 top, 1 intermediate and 1 bottom) with a 100 mm x 6 mm toe plate at the bottom.

Building plinth shall be minimum 450 mm above average finished ground level around building or high flood level whichever is the greater.

All concrete channels and ducts used for conveying liquid shall have inside finish of type F2. The width of concrete channels shall not be less than 500 mm. All open channels shall be provided with hand railings (3-rail) or concrete walls to a minimum height of 1.1 m from the access surface elevation. Kerbs to be provided below the hand railing on the catwalks/pathways shall be as per relevant sections of Factory Act. This shall not be less than 150 mm.

All exposed surfaces of inserts embedded in concrete shall be painted with two coats of enamel paint over one coat of red oxide zinc chrome primer. Surfaces in contact with concrete shall not be painted.

All structural steel members shall be painted with two coats of enamel paint over one shop coat and one field coat of red oxide zinc chrome primer.

The design of buildings shall reflect the climatic conditions on site. Process buildings shall as far as possible permit the entry of natural light and the use of glazed panelling shall be kept to a minimum with preference given to wall openings protected by weather canopies.

Emergency exit doorways shall be provided from all buildings to comply with local and international regulations. Stairways and paved areas shall be provided at exit points.

All walkways shall be minimum 1 m width and shall be covered with mosaic tiles.

F1 Finish

Formwork for Class F1 finish shall be constructed of timber, sheet metal or any suitable materials which will prevent loss of grout when the concrete is vibrated. Surfaces subsequently to be rendered, plastered or tiled shall be adequately scabbled or roughened as soon as the formwork is removed to reduce the irregularities to not more than half the thickness of such rendering, plastering or bedding for tiles and to provide a satisfactory key.

F2 Finish

Formwork for Class F2 finish shall be faced with wrought tongued and grooved boards or plywood or metal panels arranged in a uniform approved pattern free from defects likely to detract from the appearance of the surface.

F3 Finish

Formwork for class F3 finish shall be lined with panels of non-staining material with a smooth unblemished surface such as sanded plywood or hard compressed fibre board. The panels shall be as large as possible and shall be arranged in a uniform approved pattern and fixed to back formwork by oval nails. Unfaced wrought boarding or standard steel panels will not be permitted. Ribbed finishes shall be formed by a backing of sanded plywood or hard compressed fibre board, as described for a Class F3 finish, against which timber battens are fixed. Battens shall have clean, sharp arrises at base and be stopped with a waterproof filler and sanded to give a smooth surface. Battens shall be securely fixed to the backing by adhesive and screws to prevent the penetration of grout behind them.

12 SEWERAGE

12.1 Scope

This specification covers the general requirements of providing and laying sewerage network.For specifications, mode of measurements and scope of work covered under the respective items for the work included under this contract, following documents shall be referred to in the order of precedence as given below:

1) Description of the items and notes if any given in the Schedule ofQuantities.
2) Specifications.
3) Additional Conditions ofContract.
4) General Conditions ofContract.
5) Applicable Codes and Standards as specified herein with amendments/ revisions issued tilldate.

In the event of any discrepancy among the documents referred above, the document in the higher order of precedence shall prevail.In the event of any element of specification not being available in any of the documents mentioned above, the instructions of the Engineer in writing shall be followed by the Contractor.

The Work shall be carried out in accordance with the drawings and designs as would be issued to the Contractor by the Engineer duly signed and stamped by him. The Contractor shall not take cognisance of any drawings, designs, specifications, etc. not bearing Engineer's signature and stamp. Similarly, the Contractor shall not take cognisance of instructions given by any other Authority except the instructions given by the Engineer in writing.

The Work shall be executed and measured as per metric dimensions given in the Schedule of Quantities, drawings etc.

The Contractor shall acquaint himself fully with the partial provisions for supports that may be available in the structure and utilise them to the extent possible. In any case the Contractor shall provide all the supports regardless of provisions that have been already made. Nothing extra shall be payable for situations where bed plates (for supports) are not available or are not useful.

The Contractor shall incorporate seismic considerations of anchoring and isolation in the design of the systems as called for the different equipment.

Shop coats of paint that may be damaged during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with paint to match the finish over the adjoining shop paintedsurface.

In addition to the sectional testing carried out during the construction, the Contractor shall test the entire installation after connections to the overhead tanks or pumping system or mains. He shall rectify all leakage and shall replace all defective materials in the system. Any consequential damage done, on account of Contractors carelessness, open or burst pipes or failure of fittings, during testing and commissioning to the building, furniture and fixtures shall be made good by theContractor.

12.2 Scaffolding

Only steel tube scaffolding of approved design shall be used for all works. The scaffold structure shall comply with the requirements of IS:4014 and IS:3696. An independent tied scaffold (double scaffold), which has two lines of standards, shall be provided with the inner line kept at least one board clear of the finished face with extended transoms, or hop up baskets to carry an inside board. Diagonal braces shall not prevent the material being moved along the scaffold run. The scaffolding shall be suitably packed at the ends to prevent damage to the finishedwork.

12.3 Protection

Protection against damage: Care shall be taken to avoid damage from any cause at all stages. Packing pieces used for protection shall not disfigure or otherwise permanently mark the Works.

Surface protection shall be afforded by careful handling and the avoidance of the use of hooks, crowbars, or other implements that are likely to damage the works.

Protection during construction: Decorative surfaces shall be carefully protected during construction by a temporary cover.

Protection of finished work: At all stages of the Contract it is essential that all works are properly protected.

Suitable packing shall be used to ensure that scaffolding does not damage erected stone, marble, granite or other finishedworks.

Any disfigurement, discolouration or imperfection whatsoever due to any reason shall not be accepted and the Contractor shall either remedy the same or redo the work at no extra cost. The decision of the Engineer as to whether any work either in whole or in part is acceptable or not shall be final and binding on theContractor.

12.4 Guarantee

The Contractor shall guarantee and undertake to maintain and rectify the various components of the Plumbing work installed by him for their successful performance for a period of 10 years. The Contractor shall indemnify the Engineer for a similar period against any damage to property and injury to persons on account of any defective work or maintenance carried out by the Contractor. The format and text of the Guarantee and the Indemnity Bond shall be given by theEngineer-in-Charge.

12.5 Applicable Codes, Standards and Publications

All equipment, supply, erection, testing and commissioning shall comply with the requirements of Indian Standards and code of practices given below as amended till date. All equipment and material being supplied by the contractor shall meet the requirements of IS, and other Codes/ Publications as givenbelow.

12.5.1 General

IS:4111(Part 1)	Code of practice for ancillary structures in sewerage system: Part 1 Manholes
IS:2379	Colour code for identification of pipelines.
IS:5455	Cast iron steps for manholes
IS:14333	Specification for high density polyethylene pipe for sewer line

12.6 Quality Assurance and Quality Control

The Work shall conform to high standards of design and workmanship, shall be structurally sound and aesthetically pleasing. Quality standards prescribed shall form the backbone for the quality assurance and quality control system.

At the site level, the Contractor shall arrange the materials, their stacking/ storage in appropriate manner to ensure the quality. Contractor shall provide equipment and manpower to test continuously the quality of materials, assemblies etc. as directed by the Engineer-in-Charge. The test shall be conducted continuously and the result of tests maintained. In addition, the Contractor shall keep appropriate tools and equipment for checking alignments, levels, slopes and evenness ofsurface.

The Engineer shall be free to carry out tests as may be considered necessary by him at his sole discretion, from time to time, in addition to those specified in this document. The Contractor shall provide the samples and labour for collecting the samples. Nothing extra shall be payable to the Contractor for samples or for the collection of the samples.

The test shall be conducted at the site laboratory that may be established by Engineer or at any other Standard Laboratory selected by Engineer.

The Contractor shall transport the samples to the laboratory for which nothing extra shall be payable. In the event of Contractor failing to arrange transportation of the samples in proper time Engineer shall have them transported and recover two times the actual cost from the Contractor's bills.

Testing charges shall be borne by the Engineer.

Testing may be witnessed by the Contractor or his authorised representative. Whether witnessed by the Contractor or not, the test results shall be binding on the Contractor.

12.7 Sewerage Network

12.7.1 Scope of Work

All soil, waste disposal for the portion above ground level to the public sewers shall be by gravity. Without restricting to the generality of the foregoing, the sewerage system shall inter-alia include:

a) Sewer lines including earthwork for excavation, disposal, backfilling and compaction, pipelines, manholes, drop connections and connections to the municipal or existing sewer.

12.7.2 General Requirements

All materials shall be new and of quality conforming to specifications and subject to the approval of the Engineer. Wherever particular makes are mentioned, the choice of selection shall remain with the Engineer.

Drainage lines and open drains shall be laid to the required gradients and profiles.

All drainage work shall be done in accordance with the Local municipal bye-laws.

Contractor shall obtain necessary approval and permission for the drainage system from the municipal or any other competent Authority.

Location of all manholes, etc. shall be got confirmed by the Engineer before the actual execution of work at site. As far as possible, no drains or sewers shall be laid in the middle of road unless otherwise specifically shown on the drawings or directed by the Engineer in writing.

All materials shall be rust proofed; materials in direct or indirect contact shall be compatible to prevent electrolytic or chemical (bimetallic) corrosion

12.7.3 Excavation

Alignment and Grade

The sewer pipes shall be laid to alignment and gradient shown on the drawings but subject to such modifications as shall be ordered by the Engineer from time to time to meet the requirements of the Works. No deviations from the lines, depths of cutting or gradients of sewers shown on the plans and sections shall be permitted except by the express direction in writing of the Engineer.

Excavation in Tunnels

Excavation for sewer works shall be open cutting unless the permission of the Engineer for the ground to be tunnelled is obtained in writing. Where sewers have to be constructed along narrow passages, the Engineer may order the excavation to be made partly in tunnel and in such cases the excavated soil shall be brought back later on for refilling.

Opening Out Trenches

a) In excavating the trenches, etc. the solid road metalling, pavement, kerbing, etc. and turf shall be placed on one side and preserved for reinstatement after the trenches or other excavation are filled up. Before any road metal is replaced, it shall be carefully shifted and only clean metal used for replacing. The surface of all trenches and holes shall be restored and maintained to the satisfaction of the Engineer and of the Owners of the roads or other property traversed and the Contractor shall not cut out or break down any live fence of trees in the line of the proposed works but shall tunnel under them, unless the Engineer shall order to thecontrary.

b) The Contractor shall grub up and clear the surface over the trenches and other excavations of all trees, stumps roots and all other encumbrances affecting execution of the work and shall remove them from thesite.

Obstruction of Roads

The Contractor shall not occupy or obstruct by his operation more than one half of the width of any road or street and sufficient space shall then be left for public and private transit. He shall remove the materials excavated and bring them back again when the trench is required to be refilled. The Contractor shall obtain the consent of the concerned authority in writing before closing any road to vehicular traffic. The foot walks must be clear at all times.

Removal of Filth

All night soil, filth or any other offensive matter met with during the execution of the works, shall not be deposited on to the surface of any street or where it is likely to be a nuisance or passed into any sewer or drain but shall be immediately, after it is taken out of any trench, sewer or cess pool, put into the carts and removed to a suitable place to be provided by theContractor.

Excavation to be taken to proper depths

The trenches shall be excavated to such a depth that the sewer shall rest on concrete as

specified in the clauses relating thereto, so that the inverts may be at the levels given in the sections. In bad ground, the Engineer may order the Contractor to excavate to a greater depth than that shown on the drawings and to fill up the excavation to the level of the sewers with concrete, broken stone, gravel or other materials as directed by the Engineer. Such extra excavation, concrete, broken stone, gravel or other materials, shall be measured and paid for separately if the extra work was ordered by the Engineer in writing, but if the Contractor should excavate the trench to a greater depth than is required without a specific order to that effect in writing of the Engineer, the extra depth shall have to be filled up with cement concrete 1:4:8 (1 cement: 4coarse sand 8: stone aggregate 20mm nominal size) at the Contractor's own costs and charges, as directed by and to the satisfaction of theEngineer.

Refilling

After the sewer or other work has been laid and proved to be water tight, the trench or other excavations shall be back filled with selected excavated earth and compacted. Utmost care shall be taken in doing this, so that no damage shall be caused to the sewer and other permanent work. The filling in the haunches and up to 75mm above the crown of the sewer shall consist of the finest selected materials, as directed by the Engineer, placed carefully in 150mm layers, then flooded and consolidated. After this has been laid, the trench and other excavation shall be refilled carefully in 150mm layers with materials taken from the excavation, each layer being watered to assist in the consolidation unless the Engineer shall otherwisedirect.

12.7.4 Rock Fragmentation by using Pulse Plasma Technology

There is a great deal of interest in fragmentation of rocks in such areas as tunneling, quarrying, under water excavation and mining. Conventionally, blasting by explosives is the usually employed method in excavation work. Due to problems of vibration, noise, and scattering of stones, this method is prohibited of use near important buildings and residential areas. The alternatives to this method are breakage by such crushing machines as large breakers and by chemical substances. However, such breakage methods are high in cost and the problems of decrease in breaking performance were observed.

Pulse Plasma Technology involves the production of a pulsed electrical discharge by inserting a blasting probe in a cavity drilled in rock, which produces shocks or pressure waves. These pulses then propagate into the rock, leading to fracture.

Compared with conventional blasting method such as rock drilling machines, the Pulse PlasmaTechnology is friendlier to the earth, because it causes less vibration, noise, and dust, and uses no chemical substances. In the blasting procedure, a reusable blasting electrode and a power supply main body incorporating capacitors and other devices that are connected by a cable are used.

Newly developed compact rock fragmentation equipment, mainly known as Electro Power Impactor (EPI),is suitable for blasting of platy structures and boulder stones. Holes for fragmentation can be opened by hand-held tools. Therefore, the fragmentation procedure is easy and simple. By creating more than one hole in linear orientation and discharge at the same time, the rock can be fragmented.

As the proposed tender work involves breaking of extremely hard rock along the banks and bed of Mithi River, the rock fragmentation by using Pulse Plasma Technology is considered to ease the hardship in the work. The rock fragmentation work shall be carried out under the supervision of experts. The fragmented rock shall be excavated and disposed-off immediately from site.

Rock fragmentation by using Pulse Plasma Technology having zero shock wave with permissible sound level and vibration velocity less than 1mm/sec with necessary arrangement of access and coffer dam upto any depth. The technology shall be certified by Petroleum & Explosive Safety Organization, India (PESO) as non explosive process.

Contractor to restore settlement and damages

The Contractor shall, at his own costs and charges, make good promptly any settlement that may occur in the surfaces of roads, berms, footpaths, gardens, open spaces etc. whether public or private caused by his trenches or by his other excavations and he shall be liable for any accidents caused thereby. He shall also, at his own expense and charges, repair and make good any damage done to buildings and other property. If in the opinion of the Engineer he fails to make good such works with all practicable despatch, the Engineer shall be at liberty to get the work done by other means and the expenses thereof shall be paid by the Contractor or deducted from any money that may be or become due to the Contractor or recovered from the Contractor in any other manner according to the law of theland.

Disposal of SurplusSoil

The Contractor shall at his own costs and charges provide places for disposal of all surplus materials not required to be used on the works. As each trench is refilled the surplus soil shall be immediately removed, the surface properly restored and the site cleared.

MUNICIPAL CORPORATION OF GREATER MUMBAI

CIRCULAR

U/No.MGC/F/6342 dated 5.5.2018

Sub.: Revised guidelines regarding barricades being used during the execution of various infrastructure development projects by MCGM in Mumbai.

Various infrastructure development projects are being executed by MCGM for the betterment of citizens of Mumbai. During the course of execution of the projects, it is necessary to provide strong and secured barricading as a safety measure to avoid any mishaps as well as to avoid nuisance to vehicular and pedestrian traffic. Nowadays, the following types of barricades are being used exclusively in MCGM as per the convenience of various departments at different sites.

1. Water/sand fillable PVC Metro barricades.
2. RW 7.45 (G.I. sheets of 22 gauge fixed on 3 inch dia. Wooden bullies buried in existing road sufficiently)
3. RW 7.36 (G.I. sheets of 22 gauge fixed on MS Angle post buried in half the depth in drums of 20 litres capacity in 1:3:6 concrete)
4. Structural steel barricade for major trenches having depth more than 2.00 meters.

Thus from the above, it can be seen that there is no uniformity in provision of barricades as they are of different size and shape. Further it is also observed that the continuity is not maintained in providing the barricading keeping gaps in between thus endangering the safety of vehicular as well as pedestrian traffic. Also the barricades are not being cleaned, thus further adding to shabbiness. Further Mumbai being the financial capital of India, people from all over the world visit the city daily and to maintain good image of city the following decisions are taken.

A) Only two type of barricades having department wise colour coding are proposed to be used depending upon the nature of work i.e. Minor and Major.

i) **Minor works**: Barricading made out of 1.5 mm thick MS plate fixed on M.S. angle post/ frame of 65 mm X 65 mm X 6 mm having height of 1.5 m supported on as shown in Annex-I.

ii) **Major works**: Structural steel barricade made out of 1.50 mm thick M.S. Plate ISMB 250, ISLC 250X50mm and ISA 50mmX50mmX6 mm having of size 2.5 m X 2 m as shown in Annex-II.

B) The department wise colour coding for the barricading shall be as under:-

i) H.E. & W.S.P. department – **Blue**

ii) Roads, Traffic, Bridges and Coastal Roads department– **Yellow**

iii) S.P. & S.O department – **Green**

iv) S.W.D., Building Maintenance department & for ward works – **Red**

C) The basic principle behind installing secured and continuous barricading is to ensure the safety of vehicular as well as pedestrian traffic and residents in the nearby vicinity of the project. Due to non-installation of appropriate barricades on sites if any mishap occurs leading to injury or loss of life, then the contractor and contractor's Engineer in-charge will be liable for the consequent action.

D) During the course of execution of project, if it is noticed that the contractor has not provided barricading then a penalty of Rs.1000/- per meter per day will be imposed upon the contractor and will be deducted from the due Bill. This penalty shall be a part of penalty as per tender condition.

E) Details of the work shall be prominently displayed on the central panel of the barricades along-with the Social Slogans as given in Annexure III and the Cycle of the same shall be maintained.

F) The contractor shall provide and install the barricading alongwith the slogans printed as per the Annexure III, at his own cost and no payment will be made for this, however the contractor shall quote the bid accordingly by considering the cost of barricading.

The condition shall be included in the tender as given below. " Barricading shall be provided free of cost as per Circular vide U/No.MGC/F/6342 dated 5.5.2018 and as per Annexure I, II and III of Standard drawings and specifications with slogans and department wise colour codes." The copy of circular will be attached to the tender as a part of tender document.

This circular will be applicable for the new tenders proposed to be invited from 01.05.2018 and also the corrigendum shall be attached to tenders which are uploaded. However, for the projects wherein the tenders are already invited, the barricading shall be provided strictly as per tender condition. All the details (Annexure I, II & III of Standard drawings and specifications with slogans and department wise colour codes, sketches and department wise colour coding) are uploaded on MCGM portal.

This circular shall come in force with immediate effect.

sd/- 20.4.2018
(Shri V.P . Chithore)
Dir.(ES&P)

sd/- 20.4.2018
(Shri R. B. Bambale)
D.M.C.(S.E.)

sd/- 21.4.2018
(Shri Vijay Singhal)
A.M.C.(E.S.)

sd/- 21.4.2018
(Dr. Shri Sanjay Mukherjee)
A.M.C.(P.)

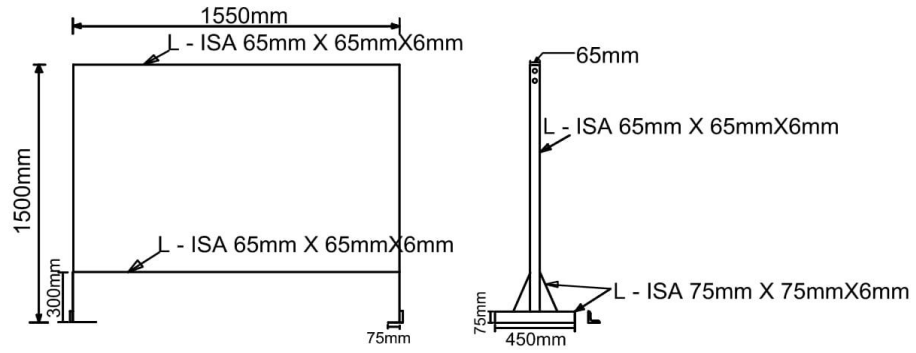
sd/- 5.5.2018
(Shri Ajoy Mehta)
M. C.

sd/-16.5.2018
(Shri P. R. Kadam)
D.M.C.(S.E.)

ANNEXURE I

A) Minor work

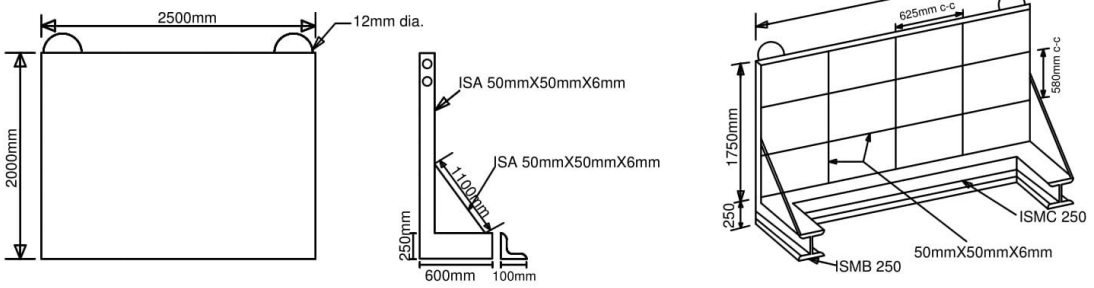
Providing, fabricating and installing the barricading made out of 1.5 m high M.S. Angle post of 65 mm X 65 mm X 6 mm with 1.5 mm thick M.S. Sheet of size 1.55 m X 1.2 m welded to the M.S. angle post/ frames and fixed to 75mm X 75mm X 6 mm angle base as shown in sketch for minor works , displaying of the social slogan as per the Annex - III, daily cleaning of the same to get better appearance and interlocking arrangement to ensure continuity in provision and to avoid gap in between etc complete and as directed by Engineer in-charge.



ANNEXURE II

B) Major works:

Providing, fabricating and installing the structural steel barricading made out of 1.5 mm thick M.S.plate of size 2500 mm X 2000 mm, ISMC 250 X 50 channels, M.S. Angles ISA 50 X 50 X 6mm and ISMB 250 as per IS 1161-1 RHS/SHS rolled angle plates of TATA Steel, Lloyd Steel, SAIL, ESSAR steel approved in straight profile of all sizes, shapes and for all works including stiffeners, bolts and nuts, filet / butt welding, splicing, machine grinding, of all member joints wherever required to give neat appearance, and dailycleaning the barricading along with displaying of the Depthwise slogans as given in Annexure -III etc with interlocking arrangement to avoid gap in between and as directed by Engineer in-change.



ANNEXURE III

1) **HYDRAULIC ENGINEER's DEPARTMENT/ WATER SUPPLY PROJECTS**
   i) Inconvenience regretted
   ii) Ensuring Mumbai's water supply
   iii) Save water Save life

2) **ROAD, TRAFFIC / BRIDGES DEPARTMENT**
   i) Inconvenience regretted
   ii) Working towards a better tomorrow
   iii) My Mumbai, Green Mumbai

3) **SEWERAGE PROJECTS DEPARTMENT/ SEWERAGE OPERATIONS DEPARTMENT**
   i) Inconvenience regretted
   ii) Reduce Reuse Recycle
   iii) Clean Mumbai , healthy Mumbai

4) **STORM WATER DRAIN DEPARTMENT/ WARD WORKS**
   i) Inconvenience regretted
   ii) Working towards a better tomorrow
   iii) Swatch Bharat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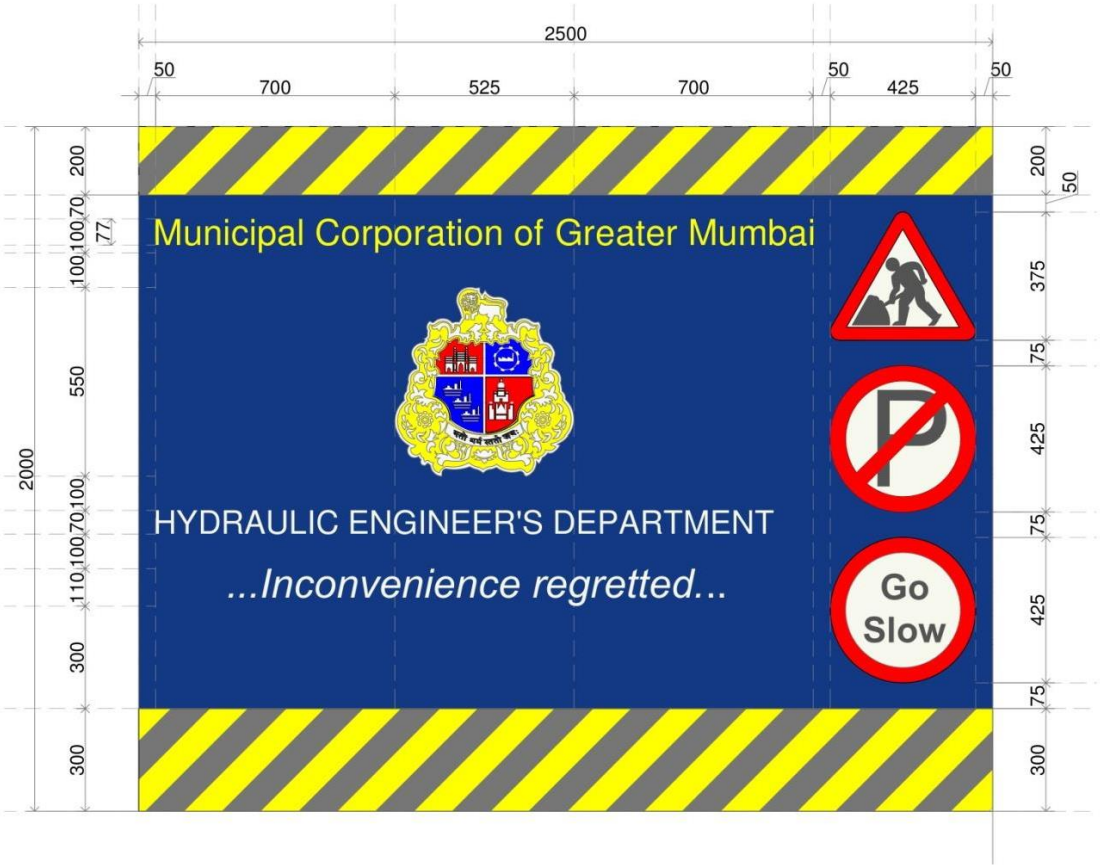
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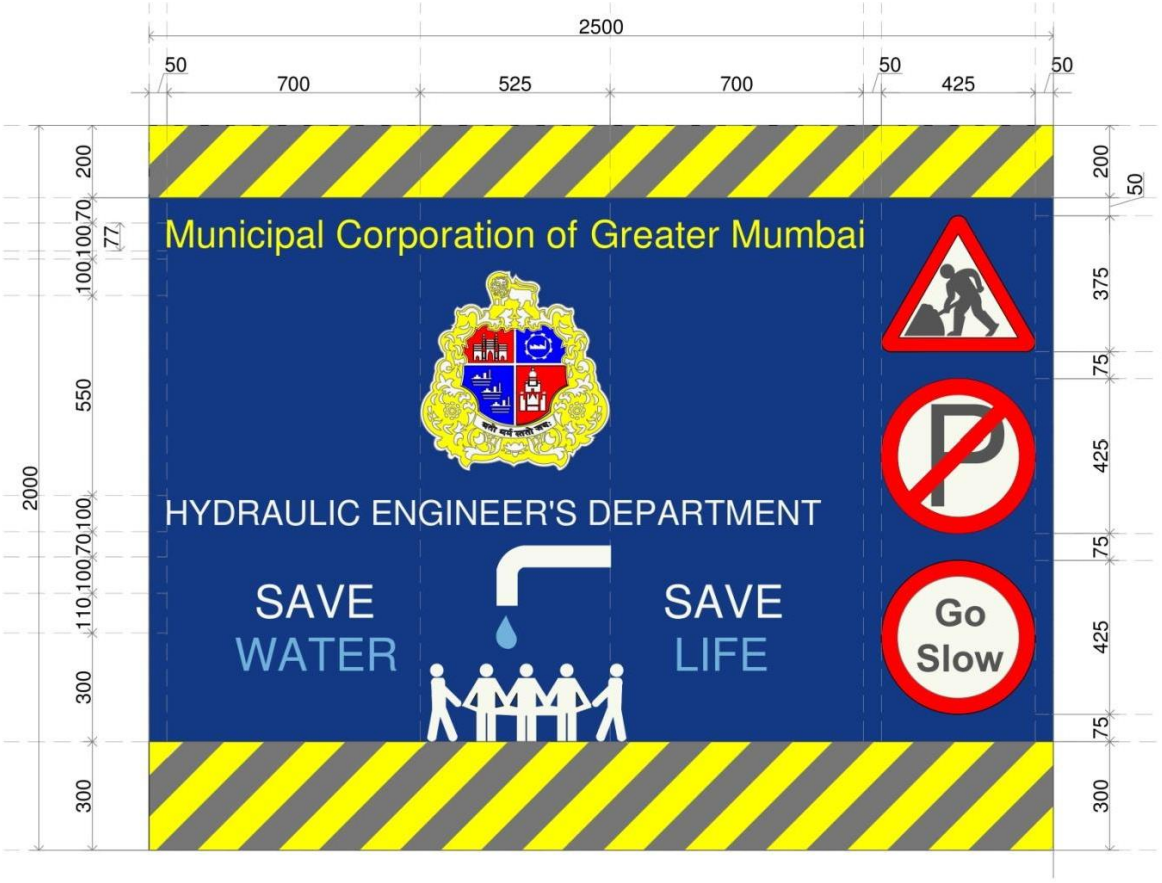
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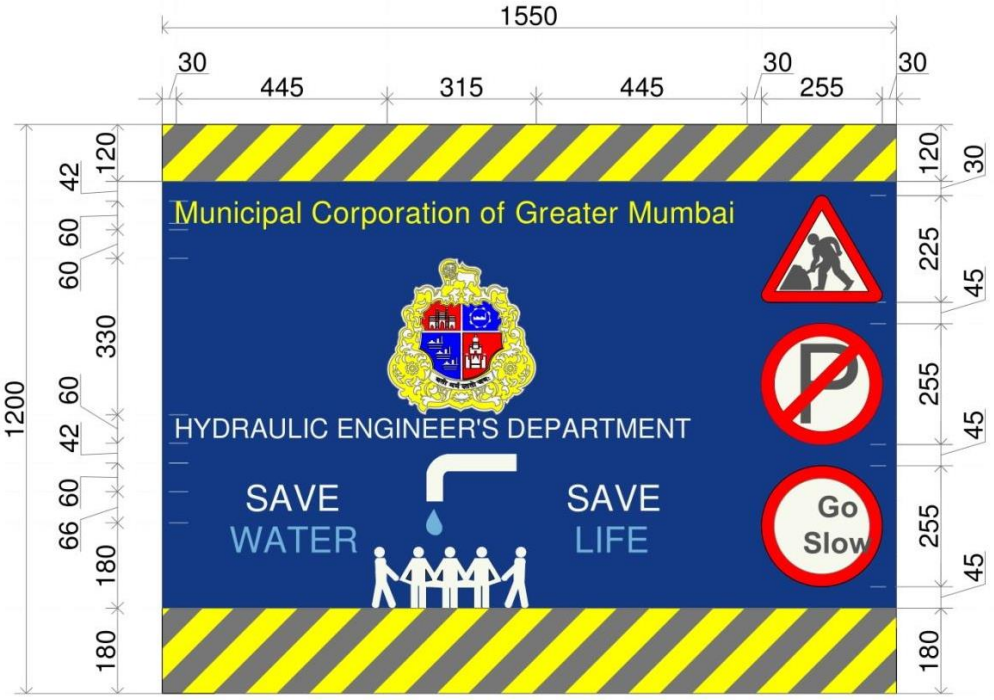
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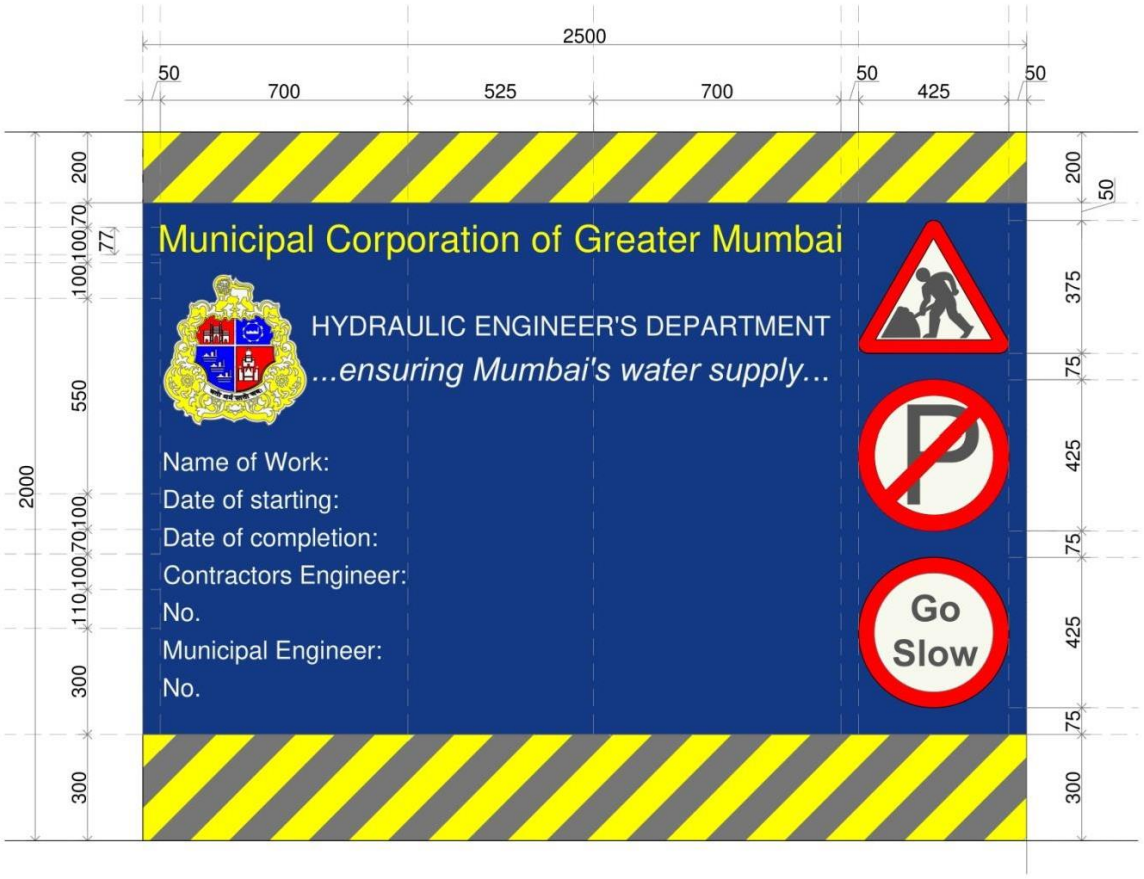
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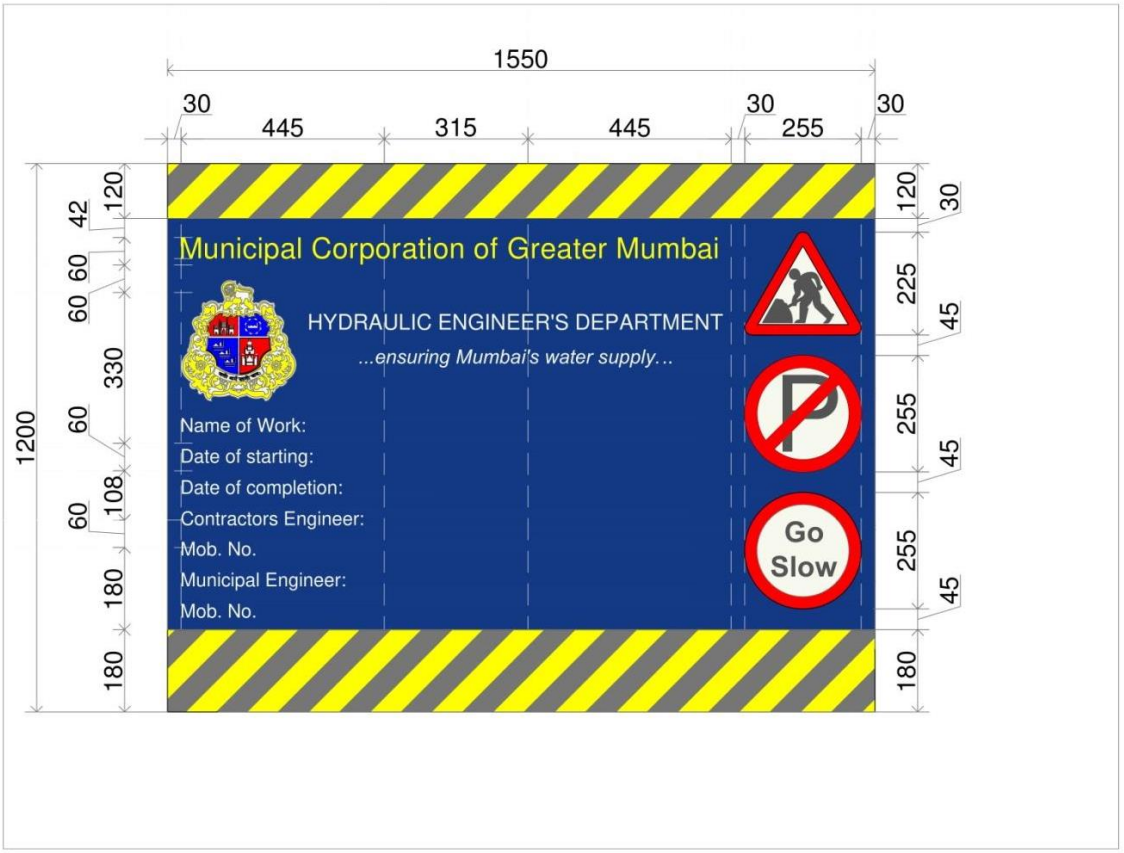
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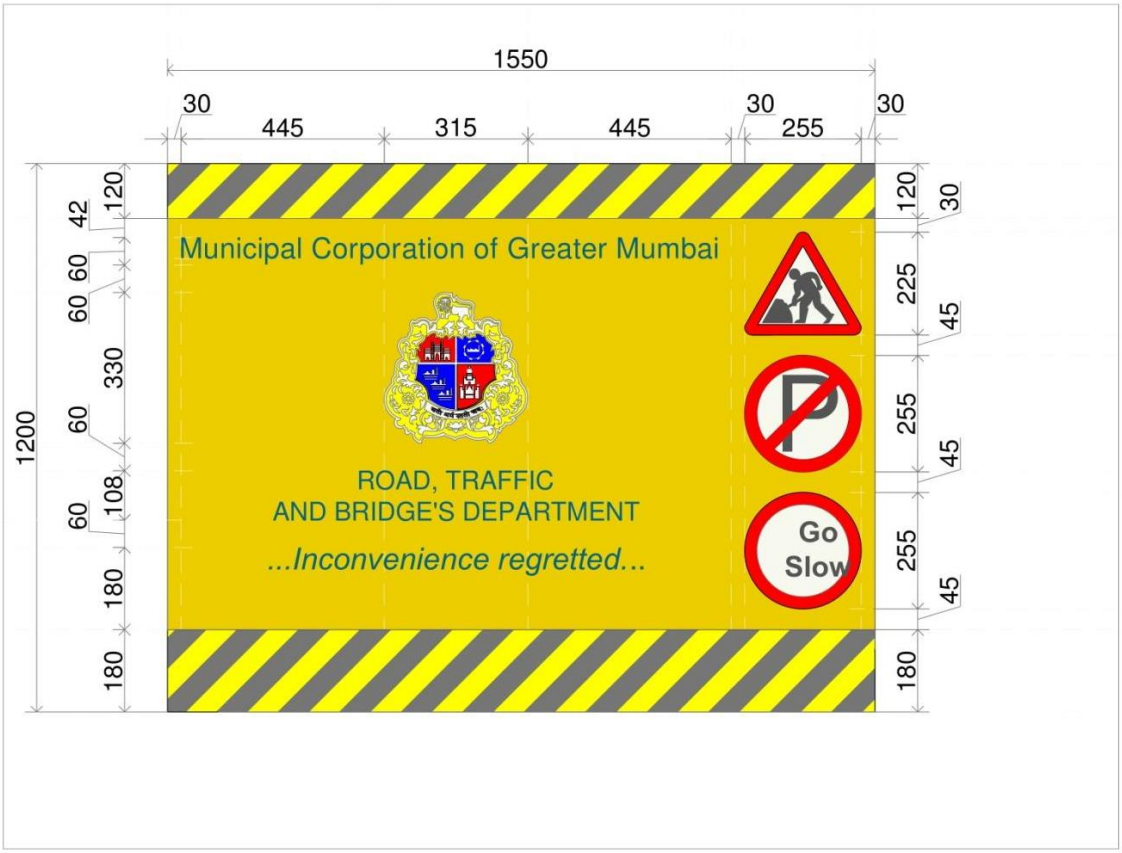
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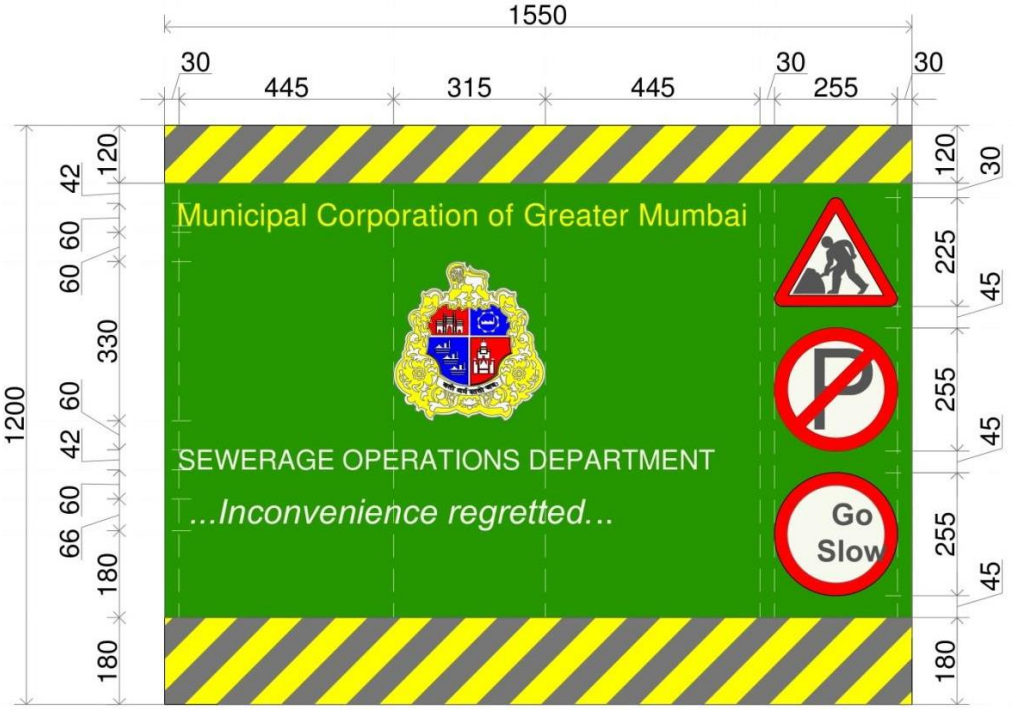
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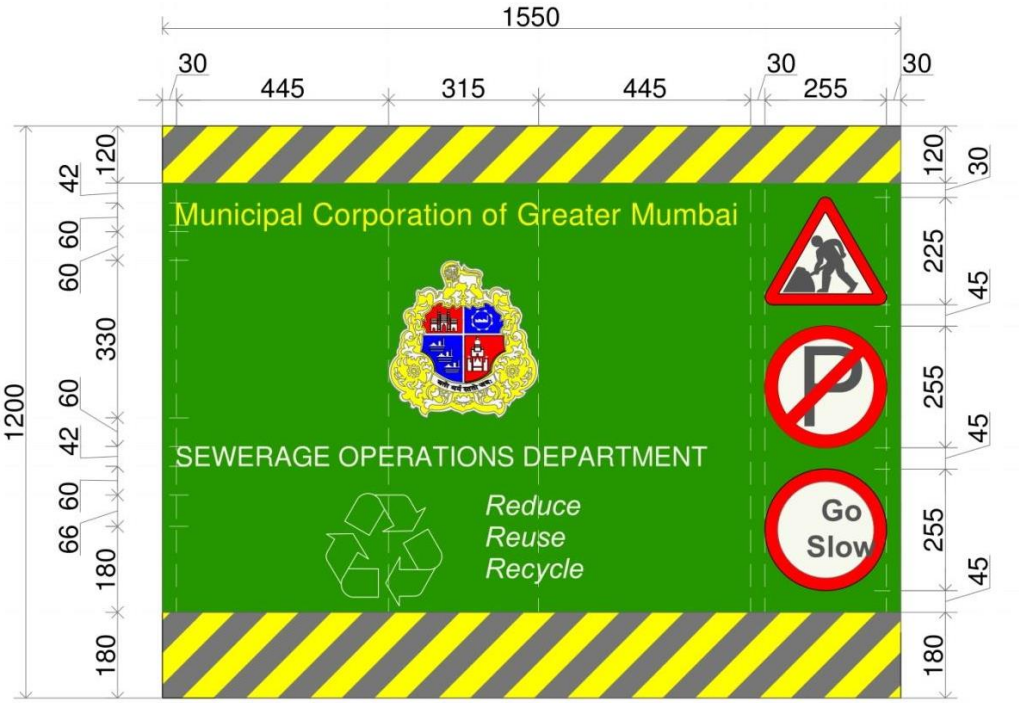
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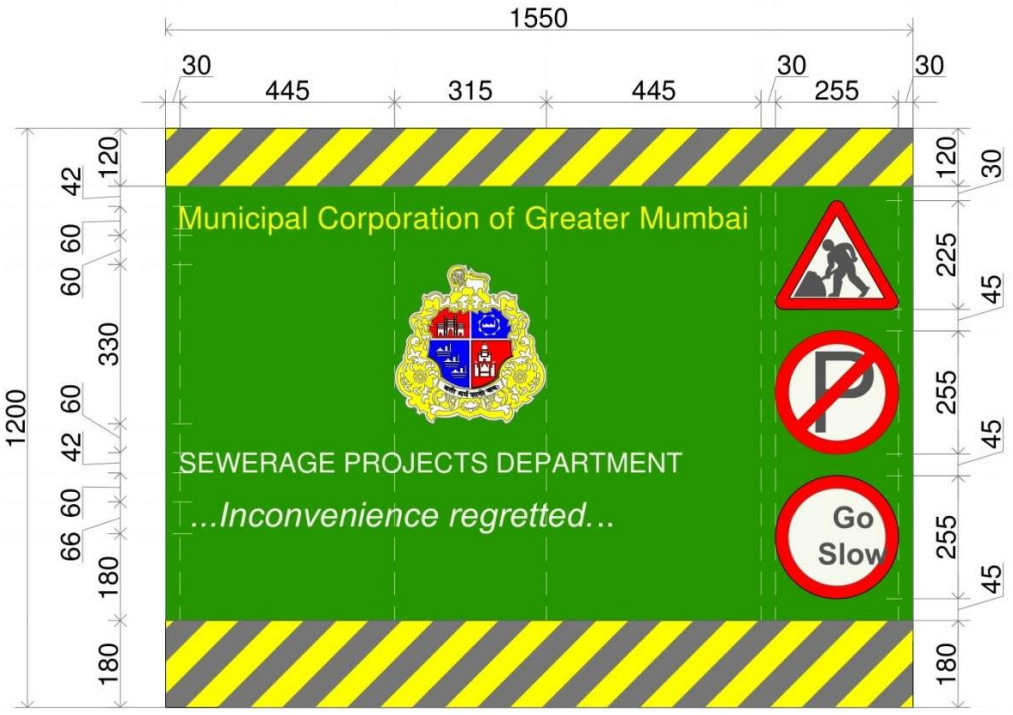
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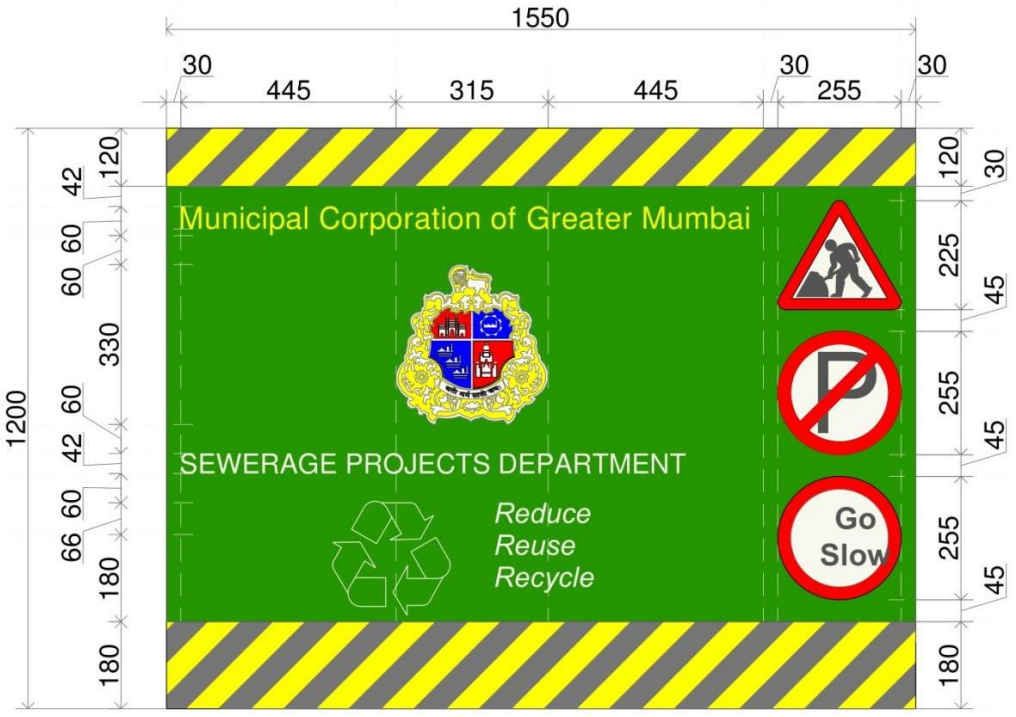
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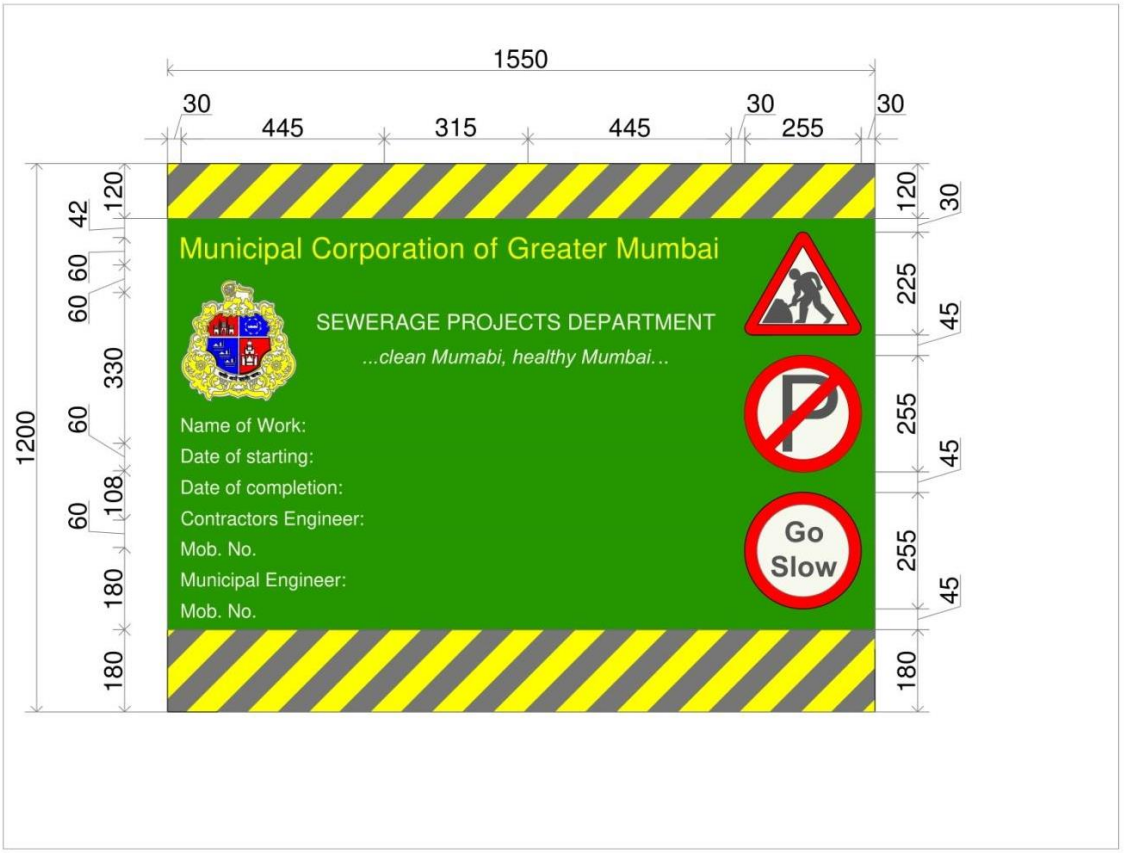
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Timbering of Sewer and Trenches

a) The Contractor shall at all times support efficiently and effectively the sides of all the trenches and other excavations by suitable timbering, piling and sheeting and they shall be close timbered in loose or sandy strata and below the surface of the sub soil waterlevel.

b) All timbering, sheeting and piling with their wallings and supports shall be of adequate dimensions and strength and fully braced and strutted so that no risk of collapse or subsidence of the walls of the trench shall takeplace.

c) The Contractor shall be held responsible and shall be accountable for the sufficiency of all timbering, bracing, sheeting and piling used and also for, all damage to persons and property resulting from improper quality, strength, placing, maintaining or removing of thesame.

Shoring of Buildings

The Contractor shall shore up all buildings, walls and other structures, the stability of which is liable to be endangered by the execution of the work and shall be fully responsible for all damages to persons or property resulting from any accident.

Removal of Water from Sewer, Trench etc.

The Contractor shall at all times during the progress of the work keep the trenches and excavations free from water which shall be disposed of by him in a manner as shall neither cause injury to the public health nor to the public or private property nor to the work completed or in progress nor to the surface of any roads or streets nor cause any interference with the use of the same by the public at no extra cost.

Width of Trench

a) The Engineer shall have power by giving an order in writing to the Contractor to increase the maximum width/ depth in respect of which payment shall be allowed for excavation and back filling in trenches for various classes of sewer, manholes, and other works in certain lengths to be specifically laid down by him, where on account of bad ground or other unusual conditions, he considers that such increased widths/ depths are necessary in view of the siteconditions.

b) The width of trenches at the bottom shall be as follows:-

- 100 mm dia pipe -550mm
- 150 mm dia pipe -550mm
- 225-250 mm dia pipe - 600mm
- 300 mm dia pipe -750mm

Maximum width of the bed concrete shall also be as above. No additional payment is admissible for widths greater than specified unless directed by the Engineer as given in clause above.

High Density Polyethylene Pipes

This specification covers the requirements for manufacture, supplying, lowering, laying, jointing, testing and commissioning of High Density Polyethylene pipes (HDPE) and fittings used for the conveyance of sewage.

All underground sewer lines where specified (other than those specified as cast iron) shall be High density polyethylene (HDPE) pipes of specified Class conforming to IS:14333. Pipes shall be true and straight with uniform bore, throughout. Cracked, warped pipes shall not be used on the work. All pipes shall be tested by the manufacturer and the Contractor shall produce, a certificate to that effect from the manufacturer.

Applicable Code

The manufacturing, testing, supplying, jointing and testing at work site of HDPE pipes and fittings shall comply with all currently applicable statutes, regulations, standards and codes. In particular, the following standards unless otherwise specified herein, shall be referred. In all cases, the latest revision of the codes shall be referred to. If requirements of this specification conflict with the requirements of the codes and standards, this specificationshallgovern.

Code No.	Title / Specification
IS: 14333	Specification for High Density Polyethylene pipes (HDPE) and fittings for the use for Sewerage
IS: 7634 Part 2	Code of practice for Laying and Jointing of High Density Polyethylene pipes (HDPE) piping system
IS: 2530	Method of test for polyethylene moulding materials and polyethylene compounds
IS: 7328	High Density Polyethylene material for moulding and extrusion
IS: 4905	Method for random sampling

Other codes as approved by Engineer but not specifically mentioned here pertaining to the use of HDPE Pipes form part of these specifications.

General

Design

Design of HDPE pipes including material details and the maximum allowable hydrostatic design stress taking into consideration, the temperature and design life of pipes shall be in accordance with the relevant clauses of IS:14333.

Grade of Material

The High-Density Polyethylene Pipes (HDPE) shall be in the range of 160 mm to 1000 mm nominal diameter of pressure rating of PN6 on material grade of PE 80/100 for sewerage applications.

Material Grade, Minimum Required Strength and Maximum Allowable Hydrostatic Design Stress shall conform to the relevant clause of IS – 14333.

Designation

Pipes shall be designated as per IS: 14333 according to the grade of material, followed by pressure rating and nominal diameter, for example, PE 80 PN 6 DN 315 indicates a pipe pertaining to material grade 80 having a pressure rating 0.6MPa and outside nominal diameter 315mm.

Diameter Range

a) Upto 630mm nominal dia.: PE80 PN6class

b) Greater than 630mm up to 1000 mm nominal diameter: PE 100PN6 class

Colour -The colour of the pipe shall be black. Manufacturing, Workmanship &Finish

General

a) The method of manufacture of HDPE pipes shall be such that the internal and external surfaces of the pipes shall be smooth, clean and free from grooving and other defects. The ends shall be cleanly cut and shall be square with axis of the pipes.

b) The Engineer shall at all reasonable times have free access to the place where the pipes and fittings are manufactured for the purpose of examining and testing the pipes and fittings and of witnessing the test andmanufacturing.

c) All tests specified either in this specification or in the relevant Indian standards shall be performed by the supplier/contractor at his own cost and in presence of the Engineer if he so desires. For this, sufficient notice before testing of the pipes and fittings shall be given to theEngineer.

d) If the test is found unsatisfactory, the Engineer may reject any or all pipes of thatlot.

Materials

The material used for the manufacturer of pipes shall not constitute toxicity hazard, shall not support microbial growth, shall not give rise to unpleasant taste or odour, cloudiness or discoloration of water. Pipe manufacturers shall obtain a certificate to this effect from the manufacturers of raw material by any reputed organisation as per the satisfaction of the Engineer.

Raw Material

a) Raw material used to manufacture the HDPE pipes shall be 100% virgin PE compound or Natural black PE resin confirming to IS: 14333(latest version), IS: 7328 and ISO: 4427 for this a certification has to be given by the resin manufacturer as per IS: 14333 (latest version). The resin proposed to be used for manufacturing of the pipes shall also comply with the following norms as per ISO:9080.

b) The resin shall have been certified by an independent laboratory of international repute for having passed 10,000-hour long term hydrostatic strength (LTHS) test extrapolated to 50 years to show that the resin has a minimum MRS of over 10MPa. Internal certificate of any resin manufacturer will not be acceptable. The minimum required strength of material shall not be lower than 6.30 MPa at 20 deg. Centigrade at 50years.

c) Certificate for having passed the full scale rapid crack propagation test as per ISO 13478.

d) High density Polyethylene (HDPE) used for the manufacture of pipes shall conform to designation PEEWA-45-T-006 of IS: 7328. HDPE conforming to designation PEEWA-45- T-012 of IS: 7328 may also be used with the exception that melt flow rate (MFR) shall not exceed 1.10 g/10 min. In addition, the material shall also conform to clause 5.6.2 of IS7328.

e) The specified base density shall be between 941.0kg/m³ and 946.0kg/m³ (both inclusive) when determined at 27°C according to procedure prescribed in IS: 7328 The value of the density shall also not differ from the nominal value by more than 3kg/m³ as per 5.2.1.1 of IS:7328. The MFR of the material shall be between 0.41and 1.10 (both inclusive) when tested at 190°C with nominal load of 5 kgf as determined by method prescribed in IS: 2530. The MFR of the material shall also be within ± 20% of the value declared by themanufacturer.

f) The resin shall be compounded with carbon black. The carbon black content in the material shall be within 2.5 ±0.5% and the dispersion of carbon black shall be satisfactory when tested as per IS: 2530.

Anti-Oxidant

The percentage of anti-oxidant used shall not be more than 0.3% by mass of finished resin. The anti-oxidant used shall be physiologically harmless and shall be selected from the list given in IS: 10141.

Maximum Ovality of Pipes

The outside diameter of pipes, tolerance on the same and ovality of pipe shall be as given in IS 14333. Ovality shall be measured as the difference between maximum outside diameter and minimum outside diameter measured at the same cross section of the pipe, at 300 mm away from the cutend.

Dimensions and Tolerances

a) The outside diameters of pipes, tolerance on the same and ovality of pipes shall be as given in relevant clause of I.S. 14333(latest version). No negative tolerances are allowed.

b) The minimum & maximum wall thickness of pipe for the given grade of material, namely PE 80/100 and PN6 class shall be as given in IS:14333.

c) The length of straight pipe used shall be 6 m or as agreed byEngineer.

Testing

The specimen of pipes for the following tests shall be selected in accordance with relevant clause of IS: 2530 and tests in accordance with the methods described in relevant clause of IS: 14333. Following tests shall be taken in consideration:

a) Hydrostatic Test

b) ReversionTest

c) Density Test

d) Melt FlowTest

e) Carbon Black Content and Dispersion

Sampling and Inspection

a) Three samples of the same size and same pressure rating selected at random shall be tested for compliance with the requirements of the type test for Internal Pressure Creep RuptureTest.

b) In case, any of the samples fails in the type test, the testing authority, at its discretion, may call for fresh samples not exceeding the original number and subject them to type test again. In case of the sample fails in the repeat tests, the type of pipe shall not beapproved.

c) Acceptance tests are carried out on samples selected from a lot for the purpose of acceptance of thelot.

d) A lot having satisfied dimensional and visual requirements shall be tested for hydraulic characteristics, reversion, density, MFR and Carbon Black content/

dispersion requirements. The lot shall be considered to have met the requirements of these tests, if none of the samples tested fails.

Workmanship /Appearance

Pipes shall be free from all defect including indentations, delaminating, bubbles, pinholes, cracks, pits, blisters, foreign inclusions that due to their nature degree or extent detrimentally affect the strength and serviceability of the pipe. The pipe shall be as uniform as commercially practicable in colour opacity, density and other physical properties as per relevant IS Code or equivalent International Code. The inside surface of each pipe shall be free of scouring, cavities, bulges, dents, ridges and other defects that result in a variation of inside diameter from that obtained on adjacent unaffected portions of the surface. The pipe ends shall be cut clearly and square to the axis of the pipe.

Carting & Handling

During handling, transportation, storage and lowering of pipes & fittings, all sections shall be handled by such means and in such a manner that no distortion or damage is done to the section or to the pipes as a whole. Unless waived by the Engineer, method statements shall be submitted by the Contractor for the approval of the Engineer before the handling, transportation and laying of any pipes commences. All pipes shall be handled and stored in compliance with the manufacturer's recommendations. Pipes and fittings /specials shall betransported from the factory to the central pipe store and unloaded there before being transported to Site. At every point of loading or unloading, all pipes and fittings shall be lifted using approved lifting tackle. Unloading by rolling down any form of inclined ramp will not be permitted. Pliable straps or slings shall be used to lift pipes. Rope, wire rope, hooks or chains shall not be allowed to come into contract with any pipe surface. All pipes shall be thoroughly inspected on arrival on site and immediately prior to installation. Any damage to the pipes shall be notified to the Engineer for a decision as to the acceptability of the pipes, with or without repairs or remedial work. The final judgement will be taken by the Engineer based on his judgement of the suitability of the items for the purposeintended.

The following procedures shall be followed so as to eliminate potential damage to pipes &fittings and to maintain maximum safety during unloading,lifting and lowering of pipes:

a) Pipes must not be stored or transported where they are exposed to heat sources likely to exceed 60 degreesC.

b) Pipes shall be stored such that they are not in contact with direct sunlight, lubricating or hydraulic oils, petrol, solvents and other aggressivematerials.

c) Scores or scratches to a depth of greater than 10% or more of wall thickness are not permissible; any pipes having such defects shall be strictlyrejected.

d) PE pipes shall not be subjected to rough handling during loading and unloading operations. Rollers shall be used to move, drag the pipes across anysurface.

e) Only polyester webbing slings shall be used to lift heavy PE (>315mm) pipes by crane. Under no circumstances, shall chains, wire ropes and hooks be used on PE pipes.

f) Pipes shall not be dropped to avoid impact or bump. If any time during handling or during installation, any damage, such as gouge, crack or fracture occurs, the pipe shall be repaired if so permitted by the competent authority beforeinstallation.

g) Straight lengths shall be stored on horizontal racks giving continuous support to prevent the pipe taking on a permanentset.

h) Pipes manufactured at factory are to be carried to the site of work directly or stacked suitably and neatly along the alignment/road side/elsewhere near by the work site or as directed by theEngineer.

i) Damages during transit, handling, storage will be to the Contractor's account and replacement for such pipes shall be made by the Contractor without any extra cost as directed by theEngineer.

Storage

a) Black polyethylene pipes may be stored either under cover or in the open. It is suitably protected from ageing due to sunlight by the addition of the appropriate quantity and type of carbonblack.

b) Straight lengths shall be stored on horizontal racks giving continuous support to prevent the pipe taking on a permanentset.

c) Storage of pipes in heated areas exceeding 30 degrees centigrade shall beavoided.

12.7.6 Laying and Jointing of Pipes

Laying

For lowering and laying of pipes, the following points shall be considered:

a) Each pipe shall be thoroughly checked for any damages before laying and only the pipes which are approved by the Engineer shall belaid.

b) While installing the pipes in trenches, the bed of the trench shall be level and free from sharp edged stones. In most cases, the bedding is not required, as long as the sharp and protruding stones are removed, by sieving the dug earth, before using the same a backfill material. While layingin rocky areas, a suitable bed of sand or gravel shall be provided. The fill to about 10 to 15 cm above the pipe shall be fine sand or screened excavated material. Where hard rock is met with, bed concrete M15, 15cm or 20cm thick sand bed as approved by the engineer may beprovided

c) As PE pipes are flexible, long lengths of fusion-jointed pipes having joints made above ground can be rolled or snaked into narrow trenches. Such trenches can be excavated by narrowbuckets.

d) During the pipe laying of continuous fusion jointed systems, due care and allowance shall be made for the movements likely to occur due to the thermal expansion/contraction of the material. This effect is most pronounced at end connections to fixed positions (such as valves etc.) and at branch connections. Care shall be taken in fixing by finishing the connections at a time the length of the pipe is minimal (lower temperature times of theday.)

e) For summer time installations with two fixed connection points, a slightly longer length of PE pipe may be required to compensate for contraction of the pipe in the cooler trenchbottom.

f) The final tie-in connections shall be deferred until the thermal stability of the pipeline is achieved.

g) The flexibility of polyethylene pipes allows the pipe to be cold bend. The fusion jointed PE pipe is also flexible as the plain Pipe. Thus the total system enables directional changes within the trench without recourse to the provision ofspecial

bends or anchor blocks. However, the pipe shall not be cold bent to a radius less than 25-times the OD of thepipe.

h) The Installation of flanged fittings such as connections to sluice / air / gate valves and hydrant tees etc. requires the use of stub ends (flange adaptors complete with backing rings and gaskets. Care should be taken when tightening these flanges to provide even and balancetorque.

i) Provision shall be made at all heavy fittings installation points for supports (such as anchoring of the flange in the soil) for the flange joint to avoid the transfer of valve wheel turning torque on to the PE flangejoint.

j) PE pipe is lighter than water. Hence care shall be taken for normal installations where there could be a possibility of flooding of the trench thus the trench shall be kept free of water till the jointing has been properlydone

k) When flooded, some soils may lose cohesiveness, which may allow the PE pipe to float out of the ground. Several design checks are necessary to see if groundwater flotation may be a concern. Obviously, if the pipeline typically runs full or nearly full of liquid, or if groundwater is always below the pipe, flotation may not be a significant concern.

l) However, weights by way of concrete blocks (anchors) shall be provided so that the PE pipe does not float when suddenly the trench is flooded and the soil surrounding the pipe is washed away. Therefore,a site condition study is necessary to ensure the avoidance offlotation.

m) Pipe embedment backfill shall be stone-free excavated material placed and compacted to the 95% maximum drydensity.

Jointing

The pipe shall have a jointing system that shall provide for fluid tightness for the intended service conditions. Appropriate jointing for HDPE pipe as per IS: 14333 shall be selected considering site and working condition, pressure and flow of liquids.

Welding Procedure

Jointing between HDPE pipes and specials shall be done as per the latest IS: 7634 part II. Method of jointing between the pipes to pipes and pipes to specials shall be with butt fusion welding using automatic or semi-automatic, hydraulically operated, superior quality butt fusion machines which will ensure good quality butt fusion welding of HDPE pipes.

Fusion Welding

Fusion welding is commonly used in HDPE and is a permanent type of joint. The pipe shall be cut square and the face of the pipe shall be slightly scraped prior to welding to remove oxidised layer. At the time of welding, levelling of the pipes is essential particularly in case of larger diameter pipes. Welding temperature shall be 200 degrees Centigrade and surface of heating mirror shall be 210 +/- 5 degrees Centigrade (heating mirror is a metallic plate heated up to the required temperature either by electrical coil embedded inside or by blow torch). The welding of the pipe shall be held in either side of the heating mirror and immediately the joint is made by application of moderate pressure of approximately 1 to 2 Kg/cm^2 for 2 to 3 seconds. The initial heating time for achieving molten rim, varies from 1 to 5 minutes depending upon the pipe wall thickness and size.

Following precautions shall be taken whilefusion welding

a) It is essential to see that the rim formed is notexcessive.

b) While jointing, the pressure shall be maintained until the joint is lukewarm and after the pressure is relieved, the joint allowed to coolcompletely.

c) The mirror shall be kept exactly around 210 degrees Centigrade which needs about 30 min. time (for electrical mirror). It is also essential to see that the temperature is maintained constant by the proper setting of regulator. For detecting the correct temperature, crayon chalk is used. For example, at 210 degrees Centigrade the colour of crayon dot on the mirror changes within 2 seconds. But the dot made shall be thin and if not, time taken will be more, indicating a wrongtemperature.

A satisfactory but welded joint of HDPE will have the strength factor of one. Temperature is of primary importance and weld efficiency may decrease if the temperature is more or less than 210 degrees Centigrade.

Fittings and Specials

All HDPE fittings/ specials shall be fabricated in accordance with IS: 8360 (Part I & III). PE Injection moulded fittings shall be as per IS: 8008 (Part I to IX). All fittings/specials shall be fabricated or injection moulded at factory only. No fabrication or moulding will be allowed at site, unless specifically permitted by the Engineer. Fittings will be butt welded on to the pipes or other fittings by use of heat fusion.

Bends

HDPE bends shall be plain square ended conforming to IS: 8360 Part I & III Specifications. Bends may be fabricated by jointing several small sections of pipes to reach the requiredangle.

Tees

HDPE Tees shall be plain square ended conforming to IS: 8360 Part I & II Specifications. Tees may be equal tees or reduced take off tees. Tees may be moulded or fabricated from pipes elements.

Site Testing

After laying and jointing of HDPE pipes is completed, the pipe line shall be tested. All equipment, material, and labour for testing shall be supplied by the Contractor. Damage during testing shall be contractor's responsibility and shall be rectified by him to the full satisfaction of the Engineer. Water for testing of pipeline shall be arranged by the Contractor at his own cost.

After the joints, have been checked by the Engineer and before backfilling of the trenches, the entire section of the sewer shall be proved by the contractor to be watertight. Water used for the test shall be removed from pipes and not discharged to the excavatedtrenches.

The Contractor shall carry out final testing of the equipment and commissioning of all pipelines to the satisfaction of the Engineer.

Bedding

Bedding shall be rectangular in section and shall extend laterally at least 150mm beyond and on both sides of the projection of the barrel of the pipe and thickness of bedding below the barrel of pipe shall not be less than 100mm for the pipe less than 150mm diameter.

Microtunnelling and Jack Pushing Method

Definitions

For the purpose of this contract document, the technical terms pertaining to microtunneling works and their functional details are defined below. The definitions herein are meant only as guidelines. If other (or new) definitions or technical terms are used by the Contractor in his submittals, they shall be clearly defined by him.

Microtunneling

Microtunneling is a process of accurately excavating, non-man entry tunnels for installing underground pipelines, using laser guided remote controlled mini shields of diameters 600-2400 mm. The microtunneling permits accurate monitoring and adjusting of the alignment and level (either manually or automatically) as the excavation proceeds.

Pipe jacking.

It is a process of lining a tunnel bore formed by a shield or other means by pushing especially designed jacking pipes (reinforced concrete or other pipes) into the tunnel bore, from a shaft (known as jacking shaft) to another shaft (known as receiving shaft).

Microtunneling and Pipe jacking:

It is an art of accurately installing smaller diameter pipelines (usually 600 mm diameter and above), without digging up of ground surface, using a laser guided remote controlled mini shields for tunnel boring and pipe jacking technique for lining the bore with the product pipe.

The process of installing a pipeline by microtunneling and pipe jacking system comprises five parts:-

(a) Micro tunnel boring machine (Shields)

(b) Automated spoil removal system

(c) Jacking system for pushing the jacking pipe and later on carrier pipe as needed

(d) Guidance system to guide the tunnel excavation

(e) Remote control system to operate the shield and other paraphernalia equipment.

MicroTunnel Boring Machine (shield)

It is mechanised, steerable mini boring machine (or shield) equipped with suitable cutter head in front to excavate smaller diameter tunnels under controlled conditions in which the tunnel face and ground water pressure are continuously balanced as the shield excavates

and moves forward. The operation and steering of the shield are remotely controlled with the aid of laser and/or CCTV system

Automated spoil removal system

This system conveys the excavated spoil from the tunnel face to the ground surface for disposal. The spoil removal rate and the speed of the shield are fully or semi-automatically controlled in such a way to achieve minimal heave or settlement. There are three systems available for the conveyance of the spoil and they are slurry system, augur system, and vacuum system.

Jacking System

The jacking system comprise high thrust hydraulic jacks mounted in a jacking frame capable of exerting the required jacking force against a purpose built thrust wall to push the pipes and the shield forward through the ground. The jacking force is transferred evenly to the jacking pipe through a push ring connected to the pipe.

Guidance System

The guidance system comprises a laser beam device or a theodolite with laser beam attachment. The device is installed in the jacking shaft and the beam is set to the desired level, gradient and alignment.

Some machines have photo sensitive cells on the target panel located at the rear of the shield which converts the laser position into digital data. The data are then electronically transmitted to the operator's control panel where digital readout of the location can be made. Some modern shields have built-in capabilities to use the digital data and automatically make necessary steering adjustments to guide the machine to the true alignment and level

The contractor shall submit complete details of the guidance system he proposes to use and shall incorporate appropriate check points and hold points in the Quality Assurance Manual that he shall implement in the contract.

The laser torch or theodolite shall be firmly supported in the jacking pit so that it is independent of any movement that may take place during the microtunneling operation.

Remote Control System

All microtunneling systems rely on remote-control capability. The control system monitors and controls the steering of the shield, spoil removal system (slurry or augur or vacuum), jacking system and guidance system. The system operation varies from totally manual to fully automated. The remote control system is usually housed in portable control cabin.

The control cabin shall be located near to the jacking pit so that the operator can visually monitor the activities in the pit. Where it is not possible to locate the control cabin near to the pit due to space limitations, a CCTV camera system shall be set up in the pit to allow the operator to monitor the activities in the pit.

For the manual operating system, the operator's skill is very crucial for a successful completion of the project. The operator shall monitor all the information and continuously feed into the control panel as necessary. He shall be alert at all time and shall observe the crew's activities and other site activities, evaluate the information and make appropriate operational decisions. The information relayed back to the operator shall be audible, tactile and visual as The MTBM shall have facility to transmit sounds and vibrations from the excavation face to the operators to enable him to make appropriate operational decisions. He shall monitor and keep record of position of the tunneling machine in relation to the design line &grade, cutter head face pressure & torque, jacking thrust, RPM, steering jack extension & their pressures, slurry pump flow rate, pressures of slurry systems, rate of MTBM advancement, Roll, Pitch, Installed length, Grout quantity etc.

In fully automated system, the machine acquires and evaluates the information and selects the operational steps for automatic steering of MTBM. The information collected shall be logged in a microprocessor to obtain a printout as necessary.

The contractor shall incorporate check points and hold points for the guidance control system in the Quality Assurance System that he shall implement in the contract.

Supplementary systems

The supplementary system required for microtunneling and pipe jacking operation shall include Muck disposal system, Pipe lubrication system, Grouting system, Guide rails, Entrance and Exit installations.

Jacking shaft (or Jacking Pit)

Jacking Shaft is an important temporary structure from where jacking operation is performed. The shaft is usually rectangular or circular in shape and built using liner plates, sheet piles or timber shoring. The size of the shaft shall be such that it is capable of accommodating the jacking equipment (and also the shield), jacking pipe and other paraphernalia or enable construction of manhole or chamber as needed. The requirement for jacking shaft shall take full cognisance of the available working space and intended equipment footprint, minimum disturbance to the traffic flow.

Receiving shaft (Receiving pit)

A purpose built temporary structure to receive and remove the tunnelling shield after its completion of a tunnel drive. The shaft is also rectangular or circular in shape and smaller than the jacking shaft. The size shall be sufficient enough to accommodate the tunnelling shield when it emerges into shaft after completion of a tunnel drive or construction of manhole or chamber as needed.

Foot print

The footprint of a microtunnel drive shall be taken as the net area occupied by the jacking or receiving shafts. The size of the footprint depends on many factors including the microtunneling system and the length of jacking pipe used. The footprint requirement shall be an important factor, especially in congested and narrow roads when selecting the microtunneling system for a project.

The Contractor shall take into consideration of the space constraints and restrictions along the pipeline route for location of shafts and he shall ensure that the microtunneling system selected for use in such sites shall require absolutely minimum space for the footprint.

Thrust wall

Thrust wall is a temporary concrete or steel structure built within the jacking shaft to transfer the jacking force to the ground during jacking operation. The jacking shafts may often have more than a single thrust wall and each thrust wall shall be perpendicular and square to the pipeline to be jacked. The thrust walls shall be in good contact with the soils behind so that wall can transmit the jacking force effectively to the ground without affecting the shoring system.

All the affected thrust wall shall be demolished fully or partly after completion of jacking operation involving in that wall.

Entrance Ring

A steel flange fitted with a rubber seal (a 10mm to 20mm thick circular rubber gasket whose outside diameter is same as that of the steel flange and the inside diameter is smaller than that of the jacking pipe) installed perpendicular to the pipeline at the entrance. The purpose of the rubber seal is to prevent the slurry or ground water from entering into the shaft through the pipe entrance.

Exit Ring

This is similar to the entrance ring except that the internal diameter of the rubber seal is much smaller than that of the jacking pipe and is installed to prevent the slurry or ground water from escaping the tunnelling machine when it emerges at the receiving shaft.

Guide Rails (or Jacking Table or Frame)

To facilitate placing of the microtunneling machine and pipes in the jacking shaft, a set of guide rails are installed in position on the base of the shaft. The guide rail assembly (also known as jacking table/ frame) shall be carefully set up in the shaft to correct alignment and gradient so that the pipe when placed on itstays in line with and square to the pipeline alignment. The guide rail assembly shall be independent of the thrust wall so that it is not disturbed due to jacking force exerted onto the thrust wall.

Thrust Pressure Plate

The thrust pressure plate is usually a 50mm or 100mm thick steel plate installed between the jacks assembly and the thrust wall. The pressure plate enables the concentrated jacking load from the jacks to be transmitted evenly to the thrust wall,

Intermediate Jacking Station.

For longer distance jacking, intermediate jacking stations, comprising a telescopic type jacking pipe assembly (usually made of steel), are used. A set of inter jacks and push ring are installed around the inner side of the female pipe of the telescopic pipe assembly. The intermediate jacking pipe assembly shall be installed at appropriate point and jacked-in along with the other jacking pipes.

Cutter head

It is usually a disc shaped wheel mounted on the face of the micro tunnelling machine (shield) and is driven by hydraulic or electrical motor, located within the machine. The excavation capabilities of a microtunneling machine depends very much on the type of cutter head used, its size, its speed of rotation and average and peak torque etc.

Cutter head can be equipped with picks, single / double disk cutters, cone shaped cutters, button bits, chisel points, scrappers etc. with sufficient openings & buckets.

Different types of cutter head configuration are used in microtunneling machines to suit the type and nature of the ground through which tunnelling is to be carried out. For example, in soft ground tunnelling the cutter head shall have bits arranged in such a way to cleave and guide the soil into a chamber behind the cutter head through the openings provided in the cutter wheel.

In the case of rock or hard ground tunnelling the cutter head shall be equipped with suitable bits, roller bits or disc cutters for effective transfer of cutting energy to rock. The cutter head shall be configured appropriately considering geotechnical parameters such as compressive strength, tensile strength, elasticity, abrasivityetc, about the material to be excavated. The tunnelling machine shall be equipped with a crushing chamber behind the

cutter head with powerful crusher to crush the excavated rocks into smaller pieces. Moreover, the machine shall be capable of exerting a large thrust force/torque on to the tunnel face to facilitate excavation of rock. The speed of rotation, torque, bit arrangement (and its structural and mechanical characteristic to withstand rock excavation for longer drive) of the cutter head and the thrust force the tunnelling machine is capable of exerting on to the rock face are important features to consider when selecting machines for tunnelling in rock.

Jacking Ring

Jacking ring or thrust plate is a purpose made structural fitting which shall be installed between the jacking assembly and the jacking pipe to transfer the point loads from the individual jacks into evenly distributed jacking force to the pipes being jacked. The ring shall be fabricated and machined, if necessary, so that it fits exactly onto end of the jacking pipe.

Horizontal Directional Drilling Method

Definition

Horizontal directional drilling (HDD) has emerged as a preferred crossing method in many situations for the installation of oil and gas pipelines as well as other utilities under watercourses, roads, rail lines, steep slopes and other obstacles.

Recognition of the advantages, limitations and potential risks of HDD is an important step in this evaluation.

The successful design and construction of an HDD is the result of a team effort combining the skills of the regulatory group, owner, engineering consultant, environmental consultant, inspection services and the specialist HDD contractor. Success in this endeavor is measured in more than the successful pull back of the pre-built pipeline drag section.

Drilling Execution Plan

The selected contractor should develop and present to the engineer a written drilling execution plan that addresses all aspects of the HDD. A full list of components of the plan is provided in Appendix C. Key topics in the plan include:

- Details of each step of the HDD;
- Detailed drawings;
- Equipment specifications;
- Workspace and water requirements;
- Monitoring plans including frequency and type; and
- Contingency plans.

Environmental Protection Plan

An environmental protection plan (EPP) should be developed by the owner to address mitigative measures to be implemented during execution of the HDD. Environmental protection planning should cover all aspects of the execution of the HDD including land, water and access needs. The EPP should address the following aspects and be closely linked to the drilling execution plan:

- Notification and approvals;
- Identification of environmental exclusion areas to be incorporated into No DrillZones;
- Environmental and social timing constraints;
- Equipment inspection and servicing;
- Clearing and grading of HDD sites and access;
- Erosion and sediment controls; and
- Monitoring.

In addition to having an EPP, it is essential to have qualified people onsite to enact the plan, to handle deviations to the plan and to report events properly to the authorities. Having an environmental specialist or biologist onsite to liaise directly with the DFO habitat

biologist or other similar authority can prove useful. Effective communication of unintended events and subsequent mitigation actions to the authorities may reduce delays or unwarranted enforcement actions contingency planning, e.g., inadvertent returns and reclamation.

Construction Consideration

Drilling

Types of Rigs

The size of HDD rigs can vary substantially. This range in sizes should be considered when planning and developing specifications for an HDD project. In general, rigs are sized according to their available pull force and rotary torque that can be applied to the drill stem and pipe string. The capabilities of each rig should be assessed for each project. The assessment of rig capabilities should take into account the possibility that formations or other subsurface materials may be encountered that could cause difficulties with the HDD project.

Drag Section

The pipe installation should be designed so that, wherever possible, the pipe string or drag section can be laid out and pulled back in one continuous section. The pipe will have to be lifted into place to match the exit angle of the drill to allow the drill rig to pull the section into place.The pipe string is usually placed on rollers as it is pulled into the drilled hole. The drag section may be cradled through a vertical curve to achieve the proper angle at the exit point. This curvature should be no more than the limiting curvature of the pipe.

Steering / Survey of Drill Head

It is necessary to ‘steer’ the drill head or mud motor during the drilling of the pilot hole. A number of steering technologies are available.

Drilling Fluids

Drilling fluid is used for a number of tasks in the HDD process including:

- Cooling and lubricating the drill stem, mud motor and bit;
- Providing hydraulic power to the mud motor which in turn converts hydraulic power to mechanical power;
- Carrying cuttings out of the bore hole;
- Stabilizing the bore hole during the drilling process; and
- Sealing fractures in the formation.

Drilling fluid is usually a mixture of freshwater and bentonite. Bentonite is naturally occurring clay that is extremely hydrophilic (i.e., has high swelling characteristics). Certain polymers may also be used that enhance the drilling fluid benefits.

A drilling fluid design plan should be established before the start of the project. This plan should also be modified, when warranted, throughout the project to ensure the drilling fluid is fulfilling its function.

The contractors' drilling execution plan should identify the equipment to be maintained onsite to check drilling fluid properties. Alterations to the mix should be made, when warranted, to stay within the proposed boundaries in the drilling fluid management plan.

A mud handling system should be onsite to ensure drilling fluid parameters are within the set standards.

Additives

Various chemical and materials can be added to the drilling fluid to adjust its properties. This is done to control:

- Density;
- Viscosity;
- Plugging and sealing capabilities; and
- Specific conditions such as swelling.

All additives should be environmentally safe. A number of additives have been recognized as safe for the water well drilling industry and, with the proper approvals, could be used for the HDD industry. All additives must be approved before use.

Monitoring

Monitoring and reporting are critical during an HDD since they provide a log of activities during the process to:

- Provide early identification of issues;
- Make appropriate changes;
- Provide a basis for mitigation; and
- Provide a record of decisions and actions to demonstrate due diligence.

It is important to ensure that sufficient records are maintained before, during and after construction to support subsequent reports prepared to satisfy engineer or government reporting requirements. This should include detailed notes and photographs of all areas monitored.

Drilling

The following monitoring and reporting activities should be reviewed for appropriateness for the size and complexity of the HDD crossing:

- Inspector daily records – a day-to-day account of the entire construction of the project;
- Contractor drilling records;
- Steering report;
- Drilling fluid volume balance report;
- Drilling fluid parameters;
- Drilling fluid additives list;
- Annular pressure modeling and reporting;

- Turbidity monitoring report;
- Surface monitoring report;
- Pull force monitoring; and
- Inadvertent return report.

Contingency Plans

A site-specific contingency plan should be prepared by the project team for each HDD. A welldesigned contingency plan should address the following:

- General measures;
- Equipment and personnel needs for containment and clean-up;
- Emergency response procedures;
- Plans for continuance of drilling or alternative plans;
- Time lines of acceptable response and notification;
- Clean-up methods and plans;
- Regulatory and stakeholder contacts;
- Monitoring plans; and
- Disposal plans.

Clean-up and Remediation

An important decision may be required when plans to be prepared to clean-up an inadvertent release of drilling mud. The decision can involve determination of whether or not clean-up and reclamation of a site will incur greater adverse effects on the environment than leaving the mud in situ and allow natural processes to reclaim the area.

Clean-up

It is important for the, contractor to submit cleanup goals for a site subjected to an inadvertent release of drilling fluids prior to commencement of clean-up activities. If a net gain is not anticipated as a result of clean-up, alternative measures may need to be implemented.

Reporting

Monitoring Reports

Prior to the start of construction, the contractor should be required to provide the proposed monitoring report forms as part of the drilling execution plan. Frequency and types of monitoring should also be presented in the drilling execution plan.

As-Built Reports

As part of project deliverables, the contractor should provide the engineer an as-built

drawing in a format approved or determined by the engineer. The contractor should also provide a set of the monitoring reports at the end of construction.

Cement Concrete Works (for Manholes and Chambersetc.)

Materials

All materials used in cement concrete and masonry works e.g., water, coarse aggregates, sand, cement, reinforcement bars, bricks etc. shall conform to relevant Indian Standards and the Specifications of the Central Public WorksDepartment.

Cement Concrete for PipeSupport

a) Wherever specified or shown on the drawings, all pipes shall be supported on a bed, all around or inhaunches.

b) Pipes in loose soil or above ground shall be supported on brick or stone masonry pillars as shown on the drawings or as directed by theEngineer.

Manholes andChambers

All manholes, chambers and other such works as specified shall be constructed in brick masonry in cement mortar 1:5 (1 cement: 5 coarse sand) or as specified in the Schedule of Quantities.

All manholes and chambers, etc. shall be supported on base of cement concrete of such thickness and mix as given in the Schedule of Quantities or shown on the drawings.

All manholes shall be provided with cement concrete benching in 1:2:4 nominal mix. (1 cement: 2 coarse sand: 4 stone aggregate 20mm nominal size). The benching shall have slope of 1:10 towards the channel. The depth of the channel shall be full diameter of the pipe. Benching shall be finished with a floating coat of neat cement.

All manholes shall be plastered with 12/15mm thick cement mortar 1:3 (1 cement: 3 coarse sand) and finished with a floating coat of neat cement inside. Manhole shall be plastered outside as above but with rough plaster with waterproofing compound.

All manholes with depths greater than 1 m. shall be provided with 20mm square or 25mm round CI footrests set in cement concrete blocks 250x100x100mm min 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20mm nominal size), at 300mm centre to centre vertically and staggered. Footrests shall be coated with coal tar before embedding.

All manholes shall be provided with cast iron covers and frames and embedded in reinforced cement concrete slab. Weight of cover, frame and thickness of slab shall be given above.

Making Connections

Contractor shall connect the new sewer line to the existing manhole by cutting the walls, benching and restoring them to the original condition. A new channel shall be cut in the benching of the existing manhole for the new connection. Contractor shall remove all sewage and water if encountered in making the connection without additional cost. Back filling and compaction shall be done carefully in layers, simultaneously on both sides to prevent unequal earth pressure. Back filling shall not be taken up until testing has been successfully completed.

Testing

All testing shall be done in accordance with IS:1172 and IS:5329 except as may be modified herein under.

All lengths of the sewer/ drain/ pipelines shall be fully tested for water tightness by means of water pressure. Testing shall be carried out from manhole to manhole. All pipes shall be subjected to a test pressure of at least 2.5m head of water. The test pressure shall, however, not exceed 6m head at any point. The pipes shall be plugged preferably with standard design rubber plugs on both ends. The upper end shall, however, be connected to a pipe for filling with water and getting the required head. The sewer/ drain/ pipeline shall be filled with water and left to stand for 2 hours and topped up. The leakage over 30 minutes shall then be measured and the loss in water shall not exceed 2 litres/cm. of diameter/km of pipeline measured during the last 10 minutes of the period oftest.

Sewer lines shall be tested for straightness by:

a) inserting a smooth ball 12mm less than the internal diameter of the pipe. In the absence of obstructions such as yarn or mortar projecting at the joints the ball shall roll down the invert of the pipe and emerge at the lowerend,

b) means of a mirror at one end and a lamp at the other end. If the pipe line is straight the full circle of light shall be seen otherwise obstruction or deviation shall be apparent.

A test register shall be maintained which shall be signed and dated by the Contractor and theEngineer.

The pipeline shall be covered only after the testing is successfully completed.

All manholes, chambers and other such works as specified shall be constructed in precast concrete manhole.

All manholes and chambers, etc. shall be supported on base of cement concrete of such thickness.

Precast reinforced concrete manhole top sections shall be produced using Type II Portland cement, or as approved by the Engineer.

Manhole steps shall be polypropylene and be cast into the manhole wall at the same time the manhole section iscast.

All manholes shall be provided with cement concrete benching in 1:2:4 nominal mix. (1 cement: 2 coarse sand: 4 stone aggregate 20mm nominal size). The benching shall have slope of 1:10 towards the channel. The depth of the channel shall be full diameter of the pipe. Benching shall be finished with a floating coat of neat cement.

All manholes with depths greater than 1 m. shall be provided with 20mm square or 25mm round CI footrests set in cement concrete blocks 250x100x100mm min 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20mm nominal size), at 300mm centre to centre vertically and staggered. Footrests shall be coated with coal tar before embedding.

All manholes shall be provided with cast iron covers and frames and embedded in reinforced cement concrete slab. Weight of cover, frame and thickness of slab shall be given above.

MakingConnections

Contractor shall connect the new sewer line to the existing manhole by cutting the walls, benching and restoring them to the original condition. A new channel shall be cut in the

benching of the existing manhole for the new connection. Contractor shall remove all sewage and water if encountered in making the connection without additional cost. Back filling and compaction shall be done carefully in layers, simultaneously on both sides to prevent unequal earth pressure. Back filling shall not be taken up till testing has been successfully completed.

Testing

All testing shall be done in accordance with IS:1172 and IS:5329 except as may be modified herein under.

All lengths of the sewer/ drain/ pipelines shall be fully tested for water tightness by means of water pressure. Testing shall be carried out from manhole to manhole. All pipes shall be subjected to a test pressure of at least 2.5m head of water. The test pressure shall, however, not exceed 6m head at any point. The pipes shall be plugged preferably with standard design rubber plugs on both ends. The upper end shall, however, be connected to a pipe for filling with water and getting the required head. The sewer/ drain/ pipeline shall be filled with water and left to stand for 2 hours and topped up. The leakage over 30 minutes shall then be measured and the loss in water shall not exceed 2 litres/cm. of diameter/km of pipeline measured during the last 10 minutes of the period oftest.

Sewer lines shall be tested for straightness by:

a) inserting a smooth ball 12mm less than the internal diameter of the pipe. In the absence of obstructions such as yarn or mortar projecting at the joints the ball shall roll down the invert of the pipe and emerge at the lower end;and

b) means of a mirror at one end and a lamp at the other end. If the pipe line is straight the full circle of light shall be seen otherwise obstruction or deviation shall be apparent.

A test register shall be maintained which shall be signed and dated by the Contractor and theEngineer.

The pipeline shall be covered only after the testing is successfully completed.

Measurement and Rates

Excavation

a) Measurement for excavation of pipe trenches shall be made per linear metre under the respective category of soil classification encountered atsite.
   i) Ordinarysoil
   ii) Hard soil (hard murrum and softrock)
   iii) Hard rock requiringchiselling
   iv) Hard rock requiringblasting.

b) Trenches shall be measured between outside walls of manholes at top and the depth shall be the average depth between the two ends to the nearest centimetre. The rate quoted shall be for a depth up to 1.5m or as given in the Schedule ofQuantities.

c) Payment for trenches more than 1.5m in depth shall be made for extra depth as given in the Schedule of Quantities over and above the rate for depthupto1.5m.

d) The original ground levels shall be jointly recorded prior to start ofwork.

Timbering andShoring

Rate quoted for excavation shall be inclusive of timbering and shoring as specified and nothing extra shall be payable for the same.

Saturated Soil

Rate quoted for excavation shall be inclusive of pumping and bailing out of water encountered from any source whatsoever.

Refilling, Consolidation and Disposal of Surplus Earth

Rate quoted for excavation shall be inclusive of refilling, consolidation and disposal of surplus earth.

HDPE pipes

HDPE pipes shall be measured for the finished length of the pipeline per linear meter i.e.

a) Lengths between manholes shall be recorded from inside face of one manhole to inside face of other manhole;and

b) Length between gully trap and manhole shall be recorded between socket of pipe near gully trap and inside face of manhole. Rate shall include all items given in the Schedule of Quantities andspecifications.

Cement Concrete for Pipes

Cement concrete in bed and all around or in haunches shall be paid per running metre between the outside wall of manholes at bottom of the trench. No additional payment is admissible in respect of concreting done for widths greater than that specified, for shuttering or cantering, concreting and curing or work in subsoil water conditions.

Manholes

a) All manholes shall be measured by numbers and shall include all items specified above and necessary excavation in all types of soils, refilling, compaction and disposal of surplusearth.

b) Manholes with depths greater than that specified under the main item shall be paid for under "extra depth" and shall include all items as given for manholes. Measurement shall be done to the nearest centimetre. Depth of the manholes shall be measured from top of the manhole cover to bottom ofchannel.

c) C. I. covers, frames & steps shall be paid separately as per schedule ofquantities.

Making Connections

Item for making connection to municipal sewer shall be paid for by number and shall include all items given in the Schedule of Quantities.

12.7.9 Promenade Work

Scope of Promenade Work :-

1. Construction of Promenade including walkway, Cycle track and allied works.
2. Civil Work such as Pile Foundation, Precast & Prestress cantilever beam and slab, Bridges etc
3. Developing landscape and plantation.
4. Electrification Work, Street Furniture & allied Works

1. Construction of Promenade including walkway, Cycle track and allied works. :-

a) The purpose of construction of promenade is to enhance the beauty of Mithi River as well as to make available space for walking / cycling / leisurely activities for citizens of the City.

b) The Minimum width of Walk way (Jogging Track) should be 5 Meter.

c) The Minimum Width of Cycle track should be 3 Meter for Two way traffic.

d) The Promenade should be protected with the glass panel besides 0.6 to 1 Meter space for keeping plants / Flower beds for beautification.

e) The total width of promenade along river bank at LBS road, Vakola, Mahim Nature park &dadardharavi 60 ft road is 9 Meter and at Double barrel is 12 Meter .

f) Walkway should be provided with ramp for differently challenged persons & tree guards.

g) The surveillance arrangement along with deployment of Security personnel shall be made for maintaining/ protecting the Promenade structure till the completion of Operation & maintenance period.

2. Civil Work such as Pile Foundation, Precast & Prestress cantilever beam and slab, Bridges etc :-

a) The foundation of promenade structure should not obstruct and disturb the flow of Mithi River.

b) wherever possible, existing Piles of retaining wall should be utilised for foundation work of Promenade structure.

c) The Precast and prestress Cantilever Beam and slab should preferably be used.

d) Promenade along opposites banks of river shall be connected with bridge including intersections to have continuous connectivity.

e) The mangroves area of river should not be disturb otherwise necessary action should be initiated.

3. Developing landscape and plantation.

a) The Purpose of Landscaping is to create a Joyful and healthy environment around the Mithi River as well as to enhance natural beauty.

b) Landscaping includes the supply, installation, laying-out and stocking of flower beds and rockeries and for the seeding or turfing of lawns.

c) To enhance / maintained / protect the biodiversity.

4. Electrification Work & Street Furniture :-

a) Lighting should be such as to illuminate the entire stretch of promenade including bridges and landscaping.

b) The street furnitures should be enough in numbers to provide rest places for the elderly and people with mobility issues.

13 INSPECTION, TESTING AND COMMISSIONING REQUIREMENTS

13.1 Inspection and Testing during Manufacture

13.1.1 General

All inspection and testing shall be carried out in accordance with the Specification and in absence of Specification, relevant Indian Standard, or internationally approved equivalent standard. After award of contract, the Contractor shall furnish a QA Plan (QAP) for approval by the Employer. The QAP shall include testing for incoming supply of raw materials and bought out items, stage inspections, and tests on finished products at manufacturer's works / appropriate testing station. The QAP shall clearly indicate tests which are intended to be witnessed by the Contractor alone and those by both Contractor andEmployer.

Inspection and test schedule shall be asfollows;

- Manufacturetests;
- Acceptance inspection / quantitychecking;
- Install /siteinspection;
- Site acceptancetest;
- Tests onCompletion;
- Process Wet Tests (by rawsewage);
- Operation Test (Tests AfterCompletion);
- Complete performance tests after designated Operation Service period (before plant handing over);and
- Test furnished as per IS Code/manufacturerQAP.

The Contractor shall carry out inspection of equipment at the place of manufacture, as per approvedQAP.

The Employer and/or duly authorised and designated representative(s) shall be entitled to attend the aforesaid inspection and/ortests.

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 Contractors 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.

The Contractor shall provide test procedure, pre-factory test results, and calculation sheet, photo in advance and provide all of test results with necessary documents including its data and photo to show the Engineer that the test is carried out in a proper condition. Construction material shall be tested by the Contractor at the approved laboratory.

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 describedbelow.

i) The Contractor shall give the Employer at least 21 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, the Contractor shall 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 theconsultants.

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 theconsultants/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 thereof as per (ii)above.

iv) If any materials or any part of the works fails to pass any inspection / test, the Contractor shall 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'sworks.

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 theContract.

vii) The test equipment, meters, instruments etc., used for testing shall be calibrated at recognised test laboratories at regular intervals and valid certificates 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. Calibration 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 programme agreed between the Engineer and Contractor's Representative. If such materials or works are found to be defective or not conforming to the Contract requirements, due to the fault of the Contractor or his sub-contractors the Contractor shall defray all the expenses ofsuch

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 suchtests.

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, thefollowing:

i) Applicable code, standard, andregulations;

ii) Fabrication sequence flow chart indicating tests and inspectionpoints;

iii) Detailed tests and inspection method, indicating the measuring apparatus to be used, items to be measured, calculation formula,etc.;

iv) Acceptancecriteria;

v) Test report forms and required code certificates and datarecords;

vi) Method of sampling, if any sampling test to be conducted;and

vii) Contractor's or Employer's witnesspoints.

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'ssatisfaction.

xii) The following Inspection and Testing procedures shall be carried out for the equipment as per approvedQAP.

The detailed procedure shall indicate or specify, without limitation, thefollowing:

- Raw Material;
- VisualInspection/Appearance;
- Chemical and Mechanical PropertyTests;
- DimensionChecking;
- Dynamic Balancing for all RotatingParts;
- StageInspection;
- Hydrostatic / Leak Testing for all Pressure Parts, Pneumatic Leak Test Wherever Applicable;
- RepairProcedure;
- OperationCheck;
- Procedure Qualification Record (PQR); Welding Procedure Qualification (WPQ) And Welders Qualification Report(WQR);
- MaterialTest;
- Assembly/Connection;and
- Documentation.

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.

The expenses incurred during inspection shall include, but not be limited to all travelling, boarding, lodging expenses.

All expenses incurred by the Engineer or his representative or persons nominated by the Engineer including third party in attending inspection / re-inspection and tests of Plant carried out within India and abroad shall be borne by the Contractor.

A maximum of two persons from the Employer's side will witness the inspection and testing along with the Contractor's representative.

The expenses incurred during inspection shall include, but not be limited to all travelling, boarding, lodging including visa chargesetc.

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. For clarity, 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 toSite.

As a guide to the Contractor the Employer reserves the right to witness testing of the following but not limited to the following Plantitems:

Electrical;

- 415 V Metal Enclosed Switchgears (PCC /MCC);
- 415 V Power Capacitor and ControlPanel;
- Diesel Standby Generator with AMF ControlPanel;
- Battery, Battery Charger and DC DistributionBoard;
- Variable FrequencyDrives;
- Non-Segregated BusDuct;
- Power & Control Cables;and
- LightingSystem;

Mechanical;

- Pumps and Blowers including their Motors, Valve and PenstockActuators;
- Valves;
- Pipes;
- SluiceGates;
- Expansion/DismantlingJoints;
- WeirGates;
- Screens;
- EOT Cranes andHoists;

Instrumentation and Control;

- Level MeasuringSystem;
- PressureGauges;
- PressureTransmitter;
- Flow MeasuringSystem;
- Temperature MeasuringSystem;
- Instrumentation and ControlCables;
- Instrument ControlPanel;

- Programmable LogicController;
- HMISystem;
- Uninterruptible Power SupplySystem;
- Wireless GPRS Gateway Testing;and
- FAT & SAT for complete ICAsystem.

All destructively tested samples shall be replaced withnew.

The Employer reserves the right to be present during the testing and inspection of all Plantitems.

13.1.2 Materials, Plant, and Equipment

The Contractor shall place orders for the material and the equipment only after approval of the QAP by the Engineer. The Contractor shall submit the detailed technical information and its drawings, unpriced copy of the Contractors order for the Plant item / equipment / material from the approved manufacturer and the procedure of submission, review and revision shall be as specified herein below.

The Contractor shall inform the Employer about the likely dates of manufacturing, testing, and dispatching of any material and equipment to be incorporated into the Permanent Works. The Contractor shall notify the Employer for inspection and testing, at least twenty-one (21) days prior to packing and shipping and shall supply the manufacturer's test results and quality controlcertificates.

The testing and approval for dispatching shall not absolve the Contractor from his obligations for satisfactory performance of the plant.

Dispatch Clearance

All mechanical/electrical/instrumentation equipment shall be tested at their respective factory which will be witnessed by tri parties (Contractor, Client /Consultant inspecting team) in line with approved QAP and Equipment Data sheet.

The test observation sheets, material tests certificates (chemical and mechanical test at laboratory) and joint inspection report shall be signed by the Contractor, Client/Consultant officials after successfully completion oftests.

The Contractor shall forward all original reports to the Client and copy to the Consultant for verification and issuances of Dispatch Clearance Certificates. No Dispatch Clearance Certificate will be issued at the factory itself by the inspecting agency.

13.1.3 Factory Acceptance Test (FAT) Document

Fifty Six (56) days prior to commencement of inspection of each Plant item / equipment, the Contractor shall supply a Factory Acceptance Test (FAT) Document for approval. This shall comprise four copies of thefollowing:

- Unpriced copy of the Contractors order for the Plant item / equipmentconcerned;
- details of the inspection and test procedures to be carried out;and
- Pre-factory test results and itsphotos.

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. To remove doubt, test certificates shall be provided for the Plant item as a whole plus certificates for the relevant component parts such as:

- Motors;
- Pumps andBlowers;
- Instruments;
- GearBoxes;
- ElectricalSwitchgear;
- Integral Control and SwitchgearPanels;
- ValveGear;
- Castings;
- Actuators;
- Cranes andHoists;
- Screens;

13.1.4 Inspection and Testing Programme

The Contractor shall submit to the Engineer not later than 56 days 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 theprogramme.

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 case equipment/material, etc. If it is found not to comply with the specification, dates for re- inspection shall be finalised and expenses incurred by the Employer for such visits shall also be recovered from the Contractor. Contractor's Representatives shall essentially be present during all inspections of Plant items. The following information shall be given in the inspection call letter mentioned above:

- Name ofmanufacturer/supplier;
- Address of place where inspection is to be carriedout;
- Proposed date/s and equipment to beinspected;
- Name/s of contact personnel at manufacturer's/ supplier/s works with their telephone and faxnumbers;
- Name of Contractor's Representative who will be present during the inspection;and
- Confirmation that internal testing has been completed. Submission of internal testing report for review before visiting theplant.

The Contractor shall provide all the necessary instruments, test facility, water / electric power, test piece, samples, engineers/ workers, all cost and others 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 one year prior tothe

tests in which they are used. Calibration certificates with expiry date and name of authorisation agency 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 Dispatch clearance certificate 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.

13.2 Tests at Manufacturer's Premises – Mechanical Equipment

13.2.1 Sewage Pumps

(a) All pumps shall be assembled completely in the shop to ensure correct fitting of all parts and shall be match-marked beforeshipment.

(b) All pumps shall undergo witness performance tests at the pump manufacturer's Works. Testing shall be undertaken with the respective job motor for all the pumps being supplied under the Contract.

(c) All tests such as Q/H curve, efficiency of pumps, power consumption, vibration and noise level shall be conducted, and NPSH tests one for each pumping station shall be undertaken to verify that the pumps meet the specified criteria. The pumps shall be run at constant flow capacity andspeed.

(d) Pump casings shall be subject to hydrostatic pressure testing as an assembly at150% of the pump shut-off head or 200% of the pump rated head whichever is higher. The hydrostatic pressure shall be held for not less than 30 minutes after all leaks have been stopped betweenattachments.

(e) Impeller and pump rotating assembly shall be dynamically balanced as per ISO1940 / Gr. 6.3 / VDI 2060.

(f) Standard running test shall be conducted as per BS 5316 Part 2 Class B / ISO 3555 at the rated speed at manufacturer's works to measure the capacity, total head, efficiency and power. These tests shall form the basis for pump acceptance except for vibration and noise. The pump shall be tested over a range comprising shut off head to maximum flow. Minimum seven readings approximately equidistant shall be taken for plotting the performancecurve.

(g) The following formula shall be taken for computing the power input to the pump: Power input to the Pump in kW: $\frac{Q \times H \times 1.02}{367.2 \times \eta p}$

Where, Q = Discharge in cum/hr

H = Total head in mwc

ηp = Efficiency of pump

(h) If the vibration, noise level readings taken during performance test show higher than that permitted, the vendor shall guarantee to show that the values shall be maintained at site after erection. Any cost of rectification needed on this count shall be borne by theContractor.

(i) Stage inspection for pumps shall be carried out as per approved QAP. The Contractor shall make all necessary arrangement for witnessing thesame.

13.2.2 Motors

(a) RoutineTests

All routine tests shall be carried out on all motors as per the latest edition of IS 325.

(b) AcceptanceTests

Full load test to determine efficiency, power factor and slip shall be conducted on all the motors.

(c) Typetests

The following type tests shall be carried out on one motor of each rating above 10 kW:

- Isolation resistance test;
- Temperature risetest;
- Momentary overloadtest;
- Vibration measurement test;
- Noise leveltest;
- Over speed /over load test;and
- Starting current, starting torque, and pull out torque at reducedvoltage.

13.2.3 Valves and Expansion Joints

(a) During testing there shall be no visible evidence of structural damage to any of the valvecomponents.

(b) Motorised valves shall be tested with their job actuator, with a differential head equivalent to their maximum working pressure, to prove that the actuators are capable of opening and closing the valves under maximum unbalanced head condition within the specified opening or closingperiod.

(c) Hydrostatically tested shall be as per relevant IS/BS standard for each type ofvalve.

(d) The following tests shall be carried out for sluice valves, knife gatevalves:

- Seat LeakageTest;
- Body HydrostaticTest;
- ValveOperation;
- Dimensional Check;and
- VisualInspection.

(e) The following tests shall be carried out for non-returnvalves:

- Seat LeakageTest;
- Body HydrostaticTest;
- ValveOperation;
- Dimensional Check;and
- VisualInspection.

(f) The following tests shall be carried out for expansionjoints:

- LeakageTest;
- Body HydrostaticTest;
- DisplacementRange;
- DimensionalCheck;
- VisualInspection.

13.2.4 Pipe-work

Testing of pipes and fitting shall be carried out in accordance with relevant Indian Standard and internationally approved standard. Pipes, fittings and expansion bellows shall be hydrostatically tested for 1.5 times the rated pressure. The following tests shall be carried out for pipelines:

- pressuretest;
- leakagetest;
- LP test for weldingpipeline;
- welding beatcheck;
- dimensional check;and
- visual inspection.

13.2.5 Crane & Hoists

The cranes shall be completely assembled in the Contractor's or Subcontractor's Works and shall be subjected to the tests as specified in IS 807/IS 3177 or relevant internationally approved standard. The Contractor shall provide the test weights.

Hoists and lifting equipment shall be assembled and tested at the place of manufacture in accordance with IS3938.

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

13.2.6 Sluice Gates

(a) Seat ClearanceCheck

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

(b) MovementTests

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

(c) LeakageTests

With the gate in closed position, design pressure shall be applied for a period not lesser than 5 minutes to the unseating side of the sluice gate and the leakage shall not exceed the maximum leakage permissible as per IS 13349.

(d) HydrostaticTests

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

13.2.7 Screens

a. All screens shall be checked for overall dimensions, assembly, and clearance between the bars / space between a rake and bar surface / aperture size and its material as well as painting works. Moreover, motion of rake/drum and wiper/self-cleaning arrangement shall also be tested atworks.
b. Conveyor shall be checked for dimensions and physical conditions, belt joint portion, travelling accuracy of belt, motors and its power consumption, and performance of safetydevice.
c. At least one screen of each type shall be tested for efficiency and operationby employing screenings. For screens having a depth of channel more than 3 metres, testing with reduced depth is acceptable.

13.2.8 DESIGN BASIS OF GATE PUMP SYSTEM

The design basis of pump gate system defines standards of the major equipment and materials for mechanical construction of a pumping station with the pump-integrated gates such as pump gate, guide frame, gate pump, flap valve, actuator, cable carrier chain and local control panel.

13.2.8.1 GENERAL MATTERS

1.1.1 Estimation of solidity in body of the pump gate should be based on the anticipated hydraulic pressure applied to the inlet and no liquid on the opposite side.

1.1.2 When estimating the actuator's lifting capacity required for pump gate operation,the hydraulic pressure to be applied to the pump gate and the weight of wire rope and gate pump should be taken into consideration.

1.1.3 When designing the pump gate, below loads should be taken into consideration.

(1) Normal load

① Hydraulic load

② The total load including the reactive load of the gate's weight and the same hydraulic pressure applied to the upper side of gate. All the additional loads applied to the gate when opening and closing.

(2) Excessive load

① Loads in case of earthquake

② All the additional loads when excessively loading or when lifting the gate stuck in guide frame.

(3) Minimum thickness of steel in gate and extra thickness

① The structural steel of gate should be at least 6mm thick either in whole steel sheet or shaped steel including corrosion allowance.But, for middle size or larger, it should be at least 9mm thick.

② Timoshenko-calculation should be made for the skin plate of gate and each of the surfaces meeting water should have extra thickness of 1mm when in SS400 and 0mm when in stainless steel for corrosion.

1.1.4 The actuator should be designed with below conditions taken into consideration.

(1) The actuator should be designed to be able to go up/down and stop at any position within operation range of the gate either when opening or closing.

(2) The rated capacity of each actuator should be designed to help the gate open and close smoothly at designed speed even when hydraulic load and counter-reactive pressure are applied under provided load conditions.

13.2.8.2 DETAILS OF GATE PUMP

2.1 PUMP GATE

2.1.1 Design specification

The pump gate shall be designed and manufactured as following specifications for each gate Pump.

- Type
- Pump installation
- Intake Canal Size
- Sealing method
- Discharge pipe dia
- Quantity

2.1.2 General matters

(1) A submersible axial propeller pump is installed in gate and it is used to discharge water from inside to outside and block backflow of the water.

(2) The gate consists of skin plate, beam, brackets, seals and main rollers and side rollers.

(3) The gate structure must be free of resonance which may occur by vibration of the gate and the submersible axial propeller pump when the pump is operating.

(4) The gate should have flanges mounted in its front and rear side each and the flange in inlet side should be connectable to the pump that discharges water from inside to outside.And the flange in the other side should have flap valve installed so that it can automatically open and close according to the pump operation.

(5) High-tension bolts must be used except for joints of the skin plate.

(6) The flange between gate and pump must have seal and must be leakage-free.

(7) Structural steel and shaped steel plate of gate must be at least 6mm thick.

2.1.3 Skin Plate

(1) Material of skin plate of gate shall be structural Steel (SS400).

(2) Skin plate must be at least 6mm thick when the gate is lighter than 10 ton and 9mm when the gate is 10ton or heavier for resistance against corrosion and abrasion.

(3) Joint of skin plate must be free of protrusion and the surface must be evenly machined after welding.

2.1.4 Beam

(1) Material of beam shall be structural Steel (SS400) and must be robust enough against hydraulic pressure applied to the gate.

(2) The beam must not be bent more than 1/800.

2.1.5 Roller

(1) For easy opening and closing of the gate, at least 2 rollers must be mounted in each side of the gate.

(2) The roller must consist of oil-less metal, stainless steel pins and washers.

(3) The roller shall be flange type to keep the gate from horizontal movement and the roller and pin must endure the load of gate stuck tight in the guide frame.

2.1.6 Seals

(1) Seal must be 4-way water-tight in any direction either inward and outward.
(2) Seal is shaped rubber and it is attached using flat bar, stainless bolts, nuts and washers.
(3) Seal must be attached for easy replacement and adjustment at installation site.
(4) Lateral seal must be P-type rubber for water-tightness.
(5) Lower seal must be flat-rubber for water-tightness.

2.1.7 Materials for major parts

(1) Skin plate : Structural Steel (SS400)
(2) Horizontal beam : Structural Steel (SS400)
(3) Vertical beam : Structural Steel (SS400)
(4) Main Roller : 304 Stainless steel
(5) Side Roller : 304 Stainless steel
(6) Main Roller Metal :Oilless Metal
(7) Side Roller Metal :Oilless Metal
(8) Main Roller Shaft : 304 Stainless steel
(9) Side Roller Shaft : 304 Stainless steel
(10) Bracket : Structural Steel (SS400)
(11) Flange : Structural Steel (SS400)
(12) Bolt &Nut : 304 Stainless steel
(13) Rubber Seal : NBR or CR

2.1.8 Painting

(1) Any rust, foreign substance, moisture and oil on the steel surface must be removed prior to painting.
(2) Stop painting when the relative humidity goes 80% or higher or when the temperature goes below zero.
(3) Prior to re-painting, any dust or impurities must be completely removed when the lastcoat is dry.
(4) Especially on welded surface, any slags must be completely removed prior to painting.
(5) Do not paint joint surface of steel and concrete unless otherwise required.
(6) Painted surface must be free of unpainted part, bubble, swelling, peel-off, foreign substance, lump of paint or any defects.
(7) Paint specification

- Primer Coat: Polyamide cured epoxy resin-based primer coating type KOREPOX EP170 Thickness 50 ㎛
- Top Coat: polyamide cured epoxy resin based high-build coating type KOREPOX EH6270 Thickness 100 ㎛
- Total thickness: 150 ㎛
- Color: Black, NCS 9000N/RAL 9005, gloss 30

2.2 GUIDE FRAME

2.2.1 Guide frame consists of bottom beam, guide beam and components required for installation of the guide frame for tetrahedral water-tightness.

2.2.2 Steel plate to be attached to the guide beam must be corrosion-free stainless steel plate (SUS304) and the parts to be installed in concrete structure must be made of structural Steel for consistent strength during gate operation.

2.2.3 Steel plate attached to the bottom beam must be corrosion-free stainless steel (SUS304) and the parts to be installed in concrete must be structural Steel and must be precise structure without distortion and deformation for water-tight gate bottom.

2.2.4 The guide beam must be able to deliver the load from the roller to the concrete structure.

2.2.5 A wedge bar must be installed at passage of the main roller to block water both from inside and outside when the gate is closed.

2.2.6 The guide frame must remain at right angle (90°) between the bottom beam and the guide beam to keep the gate water-tight.

2.2.7 Material of major parts

(1) Bottom Beam : Structural Steel (SS400)
(2) Guide Beam : Structural Steel (SS400)
(3) Roller Contact surface : 304 Stainless steel
(4) Bolt &Nut : 304 Stainless steel
(5) Anchor bolt &Nut : 304 Stainless steel

2.3 FLAP VALVE

2.3.1 Design specification

The flap valve shall be designed and manufactured as following specifications for each gate Pump.

- Type
- Discharge Dia.
- Rating
- Installation angle
- Quantity

2.3.2 General matters

(1) A flap valve is a device to be installed at the end of discharge pipe of the pump in order to prevent backflow of water in case that outside water level rises.

(2) Material and structure of the flap valve must be robust, thick and resistant enough against corrosion, abrasion and severe impact caused by backflow prevention.

(3) The flap valve consists of valve body, valve disk, body sheet, disk sheet, valve rib, hinge and water-tight rubber etc.

2.3.3 Structure

(1) The flap valve should be flange type and swing structure, and it should be 1-door when the discharge pipe is 500~600mm and 2-door when the discharge pipe is 700~1400mm.

(2) The material of body should be structural Steel (SS400) and must be resistant enough against the maximum discharged hydraulic pressure.

(3) Water-tight rubber should be oil-resistant rubber (NBR; Nitrile Butadiene Rubber) or ozone-resistant rubber (CR; Poly-Chloroprene Rubber) for perfect water-tightness.

(4) The body sheet should be stainless steel and must be designed and produced for perfect water-tightness as it is combined with disk sheet.

(5) There should be 2 upper disk hinges and solid supporting materials for the disk for enough resistance against impact when the gate is opening and closing.

2.3.4 Materials of major parts

(1) Flange and Disc: Structural Steel (SS400)

(2) Rubber seal: NBR or CR

(3) Bolt & Nut: 304 Stainless steel

(4) Hinge: 304 Stainless steel

2.3.5 Painting

(1) Any rust, foreign substance, moisture and oil on the steel surface must be removed prior to painting.

(2) Stop painting when the relative humidity goes 80% or higher or when the temperature goes below zero.

(3) Prior to re-painting, any dust or impurities must be completely removed when the last coat is dry.

(4) Especially on welded surface, any slags must be completely removed prior to painting.

(5) Do not paint joint surface of steel and concrete unless otherwise required.

(6) Painted surface must be free of unpainted part, bubble, swelling, peel-off, foreign substance, lump of paint or any defects.

(7) Paint Specification

Primer Coat: Polyamide cured epoxy resin-based primer coating type KOREPOX EP170. Thickness 50 ㎛

- Top Coat: polyamide cured epoxy resin based high-build coating type KOREPOX EH6270 Thickness 100 ㎛
- Total thickness: 150 ㎛
- Color: Black, NCS 9000N/RAL 9005, gloss 30

2.3.6 Test and inspection

(1) Operation test of valve After assembling the flap valve, completely open the valve disk then completely close.

2.4 GATE PUMP

2.4.1 General matters

(1) Description

① Pumps shall be submersible horizontal axial flow type gate pump(s) and equipped with a close coupled watertight and totally encapsulated electrical 3-phase motor, prepared for operation at a voltage supply of 415 volts, 50Hz.

The enclosure class of the motor must fulfill IP68 (IEC 60529), and the pump(s) shall be equipped with a heavy-duty power cable type 0.6/1KV PNCT in adequate length.

(1) Scope

① The pump(s) shall be designed, manufactured, selected and equipped with accessories suitable for the purpose, the duty and the operation of the entiresystem.

② The pumps shall be tested and commissioned for which the product is intended.

(2) Reference standards

The following standards are referred to in this clause:

① Machinery Directive (2006/42/EC) - Standards used: EN 809:1998 + A1:2009.

② Low Voltage Directive (2014/35/EU) - Standard used: EN 60204-1:2006 + A1:2009.

③ EMC Directive (2014/30/EU) – Standard used: EN 61326:2013.

④ Standard of enclosure class (IP) (IEC 60529).

⑤ RoHS Directives (2011/65/EU and 2015/863/EU).

2.4.2 Design & performance condition

(1) The pumps and drives shall be designed for continuous duty and shall be capable of pumping the flow range specified in the specification.

(2) The pumps shall not overload the motors at any point on the performance curve and the pump operating range recommended by the manufacturer.

(3) The pumps shall be connected to the flood gate in horizontal position to it. Thus, if the gate is hoisted, the pump is also lifted. The flood gate has optimum inlet flow conditions, and these optimum conditions are achieved by keeping the center of gravity of the floodgate on a center line through pump and gate. The orientation of the pump is horizontal, and the discharging fluid flow direction can be bi-directional guaranteeing stable operation and high performance. The horizontal arrangement has the advantage that more water can be pumped out thus keeping the water level and odor as low as possible to benefit the environment.

(4) Ideal axial and mixed flow pump sump are according to requirements stated by Hydraulic institute. That optimum shape is integrated into the gate and will improve the inlet conditions for the flow and the pumps condition in general.

(5) The pumps shall be installed to the gate with a large-sized flange for stable operation, for easy removal and service purpose.

2.4.3 Pump

(1) Construction

① Major pump components such as inlet casing, stator housing, outlet casing and terminal box shall be cast iron grade no less than ASTM A48-CL35/EN-GJL-250 [use one] and all exposed nuts or bolts shall be stainless steel grade no less than ASTM A276-304/DIN X5CrNi-189-1.4301 [use one]. All metal surface in contact with the pumping media, other than stainless steel, shall be protected by a factory applied spray coating on the exterior of the pump.

② Sealing design shall be applied on metal-to-metal contact between machined surfaces. Critical mating surfaces where watertight sealing is required shall be machined and fitted with NBR O-rings. Fittings will be the result of controlled compression of rubber O-rings in two planes and O-ring contact of four sides.

(2) Cooling

The unit shall be cooled by the passage of the pumped media, flowing along the stator housing, within the pump gate internal tube during operation. The cooling shall provide for continuous pump operation in media of up to 40°C (104°F).

(3) Cable/ Entry Seal

①The cable(s) must be designed for the specific environment and power supply either by means of direct connection(s) or by drive(s). Moreover, the cable(s) must be dimensioned to match the electrical consumption of the motor and pump running at full load.

The cable shall be of sufficient length to reach the terminal box without the need of any splices.

② The outer jacket of the cable shall be oil resistant chloroprene rubber. The pumps shall be equipped with a screened 0.6/1KV PNCT cable sized in accordance with IEC standard and an armored wire type to keep the best condition during the operation. A cable protection hose shall be available to protect the outer cable jacket when installed in acid-, solvent-, or oil containing media.

③ The cable entry shall be made in stainless steel grade no less than ASTM A743-CF-8/DIN G-X6CrNi-189 and the system precludes specific torque requirements to ensure a completely watertight and submersible seal. The system shall consist of dual cylindrical rubber seal, flanked by washers, all having a close tolerance fit against the cable outside diameter and entry inside diameter while being embedded in a cast-out cable plug. The assembly shall provide for easy replacement of the cableusing the same entry seal.

(4) Bearing

The pumps shall be fitted with bearings greased for life.

There are two positioned bearings for rotating the pump shaft. The upper bearing shall be a cylindrical roller or single ball type bearing to handle radial loads.

The bearings shall be lubricated by grease for open type or closed type. The minimum L10 bearing life shall be 60,000 hours at the most efficient operating point.

(5) Pump Shaft

The pump and motor shaft shall be integrated in one unit. The pump shaft is an extension of the motor shaft. Couplings shall not be acceptable. The shaft shall be of stainless steel grade no less than ASTM A276-410/DIN X10Cr13

(6) Propeller

(7) The propeller vane shall be made of stainless steel grade no less than ASTM A743 CF-8/DIN G-X6CrNi-189, dynamically balanced and the angle shall not be adjustable after fixation. New technology secures high precision propellers and self-cleaning design without clogging. The propeller hub shall be made of same material as the propeller and shall be fixed to the shaft by Power Lock without any machining for groove on the shaft or propeller.

(8) Shaft Seals

The shaft seal shall be of the cartridge type where the primary shaft seal and the secondary shaft seal are built together in one unit, with back to back seal system providing a sustainable sealing solution and easy replacement at the site.

The primary seal faces shall be: Silicone Carbide/Silicone Carbide (SiC/SiC)

The secondary seal faces shall be: Silicone Carbide/Silicone Carbide (SiC/SiC)

The shaft seal housing shall be in: Stainless steel grade no less than ASTM A276-304/DIN X5CrNi-189-1.4301

① The seals shall operate in a lubricant reservoir that hydro dynamically lubricates the seal faces at a constant rate

② Each seal interface shall be held in contact by a combined spring system. The seals shall require neither maintenance nor adjustment and shall be capable of operating in either clockwise or counter clockwise direction of rotation without damage or loss of spring force.

③ The lubricant chamber shall be designed to prevent overfilling and to provide lubricant expansion capacity. The drain and inspection plug, with positive anti-leak seal, shall be easily accessible from the outside. The seal system shall not rely upon the pumped media for lubrication

(9) Oil plug

①The oil plugs shall be located vertically on the hydraulic casing. It means that easy replacement of oil in vertical position is possible instead of horizontal position or disassembling the pump

② The pumps shall have two oil plugs located on the discharge casing. An upper oil plug is used for oil filling. An oil service kit shall be available for filling and replacing oil. By assembling and connecting the specified oil filling pipe system to the upper oil plug, it shall be easy to fill in oil. For easy replacement of oil, the specified pipe system shall

be connected to the lower oil plug while the upper oil plug is open. There shall be a non-return valve inside the lower oil plug to prevent oil suddenly pouring out through the oil plug. It shall be possible to visually check for oil leakage by connecting the specified pipe system to the vertical positioned pumps.

2.4.4 Electric motor

(1) The pump motor shall be an induction type, NEMA B design with a squirrel cage rotor, housed in an air filled, watertight chamber. Oil filled motors shall not be considered acceptable or equal.

(2) The stator windings and stator leads shall be insulated with moisture resistant Class “F” inverter duty rated insulation for 155°C (311 °F).

(3) The stator shall be dipped and baked three times in Class “F” insulation varnish inverter duty rated and shall be heat-shrink fitted into the stator housing.

(4) The use of bolts, pins or other fastening devices requiring penetration of the stator housing is not acceptable.

(5) The motor shall be designed for continuous duty handling media of 40°C (104°F) with a temperature rise not to exceed 105° C (221°F) and capable of from 6 evenly spaced starts per hour.

(6) The motor power rating shall be adequate so that the pump is non-overloading throughout the entire pump performance curve.

(7) Thermal switches set to open at max. 135°C (275 °F) shall be embedded in the stator lead coils to monitor the temperature of each phase winding.

(8) These thermal switches shall be used in conjunction with and supplemental to external motor thermal protection and shall be connected to the control panel through recommended monitoring unit.

(9) The motor and pump shall be integrated and assembled by the same manufacturer.

(10) The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.1.

(11) The motor shall have voltage tolerance of ±10% and frequency tolerance of ±2Hz.

(12) Upon request, a performance chart shall be provided showing curves for torque, current, power factor, input/output kW and efficiency.

2.4.5 Motor protection

(1) The stator shall have three thermal Bi-metal switches in series to monitor the temperature of each phase winding and one thermal PT100 sensor to monitor the temperature of winding. In the event of over temperature occurring, the thermal sensors shall signal the temperature to the monitoring unit and the monitoring unit shall signal the control to stop the motor and activate an alarm.

(2) The upper and lower bearing temperature sensors shall provide analogue measurement of the upper and lower bearing temperature. In the event of a high bearing temperature, the thermal sensors shall signal the temperature to the monitoring unit and monitoring unit shall signal to the control to activate an alarm

(3) Moisture switches shall be mounted in the terminal box (cable compartment) and the lower part of the motor housing to protect the motor from water leakage. The sensor type is switch or electrode type.

(4) Vibration and water-in-oil sensors shall be installed as customized sensor options.

(5) The vibration sensor monitors the vibration level of the pump. A change in the vibration level indicates an abnormal situation, clogged propeller, worn bearings, closed discharge valve, etc., indicating that service inspection should be carried out immediately to protect the pump or pipe system from the being damaged.

(6) The water-in-oil sensor measures the water content in the oil and converts the value into an analogue signal. The sensor measures the water content from 0% to 20%. It also sends a signal if the water content is out of the normal range (warning), or if the oil level is so low that the sensor is in the air (alarm). The sensor is fitted in a stainless steel tube for mechanical protection. The water-in-oil sensor can be connected to the monitoring unit.

2.4.6 Controls & Monitoring

(1) Control and monitoring modules shall continuously protect and monitor the pump condition.

(2) The modules shall have inputs for digital and analog pump sensors and shall be able to stop the pump if a sensor indicates a pump fault. A sensor module, for collecting and transfer of data, shall be placed either inside the pump or in the control cabinet next to the pump installation. The sensor modules shall work together through power line communication using a dedicated data communication protocol.

2.4.7 Painting

Pump(s) shall be protected by spray coating of epoxy paint. Before pump testing. All cast iron parts shall have minimum 50 µm two component, polyamide cured epoxy resin-based primer coating type KOREPOX EP170. The top coating shall be a two component, polyamide cured epoxy resin based high-build coating type KOREPOX H.B. EH6270 in a thickness of minimum 100 µm. The color is black (NCS 9000N/RAL 9005, gloss 30). The total thickness shall be no less than 150 microns.

2.4.8 Inspection & Testing

(1) The manufacturer shall test the pump at his own premises based on ISO 9906: 2017 Grade
2B/ANSI/HI 11.6: 2017 Grade 2B [use one]. The manufacturer holds a certificate from a 3rd party for the test bed.

(2) For the pumps in question, the pump manufacturer shall supply a complete set of performance curves in a reasonable size A4, including:
- Flow rate
- Total head
- Power output (P2)
- Total efficiency

(3) From these tests, all results such as total head, flow rates and electrical power shall be recorded. Each pump shall be tested in no less than five test points to establish its curve.

2.4.9 Documentation

The manufacturer shall provide: Data sheet including performance curves, drawings, installation and operating instructions, service instructions, service animation, service kit catalogue together with recommended service parts and certificates.

2.4.10 Installation

(1) The equipment shall be installed in accordance with the manufacturer's installation and operating instructions.

(2) The pump gate shall be permanently installed in the wet pit. The design shall be such that the pump unit(s) will be connected firmly in stable to the flange part of pump gate.

(3) The large-sized flange of each pump shall firmly install the pump unit on the pump gate

(4) A supporting device located at the stator housing, shall support the pump weight and it will help to work in easy during the maintenance work

(5) The entire pumping unit, including electric cable, shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 20 meter

2.5 ACTUATOR

2.5.1 Design specification

The actuator shall be designed and manufactured as following specifications for all Gate Pumps.

- Type
- Lifting capacity
- Winding speed
- Power supply
- Rated power
- Starting method
- Stopping device
- Quantity

2.5.2 General matters

(1) Actuator is driven by an electric motor and it is wire-rope winding equipment of fixed-type for opening/closing of pump gate.

(2) Actuator consists of mechanical equipment including structural steel frame, torque axis, bearing, gear speed reducer, coupling, actuator drum, sheave, wire rope, manual driving device and electric equipment including actuator motor, limit switch, electric brake and other equipment for effective and smooth operation.

(3) Rotatory parts such as actuator drum and gear speed reducer have prefabricated cover to protect against inclement weather or negligent accident and any parts to prone to damage or abrasion by dust are protected inside housing against dust.

(4) Housing has eye-bolts or lugs for easy handling.

(5) Actuator is designed to withstand the rated winding weight at the specified stress and safety factor.

(6) Actuator should withstand the weight by the maximum winding motor torque and it must not exceed 90% of the yield strength of the used materials.

(7) The maximum starting torque should be between 200%~350% of the rated torque.

2.5.3 Structure and materials of actuator

(1) The actuator should be made of structural Steel (KS D 3503) and special steel. And each of the components should be robust enough for operation.

(2) Decent appearance and compact size of the actuator should be preferred for neat arrangement with other equipment and the location.

(3) The gears should be robust enough and have adequate deceleration ratio against lifting load, operating force and speed of opening and closing. And the contact surfaces of the gears should be precisely machined and treated for high mechanical efficiency.

(4) Materials of major components are as follows.

- Frame : Structural Steel (SS400)
- Gear box : Cast iron (GC200)
- Sprocket case : Cast iron (GC200)
- Gear : Machine structural uses (SCM440)
- Pinion : Machine structural uses (SCM440)
- Shaft : Structural Carbon steel (SM45C)
- Sheave : Cast iron (GC200)
- Wire rope : Structural Steel (SS400)
- Cover : 304 Stainless steel

2.5.4 Torque axis

Torque axis is made of machine-structural steel and is machine-processed.

2.5.5 Bearing

Bearing can be self-aligning ball bearing, roller bearing or surface bearing.

2.5.6 Gear Speed Reducer

(1) The reducer for of the actuator must be suitable for prolonged use with high efficiency and grade 3 or higher grade of gear accuracy. And its components should be brand-new.
(2) Gear is made of cast steel or forged steel and is machine-processed and interference fit.
(3) In case of using worm gear, the worm gear and its support fixture must be fixed tight and sealed inside bathtub-type of lubrication box to prevent oil leakage.
(4) Gear should have removable housing for easy injection of lubricating oil.
(5) High speed gear reducer is sealed inside oil box for oil-bath type lubrication and the oil bath has visually observable oil level gauge.

2.5.7 Coupling

Coupling can be adjusted at site and is permanently attached to the torque axis after the adjustment.

2.5.8 Actuator Drum

- Actuator drum is made of welded steel and has enough length to wind the entire rope to lift the gate plus extra 3 windings.
- Drum should have groove and the diameter of pitch circle should be 19 times bigger than the wire rope diameter.
- Every surface that touches the wire rope must be machine-processed within allowed tolerance range to minimize friction against the rope.
- Drum should have a cover which is easy to handle to protect from the air.
- The rope handling system for drum should be of simple and safe structure that the rope can be adjusted or replaced without disassembly.
- Drum must be driven in balance and guide apparatus for rope rewinding should be installed at the end of the drum on the rewinding side.

2.5.9 Wire Rope

- Wire rope has precise length marked under applied tension and in case of zinc coated wire, it must have grease injected and must be produced by specialized manufacturer.
- A pair of wire rope drums for one gate should have S and Z-twist wire ropes to not tangle.
- The breaking strength of wire rope should be 8 times or higher than the maximum normal service load.
- One side of wire rope is connected to the wire drum and the other side is connected to the top of stand. In this case, eye bolts are used to adjust balance of the wire rope and clips are used to fix the wire rope. And it is sealed by melted lead using wire sockets (2pcs on each side) to prevent deformation of the wire rope.

2.5.10 Sheave

(1) Sheave should be made of carbon steel or other harder material than the wire rope.

(2) The pitch circle diameter of sheave should be 17 times or more bigger than the wire rope diameter.

(3) Sheave must be driven in balance.

2.5.11 Manual Driving Device

- Each actuator should have manual driving device to lift the designed load and the manual power to operate the device should be designed 10Kg or less.
- Motor must be shut off during manual operation.
- Handle should be round type which is easy to manually operate and must be designed to stop gate opening/closing if operation of the handle stops.

2.5.12 Electric Brake

- Actuator of each gate should have spring type shoe brake which operates by alternating magnetic force in order to stop and support the gate at any ascending/descending positions.
- Rated capacity of the brake should be 200% or higher of the rated full load of the actuator motor.
- Brake must be switched on when power of actuator shuts off and it must be automatically switched off when the actuator motor is on.
- Brake should have a sealed cover which is easy to inspect the sealed inside.

2.5.13 Gate Position Meter

- Each gate must have necessary 1set electric digital type gate position meter or stand type meter.
- Position meter includes gate position transmitter, distributer, digital gate position meter and all other necessary parts for indicating and detecting the gate position.

2.5.14 Painting

(1) Prior to painting, make sure that the surface of casting is smooth and clean without blow hole, tear, flaw, protrusion or any defects.

(2) Paint must be free of hygienic hazards, corrosivity in water and heat deformation and must not contaminate water.

(3) Especially on welded surface, any slags must be completely removed prior to painting.

(4) Do not paint joint surface of steel and concrete unless otherwise required.

(5) Painted surface must be free of unpainted part, bubble, swelling, peel-off, foreign substance, lump of paint or any defects.

- Paint specification

  Apply grease to machine-processed part of the actuator.

  Primer Coating: Coating: Zinc rich polyamide cured epoxy primer, Thickness 30 μm

  Top Coating: Chlorinated rubber, Thickness 120 μm

  Total thickness: 150 μm

  Color: Orange (Munsell No. F-185514)

2.6 LOCAL CONTROL PANEL

2.6.1 General matters

The local control panel is a control system to operate the actuator and it must be designed and built to ensure optimum operation of the pump gate system.

2.6.2 Control functions

Actuator of each gate is driven by local/central control panel and its control should be suitable for the following functions.

- Regardless of position of the gate, the gate must be able to open/close by Raise or Lower switches on local/central control panel.

② Gate must be able to stop and remain at any position for any time and operate by Raise, Lower or Stop switches.

- It must have limit switches in order to prevent gate exceeding upper/lower limits at opening/closing positions and to stop the gate when the wire rope is stretched.

2.6.3 Composition of control panel

① Each control panel should be installed on the actuator deck and be complete sealed type with outdoor double door structure and have entrance and window with locks.

② Each local control panel must be outdoor self-supporting structure and completely enclosed with locks on its door and window.

③ The local control panel must be made of 2mm thick stainless steel 304 plate or thicker and its supporting fixture should be made of stainless steel pipe and must be able to robustly withstand external pressure.

④ Each control panel must have switch, indicator, relay, transformer and other necessary equipment for gate control.

⑤ Each of the following equipment should be installed in the local control panel and all indicators such as gauge or lamp must be observable from outside without unlocking and opening the door or window.

- Circuit breaker for wiring
- Power voltmeter
- Power indicator lamp
- Current meter
- Starter for motor
- Socket for 220V
- Gate opening indicator lamp
- Gate closing indicator lamp
- Gate ascending indicator lamp
- Gate descending indicator lamp
- “Open”, “Close”, “Stop” Push button (Switch)
- “Local”, “Remote” control lamp and switch
- Gate position meter (Digital)
- Mould case circuit breaker for motor and other circuits
- Heater for anti-moisture condensing
- Warning light lamp
- Push button, inspection lamp for every indicator lamp

- Other necessary relay, contactor, switch and wiring component for remote control panel etc.

13.2.8.3 TRANSPORT

3.1 TRANSPORT AND HANDLING

3.1.1 Handle with extra care to prevent deformation or damage during transport.

3.1.2 Support less robust part with suitable material and protect machined surface with wooden material or by other means. And apply suitable solution or grease to prevent rust during transport.

3.1.3 Handle with extra care for electric parts and water-tight rubber to keep dry.

3.1.4 Deliverable size of guide frame should be delivered as one assembled item and undeliverable size of guide frame should be delivered separately as side, upper and bottom parts.

3.1.5 In order to prevent confusion when installing at the site, the pump gate, guide frame and each component should be identifiably marked prior to transport.

13.2.8.4 INSTALLATION AND SITE INSPECTION

4.1 GENERAL MATTERS

4.1.1 Site condition and construction

The buyer must eliminate laitance from block-out concrete surface and clean it prior to installation of the guide frame and other steel structures.

4.1.2 Local support of manufacturer

The buyer shall receive technical support from technical experts dispatched by the manufacturer for storage, site assembly, installation, test and inspection.

4.2 INSTALLATION

4.2.1 Installation of guide frame

(1) Prior to installation of guide frame, make sure to check the civil construction has been correctly made according to the design and check the anchor plates buried in concrete are correctly located according to the design.

(2) Make sure that any machined surface of the seal beam is not damaged or deformed during transport and installation as the seal beams must support the entire load of gate and must maintain perfect water-tightness.

Prepare all the necessary makeshift installation for guide frame and install safety facilities at every open entrance.

(3) Installation of the guide frame should be made in order of bottom, side and upper.

(4) All guide metals must be fixed tight to ensure that they stay in place when casting concrete.

(5) Keep the guide metals clean of cement milk during construction.

(6) After welding the guide frame at the site, add reinforcing welding and grinding to where it should be water-tight.

4.2.2 Installation of pump-integrated gate

(1) Assemble roller and bracket to the gate in order.

(2) Assemble pump, flap valve and cable to the pump gate in order.

(3) Insert the pump gate to the guide frame then thoroughly examine the joint condition of the water-tight rubber with the guide frame. If not completely connected, correct immediately.

(4) Cable carrier chains must be installed for protection of the power and sensor cables of the pump.

4.2.3 Installation of actuator

(1) Inspection of site

① The buyer must measure and mark the center line of the gate on the concrete prior to installation of the actuator.

(2) Installation of actuator

① The center line of pump gate must be accurately measured, and a lifter shall be installed for the actuator.

② An examination must be made to ensure that anchor bolts are correctly fixed and all the components accord with the drawing.

③ The upper/lower limits of position meter must be set when the actuator has been completely installed.

④ When installation of the local control panel of actuator and electric wiring work have been completed, the internal circuit of the local control panel must be inspected by connecting temporary electricity.

⑤ Test opening and closing of the gate repeatedly using temporary power and adjust the limit switch. When conducting a trial run, handle with extra care not to damage the rubber seal and spray water to the seal as it is dry.

4.2.4 Inspection

(1) Assembly Inspection

① Assembly Inspection for Pump Gate

② Assembly Inspection for Guide Frame

③ Assembly Inspection for Actuator and Wire rope

④ Assembly Inspection for Gate Pump and Flap Valve

(2) Running Inspection

4.3 TRIAL RUN AT SITE

4.3.1 Before trial run

(1) Clean and arrange objects at site in order.

(2) Arrange right personnel

(3) Check level and leakage of lubricating oil

(4) Check condition of all parts in contact

(5) Ensure that safety devices for power transfer unit and cover for rotating part are placed and fixed correctly.

(6) Ensure that there is no foreign substance. (At gear, between rotating part and cover, water-tight part of gate, passage etc.)

(7) Ensure every lever is placed in right position.

(8) Check power and test gauge and lamp.

4.3.2 Trial run

When installation of all the gate system including the gate, actuator, local control panel has been completed, a trial run must be made at site including following tests to check performance.

(1) No-load test

No-load trial runs (dry test) must be made repeatedly for the gate system by open and close the gate until all conditions meet with requirements with each of the local control panel and central control panel. The trial run must include following features.

① Check balance of the pump gate when opening and closing

② Check condition of contact and sliding between water-tight surface and supporting plate.

③ Check speed of opening and closing

④ Check current and voltage of motor

⑤ Check temperature of motor and bearing

⑥ Check interlock of gear

⑦ Check noise and vibration

⑧ Check operation of limit switch

⑨ Check accuracy of gate position meter

⑩ Check indication and operation of control panel circuit and gauge

(2) Load test

Loaded trial runs (load test) shall be made when the inside and outside water level meet with operation condition. And the loaded trial run must be a comprehensive test with the

other equipment (electrical equipment, measuring instrument, controller and monitor).

5 TRAINING

The buyer shall train his/her operation personnel for management and maintenance of the supplied pump gate system as follows.

(1) The supplier (manufacturer) shall provide technical training to the buyer's operation manager at the supplier's factory or at the installation site for efficient operation, management and maintenance of the supplied equipment.

(2) The buyer shall receive training from the supplier on maintenance and operation of the pump gate system.

13.2.9 Reinforced Cement Concrete Pipes

Testing

a) All pipes for testing purposes shall be selected at random from the stock of the manufacturer and shall be such as would not otherwise be rejected under the criteria of tolerances as mentioned inIS:458.

b) The Contractor shall provide laboratory test /analysis results of cement and aggregate components and cement vs. aggregate vs. water mixing ratio and concrete mixing time and mixingmethod.

c) During manufacture, tests on concrete shall be carried out as per IS:456. The manufacturer shall supply, when required to do so by the Engineer the results of compressive tests of concrete cubes and split tensile tests of concrete cylinders made from the concrete used for the pipes. The manufacturer shall supply cylinders or cubes for test purposes required by the Engineer and such cylinders or cubes shall withstand the tests prescribed as per IS:458. Every pressure pipe shall be tested by the manufacturer for the hydrostatic test pressure. For non-pressure pipes, 2 percent of the pipes shall be tested for hydrostatic testpressure.

d) The specimen of pipes for the following tests shall be selected in accordance with relevant clause of IS:458 and tests in accordance with the methods described in IS:3597:

- Hydrostatic Test;
- Three Edge BearingTest;
- AbsorptionTest;
- Dimension and Colour of Surface;and
- Damage.

13.2.10 Sampling and Inspection

- In any consignment, all the pipes of same class and size and manufactured under similar conditions of production shall be grouped together to constitute a lot. The conformity of a lot to the requirements of this Employer's Requirements shall be ascertained on the basis of tests on pipes selected fromit.
- The number of pipes to be selected from the lot for testing shall be in accordance with Table 15 ofIS:458.
- Pipes shall be selected at random. In order to ensure randomness, all the pipes in the lot may be arranged in a serial order and starting from any pipe, every r-thpipe be selected till the requisite number is obtained, r being the integral part of N/n where N is the lot size and n is the samplesize.
- All pipes selected shall be inspected for dimensional requirements, finish and deviation from straight. A pipe failing to satisfy one or more of these requirements shall be considered asdefective.
- The number of pipes to be tested shall be in accordance with column 4 of Table 15 of IS:458. These pipes shall be selected from pipes that have satisfied the requirements mentioned in the aboveclause.
- AlotshallbeconsideredasconformingtotherequirementsofIS:458ifthefollowing

conditions are satisfied:

- The number of defective pipes shall not be more than the permissible number given in column 3 of Table 15 ofIS:458;
- All the pipes tested for various tests shall satisfy corresponding requirements of thetests;
- In case any pipes do not satisfy the requirements of any one or more tests, one or two further samples of same size shall be selected and tested for the test or tests in which the failure has occurred. All these pipes shall satisfy the corresponding requirements of the test;and
- All destructively tested samples shall be replaced tonew.

13.2.11 Steel Cylinders Pipes and Specials

Testing

1) Welding beat check - Remove all scale on the welding points and welding beat and its thickness shall be checked by theEngineer.
2) PenetrationTest
   A suitable penetrating liquid (kerosene oil/dye) is applied to the surface of the portion under examination and is permitted to remain there for sufficient time to allow the liquid to penetrate into any defects open at the surface. After the penetrating time, the excess penetrate, which remains on the surface is removed. Then a light coloured powder absorbent called a developer is applied to the surface. This developer acts as a blotter and draws out a portion of the penetrant which had previously seeped into the surface openings. As the penetrant is drawn out it diffuses into the coating of the developer, forming indication of the surface discontinuities or flaws.
3) Each steel cylinder shall be subjected before lining/coating to a hydrostatic test under a water pressure equivalent to the test pressure in accordance with Clause 10 of IS:1916 and relevant provisions of IS:3597, provided that the whole of the area of the calculated reinforcement is used in the steel cylinder. In the case of pipes where a part of the principal reinforcement is provided in the cage, the steel cylinder shall be subjected to proportionately less hydrostatic testpressure.
4) Manufacturer's standard specials shall be hydrostatically tested before lining/coating. Where feasible, other specials shall be hydrostatically tested (before lining/coating) at factory. However, when this is not practicable, at the discretion of the Engineer, the unlined specials shall be tested by penetration test as per IS:3658 or other approved means.
5) The contractor shall submit QA/QC and methodology for weldingworks
6) Approval of weldingrods
7) Welders qualificationtest.

13.2.12 Cast Iron / Ductile IronPipes

MechanicalTests

Mechanical chemical tests shall be carried out during manufacture of pipes and fittings as specified in relevant IS codes. The results so obtained shall be considered to represent all the pipes and fittings of different sizes manufactured during that period and the same shall be submitted to the Engineer. The method for tensile tests and the minimum tensile strength requirement for pipes and fittings shall be as per relevant IS codes.

Brinell Hardness Test

For checking the Brinell hardness, the test shall be carried out on the test ring or bars cut from the pipes used for the ring test and tensile test in accordance with IS:1500.

Retests

If any test piece representing a lot fails in the first instance, two additional tests shall be made on test pieces selected from two other pipes from the same lot. If both the test results satisfy the specified requirements, the lot shall be accepted. Should either of these additional test pieces fail to pass the test, the lot shall be liable forrejection.

Hydrostatic Test

For hydrostatic test at works, the pipes and fittings shall be kept under test pressure as specified in relevant IS codes; they may be struck moderately with a 700 g hammer. They shall withstand the pressure test without showing any leakage, sweating or other defect of any kind. The hydrostatic test shall be conducted before coating the pipes and fittings.

13.3 Mechanical Equipment

All mechanical equipment shall be tested at site as per the following items:

a) The test shall verify any damage/missing parts, No. of equipment to be installed, material, location as specified in drawing, levelling, centreline, solid installation and condition of installation to be fitted in levelling of pipeline andvalves;
b) Testing run will be conducted for verifying rotation direction, vibration, noise, and stability and any leakage, ifpossible;
c) The test will be verified to check maintenance space and ease of equipment maintenance work;and
d) The testing shall be performed in full compliance with the latest version of the applicable standard testing protocol. These tests shall be witnessed by the Engineer as per procedures set forth for witnessing elsewhere in thisdocument.

13.4 Tests at Site

a) In addition to progressive supervision and inspection by Engineer, the Contractor shall offer for inspection to the Engineer, the completely erected plant/part of Plant on which tests are to be carried out. After such inspection, each equipment/sub-system shall be tested by the Contractor in accordance with the applicable standards in the presence of the Engineer. Such tests shall include but not be limited to the tests specified in the following clauses.
b) The Contractor shall possess during the entire working period the Electrical Contractor's licence of appropriate class from the concerned statutory authorities governing the area of work place. The Contractor shall fully comply with the relevant statutory rules and regulations. On completion of the installation or at intermediate stages, if required by the statutory authorities, the Contractor shall arrange for inspection and obtain approval from the concerned statutory authorities. If any fees are to be paid to statutory authorities for testing, inspection and calibration, these shall be paid by the Contractor and shall be included in his erection and commissioningcharges.

13.5 Pumps, Piping and Valves

a) The erected pipe work shall be subjected to a hydraulic test at 1.5 times the maximum pressure or twice the working pressure whichever is higher to test the soundness of the joints. Provision of the necessary pumps, gauges, blank flanges, tappings, etc. for carrying out these tests shall be included in the Contract. All gas piping shall be air tested to twice normal workingpressure.
b) Leakage tests shall be carried out on all erected pipework, pumps and valves immediately after erection and where possible before being builtin.
c) Operating tests shall be conducted onvalves.
d) The pump set shall be tested for satisfactory operation. The vibration and noise level shall be checked to be within the specifiedlimits.

13.6 Motors

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

13.7 Cranes

The crane and lifting tackle shall be tested to 125% of the safe working load. The Contractor shall arrange the test load. The Contractor shall also arrange for the appropriate certificates from the concerned authorities before regular use of the cranes and other lifting equipment.

13.8 Screens

After erection, all screens shall be tested for smooth operation and capability to handle typical wastewater solids including stringy materials. Clearance between the dead plate and tines shall be checked as applicable.

13.9 Gates and Penstocks

a) Leakage test shall be performed by the Contractor after installation of allgates.
b) Under the design seating head and unseating head, the leakage shall not exceed the limit specified in IS:13349, for shoptesting.

13.10 Reinforced Cement Concrete Pipes

a) After laying and jointing of RCC pipes is completed, the pipe line shall be washed out with sufficient water and be tested at the work site as per the Employer's Requirements and as directed by the Engineer. All equipment for testing at the work site shall be supplied and erected by the Contractor. Water for testing of pipes shall be arranged by him. Damage during testing shall be the Contractor's responsibility and shall be rectified by him to full satisfaction of the Engineer. Water used for the test shall be removed from pipes and not released to the excavatedtrenches.
b) After the joints have thoroughly set and have been checked by the Engineer and before back filling the trenches, the entire section of the sewer or storm water drain shall be proved by the Contractor to be water tight by filling in pipes with water to the level of 1.5m above the top of the highest pipe in the stretch and heading the water up for a period of onehour.
c) The apparatus used for the purpose of testing shall be approved by the Engineer. If required by the Engineer, the Contractor shall dewater the excavated pit and keep it dryduringtheperiodoftesting.Thelossofwateroveraperiodof30minutesshall

be measured by adding water from a measuring vessel at regular 10 minute intervals and noting the quantity required to maintain the original water level. For approval of this test the average quantity added should not exceed 1 litre/ hour/100 linear metres / 10mm of nominal internal diameter. Any leakage including excessive sweating which causes a drop in the test water level will be visible and the defective part of the work shall be removed and made good.

d) In case of pressure pipelines, the completed stretch of pipeline shall be tested for site test pressure. The site test pressure shall not be less than the maximum operating pressure plus the calculated surge pressure, but in no case shall it exceed the hydrostatic test pressure as specified inIS:458.

13.11 Steel Cylinder Pipes and Specials

a) After laying and jointing of steel cylinder pipes and specials with concrete lining and coating is completed, the pipeline shall be washed out with sufficient water and be tested at the work site as per the following Employer's Requirements and as directed by the Engineer. All equipment for testing at work site shall be supplied and erected by the Contractor. Water for testing of pipes shall be arranged by him. Damage during testing shall be the Contractor's responsibility and shall be rectified by him to the full satisfaction of the Engineer. Water used for the test shall be removed from pipes and not released to the excavatedtrenches.

b) Each section of the pipe line shall be slowly filled with clean water and all air shall be expelled from the pipeline. The pressure in the pipeline shall then be raised and maintained by means of pump to the test pressure. The test pressure shall not be less than 1 1/2 times the working pressure at the lowest point or the static head pressure, whichever is higher. Under the test pressure, no leak or sweating shall be visible at the welded joints. The duration of test shall not be not than 24 hours. Exposed joints shall be carefully examined and all such joints showing visible leaks shall be rewelded. Any cracked or defective pipes and specials in consequences of this pressure test shall be removed and replaced by sound material by the Contractor and the test shall be repeated to the satisfaction of theEngineer.

c) The hydrostatic shop test for pipes and fittings shall be as per the code/standard requirement. After erection at site, complete pipes and fittings shall be hydrostatically tested for a pressure of 1.5 times operatingpressure.

d) Where directed by the Engineer, welded joints on pipes larger than 675 mm diameter shall be subject to a nitrogen gas test afterwelding.

e) A tapped hole (approximately 6 mm diameter) shall be made in the socket end of each pipe by the Contractor and shall be fitted with a suitable non-return valve. Nitrogen, at 400 kPa pressure, shall then be pumped into the annular space between the spigot and socket and the pumpdisconnected.

f) If no drop in pressure occurs over the ensuing period of 30 minutes, the test shall be deemed to be successful. If the test pressure cannot be maintained for 30 minutes, all defects in the weld shall be cut back and rewelded and the test reapplied until successful. The cost of initial and subsequent testing of defective welds shall be at the Contractor's ownexpense.

g) The Contractor shall provide all items necessary for the nitrogen tests including compressor, valves, gauges andtubing.

13.12 Cast Iron, Ductile Iron Pipes and Fittings

a) After the pipes and fittings are laid, jointed and the trench partially backfilled except at the joints, the stretch of pipe line as directed by Engineer shall be subjected to pressure test and leakage test after washing the pipe line out with sufficientwater.

b) Where any section of the pipeline is provided with concrete thrust blocks or anchorages, the pressure test shall not be made until at least five days have elapsed after the concrete was cast. If rapid hardening cement has been used in these blocks or anchorages, the tests shall not be made until at least two days haveelapsed.

c) Each section of the pipe line shall be slowly filled with water and all air shall be expelled from the pipe by tapping at points of highest elevation before the test is made and plugs inserted after the tests have been completed. The specified test pressure based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge shall be applied by means of a pump connected to the pipe as directed by theEngineer.

d) The duration of test shall not be less than 5 minutes. Exposed joints shall be carefully examined and all such joints showing visible leaks shall be recaulked until water tight. Any cracked or defective pipes and fittings in consequence of this pressure test shall be removed and replaced by sound material by the Contractor at no extra cost to the Engineer and the test shall be repeated to the satisfaction of theEngineer.

e) After satisfactory completion of the pressure test, the section of pipe line shall be subjected to leakage test. The duration of test shall be 2 hours. No pipe installation shall be accepted until the leakage is less than the number of cm^3/h as determined by theformula:

Where,

$$q_L = \frac{ND\sqrt{P}}{3.3}$$

q_L = The allowable leakage in cm^3/hr

N = Number of joints in the length of the pipeline

D = Diameter in mm, and

P = The average test pressure during the leakage test in Kg/cm^2

f) Should any test of pipe laid indicate leakage greater than that specified above, the defective joints shall be repaired by the Contractor at his own cost until the leakage is within the specifiedallowance.

g) Necessary equipment and water used for testing shall be arranged by the Contractor at his own cost. Damage during testing shall be Contractor's responsibility and shall be rectified by him at his own cost. Water used for testing shall be removed from the pipe and not released in the excavatedtrenches.

h) After the tests mentioned above are completed to the satisfaction of the Engineer, the backfilling of trenches shall be done as per the Employer’s Requirements specifiedelsewhere.

13.13 Manufacturer's Works Acceptance Tests on Electrical Equipment

The following equipment / items shall be subjected to inspection, routine /acceptance tests as per latest edition of relevant Indian / International standards in the presence of Employer/ his Engineer:

a) HV/LVtransformers;
b) HVmetal enclosed switchboards&switchgears;
c) 415 V metal enclosed switchgears (PCC /MCC);
d) Power capacitor and controlpanel;
e) Dieselstandby generator with AMF controlpanel;
f) Battery, battery charger and DCdistributionboard;
g) Variable frequencydrives;

h) Non-segregatedbusduct;
i) Power& controlcables;
j) Cable carriersystem;
k) Lighting system;and
l) Earthing and lightning protectionsystems.

Copies of test certificates for the type tests and special tests not later than 5 years conducted as per relevant Indian / International Standards for all the equipment /items of above shall be furnished for the perusal of the Employer / his Engineer. If type tests and special tests have not been conducted on any of these items, the same shall be carried out in the presence of owner/ Engineer at no extra cost.

13.14 Manufacturer's Works Acceptance Tests on ICAEquipment

i. Instrumentation:

Inspection, testing and setting to work:

General

Each item of plant shall be subjected to the manufacturer's own tests which shall be certified.

Each item of plant and its installation shall be subject to inspection and testing at the place of manufacture.

The Contractor shall be responsible for the provision of all necessary test equipment. The Contractor shall demonstrate to the Engineer, the correct operation of any item of plant and the Engineer may witness any test. Tests which, in the opinion of the Engineer, were failed or not performed correctly shall berepeated.

Calibration tests for field instruments and analytical instruments shall be conducted on site after installation and the same should be witnessed by the Engineer.

Before any test is made, the Contractor shall submit to the Engineer a full list of test equipment and test procedures (method statements) to be used. Each item of test equipment shall have a standard of accuracy better than that stated by the manufacturer of the item to be tested. The Contractor shall provide evidence of the condition and performance of any item of test equipment, in the form of test certificates issued by an appropriate authority independent of the Contractor and manufacturer, or as otherwise directed by the Engineer. Test equipment shall be checked frequently during the period of thetests.

The Contractor's staff responsible for supervising and carrying out tests shall be fully conversant with the various items of equipment of other manufacturers and if necessary the Contractor shall arrange for his personnel to attend suitable training courses on his own expense.

Any fault or shortcoming found during any inspection or test shall be rectified to the satisfaction of the Engineer before proceeding with further inspection or testing of that item. Any circuit previously tested, which may have been affected by the rectification work, shall be re-tested.

Preliminary Inspection and Testing at the Place of Manufacture

Field-mounted instruments

After successful completion of the manufacturer's own inspection and testing of instrumentssupplied under the Contract, similar tests shall be carried out in the presence of the Engineer and the Contractor. Such tests shall include a demonstration that an increase or decrease of the measured value at several points over the full range of the instrument produces a corresponding increase or decrease in the instrument output signal. These tests shall include checks on the specified accuracy of the instrument at all points.

Instrument Panels, Enclosures and Mounting Boards

The manufacturer shall not present instrument panels, enclosures and mounting boards (assemblies) for inspection and testing until the manufacturer's own tests and inspection has been completed. A preliminary inspection and test of these assemblies may then be witnessed by the Engineer. The Contractor shall give not less than 7 days' prior notice in writing that he has completed his tests and inspection and is ready for the witnessed tests and inspection. Where this notice period is different in the Conditions of Contract, the Conditions of Contract shall takeprecedent.

The witnessed inspection and testing shall include the following:

a) A visual inspection of the panel assembly to show that the design, construction and finish are satisfactory and in accordance with theSpecification;
b) A check that equipment is securely mounted, accessible for removal or calibration without damage to or undue disturbance of other components, wiring orpiping;
c) That all engraving and labels are correctly positioned, fixed and designated in accordance with theSpecification;
d) Panel power-distribution circuits have the correct breaker/fuse rating coordination anddesignation;
e) Power-isolation facilities meet theSpecification;
f) The main incoming supply voltage, frequency and/or pneumatic supply pressure is within the required limits, these being checked at the beginning and end of the test and the results recorded on testcertificates;
g) The output of all power supply units again at the beginning and end of the testing with results beingrecorded;
h) The power supply voltage or air pressure of all component instruments of the assembly(s), these voltages/pressures being recorded on the testcertificate;

i) The insulation resistance of all circuits except sensitive electronic equipment which is liable to damage by application of the test voltage, such circuits being disconnected before making the insulation resistance tests and these tests being carried out in accordance with IEE Wiring Regulations; and
j) That the clean earth bar is isolated from main frame of thepanel.

Internal lighting and anti-condensation heaters and associated thermostats, isolators, limit switches and wiring shall be checked for compliance with theSpecification.

Spare capacity within the panel(s) shall be checked to see that it complies with the Specification. This shall include future equipment space, spare terminals, space in wiring trunkings and provision for additional cable entry.

Functional Testing at the Place of Manufacture

General Requirements

Once the preliminary inspection and testing is complete to the satisfaction of the Engineer, functional testing shall commence. The purpose of the functional tests are to demonstrate that instrument panels enclosures and mounting boards (assemblies) conform with requirements of the Specification.

Not less than 30 days before the commencement of functional tests, the Contractor shall submit to the Engineer, for approval, two copies of comprehensive test procedural documents detailing each test to be carried out. The document shall include results forms on which the results of each test will be entered. The forms shall include spaces for numerical values, where necessary, and witnesssignatures.

All applicable drawings and data shall be provided at the place of inspection by the Contractor. The Contractor shall provide all test instruments and equipment necessary to test the assemblies in their entirety.

The following is a typical list of the equipment required:

- SwitchBoxes;
- Indicator LightBoxes;
- Analogue SignalSources;
- Dummy Loads;
- Meters;
- Simulators;
- Desk-TopComputers;
- Programmers for DCS or Outstations;and
- Insulation TestEquipment.

ii. Programmable Logic Controller(PLC)

The Contractor shall carry out specified tests as follows in addition to any tests stated or implied by the foregoing sections of this clause.

The tests shall be carried out on the fully assembled control panel containing the PLC and associated equipment to demonstrate correct functional operation of the hardware and software systems.

Factory Acceptance Test (FAT)

The Contractor shall conduct a full programme of tests of the PLC system at the Contractor's testing facility in the presence of the Engineer to verify that all features of the system have been provided, are operating correctly and are in full compliance with the Specification. FAT shall include PLC system for facility and PLC based control system with panel mounted HMI for TSPS(s). Unless otherwise specified or agreed by the Engineer, the entire PLC system shall be assembled and tested together as an integrated system, including all master station equipment, all operators' consoles, all outstations and telemetry equipment, all instrumentation panels and uninterruptible power supplies included in this Specification. The scheduled date for the factory acceptance test shall be as agreed by the Contractor and the Engineer at least four weeksbeforethetest.FATshallbeconductedwithahardwiredsimulationpanel

connected to the PLC system. The Contractor shall note the importance of the requirement. No software based simulation testing shall be accepted or allowed.

Not less than one month before the scheduled factory acceptance test, the Contractor shall submit to the Engineer for approval two copies of a comprehensive manual detailing each test to be conducted. The manual shall include a results form on which the results of each test will be entered, including spaces for numerical values where appropriate and witnesssignatures.

Not less than 7 days before the scheduled factory acceptance test, the Contractor shall give written notification to the Engineer that a complete dry-run of the factory acceptance test has been performed successfully and that, in the opinion of the Contractor, the system exhibits stable operation and is ready for the formal factory acceptance test.

The factory acceptance test will be considered successfully completed only when the system has successfully passed all factory tests. The system shall not be delivered to Site until the successful completion of the factory acceptance test is certified by the Engineer or unless otherwise approved by the Engineer. Delay in delivery of the system due to failure of the factory acceptance test shall not constitute an unavoidable delay. If the system fails the factory acceptance test, the test shall be extended or rescheduled at the discretion of the Engineer.

All hardware to be used in the testing of the system shall have passed an agreed preliminary hardware performance test to ensure known hardware operability before software testing begins.

After successful completion of the factory acceptance test, no software changes shall be made to the system without written authorisation by the Engineer. Any changes to the system which affect the system software documentation, such as input scale modifications or changes to the control logic, shall be entered into the system documentation before delivery of the system to Site. All instruments under IC&A scope shall be tested 100%.

Factory Acceptance Test Procedures

General

The scope of the tests shall include the proving of every aspect of hardware and software operation and functions as detailedbelow.

Hardware Tests

a) Verify the correct inventory of hardware including cables and printed circuitboards;
b) Demonstrate that all spare-memory, disk-capacity and system-expansion requirements have been met;
c) Demonstrate all hardware and softwarediagnostics;
d) Verify all power supply voltages are withintolerance;
e) Verify proper earth connections and isolation of instrumentation earth for all equipment;and
f) Demonstrate operation of test simulation and indication equipment and its suitability for adequate functional testing of all systemfunctions.

Software Tests

a) Demonstrate the editing of all system parameters including set-points, timers and the like;

b) Demonstrate system configuration capabilities including the addition and deletion of input and output points, outstations, and all data base parameters;and
c) Demonstrate the addition, deletion and modification of mimic displays and report formats.

Functional Tests

The functional tests shall verify proper operation of every specified system function as an integrated system. These tests shall be conducted in conjunction with functional tests of instrumentation and control panels as specified elsewhere. All failures or discrepancies found shall be documented in the test manual.

Following a failure of any functional test, should software or hardware modifications be required it shall be the decision of the Engineer whether the factory acceptance test is to continue, re-start or be aborted. If testing is allowed to continue, any changes which are required shall be described in a system modification document, signed by both Contractor and Engineer and shall be incorporated into the final factory acceptance test documentation. The failed test shall be re-conducted and the Engineer may require the retest of functions which may be affected by themodification.

The functional tests shall include, as a minimum, the following:

a. Demonstration that the system meets the requirements of the Specification for response time and speed of screenupdate;
b. Verification of the accuracy of all analogue input points in the system. The procedure shall include applying the appropriate signal to each analogue input at a minimum of three points within the range of the input, checking for expected numerical results, and verifying appropriate update of related mimic displays. Proper sensing and action by the system to high and low out-of-range inputs shall also beverified;
c. Verification of the proper logic sense, pulse accumulation and rate computation where appropriate, of all digital inputs and verifying appropriate update of related mimic displays;
d. Verification of all control and sequencing operations and proper operation of all digital and analogue outputs. The procedure shall include simulation of all related process variables for both normal and abnormal conditions, including instrument and component failure, and demonstration of fail-safe response of the system. System outputs shall be indicated with appropriate lamps andindicators;
g) Simulation of outstation communications errors and failures and demonstration of error detection and handling, failure detection and handling, and appropriate changes to control actions as designed andspecified;
h) Verification of fault detection and diagnostics by inducing a sufficient variety of fault conditions in the system to ensure that detection processes and fail-safe operation are adequatelytested;
i) Demonstration of proper operation of all mimic displays, help pages, reports, operator procedures and historical dataaccumulation;
j) Demonstration of proper operation of all outstations following a simulated master station central processor failure;and
k) Demonstration of proper operation of all equipment during both a system wide or isolated power failure, and following power restoration. The procedure shall include the demonstration of battery backup of both master station and outstation for the full length of time specified, and proper operation of power fail, low voltage warning and all associatedalarms.

Reliability Test

After successful completion of the functional tests, a 48-hour continuous run of the system shall be performed. The test shall be passed if no system function is lost or no hardware or software failure occurs. Hardware failure is defined for this test as the loss of a major component such as the computer, an outstation, a VDU or a peripheral device. Non-repetitive mechanical failures of loggers, push-buttons and the like are excluded.

During this test, the system shall be exercised with simulated inputs and conditions in a manner which approximates the on-site operational environment. Unstructured testing by the Engineer shall be included during this test. Upon any system failure during this period, it shall be the decision of the Engineer whether the reliability test is to continue or be aborted. If testing is allowed to continue, any changes to the system which are required shall be described in a system-modification document, signed by both Contractor and Engineer and the document shall be incorporated into the final factory acceptance testdocumentation.

Factory Acceptance Test Documentation

As a minimum, the following information shall be included in the Factory Acceptance Test manual for eachtest:

- Test identificationnumber;
- Test name anddescription;
- List of all equipment to be tested including any special test equipmentrequired;
- Description of the test procedure broken down into logicalsteps;
- Description of the expected system response verifying the completion of each logical step;
- Space for recording the results of the test and the time and date of the test;and
- Space for signatures of the Contractor and theEngineer.

In addition, the Contractor shall provide a method for recording and tracing all problems, discrepancies, queries and suggestions regarding the system and software, and for formalised control of any modifications to the system.

Pre-commissioning Tests

The Contractor shall perform pre-commissioning, or preliminary, testing of the PLC system in accordance with that specified for instrumentation. The purpose of pre-commissioning tests is to confirm readiness of the system for commissioning.

The scope of pre-commissioning tests shall be generally as specified for factory acceptance tests but real field inputs and final control elements shall be used wherever practical to provide inputs to the system and to confirm proper outputs.

Where this is impractical, simulation signals shall be injected as near as possible to their ultimate sources so as to include in the tests as much of the cabling system as possible.

Each process system shall be set to work under manual control and the system tested to confirm proper operation. After proper operation of manual control mode has to be verified, tests of automatic controls of each process system shall be conducted wherever practical.

Commissioning

Site Acceptance Tests (SAT)

The Contractor shall submit all relevant draft operating manuals for the PLC System to the Engineer for approval prior to commissioning tests.

Any faults or failures of the system detected during the previous tests shall be noted and corrected to the satisfaction of the Engineer before commissioning is allowed to commence.

As part of commissioning, the PLC system shall be tested for availability for a continuous period of 60 days. During this period, the system will perform the normal functions according to the procedures described in the SAT documentation approved by the Engineer.

The system shall have passed the SAT if all major components have been free from fault or failure and exhibit full error-free functionality for 100 % of the total duration of the test, unless otherwise agreed by the Engineer. Major components include all master station equipment, outstations, communications facilities and instrument panel components, excluding push-buttons, switches and lamps and any equipment not supplied by the Contractor.

During SAT, no modifications to the system shall be made by the Contractor without the written approval of the Engineer. Erroneous functioning which requires software modifications or re-configuration to correct, other than set-point or parameter changes, shall constitute a failure of the availability test. Any changes to the system which are required and approved shall be described in a system-modification document, signed by both Contractor and Engineer and the document shall be incorporated into the final test documentation. The test shall be restarted after corrections have been made.

13.15 Manufacturer's Works Acceptance Tests on Uninterruptible Power Supplies

The Contractor shall carry out further specified tests as follows, in addition to any tests stated or implied by the foregoing sections of this clause.

The tests shall be carried out on the fully assembled unit utilising the batteries that are to be supplied with the unit.

The Contractor shall demonstrate the following:

i. change-over from full load with mains present to full load on batterysupply;
ii. carry out a discharge test on the system at full load and for the specified duty bridging time period;and
iii. carry out recharge test after operation for the specified duty bridging time at full load. The UPS shall supply the full load during the rechargecycle.

13.16 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.

13.17 Plant Protection onSite

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.

13.18 ErectionStaff

The Contractor shall provide at least two approved senior English-speaking working erectors to supervise the erection of all Plant in the Contract and in each case to act as the Contractor's Representative as set out in Clause 13 of the general conditions of contract.

In the case of a foreign firm based overseas, the Contractor's Representative shall be thoroughly conversant with the manufacturer's Plant and equipment, and its erection and shall be an expatriate.

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 Engineer will give the Contractor at least one month's notice in writing of the date on which the erection staff will be required on site, and the Contractor shall confirm the date of arrival in writing to 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 / authorisation/ 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 shall also hold valid permits issued or be recognised by the licensing board of the locality/state where the work is to be carriedout.

13.19 Erection and Building-in

The installation work shall comply with the latest applicable Standards, Regulations, Electricity Rules and Safety Codes of the locality where the installation is to be carried out. Nothing in this specification shall be construed to relieve the Contractor of this responsibility.

It shall be the Contractor’s responsibility to obtain approval/clearance from local statutory authorities including the Electrical Inspector, wherever applicable for conducting of any work or for installation carried out which comes under the purview of such authorities.

The Contractor shall carry out the complete erection of all plant, including the provision of all necessary skilled and unskilled labour, material, transportation, supplies, power and fuel, Contractor's equipment and appurtenances necessary, for the complete and satisfactory erection of thePlant.

The Contractor shall have a separate cleaning gang to clean all equipment under erection and as well as the work area and the project site at regular intervals to the satisfaction of the Employer. In case the cleaning is not up to the Employer’s satisfaction, he will have the right to carry out the cleaning operations and any expenditure incurred by the Employer in this regard will be to the Contractor’saccount.

Erectors

The Contractor's employees shall include skilled erection staff in sufficient number, who shall arrive on the site on or before the respective dates set out in the approved work programmed and prior to delivery of any item of Plant to the Site. The Engineer will not entertain any claim by the Contractor in respect of delayed erection due to a delay in the delivery of any items of Plant to the site.

Contractor's Equipment, Materials and Appurtenances

The Contractor shall have available on the Site sufficient suitable equipment and machinery, as well as all other materials and appurtenances required by him, of ample capacity to ensure the proper erection of Plant and to handle any emergencies such as may normally be expected in work of this character.

The Contractor shall be responsible if any installation materials are lost or damaged during installation. All damages and thefts of equipment/component parts, after takeover by the Contractor, till the installation is taken over by Employer shall be made good by the Contractor to the satisfaction ofEngineer.

Workmanship

Plant shall be erected in a neat and workmanlike manner on the foundation and at the locations and elevations shown on the approved drawings and other engineering documents. Unless otherwise directed by the Engineer, the Contractor shall adhere strictly to the aforesaid drawings and no departures there from will be permitted.

All Plant shall be correctly aligned, levelled and adjusted for satisfactory operation and shall be installed so that the proper and satisfactory connection can be made readily between the various units and pipe work and equipment installed under the Contract. The mounting arrangements for pump sets and blowers shall be such that the alignment offset between motors and the driven equipment shall be well within 0.1mm.

Building-in

Erection of Plant shall be phased in such a manner so as not to obstruct the work being done by other contractors. Before commencing any erection work, the Contractor shall check the dimensions of structures where the various items of plant are to be installed, and shall bring any deviations from the required positions, lines or dimensions to the notice of the Engineer and shall take such measures as are necessary for their correction.

The Contractor shall take particular care for the correct positioning and alignment of all puddle pipes which are required through concrete structures prior to, and during the pouring of concrete. The Contractor shall pin and plug in the holes prepared, all small clips, plugs, screws, nails, sleeves, inserts, etc., required for fixing electric wires and conduits, small pipe work and all other apparatus.

The Contractor shall align all equipment and holding down bolts and shall inform the Engineer before proceeding with grouting-in the item or item concerned. The Contractor shall ensure that all equipment is securely held and remain in correct alignment before, during and after grouting- in.

The Contractor shall properly bed in cement grout each item of plant or its supporting base resting on foundations, and shall grout-in where required holding down bolts placed

in the holes prepared in the foundations. The materials and workmanship used in grouting shall be such as will result in a solid anchoring of foundation bolts and complete filling of the gaps between the Plant or its base and the foundations, without shrinkage or cracking.

During erection of the Plant, the Employer will inspect the installation from time to time in the presence of the Contractor's Site representative to establish conformity with the requirements of the Specification. Any deviations and deficiencies found or evidence of unsatisfactory workmanship shall be corrected as instructed by the Employer.

All plant shall be installed in accordance with the recommendations or instructions of the manufacturer, for the particular application. Each mounting position shall be chosen to give correct operation of the equipment, ease of operation, access for maintenance and servicing and freedom from any condition which could have adverse effects.

Precautions

The approval by the Engineer of the Contractor's proposals for rigging and hoisting of any item of plant into its final position shall not relieve the Contractor from his responsibility for avoiding damage to completed structures, parts or members thereof or other installed equipment. He shall at his own cost make good, repair or replace any damaged or injured items whether structural, mechanical, electrical, architectural, or of any other description, promptly and effectively to the satisfaction of theEngineer.

No plant or other loads shall be moved across the floors of structures without first covering the floors with timber of sufficient size so that applied loads will be transferred to floor beams and girders of steel or concrete. If it is required to reduce bending stresses or deflection, the beam and girders shall be provided with temporary supports. Any movement of Plant and other loads over the floor structures shall be subject to the prior approval of theEngineer.

13.20 Tests on Completion

13.20.1 General

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

a) As-builtdrawings;
b) Operation and Maintenance Manuals;and
c) Site test results / data sheet andphoto.

Tests on Completion shall not be commenced until the aforementioned documents are approved.

The initial charges of oil, grease, electrolyte, generator fuel / oil, chemical, disposal of cake, etc. necessary for Tests on Completion shall be provided by the Contractor. Raw sewage and electricity required for Tests on Completion shall be provided by the Contractor. If necessary, the 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. In the event that raw sewage/influent wastewater is not

available at the plant, the Contractor shall defer testing until such time as sewage becomes available for treatment as described elsewhere in these Bid Documents. The Contractor shall provide adequate notice (this notice period shall be determined by the normal lead time for locally purchased chemicals plus at least 28 days) of his chemical requirements prior to commencement of the Tests on Completion involving their use.

The cost of chemicals used for the Tests on Completion shall be met by the Contractor.

The inspection and tests procedure which will be carried out are provided under the general conditions of contract and shall also consist of the following:

Manual Commissioning Tests (Clause i)

Manual commissioning tests shall be such preliminary trials, tests and retests on individual items of Plant or complete systems as are required by the Engineer to demonstrate that the Plant as a whole is ready to undergo the Manual Operation Tests and that these will take place with a minimum of interruption.

The Manual Commissioning Tests shall demonstrate not only the items of Plant under normal operation, but also their response to abnormal and emergency conditions.

The Engineer will notify to the Contractor which items of Plant will be tested and the extent to which they will be tested in order to fulfil the requirements of the Specification.

Leakage tests at 1.5 maximum working pressure shall be carried out on all erected pipe work prior to the Manual Commissioning Tests.

Pump curves shall be available for the Manual Commissioning Tests and all instruments essential for the tests shall have been calibrated.

Manual Operation Tests (Clause ii)

When the Manual Commissioning Tests have been completed so that the items of Plant have been demonstrated to the satisfaction of the Employer Representative, the Contractor shall commence the Manual Operation Tests.

These tests shall demonstrate the correct operation of the whole Plant whilst using the minimum quantity of automatic control and monitoring equipment. Such equipment shall be at least that required both for the maintenance of safety and for the normal mode of operation of the Plant.

The Plant will be required to demonstrate satisfactory operation at all design flow rates.

The tests shall be of seven consecutive days' duration; if the supply of water should fail or other matters interfere outside the Contractor's control, the tests may be of such number of broken days as the Engineer considers is theequivalent.

The exact date of commencement shall be subject to the approval of the Engineer and shall be dependent on the following conditions having been met:

(1) All relevant items of Plant in approved working order;and

(2) All items of Plant correctly identified withlabels.

Automatic Commissioning Tests (Clause iii)

The Automatic Commissioning Tests shall be such preliminary trials, tests and retests on individual items of Plant or complete system as are required by the Engineer to demonstrate that the Plant as a whole is ready to undergo the Tests of Completion and that these will take place with a minimum of interruption.

At least one week before commencement of these tests, the Engineer will notify the Contractor which items of Plant will be tested and the extent to which they will be tested to fulfil the requirements of the specification.

The Tests on Completion shall not be carried out until the completion of the above tests.

1) All pipe work shall be hydrostatically tested at site to a pressure equal to 1.5 times the maximum working pressure likely to be encountered in thesystem;
2) The Contractor shall carry out all tests on the Plant and shall supply four copies of all test results to theEngineer;
3) All tests shall be to the approval of the Engineer who may require them to be repeated, prolonged or modified as may be necessary to ensure that any or all items of Plant conform to the Contract;and
4) The Engineer shall be permitted to inspect all Plant which is undergoing tests and may himself conducttests.

Where it is necessary for the Engineer to make arrangements for the supply of water, chemicals, power, etc., for any testing, the Contractor shall not commence the tests until after these arrangements have been made on or after a date agreed by the Engineer, and the Contractor shall make no claim for delay to such testing on this account except as provided for under Clauses 44 of the General Conditions ofcontract.

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

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.

Table 13-1Acceptable Noise Limits

Equipment	Noise Level (dBA at 1.86 m from equipment)	Velocity of vibration (mm/sec)
All rotating equipment not having reciprocating parts with motor kW less than or equal to 15 kW	85	1.12
All rotating equipment not having reciprocating parts with motor kW more than 15 kW and less than or equal to 75 kW	85	1.8
All rotating equipment not having reciprocating parts with motor kW greater than 75 kW	85	2.8
All equipment having reciprocating parts viz. compressors, dosing pumps samplingpumps	85	-

The Contractor shall have a minimum of three commissioning engineers, one for process and plant and the others for mechanical/electrical/instrumentation works on site during all tests to both demonstrate the Plant and to correct any faults which may occur.

13..21 Dry Test Requirements

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

1) general inspection to check for correct assembly and quality ofworkmanship;
2) check on the presence of lubricant, cooling medium, electrolyte,etc.;
3) check on adequacy and security of Plant fixingarrangements;
4) general check to ensure that all covers, access ladders, water proofing, guard railings etc. are inplace;
5) check on damp-proofing, rust-proofing and vermin-proofing and particularly the sealing of apertures between building structures, chambers, etc. and theoutside;
6) Civil and BuildingWorks

   As a minimum requirement, the following dry tests shall be carried out on the civil engineering and building works:

   - Check for the presence of foreign bodies in pipe work andstructures.

7) MechanicalWorks

   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 to ensure smooth operation ofPlant.

8) ElectricalWorks

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

   - Check phasing andpolarity;
   - Carry out point to point check on allcables;
   - Check on security of cableterminations;
   - Check on completeness and adequacy of earthingsystems;
   - Check setting on protection relays, sizes of fuses and motor overloadsettings;
   - Carry out checks on cabling systems in accordance with the requirements of the relevantstandards;
   - Check operation of main circuit breakers by secondary injectionmethods;
   - Check rotational direction ofPlant;
   - Check instrument loop integrity, functionality andcalibration;
   - Check operation of standby generator installation and mains / generator changeover procedures; a 4-hour load test (using the normal load of the Works) shall be carried out on the generator when the load isavailable;
   - Check plant functionality;and
   - Check functionality of the central MMI and its powersupply.

13.22 Hydraulic Wet Test Requirements

Hydraulic wet tests shall be carried out on completion of dry tests.

Clear water shall be used for hydraulic wet tests. The purpose of the tests is to prove the hydraulic performance of the Works. To demonstrate this, the Contractor shall ensure that each part of the Works is hydraulically loaded to its rated throughput for a period of at least fourhours.

To ensure a sufficient supply of water to carry out these tests, the Contractor shall

provide all required facilities, including but not limited to any temporary facilities that may be required for storage and recycle of clear water or facilities for the disposal of the water off Site in an approved manner.

The following tests inter alia shall be carried out:

1) Pressure test all piped systems laid directly in the ground in accordance with the relevantstandards;
2) Fill all structures to check forleaks;
3) Fill all storage vessels to check for leaks anddistortion;
4) Run all pumped systems to checkfor;
   - Correctfunctionality;
   - Absence ofleaks;
   - Correct runningtemperatures;
   - Smoothness of running and the absence of undue vibration or stress;and
   - Check drive runningcurrents;
5) Carry out calibration of instruments whereappropriate;
6) Carry out valve operation, diversions, etc. to fully hydraulically load each process element (or where there is a requirement to withstand an overload), overload each process element;and
7) Demonstrate correct functionality of electrical, control and instrumentationsystems.

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

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

13.23 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 Plant. The safety audit shall be documented. The safety audit document shall be approved by the Engineer prior to commencement of Plant commissioning.

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

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

Where this assistance does not constitute part of the Contractors own work associated with Tests on Completion or Tests after Completion, the Contractor shall be reimbursed at the rates approved by the Engineer.

14 TESTS ON COMPLETION OF DESIGN-BUILD

14.1 Definitions

For the purposes of Section14, the following terms shall have the meanings set forth herein:

"Business Day" means any Day excluding:

i) Sunday;
ii) a Day on which MCGM is closed;
iii) any Day which is a legal holiday in the state of Maharashtra, India;or
iv) a Day on which financial institutions in the state of Maharashtra, India are authorised or required by law or other action of any Governmental Instrumentality to beclosed;

"Day" means a calendar day;

"Effluent" means wastewater that has been treated by or has otherwise passed through the Works;

"Equipment Validation" means the tests to be performed in accordance with the provisions of this Section of the Employer's Requirements;

"Hydraulic Validation Test" means a test designed to demonstrate that the Works is capable of passing the PFF in accordance with the hydraulic design of the Works;

"Influent" means all wastewater (including inflow, and infiltration) that is conveyed by the wastewater system to the Works;

"Instantaneous Flow" means the flow through a specific point at any given moment in time typically measured in m^3/s;

"Liquid Proving Period" means the period consisting of 30 consecutive Eligible Days during which tests to be performed are undertaken in accordance with the provisions of this Section of the Employer's Requirements;

"Liquid Proving Period Commencement Date "means the Day which is 30 (thirty) Days after the Contractor has submitted the Liquid Proving Period Plan, all activities required to be completed prior to completion of Commissioning have been so completed, the Works has been successfully Commissioned, and the Commissioning report submitted by the Contractor is accepted by the Employer'sRepresentative;

"Test Requirements and Procedures" means the detailed test procedures and requirements prepared by the Contractor, and approved by the Employer prior to commencement of testing;

“Testing Plan” means the plan prepared by the Contractor in accordance with this Section of the Employer’s Requirements setting out all tests to be carried out, the methodology for testing, and incorporating the Employer’s comments;and

“Testing Programme” means the testing programme developed by the Contractor in accordance with this Section of the Employer’s Requirements setting out a schedule for all tests, and incorporating the Employer’s comments.

14.2 General

14.2.1 Introduction

The Contractor shall be responsible for developing and implementing testing procedures for the construction inspection, dry, and wet testing, performance, reliability testing, and capacity demonstration of the Works in accordance with this Section of the Employer’s Requirements. The Contractor shall be responsible for providing all supplies required for carrying out such tests, including the Influent for Commissioning and testing purposes.

All tests shall be conducted in accordance with internationally recognised standards and procedures agreed between the Parties as part of the Test Requirements and Procedures.

The performance of the tests shall include inspection and performance tests of all structures, pipelines, equipment, systems, and processes under actual operating conditions, including operation of all equipment, systems, and processes in both manual, and automated modes.

During the performance of the tests, the Contractor shall have suitably qualified, and experienced technicians as required to ensure that all requirements are fulfilled.

14.2.2 Testing Plan &Programme

At least 60 (Sixty) Days prior to the proposed commencement of any testing required by the Contract, the Contractor shall submit to the Employer, in writing a Testing Plan including all relevant Test Requirements and Procedures relating to the Works, and a proposed Testing Programme.

The Employer shall have a period of 30(Thirty) Days after receipt of the Testing Plan and Programme to submit any comments including requesting that the Contractor conduct additional tests which in the opinion of the Employer should be carried out to prove that the Works has been designed, and constructed, and is capable of being operated according to the design, performance, and operation requirements specified, and is capable of attaining the requirements of this Section of the Employer’s Requirements. The Contractor shall accommodate any such comments into the Testing Plan and Programme.

The Testing Plan and Programme shall include, as a minimum, test requirements, procedures, and a detailed schedule relating to:

1) Testing of pipelines;
2) Testing of water retainingstructures;
3) Factory inspections andtesting;

4) EquipmentValidation;
5) SOTRtest;;
6) Hydraulic Validation test;and

Upon successful completion of the testing of the Works contemplated by this Section of the Employer's Requirements, the Contractor shall be permitted to submit to the Employer, for the Employer's approval, the Commissioning Certificate for the Works.

14.2.3 Test Schedule and Right to Witness Inspections andTests

In connection with the Test Requirements and Procedures, the Contractor shall periodically update the detailed testing and inspection programme. The Contractor shall promptly and, in any event, at least 10 (ten) Business Days prior to the commencement of any applicable testing provide the Employer with a copy of such programme and any updates issued with respectthereto.

The Employer and/or its Representative shall have the right to have representatives present during inspections and tests of major equipment and systems of the Works in the factory and on-site during construction. The presence of the Employer during any inspection or test shall not relieve the Contractor of its responsibility for supplying the equipment, or systems in accordance with the Contractor's Programme.

14.2.4 FactoryTests/Inspections

Selected items of equipment identified jointly by the Contractor and the Employer, including major pumps, dewatering units, switchboards, and items of critical plant must be tested or inspected at the manufacturer's factory before dispatch to Site. The Employer's Representative (if it elects to participate) will travel to the manufacturer's factory where such identified equipment will be run on a test rig set up to simulate the defined operating parameters for the equipment under test. The tests will be witnessed by the Employer's Representative (if it elects toparticipate).

Certain pieces of equipment which are not possible to test operate at the manufacturer's factory, in particular electrical switchboards, shall be inspected at the manufacturer's factory to ensure they conform to the specifications before delivery to the Site.

14.3 Equipment Validation

14.3.1 General

Equipment Validation shall be for the purpose of proving the operational performance and reliability of key pieces of equipment and ancillary systems that comprise the Plant identified by the Contractor in the Test Requirements and Procedures. The Equipment Validation includes as described in more detail below (i) pre-commissioning (on-site) testing and (ii) hydrostatic validation, in each case, for the pieces of equipment identified in the Test Procedures and Requirements. Such testing shall be undertaken, in accordance with this Section of the Employer's Requirements, upon delivery and installation of each such piece of equipment to ascertain the mechanical, electrical, electronic, and structural fitness, and reliability, as appropriate. The tests shall, as appropriate, include hydraulic leakage testing of the equipment prior to installation, confirmation that installation of such equipment is in accordance with manufacturers' recommendations, pressurised testing of the system pipelines, and a visual inspectionof all installed equipment.

During the Works Equipment Validation tests, the Contractor shall demonstrate that each applicable piece of equipment and related system achieves the applicable Technical Specifications.

14.3.2 Pre-Commissioning (On-Site)Testing

Immediately upon arrival at the Site, all equipment shall be inspected by the Contractor and the Employer's Representative (if it elects to participate) to determine whether any part of the equipment may have been damaged during transit. The equipment shall be installed by the Contractor without delay whenever possible. If the equipment cannot be installed immediately, it must be stored by the Contractor under appropriate conditions.

Upon installation, all equipment shall be subjected to the pre-commissioning testing established in the Test Procedures and Requirements.

14.3.3 Test Reports for EquipmentValidation

Within 10 (ten) Days after the completion of any particular Equipment Validation test, the Contractor shall compile and provide to the Employer’s Representative a final test report summarising the results of such test, including all information reasonably necessary to evaluate the applicable results. The Employer’s Representative shall indicate in writing within 5 (five) Business Days after receiving from the Contractor each such test report whether it accepts or disputes that such test results are accurate. The failure of the Employer’s Representative to respond within such 5 (five) Business Days period, unless extended by mutual agreement, shall be deemed acceptance of the test report.

In the event the Employer’s Representative disputes the results submitted by the Contractor, the Employer’s Representative may request that the Contractor repeats the relevant test as soon as practicable thereafter.

15 TRAINING OF EMPLOYER'S OPERATIVES BY THE CONTRACTOR

15.1 Prior to Operation Service Period

The Employer will not operate the Works but will require relevant staff to become familiar with and capable of operating the Pumping Stations during the Tests on Completion of Design-Build and the Operation Service Period, in order to adequately administer the Contract.The Contractor shall carry out training for the following personnel to the necessary standard to achieve such acapability:

- 1 No. AssistantEngineer;
- 2 No. Sub-Engineers;

These personnel may be direct employees or subcontracted by the Employer.

The training shall be carried out at the Site and shall include but not be limited to:

- Guidance on the use of the O&Mmanuals;
- Instruction on control and monitoring of the facility via PLC and without the PLC functioning;
    - Instruction on operation and maintenance of each plant item and any associated materials;
    - Instruction on security, safety features and emergencyprocedures;
    - Methods and means of testing andanalysis;
    - Data acquisition and reportingprocedures;
    - Assetmanagement;
    - Maintenance;and
    - Control of discharges to theenvironment.

The Contractor shall submit the training programme and content to the Employer's Representative for approval. The training shall be provided prior to the start of the tests on completion of Design-Build to the extent that the operatives are familiar with all aspects of the Works, including emergency procedures sufficient to allow the safe conduct of the tests and related procedures to be carried out.

15.2 Prior to Contract Completion

During the last twelve months of the Operation Service Period the Contractor shall provide formal training and hands-on experience to the Employer's operators/personnel-

- 1 No. AssistantEngineer;
- 2 No.Sub-Engineers;

The training programme shall be such that they are capable of operating the Works successfully and safely at the time of Contract Completion. The number of Employer's operators to be trained shall be 50% more than the number employed by the Contractor in the operation and maintenance of the Works. The Contractor shall assume that the operatives are skilled in their relative disciplines (i.e. electrician, fitter, laboratory technician, instrumentation technician, painter, stock controllers, etc.) but are unfamiliar with the Plant and Materials at the Site and with the exception of the process controllers and works manager, are unfamiliar with the operation of a pumping stations.

16 CONSTRUCTIONACTIVITIES

16.1 TheSite

The Site boundaries, and other relevant structures or areas are shown in the Contract Drawings in Volume 2D.

The Contractor shall take possession of the Site on the Commencement Date and shall be responsible for the Site.

16.2 Possession of the Site

A condition survey of the Site and its environs shall be carried out by the Contractor prior to commencement of any works. This shall include the condition of roads, structures, facilities, lands, plants and trees that may be affected by the Works.The surveys shall include the taking of record colour photographs covering all the areas at the Site.

Before bringing any equipment onto the Site the Contractor shall submit to the Employer's Representative one set of prints (minimum size 150 x 100mm) from the record photographs and a written record of the pre-commencement survey. Each photograph shall be uniquely numbered and the area covered by each photograph identified on plans or by written narrative. The Contractor shall confirm in writing to the Employer's Representative that the survey is a true and accurate record of the condition of the inspectedareas.

The Contractor shall not use the Site for any purpose other than carrying out the work required under this Contract. A temporary labour camp shall be permitted subject to availability of land, solely for labour carrying out the work required under this contract for DB period only. Any such labour camp shall be suitably configured, located and managed to ensure the highest standards of welfare and safety. The Contractor shall submit all details/drawings of his proposed labour camp to the Employer for his approval. The Employer may revoke the permission at his discretion. All the necessary consents/ permissions from statutory authority shall be obtained by the Contractor. No animals shall be allowed on the Site. A concrete batching plant shall be permitted on the Site, subject to availability of land and approval of the Employer. The batching plant shall supply concrete only for use on the Site. The batching plant and staff / labour quarters / huts shall be dismantled and removed from the Site within 30 and 60 days respectively after completion of construction of the plant. This will be a precondition for issuance of the CommissioningCertificate.

The tenderer shall note that the proposed site locations are affected by encroachments and acquisition of private properties. If the structures/ encroachments including utilities coming in the alignment of the proposed work, the contractor shall have to arrange for the detail total station survey of the structures / encroachments, for which no separate payment will be made.

The proposed site locations are also affected by tidal variation. The tenderer shall design, plan, schedule and execute the work accordingly. All necessary precautionary arrangements like coffer dams shall be made by the tenderer for which no extra payment will be made.

The Contractor shall not permit any animals to be brought onto the Site, with the exception of guard dogs properly trained and controlled by security personnel.

MCGM does not assume any responsibility for providing land for casting and stacking yard. MCGM may permit municipal land to be used for casting and stacking yard for the project work, if available and allowable. However, as per MCGM policy, the contractor shall have to pay 15% amount of Capital SDRR rate of respective year as a rent plus all the taxes and license fees, etc. If MCGM land is not available, Contractor have to make

his own arrangement for the casting and stacking yard at his own risk and cost.

16.3 Environmental Mitigation during Construction

16.3.1 Protection ofEnvironment

The Contractor shall take all reasonable steps to protect the environment on and off the Site and to avoid damage or nuisance to persons, public property or others resulting from pollution, noise or other causes arising as a consequence of his methods of construction, operation or demolition of existingstructures.

During the Contract, the Contractor and his Subcontractors shall abide at all times by all existing enactments on environmental protection and rules, regulations, notifications and bye-laws of the state or central government, and any other law, bye-law or regulation that may be passed or notification that may be issued in this respect in future by the state or centralgovernment.

Principal environmental regulations include but are not limited to:

Table 4-1 Environmental Regulations

Year	Environmental Regulations
1974	The Water (Prevention & Control of Pollution Act) Amendments, 1988
1975	The Water (Prevention & Control of Pollution) Rules
1977	The Water (Prevention & Control of Pollution) Cess Act, Amendment 1992
1978	The Water (Prevention & Control of Pollution) Cess Rules
1981	The Air (Prevention & Control of Pollution) Act, Amendments, 1987
1982/1983	The Air (Prevention & Control of Pollution) Rules
1986	The Environment (Protection) Act, Amendments (1989, 1990, 1993, 1996, 1997, 1998, 1999, 2000, 2001) The Environment (Protection) fourth Amendment Rules 2008
1986	The Environmental (Protection) Rules
1992	E (P) Act Notification – “Environment Statement”
1994	E (P) Act Notification – “Environmental Clearance” EIA Notification 2009
1997	Amendments in the Environment Clearance, EIA Notification – “Public Hearing” made mandatory
1989	The Hazardous Wastes (Management and Handling) Rules, Amendments, 2000 and 2003
1989	Manufacture, Storage and Import of Hazardous Chemical Rules, Amendments, 1989, 2000
1991	The Public Liability Insurance Act, 1991
1995	The National Environment Tribunal Act
1997	Prohibition on the Handling of Azodyes
1997	The National Environment Appellate Authority Act
1998	The Bio-Medical Waste (Management &Handling), Rules
1999	Notification for making 100% Utilization of Fly-ash made mandatory, Amendments 2003
2000	Municipal Solid Waste (Management &Handling) Rules
2000	Ozone Depleting Substance (Regulation &Control) Rules

1999	Regulation on recycling of Waste Oil and Non-ferrous scrape
2000	The Noise Pollution Regulations and Control Rules
2001	Batteries (Management &Handling) Rules

16.4 Removal of Waste

All material shall be disposed of in accordance with national regulations. Burning of debris is not permitted on the Site.

16.5 Working Hours

The Site normal working hoursshall be as stated in the Contract Data. However, specific sanction of Ch.E.(SWD) to carry out the work during night time, Sundays & Holidays.

The Contractor shall not be entitled to any extension of Time for Completion of Design-Build or any additional costs as a result of not being allowed to work outside normal working hours.

16.6 Noise and Vibration

The Contractor shall carry out his operations in such a manner as to minimise noise and vibration nuisance.

The Contractor shall comply with the requirements of The Noise Pollution (Regulation and Control) Rules 2000 and all latest amendments.

The Contractor shall ensure that all his equipment used in the Contract shall be designed to be reasonably quiet in operation and shall check the measures taken by the manufacturers to minimise noise during operation of the equipment. The Contractor shall ensure that all his equipment and associated platforms and connections are properly maintained to be in efficient working order and reasonably quiet in operation for the full duration of the Works. The Contractor shall fit effective silencers to machine exhausts and adopt such other means as may be necessary to reduce noise to acceptable levels.

Machines in intermittent use shall be shut down when not in use, or throttled back to a minimum. The Contractor shall remove from the Site any items of Contractor's equipment which are, in the opinion of the Employer's Representative ineffectively silenced.

All compressors, pumps and mechanical static plant shall be low noise models fitted with properly designed acoustic covers or screens to reduce noise to acceptable levels. These covers shall be kept closed whenever the machines are in use. All ancillary pneumatic percussion tools shall be fitted with mufflers or silencers of the type recommended by the manufacturer.

The Contractor shall organise his operations with regard to the positioning of plant and the location of haul routes, etc. to minimise construction noise to adjacent properties. The Contractor shall also maintain vegetation at construction sites to reduce air pollution and noise levels. The Contractor shall employ the best practical means to minimise noise produced by hisactivities.

The Contractor shall ensure that the sound levels arising from his activities during construction do not exceed the following values when measured at the Site boundary:

Table 4-16-2 Noise Limits

Period	Hours	dB(A) Leq (1 hr)	dB(A) Leq (15 min)	dB(A) Leq (Peak)
All days of week	08.00-20.00	75	80	85
At all other times*			70	75

***** When the existing ambient noise levels are higher than the limits shown in the table, the ambient noise levels may be exceeded by 5dB(A).

If so ordered by the Employer's Representative, the Contractor shall take measurements of background noise and noise attributable to his operations. Measurement and analysis shall be carried out in accordance with ISO 1996, Acoustics – Description and Measurement of Environmental Noise.

In addition, noise emitted between 18.00hrs and 09.00hrs shall be free from tonal or impulse qualities and pile driving or drilling shall not be permitted during these hours.

The Contractor shall carry out the Works in such a manner as to limit vibration at adjacent properties and at the works, due to his construction activities, to an acceptable level.

If required by the Employer's Representative the Contractor shall carry out vibration monitoring at adjacent properties.

Vibration caused by construction plant to be limited to the recommended values.

Table 4-16-3 Vibration limits

Allowable vibration (in terms of peak particle velocity) at the closest part of any sensitive property to the source of vibration, at a frequency of		
Less than 10 Hz	10 to 50 Hz	50 to 100 Hz (and above)
3 mm/s	3 to 8 mm/s	8 to 10 mm/s

16.7 Transport of Plant and Materials

The Contractor shall abide by all national regulations and laws governing the transport of goods and materials including the classification, packaging and labelling regulations, whether transport is by land or by sea.

Where lightweight material is transported, the Contractor shall ensure vehicles are adequately covered and loads trimmed if necessary to prevent spillage on to the public highway.

16.8 Traffic Management

The Contractor shall develop and agree a traffic management plan with the Employer's Representative and the police to mitigate the effects of construction traffic on traffic in the locality of the Site.

Where traffic flows on public roads will be affected, the Contractor shall provide sufficient advance warning to the Employer and the police so that advertisements and signage can be implemented.

The Contractor shall plan his transportation requirements such that rush hour traffic is notaffected.

The Contractor shall provide, erect, and maintain suitable advance warning signs advising of construction traffic ahead.

The Contractor shall, through regular inspection and maintenance, keep clean and legible at all times all traffic signs, lamps, barriers, cones and traffic control signals and shall position, reposition, cover or remove them as required by the progress of the Works or as directed by the Employer'sRepresentative.

16.9 Disposal of Spoil andWaste

The Contractor shall give due consideration to the environmental benefits of re-using excavated material.

The Contractor shall be fully responsible for removal and disposal off Site of any excavated material that is not re-used on Site. He shall be responsible for obtaining thenecessary permits, licences or other permissions required for its safe disposal in accordance with any relevant legislation and shall produce such documentation on request by the Employer's Representative. The disposal site shall be subject to the approval of the Employer's Representative. The Contractor shall ensure that vehicles are suitably loaded, or covered if necessary, to ensure material is not lost during transport.

16.10 Site Drainage and ErosionControl

Drainage of fluids from the Site including pumping from excavations and surface run off shall be limited as far as possible by the adequate planning of construction sequences and bunding of the working areas and the use of silt curtains and temporary ditch soakaways. Washing down of concrete trucks, etc. shall be to designated bins for containment and removal off Site or treatment on Site.

The discharge from dewatering pumps and surface run-off shall be disposed of in such a manner as to avoid pollution of waters. Disposal of such discharges shall not cause damage to roads, sewers, public or private property, work completed or in progress and it shall not cause unnecessary interference with the use of the roadway by the public, nor shall it constitute a healthhazard.

Soil erosion shall be minimised by the re-vegetation of working areas with grass and native species as soon as practical. The Contractor shall achieve stabilisation of debris overburden using the following methods:

- Consolidation of the excavated debris and immediate transport to disposalsite;
- Planting trees, grasses andshrubs;
- Provision to channelise rain water down the slope to minimise surface runoff;and
- Slope stabilisation of dumpedmaterial.

16.11 Contaminated Materials

The Contractor shall take samples of material arising on the Site at suitable locations and frequencies to determine whether the material is harmful to construction workers, whether it is suitable for re-use on the Site and whether, if it is to be disposed of off-Site, it requires special permits or licences for disposal. Adequate time shall be allowed for analysis and interpretation of the results in advance of relevant work. Samples shall be analysed at an accredited laboratory and the results provided to the Employer's Representative.

16.12 Dust/ Air Pollution

The Contractor shall comply with the requirements of The Air (Prevention and Control of Pollution) Act 1981 and all associated Rules and Notifications.

The Contractor shall take adequate measures to control the emission of dust from the Site. Such measures shall include sprinkling of surfaces, re-vegetation and delayed

stripping of vegetative cover where practical.

The Contractor shall cover or water stockpiles and storage areas to prevent dust pollution. The Contractor shall also cover trucks transporting construction materials to minimise spills and shall not overload vehicles.

The Contractor shall not cause any dust nuisance to third parties or to the Employer's Representative's offices.

The Contractor shall tune and service regularly all construction and transportation equipment in order to prevent air pollution.

16.13 Tidiness of the Site and Local Roads

The Contractor shall maintain the Site in tidy condition throughout the duration of the Contract.

The Contractor shall ensure that any public or private roads used by construction traffic are not contaminated with material from the Site, by the installation and operation of a wheel-wash facility or similar, if necessary. The Contractor shall bear the cost of keeping clean any roads contaminated by material from the Site, and of any consequential effects of dust arising from materials deposited on roads outside the Site.

16.14 Temporary Lighting

The Contractor shall install temporary lighting to assist security and safety of the Site and its environs.

The impact of the temporary lighting on the local population shall be reduced by the use of lanterns which prevent glare and the spread of light beyond the Site.

16.15 Preservation of Trees, Flora, Fauna andArtefacts

The Contractor shall protect existing trees, flora, fauna and artefacts wherever practicable to reduce impact on the Site to aminimum.

Trees shall be retained in accordance with the Contract and any that are to be retained shall be adequately protected to prevent damage.

16.16 Pollution

The Contractor shall carry out his activities to prevent nuisance or pollution of any type. The Employer's Representative and the Maharashtra Pollution Control Board (MPCB) shall be notified by the Contractor as soon as possible, in the event of a pollution incident or of suspected pollution.

16.17 Public Liaison &Communication

The Employer intends to develop a pro-active approach with regard to liaison with the public throughout the Design-Build Period.

The Contractor shall participate with the Employer in its endeavours to promote this public liaison objective. During all working hours the Contractor shall have at least one designated person on site who is conversant in English, Hindi and Marathi.

16.18 Parking for Construction Vehicles

All construction traffic, including personal cars and vans shall park on the Site or on other areas of land secured by the Contractor and shall be subject to approval by the Employer's Representative. No parking shall be allowed to create nuisance or hazard on

the public roads.

16.19 Contractor's Temporary and WorkingAreas

No land outside the Site has been made available to the Contractor by the Employer.

16.20 SiteSecurity

A temporary security fence and gates shall be erected by the Contractor to enclose theSite, prior to the commencement of his construction activities. The security fences and gates on the Site shall be at least 2m high and of an anti-intruder type and stock-proof. The Contractor shall undertake special precautions to:

(i) Prevent exposure of members of the public to danger due to rough ground terrain, excavations or stackedmaterials;
(ii) Prevent tampering with construction materials, site plant, machinery, site utilities, or hazardous chemicals utilised or stored on the Site. Additional fencing shall be required where materials or plant for incorporation into the works are being stored. These shall be located so that they are not visible to persons outside theSite;
(iii) Prevent access toscaffoldings;
(iv) Provide security personnel at all times;and
(v) Not permit any person not engaged on the site to enter theSite.

16.21 Storage of Plant and Materials

The Contractor shall ensure Plant and Materials for incorporation into the Works are stored in accordance with manufacturer's recommendations and protected from the weather.

The Contractor shall be responsible for a proper inventory of plant and materials together with receipts and issues and identification of same.

The Contractor shall not store or deposit any of his equipment on the Site without the consent of the Employer's Representative.

The Contractor shall ensure that no fuel or oil spillages discharge to the environment. Temporary fuel and oil storage tanks in the Contractor's compound shall be protected by an impervious containment bund. The Contractor shall carry out daily inspections for spillage of fuels/oils at the Site.

Stacked equipment and materials 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.

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

Equipment and materials shall be handled and stored so that they are not subjected to excessive stresses and so that protective coatings are not damaged.

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

Equipment and materials shall be stored in a manner that minimises risks to the environment and will be located away from sensitive receptors such as watercourses and drains, where there is risk of harm through spillage, leakage or leaching of harmful materials.

16.22 Protection againstDamage

The Contractor shall take all necessary precautions to avoid causing any damage to

buildings, structures, roads, lands, properties, trees and other features and, during the currency of the Contract, shall deal promptly with any complaints by owners or occupiers. Any damage done to road surfaces outside the Site shall be restored to the Employer's Representative's satisfaction at the Contractor'sexpense.

Where any portion of the Works is close to, across, or under any existing apparatus of public utilities or other parties, the Contractor shall temporarily support and work around, under or adjacent to all apparatus to avoid damage, leakage or danger and to ensure uninterrupted operation.

16.23 Utilities and Other Services

Any information concerning existing services within the Site that has been notified to or obtained by the Employer is contained in the Background Information. The positions are approximate. The Contractor shall make all contact with the relevant public utilities, service owners, land owners and other parties before commencing any excavations and shall satisfy himself as to the exact position of existing services which may affect or be affected by the construction of the Works.

If any information concerning the position, existence, non-existence or type of service is found to disagree with information provided by the Employer or the relevant authority, the Contractor shall notify the Employer's Representative inwriting.

The Contractor shall liaise with the relevant utility or owner of the service to determine whether the apparatus is to be diverted, removed, or left unaffected. All work carried out in the vicinity of services shall be such as to avoid drainage, leakage or danger and in the case of public utilities be in accordance with their procedures and codes of practice, copies of which can be obtained from theutility.

The Contractor shall allow for extended consultations with public utility authorities.

16.24 Archaeology

Any finds of archaeological interest such as relics of antiquity, coins, fossils or other articles of value shall be immediately brought to the attention of the Employer's Representative for appropriate further course of action.

16.25 Setting out, Datum andSurveys

The Contractor shall be responsible for the accurate location of the Works. Elevation and levels used forthe project are linked to the Town Hall Datum (THD) or Chart Datum (CD). The Contractor shall satisfy himself as to the accuracy of the survey details and levels provided on the drawings in Volume 2D and shall carry out additional surveys to verify the same. The results shall be provided to the Employer's Representative prior to work commencing onSite.

At the commencement of work on the Site, the Contractor shall provide substantial master temporary benchmarks at convenient positions over the Site, suitably protected for the duration of the Contract and agree the levels of such works with the Employer's Representative. Temporary benchmarks at intermediate locations shall be provided by the Contractor as required and agreed with the Employer'sRepresentative.

The Contractor shall establish a permanent master survey station and benchmark at a convenient point near the Site. All levels shall be referenced to Town Hall Datum or Chart Datum.

The Contractor shall set out the Works in accordance with the dimensions, lines and levels shown on his construction drawings.

The contractor shall give the Employer's Representative not less than 48 hours' notice of

his intention to set out or give levels of any part of work so that timely arrangements may be made for checking or issuing instructions.

16.26 Project Signs

Until the Works are taken over, the Contractor shall provide, erect, and maintain 2 sets of project signs with information about the project near the Site at locations which shall be subject to approval by the Employer's Representative. The details of the signs shall be provided by the Employer's Representative and a provisional sum is included for this item.

The Contractor shall not undertake or allow billposting or advertising of any kind upon the Site or on the project signs without the written consent of the Employer's Representative.

16.27 Staff and Materials to Assist the Employer's Representative

The Contractor shall place at the disposal of the Employer's Representative, competent general staff and chainmen at any or all times when and where required to assist in checking the setting out, levelling or measuring of the Works or for any other purpose during the progress of the Works together with all necessary pins, ranging rods and other materials and apparatus. Generally, the services of not more than two men will be required at any one time to assist the Employer's Representative.

16.28 Site Meetings

Monthly progress meetings shall be held at the Site. These shall be held at the Employer's Representative's office until the Site facilities are available. These shall be chaired by the Employer's Representative and attended by the Contractor and any Subcontractor or supplier deemed necessary by the Employer's Representative. The dates for the meetings shall be determined by the Employer's Representative. Minutes shall be recorded by the Employer's Representative and endorsed by the Contractor. They shall be issued to all attendees.

Design meetings shall be held monthly until issue of the final Contractor's design report as per the Contractor's Documents, and at least once every two months thereafter or as required by the Employer's Representative. They shall be held at the Site and attended by the Contractor and his design representatives. Minutes shall be recorded by the Contractor and endorsed by the Employer's Representative. They shall be circulated to all attendees. A schedule of convenient dates shall be agreed in advance.

16.29 Method Statements

The Contractor shall submit general and detailed method statements.

A general method statement shall be provided 28 days prior to commencement on Site which shall outline the procedure that the Contractor intends to employ for each element of the construction, including a comprehensive list of plant that will be used. It shall include the relevant sections of his environmental management programme, indicating whatmeasures will be employed to mitigate against environmental impact duringconstruction.

Detailed method statements shall be provided for each element of the Works. These shall comprise a step by step schedule of specific operations or activities with descriptions, dates, times and duration of each step, supported by sketches or other detail to aid their understanding. They shall include reference to relevant legislation, and permits and licences that have been or are required to beobtained.

16.30 Supply of Materials andServices

The Contractor shall be fully responsible for providing all Materials and services required for the carrying out of the Works.

The Contractor shall supply/install a temporary Site electrical distribution system including wiring. Cabling and distribution boards for power services, lighting, etc. shall be provided in a safe and efficient manner as required for his construction, Site storage and the officeareas.

Electrical welding equipment shall not be connected to the Site electricity supply and the Contractor shall provide all necessary portable generating equipment.

The Contractor shall employ competent personnel experienced with similar equipment and maintain the electricity supply and distribution system. An inspection certificate shall be supplied to the Employer's Representative on completion of the temporary installation. It shall be tested and inspected at intervals of not more than 3 months and the inspection certificates supplied to the Employer'sRepresentative.

The Contractor shall ascertain from the supplier any restrictions of supply which are likely to impose limitations on his programme of work, such as supply of water for testing purposes.

Where a supply of water, electricity or gas is required, the Contractor may make use of the permanent supplies once they are installed subject to the requirements of the supplying authority but the Contractor shall be liable for all charges for the service. The Contractor shall also be responsible for any additional facility, over and above those specifically required for the Permanent Works that he installed to provide for his use during construction, and any costs arising from their use by him.

All such facilities shall be removed by the Contractor on completion of construction. All installations shall be agreed in advance with the Employer's Representative.

16.31 Temporary Works

The Contractor shall submit to the Employer's Representative for review, drawings of Temporary Works, including staging, fencing, formwork, piling, etc., and plant at least 4 weeks prior to those items being delivered to Site. This shall include details and calculations of any loading imposed on the Permanent Works by their use.

The Contractor shall be solely responsible for the sufficiency, safety, adequacy and maintenance of all Temporary Works. No review by the Employer's Representative shall relieve the Contractor of any of his responsibilities.

16.32 Construction Plant and Equipment

The Contractor shall be responsible for making his own arrangements for all necessary construction plant and equipment including the supply, storage and maintenance. All items shall be in full working order and conform to all relevant health and safety requirements.

When requested by the Employer's Representative, the Contractor shall supply information and details of the plant and equipment including its specification, history and certification.

No review by the Employer's Representative shall relieve the Contractor of any of his responsibilities for the adequacy, safety or efficiency of his construction plant and equipment.

16.33 Smoking

Smoking shall only be permitted in designated, signed, areas.

16.34 Blasting and the use of explosive

The Contractor shall not carry out any blasting activities on site. The Contractor shall not be permitted to use explosives.

16.35 Contractor's Accommodation andFacilities

16.35.1 Location

The Contractor's temporary site offices, site huts, stores and parking areas shall be located within the Site, consistent with the requirement for him to minimise the environmental impact on the Site.

Immediately upon removal of the accommodation and related facilities the Contractor shall complete landscaping and rehabilitation of the areas occupied in accordance with the Contract.

16.35.2 Contractor'sOffice

Before commencing work, the Contractor shall erect an office for his own use in a position and to a standard and layout to be agreed by the Employer's Representative. The office shall be substantially built, weather-proof, well-lit and suitably furnished. It shall be properly secure to keep safe the papers, documents and drawings handed to the Contractor by the Employer's Representative for use in carrying out the Works. The office shall contain a letter box for the secure receipt of instructions, messages and mail from the Employer's Representative and others. The Contractor shall obtain the correct postal address and code for the office and notify the Employer's Representative accordingly. Messages or instructions left at or sent by post to this office shall be deemed to have been served on the Contractor. The Contractor's office shall not be removed from the Site until the Employer's Representative, by notice in writing, calls upon the Contractor to doso.

The Contractor shall provide, erect, construct, maintain and subsequently remove all temporary messing and sanitary arrangements, stores, workshops, compounds, parking areas, drainage, lighting and the like, necessary for the completion of the Works for the use of his own staff and work force plus those of his Subcontractors in accordance with the latest legislation.

No accommodation or living quarters shall be established on the Site. The Contractor shall not permit any person to live on the Site or any animals to be brought on to the Site, with the exception of security personnel and guard dogs properly trained and controlled.

16.35.3 Contractor'sTelephone

The Contractor shall arrange for the installation of a telephone and facsimile system connected to the terrestrial public telephone system for the use of his own staff and for those of his Subcontractors. The Contractor shall be responsible for the task of establishing, using, maintaining and removing the system. The Contractor's Representative shall be provided with a mobile telephone by the Contractor.

16.35.4 SanitaryArrangements

Throughout the period of construction of the Works the Contractor shall provide, maintain and keep clean suitable and sufficient latrines for use by his employees; he shall ensure

that his employees do not foul the Site, and shall be instructed in the proper use of the latrines.

The Contractor shall connect the latrines to sealed units suitable for disposal or to the influent stream upstream of all treatment processes subject to agreement from the Employer's Representative.

16.36 Returns of Labour and Plant Reports

The Employer's Representative will require a weekly report from the Contractor detailing the labour and plant utilised on the works during the previous week. This report shall be delivered to the Employer's Representative at the start of each week.

The weekly report on plant shall detail the number and type of the various machines and equipment utilised.

The weekly report on labour shall include all skilled and unskilled labour employed in the construction of the Works and the name and grade of each operative shall be identified, together with the normal and overtime hours worked.

16.37 Staff Welfare Management

The Contractor shall construct and maintain welfare facilities for his staff and operatives.

The Contractor shall be responsible for and provide all services to the welfare facilities and shall ensure that all sanitation Laws, labour laws and other Laws and regulations in force in the area are complied with. The Contractor shall be responsible for providing all necessary fencing and security to these areas.

16.38 Site and Laboratory Testing

The Contractor shall be responsible for testing of materials at a local national or internationally accredited laboratory and circulate the results to the Employer's Representative, who shall be afforded access to the testing facilities during normal working hours.

All testing shall be in accordance with the Contractor's quality procedures.

16.39 Daily Records

A daily record of the day's activities shall be completed by the Contractor and handed to and certified by the Employer's Representative at the end of each working day. The report shall include, as a minimum, for: work done, all labourutilised, all plant and equipment (used/standing), weather temperature/conditions, deliveries, visitors, etc.

16.40 Inspections and Testing (except Tests on Completion of Design-Build)

16.40.1 General

This section covers the procedures, inspection, testing and recording of Plant and Materials up to the start of Tests on Completion of Design-Build.

The Contractor shall provide a programme of tests ensuring co-ordination between tests to minimise attendance time.

The Contractor shall provide all labour, materials, service charges and consumables as may be required. A Provisional Sum for the Employer's Representative expenses for

attendance at and during works tests and inspections at the Contractor's or manufacturer's premises has been allowed in the Schedule of Payments.

The Contractor shall submit to the Employer's Representative at least 21 days in advance of the tests full details of the tests to be carried out (including the time and date of the tests) to ensure that all requirements of the Contract including the functional design specification requirements, have beenmet.

No inspection, acceptance or agreement by the Employer's Representative of the Works shall prejudice the right of the Employer's Representative to reject any Plant or Material if it subsequently fails to comply with the Contract.

16.40.2 Factory Inspection andTesting

Where practicable and unless "Type Test" certificates are specified, the Contractor shall carry out works tests on all Plant before dispatch to Site or to store at the manufacturer's premises. The Contractor shall arrange for third party inspection and certification and a provisional sum has been provided for this purpose. The third party agency shall be an internationally reputable independent firm and shall be subject to the approval of the Employer's Representative. The Employer's Representative shall be given the opportunity to witness the tests which shall be arranged to represent the working conditions where possible. Witness tests shall be required for all major items of Plant, except those of a standard nature, and for other Plant and Materials as required by the Employer's Representative.

The Contractor shall carry out works tests and inspections on the all major materials being fabricated or processes on or off Site and shall ensure that they comply with the drawings and Employer's Requirements. The Contractor shall ensure that the manufacturer's quality assurance procedures are being followed and that the programme is being adhered to.

The Contractor shall carry out routine and functional works tests to ensure that the item being tested functions correctly and to demonstrate conformity with the specification. No item of plant or materials shall be delivered to the Site without inspection and testing having been carried out or waived in writing by the Employer's Representative prior to carrying out of any tests.

Type test certificates shall be provided to the Employer's Representative before dispatch to Site. Where such certificates are not available, a letter of intent from the testing authority shall be provided. Where no testing or inspection requirements are detailed in the Employer's Requirements or the relevant standard, a recognised trade association standard or the manufacturer's test procedure shall be applied.

Calibration certificates for instruments used for such tests shall be provided and, if necessary, instruments shall be recalibrated before commencement of the tests.

Hardware and software testing for PLCs at the software writer's premises and at the control panel manufacturer's premises shall also be in accordance with the details in Section 24 of Volume 2C.

Other tests are detailed in the relevant sections of Employer's Requirements.

For unusual bespoke or critical elements of the civil works being fabricated, painted or tested off Site, the Contractor shall provide suitably licensed and qualified inspectors to be in full time attendance or carry out a regular visiting regime, depending on the industry bestpractice.

16.40.3 Inspection and Testing during Construction of theWorks

All water retaining structures shall be tested for water tightness in accordance with

Clause 18.18.5.

All pipelines shall be tested in accordance with Clause 24.10.

The Contractor shall provide all the necessary labour, materials and equipment to test water retaining structures, and pressure and non-pressure pipelines. Water testing of structures and pipelines shall be carried out using potablewater.

Construction materials such as concrete and its constituents, structural steelwork, piles, bitumen macadam, masonry, timber, steel grouts, sealants and all protective coatings shall be tested in accordance with the Employer'sRequirements.

All Materials supplied to or as part of the Works shall be new and subject to quality assurance inspection certification and testing to demonstrate their fitness for the purpose intended.

Where quality assured materials are not readily available or where compliance with national standards or equivalent is required, the Contractor shall supply test certificates demonstrating their compliance with the relevant specification.

16.40.4 Pre-installationInspection

The Employer's Representative shall be given the opportunity to visually inspect all items of Plant prior to installation to ensure that no damage has occurred during storage or transit.

16.40.5 Safety Inspection

Prior to commencement of the Tests on Completion of Design-Build, the Employer's Representative will arrange for an inspection to check that the Works comply with health and safety regulations. This inspection will in no way relieve the Contractor of any of his contractual responsibilities or liabilities.

16.40.6 Record Keeping

The Contractor shall keep a record of all tests and inspections including failed tests and shall pass these records to the Employer's Representative following each set of tests or inspection.

If specialist test equipment is used, the Contractor shall supply associated test sheets. Where the Contractor employs a specialist inspector, the inspector's reports shall be provided to the Employer's Representative on successful completion of manufacture or construction. Should the inspection period be in excess of one week, interim inspection reports shall be provided on a weekly basis.

17 OPERATION SERVICE PERFORMANCE REQUIREMENTS

17.1 General

In this section, the required performance of the Works during the Operation Service is described.

The Contractor shall be obliged to receive and accept all dry weather flow delivered to the interception facility during the Contract Period. The Contractor shall not stop or reduce the delivery of flows from the major nallas to the Dry Weather Flow Interception Facility . The Contractor shall not discharge any flows through an emergency bypass, except in an emergency and with the express permission of the Employer for each overflowevent.

17.2 Measurement of Qualitative and QuantitativePerformance

The minimum requirements for monitoring, sampling and analysis during normal operation are specified in Appendix B3.

The main monitoring and measurement requirements for the purposes of compliance and payment during the Operation Service Period are set out in Tables B3.2 and B3.3 of Appendix B3, however additional measurement points may be required to comply with the Contract. Any additional measurement points shall be installed by the Contractor at his cost.

17.3 PerformanceStandards

Noise Standards

The Works shall be designed, operated and maintained by the Contractor to ensure that the noise emanating from the Works does not exceed the limits set out in Table17-1below during operation, when measured at any position on the Site boundary.

Table 17-1Noise Performance Levels Outside of the Site

Time	Standard (15 minuteLeq)
06:00 – 22:00	55 dB(A)
22:00 – 06:00	45 dB(A)

The noise level 2m in a perpendicular direction from any point on any item of equipment (if unprotected) or the shell of a building or enclosure shall be continuously less than 80dBA.The noise measurements shall be carried out as per MPCB / Indian Standard.

Noise measurements shall be carried out whenever there is a complaint and in any event shall be monitored following any change in the plant design, or operation of the Works affecting noise levels.

Noise levels shall be measured using a calibrated sound level meter complying with BS EN 60651. Sound levels shall be monitored in accordance with ISO Recommendations R1996, 'Assessment of Noise with Respect to Community Response' as amended by ISO Recommendations, R1996/1, 2 and 3 'Description and Measurement of Environmental Noise' asappropriate.

17.4 Monitoring

17.4.1 General

Prior to the commencement of the Operation Service Period, the Contractor shall submit a schedule of tests and procedures to the Employer's Representative for approval, that will allow the Contractor to:

- Demonstrate effective Worksoperation;
- Demonstrate compliance with the Employer's Requirements; and
- Provide a basis for determination ofpayment.

For compliance with performance standards and for payment purposes, the required minimum frequencies for measurement for normal operation and reporting purposes are set out in separate tables in Appendix B3.

Figure B3.1 and Tables B3.1, B3.2, and B3.3 in Appendix B3 identify the minimum requirements for flow monitoring and recording facilities and identify the measurement points to be used for monitoring and measurement for compliance and for payment.

The instrumentation associated with the flow measurement for the main process streams shall record the flow rates in both daily and 15-minute averages.

Flow meters and other in-line meters shall be calibrated by the Contractor on a regular basis, in accordance with the manufacturer's recommendations. The accuracy of the flow measuring devices used for determination of payments shall be checked by the Contractor at a frequency agreed with the Employer's Representative. The Contractor shall submit a detailed methodology of this calibration to the Employer's Representative for approval.

The Contractor's information system shall be capable of displaying a minimum of two years' historical data. The system shall be capable of data handling, and management reporting as agreed with the Employer's Representative. The system shall also be compatible with the data recording systems used by the Employer to record parameters at other wastewater treatment facilities and allow export of data from the Contractor's information system to the Employer's data recording systems.

17.5 Failure to Meet PerformanceRequirements

17.5.1 General

If it is determined by the Contractor that the Works are failing to meet the performance requirements specified in this Volume for any reason, the Contractor shall take immediate remedial action and advise the Employer's Representative in writing of the specific cause for the failure and report the actions taken or the proposal to correct the deficiency.

If it is determined by the Employer's Representative that the Works are failing to meet the performance requirements specified in this Volume for any reason, the Employer's Representative will advise the Contractor in writing and the Contractor shall determine the specific cause for the failure and report to the Employer's Representative within 7 days on actions to correct thedeficiency.

Where the Contractor is unable to meet the specified contractual performance standards for whatever reason, and irrespective of whether the penalties described in the Schedule of Payments are applied, the Contractor shall use his best endeavours to maintain the performance standards as close to the specified levels as possible, at all times. Failure to do so will be deemed to be a failure of his contractual obligations.

Unless the following conflicts with more specific requirements relating to specific Failure Event types set out below, on the occurrence of a Failure Event, the Contractor shall:

- Notify the Employer of the location and extent of the Failure Event as soon as possible, and not more than 24 hours, after the Failure Event is apparent;
- Submit a report to the Employer within 3 days of the Failure Event, identifying and explaining the cause of the Failure Event, and the Contractor's plans for preventing a recurrence of the Failure Event;
- Implement the Contractor's plans for preventing recurrence of the Failure Event;and
- Report monthly on progress of implementation of the Contractor's plans for preventing recurrence of the Failure Event, measured agains the Contractor's plans until the Contractor's plans have been effected

17.5.2 Failure Events

In the event of a failure where an allowable exception cannot be identified, payment to the Contractor shall be adjusted in accordance with the terms of the Schedule of Payments for the OperationService.

Table 17-3Failure Events and Allowable Exceptions

Failure Event	Monitoring Aspect	Failure Event Description	Allowable Exception
1	Influent dry weather flow	Dry weather flow discharge to Mithi River.	Influent DWF greater than Flows specified in Appendix B1
2	Noise levels	Noise levels exceed performance requirements or complaints arereceived	None

In the event that the measurement and monitoring of the Works indicates persistent problems as evidenced by frequent failures in terms of the Failure Events identified, the Contractor shall promptly submit detailed proposals for remedying the problems to the Employer's Representative. Once the Employer's Representative has approved such proposals, the Contractor shall proceed to implement the proposed modifications at his own cost.

18 OPERATION MANAGEMENTREQUIREMENTS

18.1 General

The Contractor shall operate and maintain the Works in accordance with the Contract until the end of the Operation Service Period and during this period shall be responsible for all aspects of the dry weather flow interception facility and disposal of all screenings.

The Contractor shall be responsible for identifying off site location / land and route(s) for disposing all screenings arising from the Works and for paying all tipping and transportation charges and other associated costs including that for location / land. The Contractor shall dispose of all hazardous materials in accordance with existing laws and regulations. All permissions and consents from respective authorities shall be obtained by theContractor.

18.2 Employer's Communication

The Operation Service requirements shall apply to the whole of the Works.

The Employer shall keep the Contractor informed of proposed alterations to major infrastructure which may in the Employer's opinion. The Employer shall, except in the case of emergency, inform the Contractor where it intends to carry out any repair, maintenance, or upgrading of any part of the collection system which could have a material impact on the Contractor's ability to deliver the services.

18.3 The Site

The Site and access road are shown on the Contract Drawings in Volume 2D.

18.4 General Requirements

During the Operation Service Period, the Contractor shall take total responsibility for the operation and maintenance of the Works. As part of these general obligations, the Contractor shall undertake the following tasks:

- Provide all the staff for the managerial, technical, supervisory, and administrative responsibilities. and labour necessary to operate and maintain the Works safely and efficiently;
- Develop and implement the necessary procedures and information systems required for the OperationService;
- Carry out all flow measurement throughout the Operation ServicePeriod;
- Operate and maintain the Works, and ensure that all the itis able to operate at all times to its maximum installedcapacity;
- Achieve the performance criteria specified in thesedocuments;
- Satisfy all legal and environmental requirements for supply of water and disposal of sludge and other waste products for each day of the Operation ServicePeriod;
- Provide (including payment of all supply authority charges) all necessary services to the site, including electricity, water, gas, telecommunications, and any other services necessary for the provision of the OperationService;
- Utilise information gathered as a result of monitoring to determine what improvements can be made to optimise the operation of the interceptionfacility;
- Implement all systems required and record and make available to the Employer's Representative all necessary operation and maintenanceinformation;
- Keep and update the Operational Cost Model for the OperationService;
- Transport all waste by-products and screenings arising at theSite;

- Operate the Works in the most economic manner with respect to the consumption of energy and otherresources;
- Carry out the Tests Prior to ContractCompletion;
- Maintain the Works such that it remains in a visually and aesthetically pleasing condition at alltimes;
- Monitor all changes in legislation, codes or standards and bring these to the attention of the Employer's Representative;and Operate the Works to minimise the total long-term life cycle cost of the facility, supported by establishing the optimal timing and strategy to replace assets based on the historical operating and maintenance records.Management, Operation and Maintenance Personnel

The Contractor shall provide suitably qualified personnel for the management, operation, and maintenance of the Works. The personnel shall have skills in the following areas, but not confined to:

- Operationsmanagement;
- Maintenancemanagement;
- Assetmanagement;
- Analytical chemistry and laboratory proceduremanagement;
- Mechanical and electrical plant and equipment operation andmaintenance;
- ICA operation andmaintenance;
- Software, communications and IT systems programming andconfiguration;
- Facilities operation andmaintenance;
- Administration;
- Electrical and surveillance systems e.g.CCTV;
- Hard and soft landscaping operation andmaintenance;
- Quality management systems planning, implementation, management and auditing; and
- Health and safety planning, implementation, management andauditing.

All personnel employed by the Contractor shall be suitably qualified and have an appropriate level of training and experience in the area to which they are allocated. Prior to the commencement date, the Contractor shall submit details of the key personnel he proposes in each of the above areas to the Employer's Representative for approval.

The Contractor shall develop and maintain the competencies of personnel through yearly evaluations and encourage employee development, and reward, throughout the Operation Service Period.

All key personnel employed by the Contractor in the delivery of the service shall remain employees of the Contractor at all times. The Contractor shall not subcontract or assign any part of this obligation without the prior written consent of the Employer's Representative, which shall not be unreasonably withheld.

Should the Employer or the Employer's Representative be reasonably dissatisfied with the performance of any of the Contractor's personnel, the Contractor shall, at the Employer's Representative's written request, remove the said person(s) from the service. Any such personnel shall be immediately replaced by staff of equivalent or greater qualification and experience and this shall be subject to review by the Employer's Representative.

The Contractor shall ensure that there is a suitable level of continuity of key personnel.

Should the Contractor wish to change any personnel engaged directly in the management and operation of the service, the Employer's Representative shall be informed at least two months in advance, wherever practical.

The names, status, qualifications, years of experience and record of training of all personnel engaged in the Operation Service shall be provided as part of the Operation and Maintenance Plan. This shall include details of individual ongoing staff-training programmes. These programmes shall be updated and maintained regularly by the Contractor. Updates shall show evidence of the training carried out each year and training proposed for the following year.

Any new personnel or personnel reallocated to different duties shall be supervised by experienced staff until they are properly trained and have a level of experience deemed necessary for the service tasks being undertaken. This shall be deemed to be for a minimum of two months. The Contractor shall provide details, as part of the Operation and Maintenance Plan, of the measures to be taken to cater for these changes.

18.6 Health and Safety Requirements during Operation Service

The Contractor shall be responsible for all aspects of health and safety during the Operation Service Period and shall comply with all national and regional legislation and regulations.

The Contractor shall be responsible for the security of the Site and shall provide adequate security staff at all times to maintain site security and check incoming and outgoing traffic and persons for the duration of the Operation Service.

Throughout the Operation Service Period, the Contractor shall maintain a set of “Emergency Procedures”. The procedures shall identify the potential accidents and emergencies which could occur on the Works, and set out a clear plan of action to be followed, should any of these occur. The Contractor shall ensure that employees are aware of these procedures and display posters in prominent positions stating these procedures with emergency telephone contacts.

The Contractor shall agree emergency procedures with the emergency services and carry out emergency drills in accordance with statutory requirements and when recommended by the emergency services.

With respect to health and safety, the Contractor shall:

a) implement safe working and reporting procedures and promote safety awareness in every element of operation andmaintenance;

b) ensure adequate regard to site safetyincluding:

- Safe working procedures in all Works operation and maintenanceactivities;
- Cleanliness and care of thefacility;
- Reporting accidents and hazards;and
- Safe practice in sewers, tanks, and all otherelements..

18.7 Suppliers and Subcontractors

The Contractor shall be permitted to enter into contracts and agreements with subcontractors and suppliers for the delivery of non-critical parts of the Operation Service and/or for the supply of goods or services relevant to the Operation Service. Before entering into such arrangements, the Contractor shall submit details ofthe

Subcontractors and suppliers he proposes to use to the Employer's Representative for approval. He shall provide and update these details, as part of the O&M Plan.

18.8 Operation Service Monitoring Group

An Operation Service Monitoring Group (OSMG) will be formed for this Contract. The purpose of the OSMG will be to provide a forum for regular discussion by representatives of the Employer and Contractor of relevant ongoing matters relating to the Contract.

Meetings of the OSMG will normally take place at monthly intervals or at such longer intervals as may be agreed by the OSMG from time to time (such intervals not to exceed three months). A special meeting of the OSMG may be convened to address abnormal circumstances.

The Monthly Status Report (MSR) and in particular the Executive Summary of that report will provide the basis for much of the discussion at the OSMG meetings.

The primary role of the OSMG is to facilitate the harmonious implementation of the Contract and to provide comfort to the main stakeholders that the interests of all parties are protected. The Employer and Contractor will be kept informed of relevant operational aspects of the Contract by their representatives on the OSMG. However, the Employer's Representative, as defined in the Contract Documents, will be solely responsible for the issuing of instructions under the Contract.

It is proposed that the Employer be represented on the OSMG by one senior member of the Employer's organisation and by the Employer's Representative. It is proposed that the Contractor be represented on the OSMG by one senior member of the Contractor's organisation (Operations Manager) and by the most senior member of the Contractor's personnel on site, the Plant Manager.

One of the Employer's nominees will normally chair the meetings of the OSMG and one of the representatives of the Contractor will normally minute the proceedings. In certain circumstances, a special meeting of the OSMG may be held, to which an external stakeholder, such as a major local industry, may be invited, at the discretion of the Employer and Contractor.

The meeting agenda shall be generally based on the following generic headings, which may be changed as the Contract progresses or circumstances change:

- Minutes of lastmeeting;
- Monthly StatusReport(s);
- Complaints;
- Facility MaintenancePlan;
- Asset ReplacementSchedule;
- Operationalchanges;
- Compliancemonitoring;
- Third party interfaces;and
- Other issues asapplicable.

18.9 Real Time Reporting

To facilitate an appropriate level of real time reporting of relevant data, the Contractor shall provide easy and direct access to a view, and report facility for a limited number of parameters including:

Daily Readings;

- Power consumption from externalsupply;

ContinuousMonitoring;

- Inlet flow;
- Outlet flow;and

18.10 Monthly Status Report

A Monthly Status Report (MSR) is required to report the main events that have occurred and the significant aspects of the Works performance since the previous MSR. The Contractor shall provide such a report to the Employer's Representative on a monthly basis throughout the Operation Service Period. These reports shall be submitted within 14 days of the start of the month following that covered in the report. The MSR forms the basis of the agenda for the OSMG meetings.

The Contractor shall be responsible for ensuring that all relevant information required is gathered on Site and compiled correctly in the format required in the MSR.

The Contractor may add further reports by agreement with the Employer's Representative.

The MSR shall include a summary narrative section relating to the performance of the Works, covering the key performance areas listed in the Contract and any relevant issues that have arisen since the last report. The report shall also include performance indicators under each section, together with a comparison against the requirements of theContract.

The MSR shall be completed in full in the sequence shown in accordance with the minimum requirements outlined in Appendix E in order to deliver an acceptable MSR.

18.11 Service Delivery Review Report

The Contractor shall complete a Service Delivery Review Report at the frequencies stated in Volume 2A. The initial review shall be completed by the date stated in Volume2A.

The review shall focus on the effectiveness of service delivery and any issues arising, which require attention under the Contract. As a minimum, each review shall cover:

- Influentquantity;
- Routine and real timereporting;
- Operationalissues;
- Maintenance, (routine, planned, breakdown,emergency);
- Facility MaintenancePlan;
- Health and safetycompliance;
- Emergencyprocedures;
- Inspections andaudits;
- Testing;and
- Changeprocedures.

The Contractor shall develop a procedure for the Service Delivery Review Report as part of the Operation Service quality control procedures. The procedure shall outline the method for reviewing the above aspects of service delivery.

The Contractor shall carry out the review and present it in report format to the Employer's Representative. The report shall include summary information and any necessary appendices of data for reference purposes. Three copies of the report shall be provided. The reports shall be considered at the OSMGmeetings.

18.12 Operational Change

Operational changes may arise from the Service Delivery Review Report or at the behest of the Employer, Employer's Representative or the Contractor. They may also arise where there is any deviation from the service delivery requirements of the Contract. Operational change proposals shall be submitted to the Employer's Representative for approval prior to implementation.

As part of the Operation Service quality control procedures, the Contractor shall develop a procedure for operational changes. The procedure shall ensure that if operational changes are required, the changes will not affect the Contractor's delivery of the service. This procedure shall be implemented for any operational change within the Contract that is considered significant by any party to the Contract.

18.13 Management Meetings

Additional management meetings may be required to deal with specific issues during Operation Service.

18.14 Hours of Operation

Normal working hours shall be as stated in the Contract Data. Excluding any response to emergency events, working on Site by personnel outside these hours, may be permitted by the Employer's Representative in special circumstances, but this shall be at his discretion, and he shall have no obligation to allow it.

18.15 Routine Reporting

The Contractor shall ensure that all tests, analyses and measurements are routinely reported and that they clearly distinguish between the monitoring required to meet regulatory requirements and the monitoring required to meet Contract requirements.

18.16 Spares

During the Operation Service Period the Contractor shall replenish the stock of spares to maintain an equivalent stock of spares at all times,as required at the commencement of the Operation Service Period.

The minimum stock of spare parts held shall be the comprehensive spares required for a two- year period of Operation Service and shall be detailed in the Operation & Maintenance Plan. The Contractor shall monitor the use of spare parts and make recommendations to the Employer's Representative to vary the stock in accordance with the experience gained during the Operation Service Period.

A two-year stock of spare parts shall be provided by the Contractor with the Works handed back to the Employer on completion of the Contract.

18.17 Public Liaison

The Contractor acknowledges that the Employer shall be the sole point of contact for dealing with comments or complaints from customers of the Employer or members of the public relating to the provision of the Operation Services.

Where a customer of the Employer or member of the public makes a complaint to the Contractor, whether written or oral, in relation to any aspect of the Contractor's provision of the Operation Services, the Contractor shall notify the Employer's Representative as soon as practically possible.

Where any complaint or an enquiry has been received directly by the Contractor or received by the Employer and notified by the Employer to the Contractor, the Contractor shall report to the Employer's Representative within 24 hours in such a way that the Employer's Representative can respond prudently to the complaint in accordance with the good customer service expected.

Where a customer or member of the public has made repeated or ongoing complaints, the Contractor shall manage such complaints on a case by case basis, prepare an action plan, keep records of meetings and discussions with the customer, and submit regular progress reports at least monthly to the Employer, until such time as an agreed resolution or outcome is made with the customer or member of thepublic.

19 OPERATION AND MAINTENANCEPLAN

19.1 Overview of Requirements

As a fundamental part of the Contract for service delivery, the Operation and Maintenance Plan (O&M Plan) shall be agreed between the Employer and the Contractor. The O&M Plan shall become an evolving plan, agreed on an annual basis, which will include all aspects of the Operation Service as they are developed and applied within theContract.

The Contractor's O&M Plan for the Works shall comprise three main sections, as follows:

- O&MManual;
- Operation Management Plan; and
- Maintenance ManagementPlan.

The general structure of the O&M Plan shall be as highlighted below.

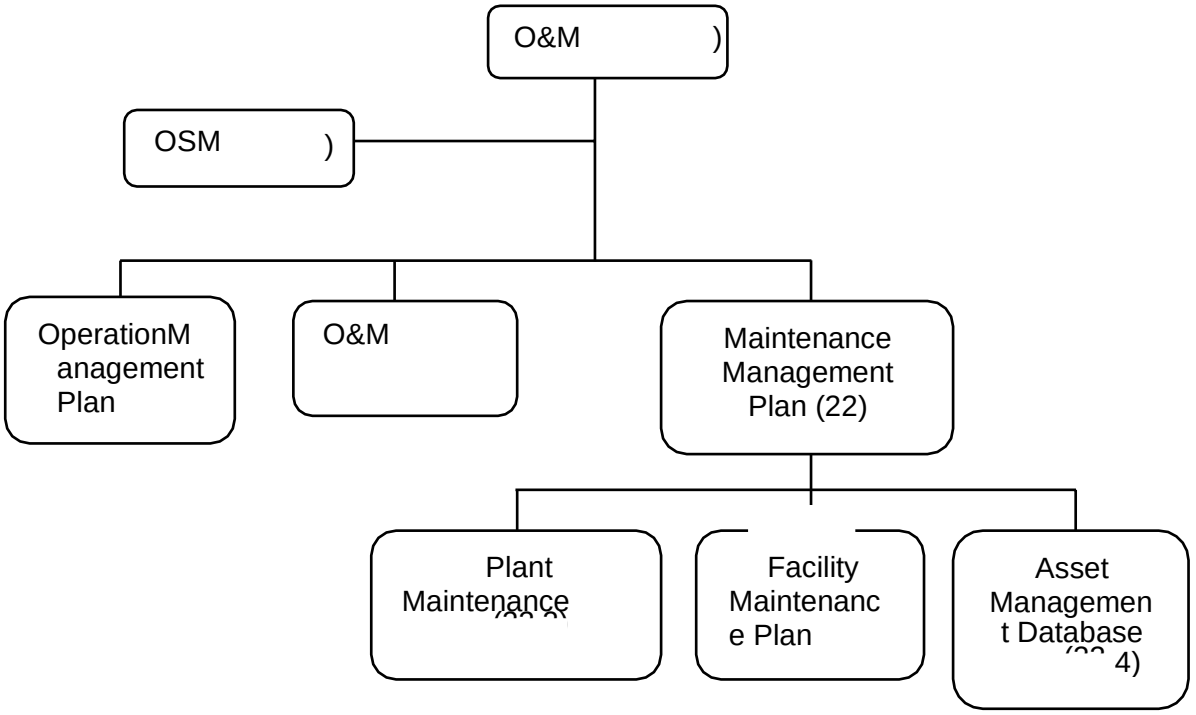

Figure 19-1 General Structure of O&M Plan

The Contractor shall submit the O&M Plan to the Employer's Representative by the times stated in Volume2A.

The O&M Plan shall ensure that the operation of the Service consistently complies with the output quality and quantity sections of this document. In addition, the O&M Plan shall ensure that the treatment, transportation, and disposal of sludge shall be carried out in an efficient and cost-effective manner in compliance with theContract.

The O&M Plan shall also ensure that the maintenance aspects of the Service shall be in compliance with all requirements on a continuous basis. It shall include systems for the safe, efficient and effective operation and maintenance of the Works, together with safe

systems of work and safe working procedures in compliance with current legislation.

The O&M Plan shall contain procedures for quality control in a separate section, together with procedures for compliance auditing and quality auditing. These shall confirm service delivery and compliance with technical, regulatory, and performance requirements.

The O&M Plan shall contain, but not be limited to:

- Staffing and details – responsibilities, qualifications andtraining;
- Plant replacementprogress;
- Designinformation;
- Operation and maintenancesystems;
- Health andsafety;
- Qualitycontrol;
- Monitoring;
- Reporting requirements and links to other documents;and
- O&M Manual(standalone).

19.2 Preparation and Implementation of the O &M Plan

The Contractor shall issue the O&M Plan in a 'manual' form with covering document control sheet to denote document status and date of issue. The O&M Plan shall be divided into sections, as per the structure outlined in Figure 19.1 with appendices for additional data where necessary. Three original copies of the O&M Plan shall be issued as a minimum. One copy shall be held at the treatment facility at all times and controlled copies shall be issued to the Employer and the Employer's Representative (one each). Should other copies be required, up to 3 additional copies shall be issued to the Employer, upon request.

The O&M Plan shall be a central point of reference for the Contractor in the delivery of the Service and shall be compiled and issued to the satisfaction of the Employer's Representative prior to the commencement of the Operation Service Period. The O&M Plan shall be implemented in accordance with the time limits in Volume 2A. To achieve this, the Contractor shall ensure that all resources and fully qualified and trained personnel are in place and that service requirements are being consistently met in accordance with the plan. The Contractor shall demonstrate this fully to the Employer's Representative.

Following the Service Delivery Review Report, the Contractor shall update the O&M Plan as appropriate, or at the intervals stated in Volume 2A.

19.3 Auditing the O & M Plan

The Employer's Representative can, at his own discretion or at the behest of the Employer, audit the Contractor's Operation Service performance against that required under the service as set out in the Contract and O&M Plan. The Employer's Representative and/or a third party specified by the Employer's Representative can carry out the audits.

Any remedial actions to the O&M Plan, or its implementation that are deemed necessary shall be discussed with the Contractor and the appropriate initiatives shall be agreed and issued to him, in writing, by the Employer's Representative. This shall include a specific timeframe for remedial actions to be taken.

Where there is a failure, on the part of the Contractor, to implement such initiatives within the specified timeframe, the Conditions of Contract provide that the Employer shall have the right to withhold payment until such time as the failure(s) are remedied. Should this

measure fail, the Employer shall retain the right to terminate the Contract and recover all costs associated with the employment of replacement staff, or Contractors.

19.4 Operation Management Plan

19.4.1 General

The Operation Management Plan shall be one of the three main parts of the O&M Plan and in itself shall comprise the procedures for the operation of the treatment facility.

The Operation Management Plan shall be capable of demonstrating in an easily identifiable schedule that the Works are and have continued to comply with the terms of all relevant licenses and legislation.

19.4.2 Procedures for the OperationService

The Operation Management Plan shall contain detailed procedures for the operation of the Works, including equipment and processes, which the Contractor proposes to use in delivering the service. A detailed control philosophy shall be provided for the dry weather flow interception facility, which shall be accompanied by a procedure for the operation of each individual item of the system. This shall form a set of clear instructions to operators and management in the dry weather flow interception facility.

The dry weather flow interception facility control system shall be capable of continuous automatic operations. The dry weather flow interception facility shall be capable of running under manual control, although normal operation shall be in automatic mode. Optimum performance of the Works is an important requirement of the control system.

19.4.3 Non-Compliant Operation

Notwithstanding the requirements defined in 'Tests on Completion of Design-Build', where the Employer is dissatisfied with test results, he may vary the location, parameter or analysis methodology for specified tests or may instruct the Contractor to carry out additional tests. If these varied or additional tests show that the tested quality or quantity of influent or effluent, Plant, Material or Workmanship is not in accordance with the Contract, the cost of carrying out these tests shall be borne solely by the Contractor. If, as a result of an examination, inspection, measurement, analysis or testing, any Plant, Materials, design or workmanship is found to be defective or otherwise not in accordance with this document, the Contractor shall promptly make good the defect at his own expense, and ensure that the item complies with the appropriatestandards.

Notwithstanding any previous test or certification, the Contractor shall, if so instructed by the Employer:

- Remove and replace any Plant or Materials which is not in accordance with this Contract;
- Remove and re-execute any other work which isnot in accordance with this Contract; and
- Execute work which is urgently required for the safety of the Works, whether because of an accident, unforeseeable event orotherwise.

Non-compliance determined by the Employer's Representative will be communicated to the Contractor by the most appropriate means and confirmed in writing. The Contractor shall determine the cause of non-compliance, identify the corrective measures, and report in writing within fivedays.

19.5 Maintenance Management Plan

19.5.1 General

The Contractor's Maintenance Management Plan shall comprise four main sections as follows:

- 1 - Dry Weather Flow Interception, Sewage Pumping Station and Storm Water Pumping Station(including Gate pumps) Facility MaintenancePlan;
- 2 - Facility MaintenancePlan;
- 3 - Asset Management Database;and
- 4 - Asset ReplacementSchedule.

The Maintenance Management Plan shall include the following:

- Operational maintenanceissues;
- Equipment calibrationrecords;
- Equipment servicerecords;
- Plant maintenance records;and
- Emergency eventrecords.

The Contractor shall also develop and implement a comprehensive computer-based maintenance management system which shall include data on each of the above sections. The computerised system shall address all Plant and Materials. It shall be capable of developing readily available historical data, including an inventory of spare parts and provision for enforcing warranties on Plant or Materials purchased. The Contractor shall also develop an Asset Management Database that includes every component of the Works. The database shall be structured to have 'parent/child' relationships for each component. The requirements of this Database are provided in the earlier section entitled 'Asset Management Database'.

The resultant maintenance work shall be logged as to when the work order was issued, when completed, by whom, duration of work, and listing of parts, and consumables used in expediting the work. This information shall be continuously updated for all equipment and presented on an annual basis to the Employer to confirm that work is being undertaken as required to protect investment in the infrastructure. The Employer, however, may request to review records more frequently.

The Contractor shall provide a weekly inspection to detect any significant variance from the baseline condition. Corrective action shall be taken by the Contractor to prevent major damage to equipment, as well as protect warranties on newequipment.

19.5.2 Dry Weather Flow Interception Facility, Sewer Pumping Station and Storm Water Pumping Station (including Gate Pump) Maintenance Plan

The Dry Weather Flow Interception Facility, Sewer Pumping Station and Storm Water Pumping Station (including Gate Pump) MaintenancePlan shall provide for the routine, planned, breakdown, and repair maintenance of mechanical, electrical, instrumentation, and electronic plant, equipment, and infrastructure contained within the Dry Weather Flow Interception Facility,Sewer Pumping Station and Storm Water Pumping Station. The plan shall be for the duration of the Operation Service Period and shall continually evolve, including all new equipment as it is installed.

The Maintenance Plan shall reflect procedures and standards for a modern Dry Weather Flow Interception Facility,Sewer Pumping Station and Storm Water Pumping Station. As

a minimum, all routine and preventative maintenance activities shall meet the requirements of suppliers, and shall not be less frequent, or less comprehensive than the requirements specified in manufacturers' warranties and instruction manuals.

The Maintenance Plan shall serve as the framework for developing the detailed maintenance plans for each item to be included in the O&M Manual. It shall therefore be based on a recognised quality maintenance methodology, for example the Reliability Centred Maintenance (RCM) approach. It shall also serve as a record of maintenance carried out on an ongoing basis, with reference to the O&M Manual where appropriate. The Contractor shall provide a statement of the methodology he proposes to the Employer's Representative for review before developing it in detail. As a minimum, the Maintenance Plan shall include:

(a) Schedules for the maintenance of the Works to include but not be limitedto;

- a complete list of assets of the Dry Weather Flow Interception Facility, Sewer Pumping Station and Storm Water Pumping Station, to be maintained;
- the frequency and type of routine and planned maintenance for asset of each Dry Weather Flow Interception Facility,Sewer Pumping Station and Storm Water Pumping Station;
- calibration of all instrumentation;and
- a listing of all essential spare parts to becarried;

(b) Methods for dealing with breakdown and repair of assets of Dry Weather Flow Interception Facility,Sewer Pumping Station and Storm Water Pumping Station toinclude;

- callout response times for asset of each Dry Weather Flow Interception Facility,Sewer Pumping Station and Storm Water Pumping Station;and
- communication with the Employer's Representative when breakdownsoccur;

(c) Procedures for the maintenance of assets of the Dry Weather Flow Interception Facility,Sewer Pumping Station and Storm Water Pumping Station;

(d) Methods for the planned replacement of assets of Dry Weather Flow Interception Facility,Sewer Pumping Station and Storm Water Pumping Station;and

(e) Records of all maintenance carried out at the Dry Weather Flow Interception Facility,Sewer Pumping Station and Storm Water Pumping Station, which shall be kept up to date and held electronically and in paper format at the Site at alltimes.

Plant and Materials shall meet the residual life requirements specified in the section entitled 'Handback Requirements' and be replaced as determined by the manufacturer's life warranties or earlier.

19.5.3 Facility Maintenance Plan

The Facility Maintenance Plan shall provide for the routine, planned and repair maintenance of all buildings, structures, roads, paths, accesses, lighting, surveillance, green areas, gardens, shrub and tree areas etc. contained within the Dry Weather Flow Interception Facility,Sewer Pumping Station and Storm Water Pumping Station Site. As a minimum, all routine and preventative maintenance activities shall meet the requirements of suppliers.

The Contractor's facilities maintenance plan shall include procedures and standards for a modern Dry Weather Flow Interception Facility, Sewer Pumping Station & Storm Water Pumping Station and its obligations shall not be less frequent, or less comprehensive than those specified in suppliers', or manufacturers' warranties, and manuals.

The plan shall ensure that maintenance is carried out at an adequate level for the efficient, long-term reliability and preservation of the Employer's capital investment. It

shall also ensure that buildings, grounds, and landscaping are kept in an aesthetically attractive and clean condition and in compliance with all national regulations.
The Contractor shall carry out ground maintenance so that all areas of the Site are kept neat, tidy and free of any item which could constitute a nuisance or pose a threat to the safety of any person, property, environment or to the provision of the Operation Services.

The Contractor shall include, but not be limited to, the following activities for buildings, structures, grounds, and Site:

Buildings andStructures

- Repairing/ replacing all worn out items, breakages and leaksimmediately;
- Cleaning roof guttering and drainage, windows and doors at six monthlyintervals;
- Cleaning and maintaining ventilation systems at six monthlyintervals;
- Washing down walls and wall tiles at least every six months, or more frequently, as appropriate;and
- Painting internal and external surfaces regularly (every 3 years as a guideline) and as detailed in maintenanceschedules;
- Maintenance of water proofing and damp proofing shall be done at regular Intervals every 12 months or when changes have been made to the structure near or around the installed waterproofing and damp proofingmembrane.

Grounds andSite

- Mowing the grass once per week in the growing season and once per month otherwise, including trimming of any edges, cutting hedges, shrubs, weeding and applying weed killer to maintain an attractive appearance of theWorks;
- Pruning trees once per annum to minimise interference with or damage to the Dry Weather Flow Interception Facility and Sitework;
- Cleaning paths and roadways on a monthly basis, including freeing surface water drainage systems, gullies andmanholes;
- Inspecting and repairing, as required, cracks, erosions, depressions, and potholes and slab shifts on paved areas, sidewalls and other areas on a monthlybasis;
- Inspecting and repairing, as required, security fencing, access gates and secure accesses to all Site areas on a monthly basis;and
- Resurfacing to paved areas whenrequired.

19.6 Asset Management Database

The Contractor shall develop an Asset Management Database that includes every component of the Works. The database shall be structured to have ‘parent/child’ relationships for each component. A sample asset hierarchy is provided in Appendix G to illustrate the required approach to the parent/child relationship of the Asset Management Database.

The number of systems, assemblies and components for each process area in the Asset Management Database shall be based on a threshold replacement value of each asset (INR 10 lac). If an asset does not exceed the threshold, it shall be grouped with similar assets that are part of the same component, assembly or system until the value of the group of assets exceeds the threshold value.

The following variables shall become fields in the database and the Contractor shall populate the fields for each component during the development of the Asset ManagementDatabase:

- Processarea;
- Component category (process, structural, building structural, architectural, building mechanical, building electrical, site works, piping, process equipment, process electrical orinstrumentation);
- Replacementcost;
- Year ofconstruction;
- Usefullife;
- Consequence of failure of the component on the operation of the facility on a 1 to 5 scale;
- Probability of failure of the component on the operation of the facility on a 1 to 5 scale;
- Risk of failure of the component on the operation of the facility on a 1 to 25 scale. Risk is defined as the product of the probability of failure and the consequence of failure;
- Size/capacity of thecomponent;
- Photograph of the component;and
- Estimated replacement time frame (0-5 years, 6-10 years, 11-25 years, > 25years).

The Contractor shall develop the Asset Management Database in Microsoft Excel, Microsoft Access or a commercial Asset Management software application. The Asset Management Database and software application shall be subject to approval by the Employer's Representative.

19.7 Asset Replacement Schedule

The Maintenance Management Plan shall contain all information in regard to the set-up, operation and status of the Asset Replacement Schedule and Asset Replacement FundExpenditure. The Asset Replacement Schedule shall be developed using the information that is contained in the Asset Management Database.

The Asset Replacement FundExpenditure shall be operated in accordance with Schedule of Payments in Volume3.

During the Contract, the Contractor shall keep the Asset Replacement Schedule up to date to reflect any changes that have occurred. This Modified Asset Replacement Schedule shall be based on the anticipated life expectancy of installed process plant. The Modified Asset Replacement Schedule shall be based initially on the Asset Replacement Schedule included with the Contractor's Tender Submission, then updated annually as experience is gained on the actual reliability of the various items of plant, to accurately reflect the planned operation, and maintenance of the Works. The tenth and all subsequent annual reviews shall extend the period covered by the Modified Asset Replacement Schedule to cover an additional five years beyond the Operation Service Period.

The Contractor shall be encouraged to introduce innovation and improved efficiency into the operation of the Asset Replacement FundExpenditure, where it can be demonstrated to be economically advantageous to the Employer in terms of improved efficiency, reduced environmental impact or cost reduction.

When the Contractor wishes to introduce an innovation, he shall put forward his proposal in writing to the Employer's Representative in accordance with the Schedule of Payments.

19.8 Operation and Maintenance Manual

The Contractor shall provide an Operation and Maintenance Manual (O&M Manual) to the Employer and the Employer's Representative in a "manual" form, with covering document control sheet to denote document status and date ofissue.

The manual shall be provided under the O&M Plan but as a separate standalone document, which shall form a hard copy technical reference for the works, (both new and existing). The manual shall apply specifically to the functional and technical aspects of existing and new installations, processes, equipment and components.

The manual shall commence with an introduction and general section comprising contents, description of the whole installation and relevant addresses and phone numbers of manufacturers and suppliers. This shall be followed by a description of the Works and its design, operation, control and protection. Following this, it shall contain clear, factual descriptions, instructions, diagrams, drawings and explanations of all installations, processes, plant and equipment. These shall be free from such irrelevant matters as might be contained in contractors', manufacturers' or suppliers' general or promotionalliterature.

Three original copies of the O&M Manual shall be issued as a minimum. One copy shall be held at the Site at all times and controlled copies shall be issued to the Employer and the Employer's Representative (one each). Should other copies be required, these shall be issued as agreed between the Employer and the Contractor.

All textural materials shall be bound in A4 ring binders and drawings bound in A3 4-ring binders, except where they accompany A4 text, where they shall be folded to A4 size. Binders shall have clear pockets in the front and spine.

The O&M Manual shall read such that it has been written specifically for the Works by the Contractor and shall not refer to Plant or Materials that are irrelevant. It shall be divided and sub-divided logically into a series of volumes for ease of use on a day to day basis and for ease of location of plant details, reporting procedures andpolicies.

The preparation of the O&M Manual shall be to a programme to be agreed with the Employer's Representative. This shall indicate the delivery schedules, draft submissions, collection and submission of suitable asset and maintenance data, collection and submission of the supplier's operation and maintenance manuals and a system for vetting and approving the manual. The O&M Manual shall be provided within the time shown in Volume2A.

For all installations and processes, the manual shall contain the following sections, as a minimum:

- Introduction;
- Safety, health and welfareinformation;
- Overview of thefacility;
- Description of the operation ofprocesses;
- Design information and relevantcalculations;
- Routine tasks and staff duties & task checklist;
- Functional descriptions of plantelements;
- As-builtdocumentation;
- Calibration reports for instrumentation, control and analoguecircuits;
- Fault findinginstructions;
- Maintenance instructions stating maintenance routines andintervals;
- Procedures for disassembly, repair andassembly;

- List of components indicating manufacture, type, component number, ordering numbers, position and otherdata;
- Manufacturer's or supplier's literature and dataleaflets;
- Lists of spare parts (including order references and partnumbers);
- Lists of tools;and
- Lists ofconsumables.

For mechanical installations, the manual shall contain the following sections, as a minimum:

- Machinery type and serialnumber;
- Machinery rated capacity and loadinformation;
- Operatinginstructions;
- Safety instructions;
- Emergencyprocedures;
- Lubrication charts (all equipment included in onechart);
- Maintenance instructions stating maintenance routines andintervals;
- Fault-finding details for rectification of basicfaults;
- List of spare parts giving part numbers in relation to a drawing preferably of the exploded view type (including order references and partnumbers);
- Manufacturer's or supplier's brochures accompanied with names andaddresses;
- Performance curves anddiagrams;
- Testcertificates;
- Specification of corrosion protection;and
- Specifications for repair of all painted/coatedsurfaces.

For electrical components the manual shall be divided into separate sections for the following installations:

- Controlpanels;
- Instruments;
- Control and measuring components (signallingsystem);
- Power Distribution and Single Line Diagrams;and
- Othercomponents.

For electrical, ICA and surveillance equipment the manual shall contain the following sections, as a minimum:

- CE labelling and declaration ofconformity;
- Layoutdrawings;
- Control Schematic and wiringdiagrams;
- Detaileddescriptions;
- Safety instructions;
- Emergencyprocedures;
- Operatinginstructions;
- Fault-findingcharts;
- Maintenance instructions stating maintenance routines andintervals;

- Componentlist;
- Lists of spare parts (including order references and part numbers);and
- For electrical and surveillance components, Operation and Maintenance manuals shall be provided from the original equipment manufacturers of suchequipment.

19.9 Plant Manager

No later than six months before the anticipated start of the Process Commissioning, the Contractor shall nominate a Plant Manager. As a minimum, the Plant Manager shall have:

- 12years' experience in the O&M of municipal TreatmentPlants;
- A bachelor degree in Engineering;and
- Operations Manager experience for at least two Sewage or Storm Water Pumping Stations which included silt / wasteremoval of similar size, process technologies, complexity, and capacity in the last7years.

The submission shall include details of the nominee's experience and qualification (CV). If a Plant Manager was identified in the prequalification process and if a different person is nominated during the Contract Period, the appointment of the Plant Manager shall be subject to approval by the Employer'sRepresentative.

The Plant Manager shall be appointed before the commencement of the Tests on Completion of Design-Build for the whole of the Works (including pre-commissioning tests) and shall be a full time appointment.

The Plant Manager shall be involved in:

- Development of the Operations Management Plan including the organisationchart;
- Compilation of a full asset register of the facility, and establishment of an asset maintenance system and operations system;and
- Establishment of a training plan and hiringof staff ahead of operations asnecessary.

Whenever the Contractor wishes to replace the Plant Manager, a nomination shall be submitted to the Employer's Representative for approval at least six months prior to the intended replacement date. The Contractor shall use best endeavors to ensure that the replacement Plant Manager shall have a working overlap of at least three months with the current PlantManager.

19.10 Operational Cost Model

The Contractor shall develop and maintain current throughout the Operation Service Period an Operational Cost Model which shall be based on the financial cost model submitted with the Tender Submission but which shall fully reflect the actual costs being incurred and anticipated to be incurred during the Operation Service. The Operational Cost Model shall be submitted to the Employer's Representative for review as requested by him.

The Operational Cost Model shall be made available for review by the OSMG and shall be updated quarterly. The OSMG shall be entitled to see any financial information relating to the Operation Service that may be reasonably requested from theContractor.

19.11 Independent Compliance Auditing

As part of the O&M Plan, the Dry Weather Flow Interception Facility, Sewer Pumping Station and Storm Water Pumping Station shall be inspected annually by the Employer's Representative and/or an independent Engineer approved and overseen by the Employer's Representative. The purpose of the annual inspection

shall be to verify that the operation and maintenance of the treatment facility is performedin conformance to the O&M Plan and the requirements of theContract.

The Contractor shall develop a compliance auditing plan which shall address:

- Tests for each piece of equipment to determine its physical and operational conditions;and
- The physical and operational conditions, and general status of repairs, of all equipment, buildings, structures, pavements, grounds, utility lines, spare parts, inventories,etc.

The Employer's Representative and/or the independent Engineer shall prepare a detailed report documenting the findings of the inspection. The report shall include an assessment of the current conditions of each item or component, its estimated remaining service life, and whether the current conditions are consistent with the maintenance and general upkeep requirements of the contract and in accordance with the O&M Plan. A copy of the report shall be submitted to Employer's Representative forreview.

In the event that such inspections reveal work not in accordance with the O&M Plan or with the Contract or lack of repairs or necessary maintenance to the Dry Weather Flow Interception Facility or equipment, the Employer's Representative shall bring to the attention of the Contractor such items and the Contractor shall perform the repairs and maintenance activities identified by the inspection.

The annual inspection shall also review:

- Chemicals (all areas where chemicals and hazardous materials are stored or used, procedures, and records shall be inspected to ensure compliance with the O&M Manual and all applicable regulations andstandards);
- Operation Service records (all records kept by the Contractor, including safety and emergency conditions records shall bereviewed);
- O&M Plan (conformance to approvedplan);
- Training and staffing plans (conformance with approved training and staffing plans);and
- Health and Safety Plan.

20 HANDBACKREQUIREMENTS

20.1 General

At the end of the Operation Service Period, the Contractor shall handback the Works to the Employer.

Immediately prior to the end of the Operation Service Period, the Contractor shall carry out final repairs to the Works. These shall include repainting as necessary and making good any defects or damage. The Contractor shall replace all spare parts and consumable stores used in the Works and top up all fuel, oil, and water tanks.

The Works shall be handed back in a condition which would permit the Works to receive influent, treat, and dispose of effluent subsequent to Handback in accordance with the standards required by the performance requirements (assuming that the Works are operated and maintained in accordance with the Operational Specifications and Maintenance Specifications).

The whole of the Works shall be handed back in a clean and maintained state and in full operation and good working order.

The Plant and Materials shall have been maintained in accordance with the Maintenance Management Plan.

20.2 Residual Life and Planned Asset Replacement at Handback

At the time of Handback, all Permanent Works shall be in a condition in which the components of the Works identified in the table below shall satisfy the remaining useful life specified in the table.

Table 20-1 Residual Life at Handback

Item	Minimum Remaining Useful Life
Civil engineering and building works (includingunderground services and pipes)	40
External pipework	40
Roads	15
Mechanical – internal pipework and valves	15
Mechanical – rotating machines and complex equipment	03
Mechanical – Gate Pump, Actuator, etc.	05
Electrical - cables	15
Electrical - HT electrical, transformers &switchgear	10
Electrical - LT electrical and switchgear	03
Instrumentation	04

The Contractor shall manage the scheduling of the replacement of assets such that there are no planned replacements (as identified in the Modified Asset Replacement Schedule) during the 5 years following ContractCompletion.

20.3 Notification of Expiry of the Operation Service Period and JointInspection

The Employer shall notify the Contractor of the intended date for the expiry of the Operation Service Period not less than two years before the said date.

Upon receipt of the Employer's notification and in accordance with Clause 11.8 of the Conditions of Contract, the Contractor and the Employer's Representative shall carry out a joint inspection of the Works to identify any defects, damage, and plant replacements that may be necessary prior to the expiry of the Operation Service Period.

The Contractor shall provide a programme for making good the defects and damage and replacing items of plant, all as identified in the joint inspection, for approval by the Employer's Representative.

The Contractor and the Employer's Representative will carry out further joint inspections at intervals not exceeding 6 months. They will assess the Works condition and operation, progress with the implementation of the above measures and identification of any further measures to be implemented.

20.4 Tests Prior to Contract Completion

20.4.1 Procedure

The Contractor shall carry out Tests Prior to Contract Completion in accordance with Clause 11 of the Conditions of Contract and the Employer's Requirements.

The Contractor shall prepare a detailed method statement for carrying out Tests Prior to Contract Completion and submit it to the Employer's Representative for review. The Tests Prior to Contract Completion shall be similar to the procedures for the Tests on Completion of Design-Build described in Section 14. These shall include flow measurement, developed to include new elements of the Works added since the Tests on Completion of Design-Build were carried out, and modified to include procedures and methods appropriate at the end of the Operation ServicePeriod.

As a minimum, Tests Prior to Contract Completion shall demonstrate to the satisfaction of the Employer's Representativethat:

a) The Works are meeting the required performance, current at the time of testing and all other outputs conform with current legislation and regulations under all operating conditions that can beexpected;
b) The Works comply with the Contractor's design and the Employer'sRequirements;
c) The capacity and efficiency of all Plant and process units are within the designlimits;
d) Disposal of site products, by-products, sludge, and waste is in accordance with current legislation;and
e) All Plant and the Works remain fit for their intendedpurposes.

The inspections, tests, monitoring and analysis shall be witnessed by persons nominated by the Employer's Representative.

The Tests Prior to Contract Completion shall be deemed to have been completed when the Works have been operated without breakdown of any item of Plant for a continuous period of one month and compliance with all the criteria stated above has been demonstrated to the Employer's Representative's satisfaction and the results of the tests have been submitted to the Employer's Representative as stated below.

The Contractor shall be responsible for any remedial measures necessary to achieve the above criteria.

No inspection, or approval or failure to give approval/consent to or response by the Employer's Representative or his staff of the Works, Plant and Materials shall release the Contractor from any of his obligations under theContract.

It is a requirement of the Contract that all Plant and Material shall be suitable for ongoing use to the benefit of the Employer at the conclusion of the Operation Service Period. Accordingly, they shall comply with the residual life requirements of the section entitled 'Handback Requirements'. This shall be assessed by the Employer's Representative by reference to the Works condition and where relevant to the history of its performance, breakdown, and maintenance, etc.

Where residual life expectancy does not meet the Contract requirements, the Employer shall have the option to deduct money from the final payment due to the Contractor, or seek damages in lieu of the Plant beingreplaced.

Inspection of the Works for the purposes of assessing the residual life of the Works shall be part of the Tests Prior to ContractCompletion.

20.4.2 Handback of the Works to the Employer

The Works shall be transferred to the Employer at the date stated in the Contract Completion Certificate in accordance with Clause 8.6 of the Conditions of Contract.

Shortly before Handback of the Works, the Contractor and the Employer's Representative shall carry out a final joint survey of the Works. A schedule of minor defects shall be compiled by the Contractor and submitted to the Employer's Representative. Upon the Employer's Representative being satisfied regarding such final inspection and subject to the Contractor having successfully completed the Tests Prior to Contract Completion, the Employer's Representative shall issue to the Employer and the Contractor a Contract Completion Certificate stating any minor works remaining to be completed. The Employer shall thereafter be responsible for the care, safety, operation, servicing, and maintenance of theWorks.

20.4.3 Training of the Employer's Operators

The Contractor shall provide formal training and hands-on experience to the Employer's operators during the last twelve months of the Operation Service Period.

20.4.4 Final Documentation

Prior to commencement of the Tests Prior to Contract Completion, the Contractor shall submit to the Employer's Representative three copies of a final version of all the documentation utilised and required for the operation and maintenance of the Works. As a minimum, this shall be the documentation required in Sections 14and 17 and health and safety documentation required by legislation. It shall include inter alia up to date recordsof:

- Updated as-built drawings of the Works (hard and softcopy);
- Design details (calculations etc.);
- Operation and Maintenance Manual including standard procedures, emergency procedures and environmental managementprocedures;
- Plant inventory and data sheets for each item ofplant;
- Software for all programmable devices (PLCetc.);
- Maintenance Management Plan including the Modified Asset ReplacementSchedule;
- Records of test results, inspections, surveys, investigations, monitoring, sampling, analysis (if not includedelsewhere);

- Control system functional designspecification;
- Monthly Maintenance Reports for the previous sixmonths;
- The last two annual maintenance reports;and
- Schedule of outstanding repairorders.

Any changes arising from the Tests Prior to Contract Completion shall be made prior to Handback of the Works.

APPENDIX A

APPENDIX A – DESIGN STAGE CONTRACTOR'S DOCUMENTS

The schedules in this Appendix identify typical minimum design stage details that shall be **submitted as part of the Contractor'sDocuments.**

A1 Civil

General

- Site layouts providing information on levels and detailing the locationof;
- Buildings;
- Processplant;
- Roadways;
- Drainage;
- Buriedpipelines;
- Cable routes for direct in ground and ductedsystems;
    - Plans, elevations and main sections of all structures andbuildings;
    - General arrangements and main sections of all facilityareas;
    - Drainageprovisions;
    - General arrangement drawings showing the location of each Plantitem;
    - Detail drawingsof;
        - Cable and pipeworkchambers;
        - Buriedpipework;
        - Pipework connections;and
        - Contractinterfaces;
    - Reinforcementdrawings;
    - Bar bending schedules;
    - Calculationsfor;
        - Structural;
        - Civil design;and
        - Earthworks and foundationdesign.

A2 Process

- Drawings;
- Comprehensive P&IDs including detailsof;
- Pipeline sizes and materials valve size and type;
- Instrumentation;
- Identification of controlling PLC;and
- Pumping hydraulic calculations (including surge analyses if appropriate);
- Plant hydraulicflows;
- Electrical;and
- Electricaldrawings;
- Power distribution single line drawing for the Dry Weather Flow Interceptionfacility, Sewer Pumping Stations and Storm Water Pumping Stations;
- Single line and schematic drawing (see note 1) for each switchboard andMCC;
- Internal and external (see note 2) general arrangement for each switchboard and MCC;

- General arrangementdrawings;
- Cable blockdiagrams;
- Cable connection diagrams (orschedules);
- Cable routing / installationdrawings;
- Foundation and fixing details drawings;and
- Earthing system general arrangementdrawings;
- Electrical schedules cableschedules;
- Load and power consumption schedule junction box schedule;and
- Electrical calculationsfor;
- Cable sizing fault level;and
- Documentation;
- Functional design specification(FDS);
- Factory acceptance test document (FAT);and
- Site acceptance document(SAT).

A3 Electrical BuildingServices

- Drawings;
- Single line schematic for each distribution and sub-distributionboard;
- General drawings showing the location of each luminaire, socket outlet, fan etc. including details of mounting height;and
- Fixingdetails;
- Schedule;
- Luminaire data sheets socket outlets datasheets;
- Lux level calculations for lightingdesign;
- Fan data sheets;and
- Calculations for cable sizing lightinglevels.

A4 Control andInstrumentation

- Drawings;
- Power supply distribution single line and schematic diagrams (see note 1) for each controlpanel;
- Internal and external (see note 2) general arrangement for each control panel (dimensional);
- Control and instrumentation loop drawings (see note3);
- Instrument installation detail drawing (hook up, see note4);
- Cable blockdiagrams;
- Cable routing / installationdrawings;
- Foundation and fixing details and trench drawings;and
- Mimic generalarrangement;
- Schedules;
- Cableschedule;
- Cable interconnectionschedule;
- Control and instrumentation load schedule for each controlpanel;
- I/Oschedule;
- Junction box schedule instrument schedule;and

- Instrumentation, process control set point schedule instrument datasheets;
- Documentation;
- Functional design specification(FDS);
- Factory acceptance test document (FAT);and
- Site acceptance test document(SAT).

Notes:

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 eachcomponent.
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 instrumentlabels.
3. Control and instrumentation loop drawings shall show the complete circuit associated with an instrument or device including details and location of power supplies, cabling and terminations on a singledrawing.
4. Hook up drawings shall detail how an instrument or device is installed. Electrical control schematics, loop diagrams and schedules shall, where practical, be A3 size drawings; all other drawings shall be A1size.

A5 Mechanical

- Drawings;
- General arrangement of plant, pipework and ducting, includingsections;
- Isometric views of pipework and ducting systems;and
- Detail drawings of proprietary and fabricated plantitems;
- Schedules;
- Pumpcurves;
- Plant performance details pipelineschedules;
- Valve schedules;and
- Calculations for pumps andpipelines.

A6 Mechanical BuildingServices

- Drawings;
- Single line schematics for drainage systems;and
- General drawings showing the location of each mechanical building service plant item fixingdetails;
- Schedule;
- Plant data sheets pipeline schedules;and
- Valveschedules;
- Calculations for systemsizing.

APPENDIX B

APPENDIX B – PERFORMANCE REQUIREMENTS

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APPENDIX B1 – DESIGN FLOWS AND LOADS

Influent Parameters

Table B1.1 –Not Used

ADWF and PFF are based on the short term dry season flow and load survey carried out in Feb / Mar 2017.
BOD, COD, TSS and NH_3 – N are based on theoretical concentrations for design purposes.

The Contractor shall design the interception works based on the flows and loads in Volume5.

Refer to Volume 5 for details of the short term dry season flow and load survey carried out in Feb / Mar 2017.

Effluent Parameters

Table B1.2 –Not Used

Table B1.4 –Not Used

Table B1.6–Not Used

APPENDIX B2 – NOT USED

Table B2.1 – Not Used

Table B2.2 – Not Used

Table B2.3(a) – Not Used

Table B2.4 – Performance tests concerning sewage screening and screenings handling

Parameter	Performance criteria	Test background and procedure
Dry solids content in the washed and dewatered screenings	Not more than one spot sample of screenings taken over seven consecutive days shall have the dry solids content lower than the designedvalue	There will be no formal sampling programme. Measurements may be made at the request of the Employer'sRepresentative.
Organics content in the washed and dewatered screenings	Not more than one spot sample of screenings taken over seven consecutive days shall have the concentration of organic solids content higher than the specified performance standard.	There will be no formal sampling programme. Measurements may be made at the request of the Employer'sRepresentative.
Screenings removal efficiency and quality	There shall be minimal carryover of screenings during the test period. The screenings shall be sufficiently clean at all times for disposal at the Designated Landfill Site.	The carry over shall be assessed visually at random by the Employer's Representative.
Continuous operation and reliability of screens, washing and dewatering plant.	The downtime of any unit over the test period shall not be greater than 4%.	The Contractor shall keep an operation and maintenance log for each unit.

Table B2.5 – Not Used

Table B2.6 – Not Used

Table B2.7 – Not Used

Table B2.8 – Not Used

Table B2.9 – Not Used

Table B2.10 – Not Used

Table B2.11 – Not Used

Table B2.12 – Not Used

Table B2.13 – NOT USED

Table B2.14 – Not used

Table B2.15 – Performance Tests Concerning Noise

Parameter	Performance Criteria	Test background and procedure
The noise level of equipment	The noise level 2m in a perpendicular direction from any point on any item of equipment (if unprotected) or the shell of a building or enclosure shall be continuously less than80dBA.	1. Noise levels shall be measured by the Contractor using a suitable hand held instrument. 2. Noise measurement shall be carried out to ISO Recommendations R1996 & 1996/1, 2 and 3 asappropriate.
Noise levels at Site boundary between 22:00hrs and06:00hrs	Noise levels from the Works shall be continuously less than 45dBA (15 min Leq) at the Siteboundary.	
Noise levels at Site boundary between 06:00hrs and22:00hrs	Noise levels from the Works shall be continuously less than 55dBA (15 min Leq) at the Siteboundary.	

APPENDIX B3 – MONITORING, SAMPLING AND ANALYSIS

Table B3.1a – Minimum monitoring, sampling and analysis during normal operation

For notes see following page.

Table B3.1b – Minimum monitoring, sampling and analysis during normal operation

Table B3.2 – Not Used

Table B3.3 – Programme of Analyses – for Payment Purposes

APPENDIX C

APPENDIX C – EMPLOYER'S ACCOMMODATION

Appendix C1 Employer's Accommodation for Design-Build Period

APPENDIX C1 – EMPLOYER'S ACCOMMODATION FOR DESIGN-BUILD AND O&M PERIOD

C1.1 Accommodation

Table C1-1 Accommodation

Type	MinimumArea (m^2 each)
General Offices (Double) (with A/C) (2 no.)	12
Store Room (with A/C)	6
Kitchen (with A/C)	12
Dining (with A/C)	12
WC (1 no.)	4
Shower Rooms (1 no.)	4
Changing Rooms (1 no.)	12

A/C – Air conditioning

C1.2 Office Equipment and Supplies

Accommodation shall be fitted out as required by the Employer's Representative. All equipment shall be new.

Table C1-2 Office Equipment and Supplies

Item	No.
Office desk min. size 1.5m x 0.85m with 3 drawers	4
Arm chairs swivel type	2
Swivel chairs (no arms)	2
Table 1.5m x 0.85m	1
Stacking chairs	1
A0 drawing hangers complete with A0 hangers.	1
Four draw suspension type filing cabinets	2
Shelving 225mm wide x 50m	1
Plan chest A0 size, 6 drawers	1
15" rotating electric fans	2
Wastepaper bins	4
Boot scraper	1
Pin-up boards and pins	2
Door mats	2
Coat hooks	4
A3/A4 high speed photocopier	1
Fax machine	1
Mobile phone	4

C1.3 ITEquipment

The following IT equipment shall be provided by the Contractor and fitted out in the accommodation. It shall all be new and from a source to be approved by the Employer's Representative and the Contractor shall take out a Maintenance Contract for all of the supplies equipment for the duration of its life on Site. The Maintenance Contractor shall report only to the Employer's Representative.

Office Computers

2 No. high specification modern laptops complete with large capacity hard disc drive and RAM, large colour monitor, mouse, fax modem, DVD/CDRW drive, USB drives, etc.

2 No. high specification modern desktops complete with large capacity hard disc drive and RAM, large colour monitor, mouse, fax modem, DVD/CDRW drive, USB drives, etc.

1 file server with networking software, large capacity network storage and associated backup device.

All computers shall be provided complete with standard software including Microsoft Windows and Office Suite. Additionally 1No. of the desktop computers shall be provided with Autocad and one of the laptops shall be provided with Primavera.

The Contractor shall be responsible for cabling, setting up, configuring and maintaining the network.

Network printers, scanners and copiers (all printers to contain approved network card connected to all office computers) as follows:

- 1 No. laser A4/A3;and
- 1 No. laserA4.

Other Items

The Contractor shall be responsible for the provision of high speed broadband connection (10 mbps) for e-mail/internet access at all office computers for the duration of the Design Build and O&Mperiod.

C1.4 Equipment

The Contractor shall provide the following equipment for the exclusive use of the Employer's Representative and staff for the duration of the construction phase of the Works:

The equipment shall be new and from an approved supplier. The Contractor shall supply current calibration certificates for survey equipment and maintain, calibrate and insure the equipment through the Construction Phase of theWorks.

C1.5 ProtectiveClothing

The Contractor shall provide the following protective clothing for the exclusive use of the Employer's Representative and staff:

Table C1-4 ProtectiveClothing

Item	No.
"Goretex" or equivalent waterproof coats and leggings	6
Reflective jackets	6
Disposable overalls	3
Work boots steel toe capped	6
Wellington or equivalent boots steel toe capped + sole lined	6
Hardhats	6
Ear plugs, pairs	12
Gloves	6
Gumboots	6
Sunglasses	6
Harness	6
Portable H2S monitoring device	2
Storage cupboards	3

C1.6 Kitchen and DiningEquipment

The Contractor shall equip the kitchen with the following items:

Table C1-5 Kitchen and Dining Equipment

Item	No.
Fully plumbed stainless steel sink and draining board	1
Work top (3 m^2)	1
Stools	4
Cupboard	1
Refrigerator	1
4 ring gas burner	1
Microwave oven	1
Kitchen table	1
Dining tables	1
Chairs	6
First aid box	1
Mugs	8
Plates and cutlery (sets)	8
Washing up bowl	2
Tray	4

C1.7 Stationery & General

The Contractor shall provide stationery and general consumable office supplies for the sole use of the Employer's Representative and staff. The cost of providing these items shall be recoverable on verification of receipts by the Employer's Representative against the relevant provisional sums. The Contractor shall ensure the following items are procured at competitive rates from an approved source:

- Office stationery(pens, pencils, erasers, stapler, punching machine, highlighter, post-it, filing, filing ancillaries, note books, A4 writing pads, paper cutting knife, A3/A4 Papers, A3/A4/A5 envelopes,etc.);
- Postagestamps;
- Batteries;
- Printer cartridges;
- Washing upliquid;
- Handtowels;
- Soap;
- Handcleanser;
- Papertowels;
- Replacement items for first aidbox;
- Barrier cream;
- Disinfectant;
- Cleaningmaterials;
- Dustpan,brush;
- Softbroom;
- Hardbroom;
- Wastebin;
- Doormats;and
- Bucket andmop.

APPENDIX D

APPENDIX D – TYPICAL PLC INPUT/OUTPUT (I/O) SCHEDULE

Typical I/O Schedule

Table D-1 Typical PLC Input/Output (I/O) Schedule

Item	PLC I/O			
	DI	DO	AI	AO
1. Each drive				
Running	X			
Trip/fault	X			
Available	X			
Alarm state	X			
Speed command				X
Run command		X		
Emergency stop operated	X			
Available	X			
Hours run	X pulse			
Duty drive selected	X			
2. Each motor actuated valve				
Open state	X			
Closed state	X			
Fault	X			
Available	X			
Open command		X		
Close command		X		
3. Main distribution board incomers and generator incomer				
Closed	X			
Tripped	X			
Power consumed incomer 1	X pulse			
Power consumed incomer 2	X pulse			
Loss of mains power	X			
4. Generator				
Running	X			
On load	X			
Available for automatic use	X			
Fault	X			
Fuel system fault	X			
Low fuel level	X			
5. Level (digital)				
High high	X			

Item	PLC I/O			
	DI	DO	AI	AO
High	X			
Low	X			
Lowlow	X			
6. Level (analogue)				
Value				
Fault	X		X	
7. Flow (analogue)				
Value	X pulse		X	
Fault	X			
8. Pressure differential (analogue)				
Value			X	
9 Each Monitoring and Control Instrument				
pH value			X	
Analogue output instrument			X	
Digital output instrument	X			
10. Control systems / General Equipment				
110 V ac mcbtripped (common for each CP)	X			
24 V dc mcb tripped (common for each CP)	X			
UPSfault	X			
UPS battery low	X			
PLCfault	X			
Radio system fault	X			
11. GeneralEquipment				
Intruder alarm activation	X			
Fire alarmactivation	X			
Gas detectionalarm	X			

APPENDIX E

APPENDIX E – MONTHLY STATUS REPORT IN OPERATIONS PERIOD

Minimum section requirements of Monthly Status Report (MSR)

Table E1 Monthly Status Report in Operations Period

Section	Minimum Requirements
1. Introduction	A brief summary, including: • the date on which the Operation Service Period commenced, in accordance with the CommissioningCertificate; • the number of MSRs produced since the Operation Service commenced; • the period covered by the reportand • confirmation that all issues relevant to the Site activities and Works performance during the reporting period covered are included in the body of thisreport.
2. Executive summary	A clear, concise summary of the main events that occurred and the significant aspects of Works performance during the reporting period. This Section shall include, where applicable, descriptions of: • analysis results for the reporting period and whether the results were within the specification of theContract; • any reasons why the analysis results are not within the requiredspecification; • recommendations to improve the efficiency of the treatment process and quality of the outputs of thefacility; • any complaints that were received and how they were dealt with; • any alarmcallouts; • any new procedures that were implemented and when they commenced; • any health and safety issues raised since the lastreport; • any equipment that was taken out of / put intoservice; • planned vs actual operation &maintenance activities and target ratios;and • other issues of relevance (e.g. implementation of Independent Compliance Audit, asencountered).
3. Graphical presentation of data	Flow data and analysis results shall be tabulated and graphed for each process parameter listed using a proprietary computer package: • total daily inletflows; • total daily outletflow; • BOD, suspended solids and other parameters of final effluent as per the consent;and • the permissible flow and effluent limits, as defined by the Contract,shall be indicated on allgraphs.
4. Comments on	The analysis results shall be discussed in sufficient detail to allow

Section	Minimum Requirements
analysis results	the performance of the Works to be assessed thoroughly in comparison to the requirements of the Contract. During any problematic period of service delivery, all aspects of the Site results shall be commented on in detail. Specific reference shall be made to thefollowing: • final effluent quality compared to discharge standard requirements; • mixed liquorfigures; • microscopic analysisresults; • raw influent figures;and • thickened sludgefigures. • any major change in results since the previous reporting period; • digester contentsresults; • activated sludgefigures; • figures for the dewatering equipment;and • any other issues ofrelevance.
5. Process operational changes	Table showing any process operational changes made with the following headings: • description of the change made to the operationalprocess; • purpose of thechange; • date the change was implemented;and • name and position of person who carried out thechange.
6. Health and safety issues	Health and safety issues that have arisen on Site during the reporting period are commented on in this section. It shall include details of any Site inductions or training undertaken. Any accidents or incidents shall be reported in full together with statisticalresults.
7. Operational maintenance issues	The snags, listed in tabular format, that are dealt with on Site during the reporting period are taken from the previous MSR. Table to include: • snagnumber; • nature of the snag, i.e. mechanical, controls, electricaletc.; • description of thesnag; • priority status of thesnag; • any comments relevant to any corrective action already taken; and • date the snag was firstreported.
8. Complaints register	Complaints shall be logged in a standard, systematic fashion and shall be dealt with appropriately in accordance with the Contract and reported in this section of the MSR. The information required to complete the complaints register is: • complainant's name andaddress; • date and nature of thecomplaint;

Section	Minimum Requirements
	• date of acknowledgement to the complainant andauthor; • action taken to eliminate or mitigate the cause of the complaint; • cause of thecomplaint; • author of the final outcome report;and • date the final outcome report was forwarded to theEmployer.
9 Alarm callouts and site incidents	The details of all alarm call-outs (events outside of normal working hours) and Site incidents (events occurring during normal working hours).
10. Analysis results	The results of sampling and laboratory analysis required in accordance with the Contract.
11. Site visit records	A record of all visitors shall be kept on Site and presented in each MSR. The record shall include: • date the Site visitoccurred; • name, company and position of the person(s) thatvisited; • arrival and departure time;and • purpose of thevisit.
12. Weather records	A log briefly describing the weather for each day during the reporting period.
13. Equipment calibration records	Site equipment shall be calibrated regularly, in accordance with the manufacturer's instructions and based on the calibration schedule available from the Site database or when a piece of equipment is put back into service. If Site equipment is calibrated during the reporting period, the details are entered into the equipment calibrations record and included in this section of the MSR. The data to be included, in tabular format, is asfollows: • date the calibrationoccurred; • description of the equipment that wascalibrated; • serial number of the equipment that wascalibrated; • by whom the equipment was calibrated (name andcompany); • when the next calibration isdue; • whether a calibration certificate was produced;and • any relevantcomments.
14. Equipment service records	Site equipment shall be serviced as frequently as stated in the suppliers' literature or the O&M Manual or if a fault occurs with the equipment and it needs repair. The equipment service record shall present in tabular format, the details of each service including: • date the serviceoccurred; • description of the servicedequipment; • serial number of the servicedequipment; • by whom the equipment was serviced (name andcompany); • when the next service isdue;

Section	Minimum Requirements
	• any relevant comments in relation to theservice.
15. Plant maintenance records	The Contractor shall undertake examination and maintenance of all plant and equipment in accordance with the frequency recommended by the manufacturer, the O&M Manual and in accordance with the Contract. The examinations and maintenance activities shall be recorded in a plant maintenance schedule and presented in this section of the MSR. The information required to complete the plant maintenance schedule report, which shall be in tabular format, is as follows: • description of theequipment; • serial number of theequipment; • section the maintenance schedule was taken from in the O&M Manual; • items that need to be checked every week, month, 3 months, 6 months or year for that piece ofequipment. As the item of work is checked for each piece of equipment, it shallbe marked on the Table and initialled to indicate that it has been examined.
16. Silt / waste disposal records	Silt / waste that is removed from Site shall be documented in the Site database and the information shall be transferred to the non-sludge waste disposal record for inclusion in the MSR. The information required for the non-sludge waste disposal record is asfollows: • date the waste wasremoved; • description of thewaste; • amount of waste removed at thattime; • by whom the waste was removed (name andcompany); • intended destination of the waste;and • receipt for acceptance of thewaste.

Section	Minimum Requirements
17. Facility maintenance records	Certain aspects of the site must be checked regularly to ensure that the facility is maintained in good order. A record in tabular format shall be presented in this section of the MSR together with any relevant comments. The aspects that must be kept under constant surveillance shall be established and agreed and shall include as a minimum: • lawnmaintenance; • shrubmaintenance; • hardsurfaces; • exteriorpainting; • housekeeping; • buildings; • interior painting;and • welfare&sanitation. Each of the listed aspects of site maintenance shall be examined and deemed to be in “excellent” condition, “acceptable” condition or “unacceptable” condition. When an item is in an unacceptable condition, steps must be taken to improve the condition of that item.
18. Emergency event records	Any emergency events that occur during the reporting period must be reported in this section of the MSR and must include the following information: • date the emergencyoccurred; • how the emergency wasnoticed; • location of theemergency; • description of theemergency; • how the emergency was dealtwith; • person(s) involved in dealing with theemergency; • duration of the emergencysituation; • date of the Emergency Response Review Meeting; • attendees at the Emergency Response Review Meeting;and • action(s) taken to prevent such an emergency occurringagain. A separate sub-section shall be compiled for each emergency event that occurred during the reporting period.
19. Plant breakdown records	A detailed record shall be kept and presented here of any failure ofany element of the Works or of the Works itself.
20. Analysis for payment	The analysis and measurement for payment, including any deductions for failures and including the calculations for payment of the variable charges shall be included in this section of the MSR.
21. Plant replacements	A record of all plant or asset replacements undertaken during the reporting period.
22. Record of	A record of the laboratory analysis undertaken.

Section	Minimum Requirements
laboratory services	
23. Training record	Records of all personnel training that took place in relation to the operation and maintenance of the Works during the reporting period.
24. Employee sickness and absence records	Any absence from the works due to illness or otherwise of members of the Contractor's personnel with details of temporary replacement personnel.
25. Use of energy and utilities	The Contractor shall keep records of the hours of operation of each item of electrical plant and the total energy usage on a daily, weekly and monthly basis as part of the procedures for operation of the facility. Total energy usage records shall include day, night and total kW hrs, watt less units and maximum demand usage. The records shall clearly define energy used from the energy generation facilities on Site and energy taken from the external supply. The Contractor shall also report on the Renewable Energy Certificate process under this section.
26. Process stoppages & unit cleaning	The details of any process stoppages or unit cleaning undertaken shall be presented in this section of the MSR.
27. Unusual or abnormal conditions	Unusual circumstances arising from industrial disputes, accidental spillage, mechanical breakdown, power failure, stoppage for essential maintenance, or abnormal weather conditions shall be noted by the Contractor in detail and taken into consideration when interpreting the analytical data from theWorks.

APPENDIX F – PROCEDURES FOR CONSTRUCTION PERMIT

Directorate of Industries, Government of Maharashtra

As per Doing Business Report of World Bank Group, the procedures for obtaining construction permit are outlined below:

- Submit application and design plans at Building Proposal office of BMC and pay scrutinyfee;
- Receive Site inspection from Building ProposalOffice;
- Obtain Intimation of Disapproval from the Building Proposal Office and payfees;
- Submit structural plans approved by a structural engineer toBMC;
- *Apply for No Objection Certificate (NOC) from TreeAuthority;
- *Receive inspection from TreeAuthority;
- *Obtain NOC from TreeAuthority;
- *Request and obtain NOC from Storm Water and DrainDepartment;
- *Request and obtain NOC from SewerageDepartment;
- *Request and obtain NOC from ElectricDepartment;
- *Request and obtain NOC from EnvironmentalDepartment;
- *Request and obtain NOC from Traffic & CoordinationDepartment;
- *Request and obtain NOC fromCFO;
- Obtain Commencement Certificate from Building Proposal Office and pay DevelopmentCharges;
- Request and receive inspection ofplinth;
- Submit letter stating completion of building works to obtain an Occupancy Certificate and Certificate ofCompletion;
- *Request and obtain completion NOC from TreeAuthority;
- *Request and obtain completion NOC from Storm Water and DrainDepartment;
- *Request and obtain completion NOC from SewerageDepartment;
- *Request and obtain completion NOC from ElectricDepartment;
- *Request and obtain completion NOC from EnvironmentalDepartment;
- *Request and obtain completion NOC from Traffic & CoordinationDepartment;
- *Request and obtain completion NOC fromCFO;
- Request and receive competition inspection fromBMC;
- Obtain OccupancyCertificate;
- Obtain CompletionCertificate;
- Apply for permanent waterconnection;
- *Receive on-site inspection for connection to water by the Water SupplyDepartment;
- *Obtain permanent waterconnection;
- Apply for permanent sewerageconnection;
- *Receive on-site inspection for connection to sewerage by SewerageDepartment;
- *Obtain permanent sewerageconnection;
- *Apply for permanent power connection and payfees;
- Receive on-site inspection fromBEST;
- *Obtain power connection fromBEST;
- *Apply for telephoneconnection;
- *Receive on-site inspection and connection to telephone by the utility provider;and

The Tenderer shall provide compliance as per Environmental Clearance from MOEF, No. 11-49/2007-IA-III dated 28th January 2008as per Annexure 14 attachedseparately.

* Takes place simultaneously with another procedure.

Additionally,

Clearance for sludge/solid waste disposal from the Employer

Approval of design of the project under the Factories Act, 1948 and registration of the Project under the same legislation as Project would constitute a factory as defined therein.

APPENDIX G – SAMPLE ASSET HIERARCHY

				Component Category	Size/capacity/ Description	Asset Management Data								
						Year of installation	Current Age	Useful life	Remaining life	Replacement value	Probability of failure	Consequence of failure	Risk	Renewal Time Frame
Process Area														
	Systems													
		Assemblies												
			Components											
Process 1														
Process 2														

APPENDIX H – LIST OF SUPPLIERS

Items: MECHANICAL ITEMS

Table H-1 List of Mechanical Equipment / Items

Sr. No.	Item Description	Vendor/ Manufacturer/ Make
1	Air Compressor	M/s Ingersoll Rand
		M/s Kaeser
		M/s Kirloskar Pneumatic
		M/s Atlas Copco
		M/s Chicago Pneumatic
		M/s ELGI
2	Air Blowers (Roots Type)	M/s Swam
		M/s Everest
		M/s Usha compressors
		M/s TMVT
3	Chlorination System	M/s Industrial Device
		M/s Pennwalt
		M/s Capital Controls
		M/s Siemens
4	Cranes (EOT, Hoists ,Jib cranes)	M/s W.H. Brady
		M/s Transpade Engineers
		M/s Demag
		M/s Electromech
		M/s Hercules
5	Centrifuge Decanter	M/s Pennwalt
		M/s HumboltWedag
		M/s GEA Westfalia
		M/s Andritz
		M/s Alpha Laval
6	Exhaust Fans	M/s Alstom
		M/s Flaktwood
		M/s Bajaj
		M/s Crompton Greaves
7	Flash Mixer/ Agitator	M/s Fibre&Fibre

Sr. No.	Item Description	Vendor/ Manufacturer/ Make
		M/s Ceecons
		M/s Remi Process
		M/s Milton Roy
8	Horizontal Centrifugal Pumps	M/s KBL
		M/s Grundfos
		M/s Wilo /Mather & Platt
		M/s KSB
		M/s Pentair
		M/s Sulzer
	Submersible Pumps	M/s KSB
		M/s Xylem/ITT
		M/s Wilo
		M/s ABS
		M/s Grundfos
		M/s Kishor
	Submersible Pumps-Tube installed	M/s ABS Sulzer
		M/s Xylem
		M/s Wilo
		M/s Grundfos
		M/s KSB
	Helical Rotor Screw Pumps	M/s Rotomac Pumps
		M/s Netzch technology
		M/s PD Pumps
		M/s Tushaco Pumps
		M/s Roto Pumps
9	Chemical Dosing Pumps	M/s Milton Roy
		M/s Prominent
		M/s V K Pumps
		M/s Positive Metering Pumps
		M/s Swelore
10	Submersible Mixer	M/s ABS-Sulzer
		M/s Grundfos
		M/s KSB
		M/s ITT FLYGT-Xylem
11	Clarifiers and Thickener Mechanism	M/s Voltas
		M/s Triveni
		M/s Shivpad
		M/s Emco KCP
12	Vortex type Grit Removal Mechanism	M/s Triveni

Sr. No.	Item Description	Vendor/ Manufacturer/ Make
		M/s Bilfinger
		M/s Huber
		M/s Smith and Lovless
13	Butterfly Valve	M/s Pentair
		M/s Fouress
		M/s VAG Valves
		M/s AVK Valves
		M/s KBL
14	Sluice Gate Valve	M/s VAG
		M/s Fouress
		M/s IVC
		M/s Makimura
		M/s Dezurik
		M/s IVI
		M/s KBL
		M/s AVK
15	PP Valve	M/s Shenco
		M/s U N Polyvalves
16	Penstock Gates	M/s Jash
		M/s Hambaker
		M/s Orbinox
		M/s VAG
		M/s Yashwant
17	M.S – Cement Lined Pipes	M/s Jindal
		M/s PSL
		M/s Welspun
18	SS Pipes	M/s SAIL
		M/s Jindal
		M/s Remi
19	CI/DI/GI pipes	M/s Electrosteel
		M/s Lanco steel
		M/s Jindal
		M/s Kejriwal Castings
20	DI Fittings	M/s Kiswok
		M/s Kejriwal Castings
		M/s Electrosteel
21	Motorized Weir Gates	M/s Jash
		M/s Yashwant
22	Chlorine Tonners	M/s ISGEC

Sr. No.	Item Description	Vendor/ Manufacturer/ Make
		M/s Meenakshi Associates
23	Fine Bubble Diffusers	M/s Environmental Dynamics
		M/s OTT GMBH
24	Centrifugal Air Blowers (Turbo Blower)	M/s Howden
		M/s Siemens
		M/s Hoffman and Lamson
		M/s Aerzen
25	Mechanical Screens (Bar type)	M/s MahrMachinenBau – MM2 MM
		M/s Kuhn GMBH
		M/s Headworks
		M/s Huber
26	Pressure Vessel	M/s Thermax Limited
		M/s Ion Exchange
		M/s Cheema Boilers Ltd.
27	Electric Actuators	M/s Auma
		M/s Limitorque
		M/s L Bernard
		M/s Rotork
28	Pneumatic Actuators	M/s Rotex
		M/s Bettis
		M/s VAG Pasak
		M/s Janson
		M/s D Torque
		M/s Elomatic
29	UPVC & HDPE Pipes	M/s Jain Irrigation
		M/s Finloex
		M/s Duraline
		M/s Time Technoplast
		M/s Pennwalt Agro
		M/s Supreme
		M/s Astral
		M/s George Fischer
30	Motors	M/s Crompton Greaves Ltd
		M/s Seimens
		M/s Marathon Electric (Alsthom)
		M/s Kirloskar Electric company
		M/s Bharat Bijlee Ltd
		M/s ABB

Sr. No.	Item Description	Vendor/ Manufacturer/ Make
31	Ball Valves	M/s BDK Engineers
		M/s Flowchem
		M/s Virgo
		M/s KBL
		M/s Audco
		M/s Fouress
		M/s Microfinish
32	Knife Gate valves	M/s Jash Engineering
		M/s VAAS
		M/s Dezurik
		M/s Fouress
		M/s ORBINOX
		M/s VAG
		M/s AVK
33	Diaphragm valves	M/s. Crane Process
		M/s. Microfinish
		M/s. BDK Engineers
		M/s. Leader
		M/s. Saunders
34	Eccentric Plug valves	M/s Dezurik
		M/s VAAS
35	Alum Rapid Induction Mixer	M/s Rite water solution
36	Gas Scrubber	M/s Innovative Environmental
		M/s Combustion research associates
37	Gas Flare	M/s Combustion research associates
38	Heat Exchanger	M/s Alpha Laval
		M/s Positron Engineering Corporation
		M/s Ammus
		M/s Rakhoh
39	Air conditioner	M/s Bluestar
		M/s Voltas
		M/s O General
		M/s Carrier
		Ms. Daikin
40	Dissolved Air Floatation	M/s Krofta
		M/s Water Works
		M/s K-Pack
41	Ultra Filtration	M/s Hyflux

Sr. No.	Item Description	Vendor/ Manufacturer/ Make
		M/s Hydranautics
		M/s Koch Membrane
		M/s Toray
42	Disc Filtration	M/s Amiad
43	Gate Pump Technology	M/s Ishogaki Company Ltd.
		M/s Hasuh Industrial Corporation
		M/s Grundfos Pumps India Pvt. Ltd.
44	Pulse Plasma Technology	M/s KAPRA
		M/s B&B Engineering Co.
		M/s Dattatrya Inc. Vadodara
		M/s Amanky Infrastructure Pvt. Ltd.
		M/s I.S. Engineering

Items: ELECTRICAL ITEMS

Table H-2 List of Makes for Electrical Equipment / Items

Sr. No.	Description	Vendor/Manufacturer/Make
1	Compact Substations	ABB
		Siemens
		Schneider Electric
		Crompton Greaves Limited
2	Distribution Transformers	ABB
		BHEL
		Schneider Electric
		Crompton Greaves Limited
		Transformers & Rectifiers India Limited
		Voltamp Transformers Limited
		EMCO
3	Transformer Lighting - Dry Type (Cast Resin)	SGB
		Kotsons
		PS Electricals
		Schneider Electric
		ABB
		Indcoil
		Automatic Electric Ltd.
		Crompton Greaves Limited
4	Switchgear/Switchboard MV – 11/33kV - Outdoor Type	Siemens
		ABB
		Crompton Greaves Limited

		Schneider Electric
5	Switchgear/Switchboard MV – 6.6/11/33kV - Indoor (VCB)	Siemens
		ABB
		Schneider Electric
		BHEL
6	Protective relays (Numerical Type)	ABB
		Siemens
		GE

Sr. No.	Description	Vendor/Manufacturer/Make
		SEL (Schweitzer Engineering Laboratories)
		Alstom
7	Protective Relays (ElectromechanicalType)	ABB
		Siemens
		GE
		Schneider Electric (formerly Areva/EE)
8	Auxiliary Relay	Schneider Electric (formerly Areva/EE)
		ABB
		Siemens
		VA Tech
		L & T
9	Electronic circuit Relay	OEN
		Omron
		Allen Bradley
		PLA
10	Control and Relay Panel	ABB
		Siemens
		EasunReyrolle
		Alstom
		Schneider Electric
11	Instrument Transformers (CT/PT)	Automatic Electric
		Crompton Greaves
		Indcoil
		Kappa
		Precise
		Pragati
		Gilbert and Maxwell
		Silkaans
		Jyoti
		ECS
		Schneider Electric
		ABB
		Siemens
12	Switchgear/Switchboard L.V.- Drawout/Fixed Type (PCC/MCC/PMCC/MLDB/MPDB/ MOVDB/APFC)	Siemens
		L&T
		Schneider Electric
		ABB
13	Air circuit breakers	L & T

Sr. No.	Description	Vendor/Manufacturer/Make
		Siemens
		Schneider Electric (M&G)
		ABB
14	MCCB's	L & T
		Siemens
		Schneider Electric (M&G)
		ABB
15	Switch Disconnector Fuse Unit (SDF) And Switch Disconnector Isolator	Siemens
		Technoelectric
		Schneider Electric
		L&T
16	Change-over switch	Havells (euroload)
		C&S
		Schneider Electric
		GE Power
		Kraus &Naimer
		Siemens
		BCH
		L&T
17	V F Drives / Electronic Soft starter	Siemens
		Allen Bradley (Rockwell Automation)
		Yaskawa
		Schneider Electric
		ABB Danfoss
18	MV capacitors (APP)	Universal Cables
		Manohar Brothers (Capacitors)
		ABB
		Epcos
		Shreem
19	LV capacitors (APP)	Universal Cables
		ABB
		Malde
		Madhav
		Epcos
		Aswani
		Schneider Electric
		L&T
20	Series Reactors For Capacitors	Manohar Brothers
		WHEPL

Sr. No.	Description	Vendor/Manufacturer/Make
		Epcos
21	APFC Panel	Epcos
		Aswani
		Manohar Brothers
		Siemens
		L&T
		Crompton Greaves
22	APFC Relay / Controller	TAS Powertek
		Syntel
		ABB
		Cummins
		Epcos
		Schneider Electric
23	AC Power Contactor	Siemens
		ABB
		L&T
		BCH
		Schneider Electric (Telemecanique)
24	DC Power Contactor	BCH
		BHEL
		Siemens
		L&T
		Schneider Electric
25	Auxiliary contactors	Siemens
		L & T
		Schneider Electric (Telemecanique)
26	Electronic / Microprocessor based overload relay	Siemens
		ABB
		Schneider Electric
27	Bi-metal / Overload Relay	Siemens
		Schneider Electric
		L&T
28	Thermistor relay	Alstom
		Minilec
		Insta controls
29	Single Phasing Preventer	Siemens
		Minilec
		Alstom

Sr. No.	Description	Vendor/Manufacturer/Make
		Schneider Electric
		L & T
30	Time switch	GIC
		Theben
		Siemens
		Schneider Electric
		Legrand
31	Timers	GIC
		Theben
		BCH
		Siemens
		Electronic Automation Pvt Ltd.
		Minilec
		L&T
		Legrand
		Schneider Electric
32	Time Delay Relay	Schneider Electric
		ABB
		Siemens
		BCH
		L&T
		Omron
		PLA
33	Motors	Siemens
		Bharat Bijlee
		Crompton Greaves
		Marathon Electric Motors (India) Ltd. (Formerly Alstom Ltd)
		BHEL
		ABB
		Kirloskar
34	Battery Charger & DCDB	Hitachi
		Caldyne Automatics
		Chhabi Electricals
		Mass-tech Controls
		HBL Power Systems
		Automatic Electric
		Amara Raja
		Universal Instruments

Sr. No.	Description	Vendor/Manufacturer/Make
35	Luminaire	Philips
		Zumtobel
		Thorn
		Osram
		Crompton Greaves
		Bajaj
		GE
36	Lamps	Philips
		GE
		Osram
		Sylvania
		LVD
		Neptune, USA
37	Ballast	Philips
		Crompton Greaves
		Bajaj
		ATCO
38	Cables H.V. - 33 kV XLPE Insulated	Universal Cables Ltd.
		NICCO
		KEC International Ltd
		Cable Corporation of India Ltd
39	LT Power Cables/ Earthing Cable	Universal Cables Ltd.
		NICCO
		KEC International Ltd
		Cable Corporation of India Ltd
		Finolex
		INCAB
		Polycab
		LAPP
		RR Kabel
40	LT Control Cables	LAPP
		Polycab
		NICCO
		Universal Cables Ltd.
		KEC International Ltd
		Finolex

Sr. No.	Description	Vendor/Manufacturer/Make
		INCAB KEI
		Cable Corporation of India Ltd
41	HFFR wires (including panel wiring)	Finolex
		Polycab
		LAPP
		RR Kabel
42	Non-insulated Copper Earthing conductors	Gupta Industrial Corporation (Vasai, Palghar)
		Bharat Wires & Ropes
		Diamond Cables
43	Distribution Boards (other than MLDB, MPDB, MOVDB) / Panels / Enclosures / JB / Marshalling Panel	Siemens
		C&S
		Schneider Electric
		Rittal
		President
		Enclotek
		Eldon
		Hensel
		Legrand
		Manshu Comtel
		Pentair
		ABB
		BCH
44	MCB, RCCB, RCBO / MCB Isolators	Legrand
		Schneider Electric
		Klockner Siemens
		Moeller
		ABB
45	MPCB	Siemens
		Schneider Electric
		Moeller
		ABB
		L&T
46	Alarm Annunciators (solid state type with LED illumination) / Facia Annunciator	Digicont
		Industrial Instruments & Controls
		Procon Inst. (P) Ltd
		MTL India Pvt. Ltd.
		Rochester Instruments System Ltd.
		IDECIZUMI

Sr. No.	Description	Vendor/Manufacturer/Make
		Minilec
		IICP
		Proton Electronics
		Alstom
		Yashmun
		ICA
		Ronan (Waree)
47	Decorative switches, sockets and metal boxes (single plate arrangement)	Honeywell (MK Electric)
		Anchor (Panasonic)
		Havells (Crabtree)
48	Modular switch & socket (wraparound) (twin plate arrangement)	Anchor (Panasonic)
		Anchor (Roma / Ave)
		Honeywell (MK Electric)
		Legrand
		Havells (Crabtree)
		Schneider Electric (Clipsal)
		Siemens
		ABB
		Gewiss
49	Ceiling Fan	Usha
		Crompton Greaves
		Bajaj
		Orient
		Khaitan
		Almonard
50	Wall Mounting Fan	Almonard
		GEC
		Crompton
		Bajaj
		Orient
		Usha
51	Exhaust Fan / Ventilation Fan	Nadi
		Usha
		Almonard
		Bajaj
		Crompton Greaves
52	Air Circulators/Man Coolers (Pedestal/Wall Mounted)	Almonard
		Bajaj
		Crompton Greaves

Sr. No.	Description	Vendor/Manufacturer/Make
53	Cable termination/jointing kits	Raychem (Tyco Electronics / RPG)
		3M(Cold Shrink/Push-on)
		ABB Kabeldon
54	Control / selector switch	Kraus &Naimer
		Kaycee
		GE Power controls
		L&T
		Siemens
		ABB
		Schneider Electric
55	Indicating Lamps (Multi-chip LED)	Binay
		Teknic Controls
		Vaishno
		Siemens
		L & T
		Schneider Electric
		Concord
		BCH
56	Terminal Block / Connectors	Wago
		Connectwell
		Pheonix
		Elmex
57	Control transformer	Indcoil
		Precise Silkaans NEC
		Gauss Electricals
58	Semiconductor Fuse	Siemens
		Schneider Electric (Ferraz Shawmut)
		Eaton (Cooper Bussmann)
		GE
59	HRC fuse (Power & Control)	Siemens
		L&T
		GE
		Eaton (Cooper Bussmann)
		Technoelectric
		Schneider Electric (Ferraz Shawmut)
60	Push buttons	Siemens
		Schneider Electric (Telemecanique)
		Teknic Controls
		L&T

Sr. No.	Description	Vendor/Manufacturer/Make
		Concord
		BCH
		Vaishno Electricals
61	Push button station	Siemens
		Schneider Electric
		R Stahl
		Hensel
		Bals
		Gewiss
62	Non metallic enclosures (including Industrial Receptacles)	Rittal
		Hensel
		SCAME
		Menekkes
		Bals
		Siemens
		Schneider Electric
		BCH
		PCE
		Legrand
		Gewiss
63	Digital Meter – Ammeter & Voltmeter	Schneider Electric (Conzerv)
		Automatic Electric
		Rishabh
		Schneider Electric (Power Measurement/ION)
		Circutor
		Siemens
		Masibus
64	Electromechanical – Ammeter & Voltmeter	Automatic Electric
		MECO
		IMP
		Rishabh
65	Load Manager / Multi Function Meter / kWh	Schneider Electric (Conzerv / (Power Measurement / ION)
		Circutor
		Rishabh
		Schneider Electric
		Alpha (ABB)
		Schlumberger
		SEMS (Secure)

Sr. No.	Description	Vendor/Manufacturer/Make
		Electro Industries / GaugeTech
66	Power quality analyser	A-eberle
		Schneider Electric (Power Measurement/ION)
		Schneider Electric (Conzerv)
		Chino – Laxsons
		Yokogawa
		Rishabh
		Fluke
		Hioki
67	Cable lugs	Dowells
		Comet
		3D (Billets Elektro Werke Pvt. Ltd)
68	Cable Glands (safe area - double seal cone grip type)	Comet
		Jainson
		Braco
		Baliga
		R.Stahl
		Crouse Hinds
		Siemens
		Hex (Brass Copper & Alloy(I))
		Cosmos
69	Polyamide Cable Glands	Lapp
		Hensel
		Gewiss
		Fibox
70	Lightning Arrestors	WS
		Jayshree
		Elpro
		Oblum
		Crompton Greaves
71	Surge Suppressors	OBO
		Emerson
		Furse
		Dehn+Sohne
		Erico
		Pepperl+Fuchs
		MTL
		Schneider Electric

Sr. No.	Description	Vendor/Manufacturer/Make
		ABB
		Weid Muller
		Siemens
		Phoenix Contact
72	Uninterrupted Power Supply (UPS)	Emerson Network Power (India) Pvt. Ltd. (Liebert / Chloride)
		Schneider Electric (MGE / Gutor / APC / Invensys)
		Aplab
		Fuji Electric , Japan
		Hitachi
		Eaton
		Riello-PCI
		Socomec
		ABB (Newave)
73	Floor trunking system (GI trays, troughs & pull boxes) and GI Cable trays	OBO
		Honeywell Patny
		Legrand
		Indiana
		Profab
		Sadhana
		Sterlite
		Reliance
		Jenco/Pentax Ferro Incorporate
74	Furniture trunking system / Cable managementSystem	Legrand
		Schneider Electric
		Rittal
		Panduit
		Honeywell
		Eubiq
75	UPVC Conduit/JB/flexible conduit/tees/ Bevels, elbow & accessories/fittings	Precision
		Polycab
		Sudhakar
		AKG
76	GI Conduit / Pipes	JK Tube Company (AKG)
		BEC Industries
		Zenith
		SAIL
		TATA Steel
		Jindal

Sr. No.	Description	Vendor/Manufacturer/Make
77	MS Conduit	JK Tube Company (AKG)
		BEC Industries
		Jindal
		TATA Steel
		SAIL
78	Casing Capping	Precision
		Circle ARK
		Mody
79	Lighting Controller / Lighting ManagementSystem	Lutron
		Zumtobel
		Philips
		Tridonic Atco
80	Lead Acid Battery (Plante / Tubular)	Exide
		HBL Power Systems Ltd.
		Amara Raja Batteries Ltd.
		Hoppecke
81	SMF/VRLA battery	Exide
		HBL Power Systems Ltd.
		Amara Raja Batteries Ltd.
		Hoppecke
82	Ni – Cd Battery	HBL Power Systems Ltd.
		Hoppecke
		Amco Saft
83	Lighting Poles	Bajaj
		Bombay Tubes and Poles
		Valmont
		India Electric Poles
84	High mast lighting system	Philips
		Bajaj
		Crompton Greaves
		BP Projects
		Valmont
85	EMS	ABB
		Siemens
		Alstom
		Schneider Electric
		Electro Industries / GaugeTech
		Rishabh

Sr. No.	Description	Vendor/Manufacturer/Make
86	Fire Barriers / Sealing	Brattberg
		Roxtec Signum NavellMultikil
87	Water barriers/sealing system	Roxtec
		Rayflate (Tyco Electronics)
88	Decontactor	BCH
89	Insulating mats	Electromat
		Dozz
		Raychem RPG
90	Emergency Light / Installite / Conversion module / BatteryPack	Prolite
		Legrand
		Philips
		Tridonic Atco
		Zumtobel
91	Choke (for VVVFD)	Siemens
		ABB
		Danfoss
		Allen Bradley (Rockwell Automation)
		Yaskawa
92	Power Supply Unit	Siemens
		MTL
		Aplab
		Pheonix
		Cosel
93	Busduct	C&S
		Stardrive
		Godrej
		Schneider Electric
		Siemens
94	Voltage / Power / Current / Frequency / Energy Transducer	ABB
		AE
		Siemens
		Schneider Electric
		Rishabh
		Masibus
95	Encoders	Hubner
		Honeywell
		Turck
96	Limit Switch	BCH

Sr. No.	Description	Vendor/Manufacturer/Make
		Honeywell
		Siemens
		Jay Balaji
		Wago
97	Aviation Obstruction Light (multiple LED type)	Binay
98	Diesel Engines	Cummins
		Caterpillar
		MTU
		Mitsubishi
		Wartsila
		Rolls Royce
99	Alternators for DG Sets	Cummins (Stamford / AvK)
		Leroy Somer
		BHEL
100	Digital Multimeter for Operation &Maintenance	Beckmann
		Fluke
		AVO
101	Clip-On Ammeter for Operation &Maintenance	HCK, Germany
		Kyoritsu Electrical, Japan
102	Solar Power System	Tata Power Solar System
		Bajaj Electricals
		Emmvee Solar Systems

List of Makes for Instruments:

Table H-3 List of Makes for Instruments

Sr. No.	Description	Vendor/Manufacturer/Make
a.	Level Indicator Transmitter	EMERSON
		ABB,
		Endress+Hauser
		Yokogawa
		Siemens
		Honeywell India
b.	Flow Meters / Flow Indicator/ Transmitter	EMERSON
		ABB
		Yokogawa
		Endress+Hauser

Sr. No.	Description	Vendor/Manufacturer/Make
		Krohne Marshall
		Siemens
c.	Level Gauges /Level Switches	EMERSON
		ABB
		Endress+Hauser
		Kobold
		SBEM Pvt Ltd
		Mangnetrol Pvt Ltd
		Nivo Control Pvt Ltd
		Punetechtrol Pvt Ltd
d.	Pressure Gauges/Pressure Switches	ABB,
		Wika
		Kobold
		Gen Inst Co
		Baumer Technologies India Pvt. Ltd
		Ashcroft India Pvt Ltd
		H Guru Instruments Pvt Ltd
		Manometer (India) Pvt Ltd
		Forbes Marshall Pvt Ltd
		Scientific Devices Pvt Ltd
e.	Pressure Indicator Transmitter	EMERSON
		ABB,
		Endress+Hauser
		Siemens
		Honeywell India
		Yokogawa India Ltd
f.	Temperature Indicator Transmitters	Kobold
		Endress+Hauser
		ABB
		Radix Pvt Ltd
g.	Water Quality Analyzers (Dissolved Oxygen, Residual Chlorine, Turbidity, pH, Conductivity, ORP, TSS, MLSS, SS, BOD, COD, TOC, etc.)	M/s SWAN
		M/s Endress+Hauser
		M/s Yokogawa
		Hach
		ABB
		Emerson
		Forbes Marshall
		Mettler - Toledo
		WTW Gmbh

Sr. No.	Description	Vendor/Manufacturer/Make
		Dr. Lange
		Royce Technologies

List of Makes for Un-interrupted Power Supply and Batteries:

Table H-4 List of Makes for Un-interrupted Power Supply and Batteries

Sr. No.	Description	Vendor/Manufacturer/Make
a.	Un-interrupted Power Supply	APC
		DB & ELECTRONICS
		NUMERIC POWER SYSTEMS
		Emerson
		Schneider Electric (MGE / Gutor / APC / Invensys)
		Aplab
		Fuji Electric , Japan
		Hitachi
		Eaton
		Riello-PCI
		Socomec
		ABB (Newave)
		Amtech Electronics India Ltd.
b.	Batteries	Lead Acid Battery (Plante / Tubular)
		Exide
		HBL Power Systems Ltd.
		Amara Raja Batteries Ltd.
		Hoppecke
		SMF/VRLA battery
		Exide
		HBL Power Systems Ltd.
		Amara Raja Batteries Ltd.
		Hoppecke
		Ni-Cd Battery
		HBL Power Systems Ltd.
		Hoppecke
		Amco Saft

List of Makes for Cables

Table H-5 List of Makes for Cables

Sr. No.	Description	Vendor/Manufacturer/Make
a.	Cables	Universal Cables
		Polycab
		Havell's
		Finolex
		NICCO
		KEI Industries Limited

List of Makes for Enclosures/ Panels

Table H-6 List of Makes for Enclosures / Panels

Sr. No.	Description	Vendor/Manufacturer/Make
a.	Enclosures / Panels	Rittal
		ECIL
		Pyrotech
		Eldon
		Universal
		C&S Electric
		Siemens India Ltd
		Schneider Electric India Pvt Ltd

List of Makes for Alarm Annunciators

Table H-7 List of Makes for Alarm Annunciators

Sr. No.	Description	Vendor/Manufacturer/Make
a.	Alarm Annunciators	ALAN
		Unitech Instruments
		Minilec
		Digicont
		Industrial Instruments & Controls
		Procon Inst. (P) Ltd
		MTL India Pvt. Ltd.
		Rochester Instruments System Ltd.
		IDECIZUMI
		IICP
		Proton Electronics
		Yashmun

List of Makes for Process Indicators

Table H-8 List of Makes for Process Indicators

Sr. No.	Description	Vendor/Manufacturer/Make
a.	Process Indicator	Masibus
		Unitech Instruments
		Nivam
		GSV

List of Makes for Automation

Table H-9 List of Makes for Automation

Sr. No.	Description	Manufacturer/Make
a.	Workstations , Servers	Dell, HP, Compaq etc.
b.	Programmable Logic Controllers	Schneider Electric
		Siemens
		Rockwell Automation
		ABB
		Mitsubishi
		GE
		Omron
		YOKOGAVA
c.	GSM/GPRS Equipment	Motorola,
		GE,
		Seimens,
		GSV Microtek,
		DataRadio,
		Sheetal Wire-less Systems
d.	Printer	Epson
		HP
		Brother
		Canon

Sr. No.	Description	Manufacturer/Make
e.	Interface Devices	D-Link
		Mrotek
		Tmas
		MTL Instruments Pvt Ltd
		Osna Electronics Pvt Ltd
		Phoenix
f.	Communication Cables (OFC / Modbus / CAT 6 / TCP /IP)	Delink
		Cords
		RR CABLE
		Icon
		Aksh

List of Makes for Laboratory Instruments

Table H-10 List of Makes for Laboratory Instruments

Sr. No.	Description	Manufacturer/Make
a.	Laboratory Instruments	Hach India Pvt Ltd
		Orbit
		WTW Gmbh
		Merc
		Xylem
		Thermo

All the equipment, to be supplied under this contract shall be from experienced manufacturers. Only equipment from those manufacturers who have sufficient proven experience of manufacturing the respective equipment of similar capacity shall be considered. The naming of a manufacturer in this specification is not intended to eliminate competition or prohibit qualified manufacturers from offering equipment. Rather, the intent is to establish a standard of excellence for the material used and to indicate a principle of operationdesired.

In order to achieve standardisation for appearance, operation, maintenance, spare parts and manufacturer's service, like items of equipment provided hereunder shall be the end products of one (1) manufacturer.

The Contractor may propose alternate makes for the equipment mentioned above, however, for all manufacturers / Makes / vendors / technology providers the bidder shall submit the following:

1. Demonstrate that the proposed makes are “Superior / Equivalent” to the approved makes.
2. Manufacturer involved in manufacture of specified equipment for at least 10 years before biddate.
3. At least 5 successful installations commissioned in last 5 years before bid date and satisfactorily operating for at least one year before bid date. End user certificateshall

be provided for the same.

4. Manufacturer to provide full contact information for each reference as part of technical bid and the above qualities and requirements shall be demonstrated and evidenced by inspection of manufacturing units and successfully installed plants (at the end user's plant/premises) for the equipment's desired and successful operation and certification by the EmployerRepresentative.

The Employer shall reserve the right to accept or reject the Tenderer proposed makes of Equipment.

The Tenderer shall provide a list of all mechanical, electrical and instrumentation equipment/items indicating selected make. The Contractor shall indicate maximum two makes / vendors / manufacturers / technology providers selected either from the lists of approved suppliers or alternate make proposed and accepted by the Employer during the tendering stage. Post award, no change in selected make shall be allowed except for extraordinary circumstances. The Contractor may submit his proposal to the Employer for acceptance of change of make clearly stating reasons. The Employer shall reserve the right to accept or reject the Contractor's proposal of change of make.

APPENDIX J–SEWER MAINTENANCE PLAN

Appendix J1 Sanitary Sewer Overflow Inspection / Verification Report

Appendix J2 Accessibility Field Review Form

Appendix J3 Manhole Physical Survey Form

Appendix J4 Project Tracking Form

APPENDIX J1 - SANITARY SEWER OVERFLOW INSPECTION/VERIFICATION REPORT

Assignment Information:							
Inspector Name:				Date of Inspection:			
				Time of arrival for Inspection:			a.m./p.m.
Initial Contact Information:							
Time of Call:		a.m./p.m.		Date of Call:			
Caller's name:				Caller's Phone Number			
Caller's address:							
Caller's Description of Problem:							
Initial Response Information (to be completed by the Inspector)							
Arrival time at the scene		a.m. / p.m.					
Is there any immediate evidence of hazardous materials present at the scene?					☐	YES	☐ NO
If YES, then the Inspector is required to contact the local fire department and take direction from them. Note that vehicle engines, portable pumps or open flames can provide the ignition for an explosion. Maintain a safe distance and observe caution until and after assistance arrives. Refer to the SSORP for further initial response coordination.							
Field Investigation Information:							
1.	Has the event caused impact on the local surface waters? (If yes, include specific information below)				☐	YES	☐ NO
2.	Characterize the event by evaluating the following:						
	a.	The sewage overflowed to the stormwater system.			☐	YES	☐ NO
	b.	This event was caused due to a failure in a pre-planned or an emergency maintenance issue involving bypass pumping.			☐	YES	☐ NO
	c.	Observation or on-site evidence clearly indicates that sanitary sewage was retained on land and did not reach surface waters.			☐	YES	☐ NO
	d.	Characterize other additional pertinent information below:					
3.	Identify or estimate the time the event started based on visual information or the Caller's understanding of the event start time.						a.m./p.m.
4.	Estimate the end date and time of the event using the following:						
	a.	When the blockage is cleared or flow is controlled or contained; or when the flow of the sanitary sewer is controlled or contained by removing the blockage.			Date:		a.m./p.m.
	b.	The arrival time of the inspector or response crew, if the overflow stopped between the time it was reported and the time of arrival.			Date:		a.m./p.m.
5.	Estimate the flow rate of the event in gallons per minute by:						
	a.	Direct observations of the overflow					GPM
	b.	Estimated measurement of actual overflow					GPM
6.	Estimate the volume in million gallons of the event flow by multiplying the duration of the overflow by the overflow rate calculated above.						MG
7.	Describe any damage to the exterior areas of public and private property observed (use the back of this form to provide additional detail as required):						
NOTE: The Inspector is required to photograph the event and damages described above.							

APPENDIX J2 - ACCESSIBILITY FIELD REVIEW FORM

Inspector Name:		Date of Field Review:	

	Manhole Structure Number	Manhole Status		Photograph Taken	Description of Accessibility Problem
		No Action Required	Corrective Action Required		
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

APPENDIX J3 - MANHOLE PHYSICAL SURVEY FORM

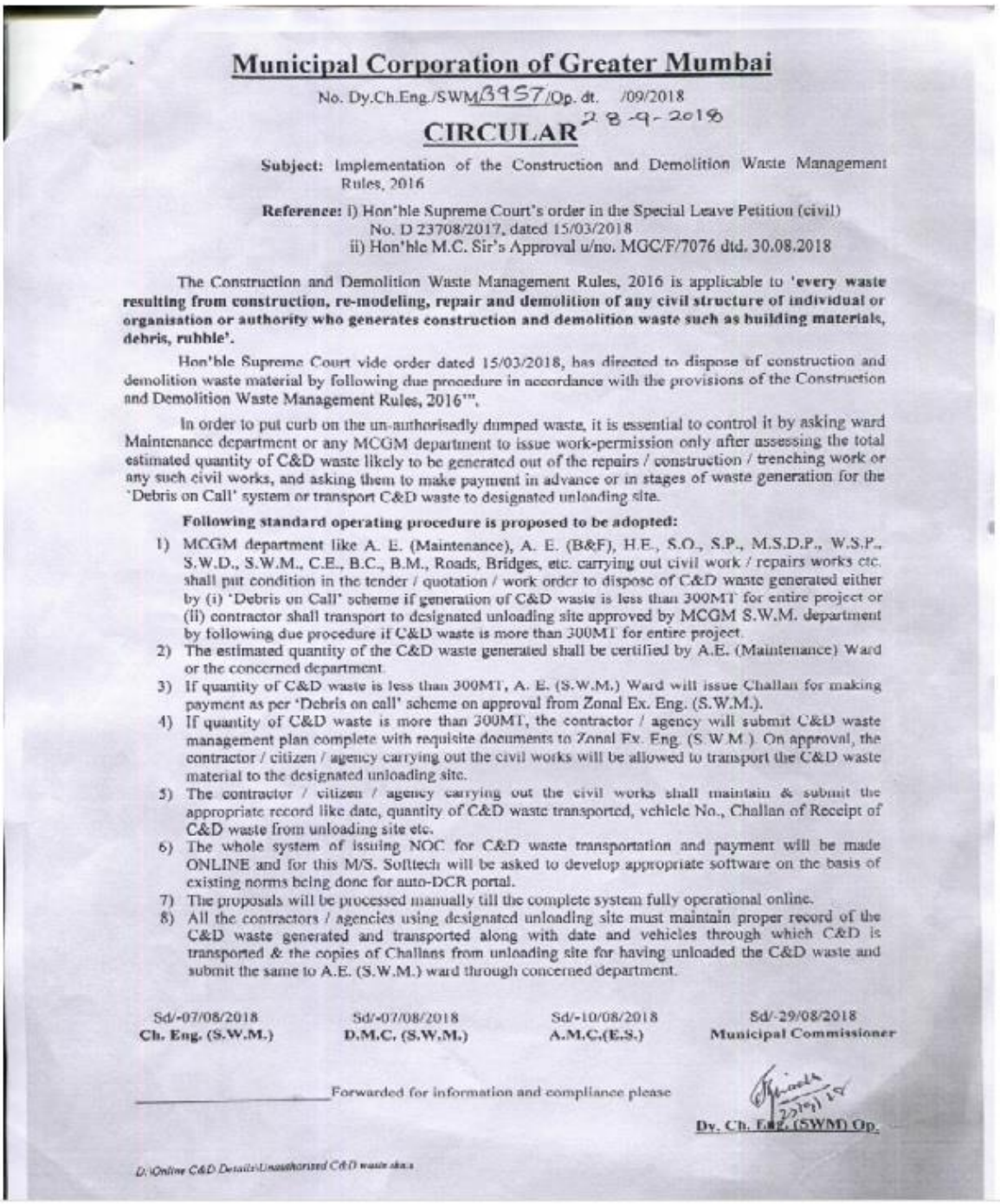
Inspector Name:										Date of Physical Survey:			
Manhole Number:		Location Description:											
Weather Conditions:													
Casting / Lid:													
Type: ☐	Vented	☐	Solid		Buried:	☐	Yes	☐	No		How Deep?		FT
Ladder Bars:													
Type: ☐	Steel	☐	PVC	☐	Cast Iron	☐	None						
Condition:	☐	Good (no repair necessary)	☐	Fair (some repair required)	☐	Poor (extensive repair required)	☐	Replace					
	Description of Repair Work												
Barrel:													
Construction:	☐	Brick	☐	Precast:	☐	Other:							
Condition:	☐	Good (no repair necessary)	☐	Fair (some repair required)	☐	Poor (extensive repair required)	☐	Replace					
	Description of Repair Work												
Bottom:													
Construction:	☐	Brick	☐	Precast	☐	Cast-in-place							
Condition:	☐	Good (no repair necessary)	☐	Fair (some repair required)	☐	Poor (extensive repair required)	☐	Replace					
	Description of Repair Work												
Debris:													
Additional Observations: (include a description of materials needed for repair, access, traffic, and other issues that the repair crew will need to know prior to arriving at the site.)													

APPENDIX J4 - PROJECT TRACKING FORM

Project Number:					
Date of complaint (if any) or Work Order:		Name of complainant (if any):			
Address:					
Location Description:					
Complaint Tracking Number (if any):					
Description of reported condition or Maintenance Request:					
Manhole from:		Manhole to:			
Charge to:		Project Classification:			
Contractor:					
Project Engineer:					
Project Inspector:		**Work Type:**			
Crew Foreman:		☐	Main Line New Installation		
Project Summary Information		☐	Main Line Replacement		
Start Date:		☐	Min Line Repair		
Completion Date:		☐	Main Line Bulk Head		
Estimated Days to completion:		☐	Main Line Fill, Seal Abandon		
Cut Size (feet):	Length	Width			
	Average Depth	☐	Manhole New Installation		
Permit Number:		☐	Manhole Replacement		
Utilities Phone Numbers:	Gas	☐	Manhole Repair		
	Electric	☐	Manhole Rehabilitation		
	Phone	☐	Manhole Raise		
	Cable				
	Water	☐	Encasement Installation		
Project Notes (include description of equipment used, number of personnel required and any difficulties encountered):		☐	Encasement Repair		
		☐	Force Main Replacement		
		☐	Force Main Repair		
		☐	Force Main Valve Replacement		
		☐	Force Main Valve Repair		
		☐	Low Pressure Force Main Replacement		
		☐	Low Pressure Force Main Repair		
		☐	Low Pressure Force Main Valve Replacement		
		☐	Low Pressure Force Main Valve Repair		
One Call Serial Numbers and Dates:					
		☐	Building Lateral New Installation		
		☐	Building Lateral Replacement		
		☐	Building Lateral Repair		
		☐	Building Lateral Relocate		
Project Difficulty Rating:		☐	Other (describe):		
(Easy, Moderate, Difficult)					

Annexure – I

The contractor has to follow the Circular of implementation of the Construction and Demolition Waste Management Rules, 2016 vide U/No. Dy.Ch.Eng./SWM/3957/ Op dated 28.9 2018 and the copy of circular is attached herewith as a part of tender document.



Municipal Corporation of Greater Mumbai

No. Dy.Ch.Eng./SWM/3957/Op. dt. /09/2018

28-9-2018

CIRCULAR

Subject: Implementation of the Construction and Demolition Waste Management Rules, 2016

Reference: i) Hon'ble Supreme Court's order in the Special Leave Petition (civil) No. D 23708/2017, dated 15/03/2018
ii) Hon'ble M.C. Sir's Approval u/no. MGC/F/7076 dtd. 30.08.2018

The Construction and Demolition Waste Management Rules, 2016 is applicable to **'every waste resulting from construction, re-modeling, repair and demolition of any civil structure of individual or organisation or authority who generates construction and demolition waste such as building materials, debris, rubble'.**

Hon'ble Supreme Court vide order dated 15/03/2018, has directed to dispose of construction and demolition waste material by following due procedure in accordance with the provisions of the Construction and Demolition Waste Management Rules, 2016'".

In order to put curb on the un-authorisedly dumped waste, it is essential to control it by asking ward Maintenance department or any MCGM department to issue work-permission only after assessing the total estimated quantity of C&D waste likely to be generated out of the repairs / construction / trenching work or any such civil works, and asking them to make payment in advance or in stages of waste generation for the 'Debris on Call' system or transport C&D waste to designated unloading site.

Following standard operating procedure is proposed to be adopted:

1) MCGM department like A. E. (Maintenance), A. E. (B&F), H.E., S.O., S.P., M.S.D.P., W.S.P., S.W.D., S.W.M., C.E., B.C., B.M., Roads, Bridges, etc. carrying out civil work / repairs works etc. shall put condition in the tender / quotation / work order to dispose of C&D waste generated either by (i) 'Debris on Call' scheme if generation of C&D waste is less than 300MT for entire project or (ii) contractor shall transport to designated unloading site approved by MCGM S.W.M. department by following due procedure if C&D waste is more than 300MT for entire project.
2) The estimated quantity of the C&D waste generated shall be certified by A.E. (Maintenance) Ward or the concerned department.
3) If quantity of C&D waste is less than 300MT, A. E. (S.W.M.) Ward will issue Challan for making payment as per 'Debris on call' scheme on approval from Zonal Ex. Eng. (S.W.M.).
4) If quantity of C&D waste is more than 300MT, the contractor / agency will submit C&D waste management plan complete with requisite documents to Zonal Ex. Eng. (S.W.M.). On approval, the contractor / citizen / agency carrying out the civil works will be allowed to transport the C&D waste material to the designated unloading site.
5) The contractor / citizen / agency carrying out the civil works shall maintain & submit the appropriate record like date, quantity of C&D waste transported, vehicle No., Challan of Receipt of C&D waste from unloading site etc.
6) The whole system of issuing NOC for C&D waste transportation and payment will be made ONLINE and for this M/S. Softtech will be asked to develop appropriate software on the basis of existing norms being done for auto-DCR portal.
7) The proposals will be processed manually till the complete system fully operational online.
8) All the contractors / agencies using designated unloading site must maintain proper record of the C&D waste generated and transported along with date and vehicles through which C&D is transported & the copies of Challans from unloading site for having unloaded the C&D waste and submit the same to A.E. (S.W.M.) ward through concerned department.

Sd/-07/08/2018	Sd/-07/08/2018	Sd/-10/08/2018	Sd/-29/08/2018
Ch. Eng. (S.W.M.)	**D.M.C. (S.W.M.)**	**A.M.C.(E.S.)**	**Municipal Commissioner**

Forwarded for information and compliance please

Dy. Ch. Eng. (SWM) Op.

D:\Online C&D Details\Unauthorized C&D waste.docx

बृहन्मुंबई महानगरपालिका
विधी खाते

परिपत्रक क्र. 10318 दि. 24.03.2022

विषय - कंत्राट करार करण्यासाठी वसूल करावयाचे विधी आकार (Legal charges) व लेखनसाहीत्य आकार (Stationery charges)

संदर्भ - 1. विधी खात्याचे परिपत्रक क्र. 03 दि. 22.06.2021
2.परिपत्रक क्र. सीए/एफआरएम/49 दि. 07.02.2013
3. क्र. सीए/एफआरएम/एफआय/82 दि. 07.03.2022

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महानगरपालिकेच्या विविध खात्यांमार्फत मागविण्यात येणा-या निविदांसंदर्भात लेखी करार करताना पक्षकाराकडून एकत्रितरित्या आकारावयाच्या विधी आकार व लेखनसाहित्य आकाराची उपरोक्त संदर्भित क्र. 1 वरील परिपत्रकानुसार दि. 01.04.2021 पासून आकारणी करण्यात येते.

तथापि महापालिकेच्या विविध खात्यांच्या आकार/शुल्कसूचीमध्ये नियमित वाढ करण्याबाबत परिपत्रक क्र. सीए/एफआरएम/49 दि. 07.02.2013 अन्वये, दरवर्षी 1 एप्रिल या दिनांकापासून शुल्कसुचीतील दरामध्ये 10 टक्के इतकी वाढ करुन पुढील रु.10/- च्या पूर्णांकात दर लागू करण्याबाबतच्या सूचना प्रसूत करण्यात आलेल्या आहेत. त्यानुसार खालील तक्त्यामध्ये दर्शविल्याप्रमाणे सुधारीत विधी व लेखन साहीत्य आकार (एकत्रितरीत्या) विहीत करण्यात आले आहेत.

अनु. क्र	कंत्राट करार करण्यासाठी एकत्रितरित्या आकारावयाच्या विधी व लेखन साहीत्य आकारांसाठी कंत्राट कराराची रक्कम	एकत्रितरित्या आकारावयाचे सुधारीत विधी व लेखन साहीत्य आकार दि. 01.04.2022 पासून दि. 31.03.2023 पर्यंत
1	रु. 10,0001 ते रु.. 50,000	निरंक
2	रु. 50,001 ते रु. 1,00,000	रु. 6,290/-
3	रु. 1,00,001 ते रु. 3,00,000/-	रु. 10,380/-
4	रु. 3,00,001 ते 5,00,000/-	रु. 12,470/-
5	रु. 5,00,001 ते रु. 10,00,000/-	रु. 14,510/-
6	रु. 10,00,001 ते रु. 20,00,000/-	रु. 16,570/-
7	रु. 20,00,001 ते रु. 40,00,000/-	रु. 18,660/-
8	रु. 40,00,001 ते रु 1,00,00,000/-	रु. 20,720/-
9	रु. 1,00,00,001 ते रु. 10,00,00,000/-	रु. 24,450/-
10	रु. 10,00,00,001 ते रु. 20,00,00,000/-	रु. 28,220/-

11	रु. 20,00,00,001 ते रु. 30,00,00,000/-	रु. 31,980/-
12	रु. 30,00,00,001 ते रु. 40,00,00,000/-	रु. 35,740/-
13	रु. 40,00,00,001 ते रु. 50,00,00,000/-	रु. 39,470/-
14	रु. 50,00,00,000 ते रु. 1,00,00,00,000/-	रु. 47,000/-
15	रु. 1,00,00,00,001 ते रु. 2,00,00,00,000/-	रु. 58,270/-
16	रु. 2,00,00,00,001 ते रु. 3,00,00,00,000/-	रु. 65,770/-
17	रु. 3,00,00,00,001 ते रु. 4,00,00,00,000/-	रु. 75,120/-
18	रु. 4,00,00,00,001 ते रु. 5,00,00,00,000/-	रु. 84,510/-
19	रु. 5,00,00,00,00 पासून कोणत्याही मर्यादेपर्यंत	रु. 93,920/-

25/3/2022

(सुखश्री मि. मोदले)
उप कायदा अधिकारी (हस्तांतरण 1 व 2)
विधि खाते

24/03/2022

(सुनिल क. सोनवणे)
कायदा अधिकारी
विधि खाते

परिपत्रक क्र. 10318 दि. 24.03.2022

प्रत ..... यांना माहीतीकरीता व पुढील आवश्यक त्या कार्यवाहीकरीता अग्रेषित.

24-03-2022

(संदिप मो. पाटील)
उप कायदा अधिकारी (आस्थापना)
विधि खाते

MUNICIPAL CORPORATION OF GREATER MUMBAI

Office of the DMC CPD,
Central Purchase Department,
566, N.M.Joshi Marg, Byculla, Mumbai-400 011.

No. DyChE/ CPD/ 2025 / dt. 01/09/2021

CIRULAR

Sub: Formation of Grievance Redressal Committee (GRC) to address grievances from bidders.
Ref.: MGC/F/4961 dated 09/08/2021.

Hon. M.C.'s accorded sanction under reference to form Grievance Redressal Committee (GRC) to address grievances from the bidders regarding responsiveness/ non-responsiveness in Packets 'A', 'B' or 'C' in all the tenders. Therefore, all HOD's are requested to incorporate following condition in all the tenders;

Grievance Redressal Committee (GRC)

1. *If a Bidder is not satisfied with the decision of responsiveness/ non responsiveness in Packets 'A', 'B' or 'C', by the concerned HOD, he may appeal to D.M.C. (C.P.D.) by paying fee of Rs. 25,000/-.*

2. *D.M.C. (C.P.D.) will assign the work of co-ordination of various activities and administration work of G.C.R. to nominated Registrar – Shri. Uday B. Mande.*

3. *The Committee for hearing grievances and passing orders will be constituted as follows:*

   (a) *The Committee will comprise of D.M.C. / Director / Jt.M.C. of tender inviting department and D.M.C. / Director / Jt.M.C. of the department for which tender is being invited.*

   For example, if tender is invited by C.P.D. dept, for K.E.M. Hospital then the Committee will be of DMC(CPD) and DMC (PH).

   (b) *In case the tender inviting department and department for which tender is being invited are same then the concerned DMC/ Director/ Jt.M.C. of the same department and DMC(CPD) will be the members of the Committee.*

   For example, if tender is invited by Dean (KEM) for KEM Hospital then the Committee will be DMC (PH) and DMC(CPD).

In tabular format:

Tender inviting Department	***Work belonging Department***
DMC(CPD) or DMC /Director / Jt.M.C. of concerned Department.	*Concerned DMC / Director/ Jt.M.C.*

4. *In case the work is pertaining to various departments then concerned DMC / Director/ Jt.M.C. having major contribution of work will be one of the member of the Committee.*

5. *The Committee will hear the grievances of bidder within 30 days on receipt of bidder's application and will pass an order within 45 days.*

6. *If Bidder is not satisfied with the decision of the above Committee, he may appeal to the concerned Addl. Municipal Commissioner of Tender Inviting Department. The Addl. Municipal Commissioner will hear the case within 45 days from the date of receipt of application for second appeal from the bidder and will pass the order within 60 days.*

Sd/- 27.07.2021
Dy ChE (Civil) CPD

sd/- 27.07.2021
D.M.C. (C.P.D.)

Sd/- 30.07.2021
A.M.C. (WS)

sd/- 06.08.2021
Hon,ble M. C.

The above circular approved by Hon,ble MC is submitted for necessary action please.

01/09/2021
Dy ChE (CPD) Civil