COIMBATORE CITY MUNICIPAL CORPORATION

24X7 WATER SUPPLY PROJECT

CONCESSION AGREEMENT

COUNTER PART

VOLUME - III

S.No	Components
22	Kurunji Garden SR - Zone B (Proposed)
23	Madathur SR (Existing)
24	Revathy Layout SR (Existing)
25	RS Puram SR - Zone A (Existing)
26	RS Puram SR - Zone B (Existing)
27	Sanganur Chinthamani SR (Existing)
28	Venkatapuram SR (Existing)

The design and construction of the water supply system shall facilitate future expansion of the system as the population of the water supply area grows.

The works objective is to provide a complete and fully functioning water supply system including but not necessarily limited to the items described in the Scope of Works The provisions contained in this Specification are intended to supplement the General Conditions of the Construction Contract for the purpose of providing greater specificity of the Construction Services that the Concessionaire shall perform.

The design verification shall be undertaken following national standards based upon 24/7 water supply considerations

If not otherwise specified below, the design shall be carried out with regard to the following standards and guidelines with the indicated ranking and priority:

1. Manual on Water Supply and Treatment (third edition -revised and updated) by Government of India, Ministry of Urban development, New Delhi, March 1999.
2. Indian standards, codes and guidelines whenever existing.

Materials and construction methods to be used shall be so as to ensure that the residual life of the water supply system shall be of at least 30 years

The Concessionaire shall sign and maintain insurances according to the General Conditions of Contract, and make Performance Security according to the General Conditions of Contract (in the following GC).

The CCMC shall provide required land, including acquisition, for the Project and right of access to Project areas according to GC.

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2.3 Design Services

2.3.1 General Design and Engineering

1. The Concessionaire shall verify the basic and detailed design and the engineering work in respect of that design in compliance of the Detailed Project Report provided by CCMC with the provisions of the Contract, or where not so specified, in accordance with good engineering practice.
2. The Concessionaire shall be responsible for any discrepancies, errors or omissions in the specifications, drawings and other technical documents which are prepared by the Concessionaire, whether such specifications, drawings and other documents have been approved by the Client or not.
3. The Concessionaire shall make their own investigations as deemed necessary to ensure that the design is adequate for meeting the specifications and shall have full responsibility for any design, data, drawing, specification or other document, developed by the Concessionaire. The Concessionaire shall be entitled to disclaim any modification thereof provided or designated by or on behalf of the Owner, by giving a written notice of such disclaimer to client.

2.3.2 Construction Documents

1. The Concessionaire shall prepare all the necessary Construction Documents and include the same as part of the CIP. The Construction Documents shall include the plans, designs, drawings, detailed list of requirements, as-built documents, operations manuals, specifications, schematic design documents, design development documents, and all modifications thereto required in order to properly and fully test for, analyze for, plan, design and build the Project as contemplated in the Technical Standards and the remaining provisions of the Contract.
2. Environmental and social managements shall be included in the Construction documents to be prepared by the Concessionaire as required.
3. The Concessionaire shall prepare any other document, as may be requested by the Engineer-in-charge, that the Engineer-in-charge considers necessary to monitor the progress of the Construction Services and assess the Concessionaire's compliance with the Contract.
4. The Concessionaire shall also prepare any other documents necessary to instruct the

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Concessionaire's Personnel.

5. The Concessionaire shall provide each of the Engineer-in-charge and the Client with two sets of all of the Construction Documents in reproducible form and shall modify them to keep them up-to-date as requested by the Engineer-in-charge acting in a professionally reasonable manner. The Construction Documents, with the exception of the as-built documents, shall be subject to the review and approval of the Engineer-in-charge prior to performing any of the services.
6. When the Concessionaire notifies the Owner of completion of the Water Supply System, the Concessionaire shall provide to the Engineer-in-charge one copy of the 'as-built_ Construction Documents in reproducible form showing the exact 'as built_ locations, sizes and details of the project and Water Supply System and construction Services as executed. The Project and the Water Supply System shall not be considered to have reached Completion until such Construction Documents have been provided. The Concessionaire shall update the 'as-built_ Construction Documents as necessary for the correction of defects or deficiencies.

2.3.3 Considerations for Design checking and verification

The Concessionaire shall:

1. Protect public health and safety in relation to impact from the works;
2. Maximize the protection of the environment and minimize any adverse environmental impacts caused by the works;
3. Ensure the works have the capacity to fulfil the anticipated services within the time horizon as stipulated in the following design criteria;
4. Ensure that the works are designed in order to maximize its duration as a fully functional water supply system that meets or exceeds the Technical Standards; and
5. Ensure that the works are designed to meet the requirements of the Technical Standards and the Design Criteria.

2.3.4 Preparatory Work and Establishment of Design Data

The Concessionaire shall for his own account carry out field investigations and surveys as deemed necessary to obtain sufficient physical conditions as required for the design. Normally, the following field investigations and surveys may be required and shall therefore be considered by the Concessionaire:

Through detailed topographic/cadastral surveys for project sites, as required for detailed

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design, ensure that the water distribution facilities can be designed to operate properly, and so that quantities of work and materials required can be accurately determined.

Field Survey:

Field survey shall be done with Total Station method. The scope of the assignment includes: Conducting detailed engineering survey by using Total Station instruments for entire pipe line route along/ across different road network for Feeder Mains, and Distribution network etc. It is hereby clarified that field surveys for the components in the upstream of MSR/MBR which are not included in the Scope of Work are not required to be carried out by the Concessionaire. The following details will be collected:

Scope of Work for Sub Soil Investigation work:

Geotechnical soil investigations shall be done at Concessionaire's own cost at all structural locations and if necessary for the excavation and support of pipelines at suitable intervals along the pipeline alignment. For selection and design of foundation system of the various structures, sub soil investigation is required. Various parameters of the foundation soil and safe bearing capacity of soil have to be determined by conducting subsoil investigation work at pin point location only.

Sub soil investigation work is to be done for determining various parameters of foundation soil viz. particle size; Atturberg's Limit; Plasticity Index; Density; Sp. Gravity; Voids Ratio; C-Ø value; consolidation; sub surface water level etc. making standard penetration test (SPT) at every 1.5 m. interval or wherever there is change of strata, and calculating the Safe Bearing Capacity of Soil for determining type and size of the various structures viz. service reservoirs, sumps etc.

The subsoil investigation report shall include all the field investigation; Bore Hole Log showing soil profile, 'N_ values at different depth (Observed, corrected and average); determined soil parameters in tabular form as listed in the scope of work; graphical representation of the soil parameters; and calculation of safe bearing capacity including recommendation for type of foundation etc. From the above sub soil investigation work various soil parameters at the location of various structures shall be determined and ultimate as well as safe bearing capacity of the foundation soil shall be calculated based on these data the type and size of foundation for various system components.

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Design Criteria:

The Concessionaire shall aim at 24/7 water supply. The Concessionaire shall ascertain the design details entire water supply system as per applicable standards including CPHEEO Manual on Water Supply and Treatment.

2.4 Construction Services

2.4.1 General

1. The Concessionaire shall carry out all building and construction of all items required to meet the output requirements.
2. The Concessionaire shall provide all of the demolition, excavation, building, co-ordination, repair, warranty, review, inspection, testing, quality assurance and control, monitoring, scheduling, clean-up and other construction work and services required for the modification of the Sites and the building of the Water Supply System as contemplated by Construction Documents.
3. The Concessionaire shall have total control of the building and construction services and shall effectively direct and supervise the building and construction services so as to ensure conformity with the Construction Documents.
4. The Concessionaire shall be solely responsible for construction means, methods, techniques, sequences, and procedures and for coordinating the various parts of the Construction Services under the Contract.

2.4.2 Establishment of Concessionaire's Camp and Working Sites

The Concessionaire shall in connection with the mobilization of the works and sites assure the following facilities and conditions:

1. Establish design office with all required design facilities for the design staff.
2. Provide potable water for construction site personnel and general cleaning in addition to any required for the construction, testing and commissioning of the Works.
3. Install, operate, maintain and subsequently remove temporary electricity supplies in addition to supplies required for testing and commissioning the Works.
4. Erect, construct, maintain and subsequently remove all temporary accommodation necessary to for the efficient conduct and self-supervision of the Contract.
5. Before starting work, instruct all employees in the necessity for pollution prevention. Any employee or Concessionaire's representative polluting or fouling the Sites shall be

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immediately expelled from the Site. No medically unsuitable persons may be employed in or around water supply installations. Arrange for employees to be examined and tested in the manner approved by the Owner's Medical Officer and the Engineer-in-charge.

2.4.3 Site Work

During work on the sites the Concessionaire shall:

1. Ensure that methods of working cause minimum disturbance to land, owners and occupiers where Works are constructed on over under in or through privately owned land.
2. Check and confirm survey data and benchmarks and their precise relationship to the National Datum (Permanent Bench marks) before using the data to establish any further benchmarks. The Concessionaire shall be entirely responsible for all levels and setting out undertaken by him in the Works.
3. Establish working and construction lines and grades according to approved detailed design drawings and supply all the materials needed to establish and preserve survey points and bench marks.
4. Set out the works precisely in vertical and horizontal planes and angles. Mark the location of corners with timber pegs. Locate offset pegs at one meter offsets so that all corner points can be relocated after excavation. Setting out shall be verified by the Engineer-in-charge before excavation.
5. On completion of the works remove any temporary access required for the execution of the Works and reinstate the access route as a minimum to the same condition it was in before entry to the Site.
6. Keep the works well drained and ensure that as far as is practicable all work is carried out in the dry. Excavated areas shall be kept well drained and free from stagnation of water.
7. On completion of the Works, leave all areas that have been occupied for whatever reason in a condition equal or better than at the time of entry. Remove and dispose of all surplus plant and materials.

2.4.4 Procurement and Transportation

1. The Concessionaire shall manufacture or procure and transport all the Plant and Equipment in an expeditious and orderly manner to the Site.
2. The Concessionaire shall at its own risk and expense transport all the Plant and Equipment, the Concessionaire's Equipment (Construction) and the Concessionaire's

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Equipment (Operations) to the Site by the mode of transport that the Concessionaire judges most suitable under all the circumstances.

3. Unless otherwise provided in the Contract, the Concessionaire may select any safe mode of transport operated by any person to carry the Plant and Equipment, the Concessionaire's Equipment (Construction) and the Concessionaire's Equipment (Operations).
4. Upon dispatch of each shipment of the Plant and Equipment, the Concessionaire's Equipment (Construction) and the Concessionaire's Equipment (Operations), the Concessionaire shall notify the Owner by telex, cable, facsimile or e-mail of the description of the Plant and Equipment and of the Concessionaire's Equipment (Construction), the point and means of dispatch, and the estimated time and point of arrival in the country where the Site is located, if applicable, and at the Site. The Concessionaire shall furnish the Owner with relevant shipping documents to be agreed upon between the parties.
5. The Concessionaire shall be responsible for obtaining, if necessary, approvals from the authorities for transportation of the Plant and Equipment, the Concessionaire's Equipment (Construction) and the Concessionaire's Equipment (Operations) to the Site. The Owner shall use its reasonable endeavors in a timely and expeditious manner to assist the Concessionaire in obtaining such approvals, if requested by the Concessionaire. The Concessionaire shall indemnify and hold harmless the Owner from and against any claim for damage to roads, bridges or any other traffic facilities that may be caused by the transport of the Plant and Equipment, the Concessionaire's Equipment (Construction) and the Concessionaire's Equipment (Operations) to the Site.
6. The Concessionaire shall, at its own expense, handle all imported Plant and Equipment, Concessionaire's Equipment (Construction) and Concessionaire's Equipment (Operations) at the point(s) of import and shall handle any formalities for customs clearance. If the Applicable Law requires any application or act to be made by or in the name of the Owner, the Owner shall take all necessary steps to comply with such Applicable Law. In the event of delays in customs clearance that are not the fault of the Concessionaire, the Concessionaire shall be entitled to an extension in the Time for Completion.

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2.4.5 Building Responsibilities Temporary Supports, Structures and Utility Services

1. The Concessionaire shall have the sole responsibility for the design, erection, operation, maintenance, and removal of temporary supports, structures and utility services and the design and execution of construction methods required in their use.
2. The Concessionaire shall engage and pay for registered professional engineering personnel skilled in the appropriate disciplines to perform those functions referred to in Point 1 where required by law or by the Construction Documents and in all cases where such temporary supports, structures and utility services and their designs and method of construction are of such a nature that professional engineering skill is required to produce safe and satisfactory results.

2.4.6 Document Review

The Concessionaire shall be responsible for all approvals and permits of the Construction Documents of the present specification. If the Concessionaire during the course of the construction does discover any error, inconsistency or omission in the Construction Documents, the Concessionaire shall not proceed with the work affected until the Concessionaire has corrected any such errors or inconsistency or supplied any missing information and these corrections have been approved in writing by the Engineer-in-charge or the Owner.

2.4.7 Plant and Equipment

1. The Concessionaire shall provide and pay for labour, Plant and Equipment, tools, construction machinery and equipment, materials and supplies, water, heat, light, power, transportation, and all other facilities and services necessary for the performance of the Construction Services in accordance with the Construction Documents.
2. The Concessionaire shall ensure that all Plant and Equipment provided are new. Plant and Equipment which are not specified shall be of a quality consistent with those specified and their use shall be acceptable to the IVA or Engineer-in-charge.

2.4.8 Documents at the Site

The Concessionaire shall keep one copy of the Construction Documents as up-dated, submittals, reports and records of meetings at the Site, in good order and shall make them available to the Owner and the Engineer-in-charge upon request and at any reasonable time.

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2.4.9 Use of the Sites and Water Supply System

1. The Concessionaire shall confine construction machinery and equipment, storage of Plant and Equipment, Concessionaire's Equipment (Construction) and Concessionaire's Equipment (Operations), and operations of Concessionaire's Personnel to limits indicated by laws, ordinances, permits or the Construction Documents and shall not unreasonably encumber the Site with Plant and Equipment, Concessionaire's Equipment (Construction) or Concessionaire's Equipment (Operations). The Concessionaire shall not load or permit to be loaded any of the working areas or the Water Supply System with a weight or force that will endanger the safety of the areas or the Water Supply System.
2. The Concessionaire shall not store Plant and Equipment, Concessionaire's Equipment (Construction) or Concessionaire's Equipment (Operations) at the working areas which are not necessary for the construction of the Project.

2.4.10 Setting Out

1. The Concessionaire shall be responsible for the true and proper setting-out of the Sites and the Project in relation to benchmarks, reference marks and lines specified in the Construction Documents.
2. If, at any time during the construction of the Project, any error shall appear in the position, level or alignment of the Sites and the Water Supply System, the Concessionaire shall forthwith notify the Engineer-in-charge of such error and, at its own expense, immediately rectify such error to the reasonable satisfaction of the Engineer-in-charge.

2.4.11 Quality Assurance

1. The Concessionaire shall institute a quality assurance system to ensure compliance with the requirements of the Construction Documents. Compliance with the quality assurance system shall not relieve the Concessionaire of its duties, obligations or responsibilities.
2. The Concessionaire shall submit for approval details of all quality assurance procedures and documents relating to Concessionaire's compliance with the quality assurance system to the Engineer-in-charge before each stage of the Construction Services are commenced as set out in the Time Schedule. When any document is issued to the Engineer-in-charge, it shall be accompanied by the signed quality statements for such document, if any. The Engineer-in-charge may audit any aspect of the quality assurance system and the Concessionaire shall take any corrective action as the IVA may deem appropriate.

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Concessionaire's Access Routes and Rights of Way during the Construction Period

1. The Concessionaire shall satisfy itself as to the suitability and availability of the access routes it chooses to use during the Construction Period for access to and from the project areas. The Concessionaire shall, as between the Parties, be responsible for the maintenance of access routes during the Construction Period. The Owner will not be responsible for any claims which may arise from the use or otherwise of any access route. The Owner does not guarantee the suitability or availability of any particular access route, and will not entertain any claim for any non-suitability or non-availability for continuous use, during the Construction Period, of any such route.
2. The Concessionaire shall design Site Roads to provide access for proper operation and maintenance of the works and to support the heaviest wheel load expected on the site under all weather conditions. Arrange road surfaces so that where operating vehicles enter buildings there is a short ramp and road drainage leads away from buildings. Ensure road profiles cause no surface ponding and surface water is drained away in drains to avoid damage to the roads or to the site.
3. The Concessionaire shall bear all costs and charges for special or temporary rights-of-way required by it for access to working areas and the Concessionaire's camp. The Concessionaire shall also provide, at its own cost, any additional facilities outside the project areas required by it for the purposes of the Construction Services.

2.4.12 Site Regulations and Safety

1. The Concessionaire shall establish Site regulations setting out the rules to be observed in the execution of the Contract at the Sites and shall comply therewith. The Concessionaire shall prepare and submit to the Owner, with a copy to the Engineer-in-charge, proposed Site regulations for the Owner's approval, which approval shall not be unreasonably withheld. Such Site regulations shall include rules in respect of security, safety of the Site, Existing Facility and the Water Supply System, gate control, sanitation, medical care, emergency preparedness, emergency response, on-site safety training of employees and fire prevention.
2. The Concessionaire shall comply with all applicable safety regulations in providing the Construction Services and in occupying any part of the Sites, Existing Facility or Water Supply System. Unless otherwise stated in the Construction Documents, the Concessionaire shall, during the Construction Period,

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2.1 provide secure fencing, lighting, guarding and watching of the Construction Services;

2.2 provide temporary roadways, footways, guards and fences which may be necessary for the accommodation and protection of its employees, Site visitors, owners and occupiers of adjacent land, the public and others;

2.3 prepare a manual of safety policies and procedures applicable to each stage of the Construction Services and to the Project as a whole and distribute such manual to all of its Sub-Concessionaires, agents, representatives and employees working at the Project; and

2.4 Carry out safety briefings of applicable site regulations to all employees, Sub-Concessionaires, agents, representatives and visitors to the Project, Existing Facility and the Water Supply System prior to permitting first access of the applicable person to the project areas or the Water Supply System, and at regular intervals thereafter.

3. During the Construction Period, the Concessionaire shall develop and implement a comprehensive occupational health and safety program for the protection of the Concessionaire's Personnel and all other persons who may attend at the project areas or the Water Supply System. The program shall include a description of how the Concessionaire will,

3.1 carry out all occupational health and safety responsibilities in respect of the Project as required under the Applicable Law;

3.2 develop and manage all required occupational health and safety reporting procedures; and

3.3 Manage all occupational health and safety claims.

2.4.13 Concessionaire's Equipment (Construction) and Site Clearance

1. All Concessionaire's Equipment (Construction) brought by the Concessionaire onto the Site shall be deemed to be intended to be used exclusively for the execution of the Contract. The Concessionaire shall not remove the same from the Site without the Engineer-in-charge's consent that such Concessionaire's Equipment (Construction) is no longer required for the execution of the Contract.
2. The Concessionaire shall maintain the Sites, Existing Facility and Water Supply System in a tidy condition and free from the accumulation of waste products and debris. The Concessionaire shall remove waste products and debris resulting from the Sites and shall

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leave the Facility clean and suitable for occupancy and performance of the Operations Services before attainment of Substantial Completion. The Concessionaire shall remove products, tools, construction machinery, and equipment, including the Concessionaire's Equipment (Construction), not required for the performance of the remaining Construction Services.

3. Prior to notifying the Owner pursuant to this document 5B 6(1), the Concessionaire shall remove products, tools, construction machinery and equipment, and waste products and debris, including the Concessionaire's Equipment (Construction).
4. Upon the issue of any Completion Certificate, the Concessionaire shall clear away and remove, from the Site all Concessionaires_ Equipment (Construction), surplus material, wreckage, rubbish and temporary work or structures. The Concessionaire shall ensure that the Sites, Existing Facility and the Water Supply System is in a clean and safe condition to the satisfaction of the Owner's Engineer-in-charge.
5. If the Concessionaire fails to remove, no later than 30 days after the issue of the Completion Certificate, any remaining Concessionaire's Equipment (Construction), surplus material, wreckage, rubbish and temporary work or structures, the Owner may sell or otherwise dispose of such items. The Owner shall be entitled to retain, from the proceeds of such sale, a sum sufficient to meet the costs incurred in connection with the sale or disposal, and in restoring the Sites, Existing Facility and Water Supply System. Any balance of the proceeds shall be paid to the Concessionaire. If the proceeds of the sale are insufficient to meet the Owner's costs, the outstanding balance shall be recoverable from the Concessionaire by the Owner.
6. The Owner will, if requested, use reasonable efforts to assist the Concessionaire in obtaining any local, state or national government permission required by the Concessionaire for the export of the Concessionaire's Equipment (Construction) imported by the Concessionaire solely for use in the execution of the Contract that is no longer required for the execution of the Contract.
7. Clearing and grubbing operations on sites shall be the minimum practicably necessary to construct the Works. The Concessionaire shall protect trees and other vegetation designated for preservation.
8. Re-install any road furniture (e.g. traffic signs) removed to its original location in at least equal condition immediately after completion of pipe laying at a particular location.
9. No blasting shall be carried out.

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2.4.14 Protection of the Environment

The Concessionaire shall take all reasonable steps to protect the environment, both on and off the sites, and to limit damage and nuisance to people and property resulting from pollution, noise, dust and other results of its Services, including, adopting working practices that prevent or minimize the transfer of any pollutant off-site; maintaining the access roads in good repair; using appropriate dust suppressant methods; restricting trucking and loud machinery and equipment use to daylight hours; using mufflers, silencers and other appropriate methods to minimize the noise of the construction; using "silt fencing", hay bales, silt traps or other methods to minimize soil erosion and prevent the contamination of surface water and the transportation of soil and sediment off-site onto adjacent properties; and maintaining clean sites, Existing Facility and Water Supply System that are free of garbage, except the disposal area, and debris.

The Concessionaire shall, at all times during building and construction, ensure that the Environmental Management Plan is followed.

2.4.15 Security of the Site, Existing Facility and Water Supply System

Unless otherwise stated in the Construction Documents:

The Concessionaire shall be responsible for keeping unauthorized persons off the Sites, Existing Facility and Water Supply System, the Concessionaire shall maintain detailed record of all persons that enter the Sites, Existing Facility and the Water Supply System; and the Concessionaire shall ensure that authorized persons shall be limited to the Concessionaire's Personnel, the Engineer-in-charge, employees of Sub-Concessionaires and persons authorized by the Owner or the Engineer-in-charge.

2.4.16 Co-operation with other Authorities and Utilities

The Concessionaire shall consult and get approval from applicable authorities and utilities in connection with the following work:

1. Before starting any excavations, the Concessionaire shall satisfy himself and the Engineer-in-charge as to the exact position of existing services by exploratory excavations and shall make his own arrangements with the service providers for any diversion or removal of services required.
2. The Concessionaire shall be responsible for liaison with all relevant authorities and utilities and arrange his construction schedule to minimize inconvenience to all other parties and the public.

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3. Make least possible interference with existing amenities, whether natural or man-made. Keep Site clearance to minimum. Divert around the perimeter of the sites any minor watercourses crossing the sites that are needed for agriculture outside the site boundaries.
4. Discharge or dispose of all water and waste products from the sites to the satisfaction of the Engineer-in-charge and of any authority or person with an interest in land into which water and waste products may be discharged, without limitation to the Concessionaire's general obligations.
5. Accept responsibility for safeguarding all pipes, cables and other things that would otherwise be liable to suffer damage without precautionary measures.
6. Complete permanent fencing or other temporary safeguards around electrical equipment as far as practicable before connection of electricity supply.
7. Ensure that all assemblies and sub-assemblies delivered to the site are of suitable size and weight for access to the place of installation and pack all items of plant and materials for transport to avoid damage from handling or weather. It is the sole responsibility of the Concessionaire to maintain protection of the equipment.

2.4.17 Physical Cultural Property

1. The Concessionaire shall take reasonable precautions to prevent its employees, agents, representatives, Sub-Concessionaires, or other persons from removing or damaging any fossils, coins, articles of antiquity, and structures and other remains or things of geological or archaeological interest at the Site. The Concessionaire shall, immediately upon discovery of such article or thing, advice the Engineer-in-charge, who may issue instructions for dealing with it. All fossils, coins, articles of value or antiquity, and structures and other remains or things of geological or archaeological interest discovered on the Site shall be the property of the Owner.
2. If the Concessionaire suffers delay or incurs any damages or costs in following any instructions of the Engineer-in-charge pursuant to this document, and if such delay or damages or costs were Unforeseeable, the Concessionaire shall give notice to the Engineer-in-charge, with a copy to the Owner. After receipt of such notice, the Engineer-in-charge shall determine if the Concessionaire is entitled to any extension of time or any compensation for such damages or costs and shall notify the Concessionaire accordingly.

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2.4.18 Emergency Work

1. If, by reason of an emergency arising in connection with and during the execution of the Construction Services, any protective or remedial work is necessary as a matter of urgency to prevent damage to the Sites, Existing Facility or Water Supply System, the Concessionaire shall immediately carry out such work.
2. If the Concessionaire is unable or unwilling to do such work immediately, the Owner may do or cause such work to be done as the Owner may determine is necessary in order to prevent damage to the Sites, Existing Facility or the Water Supply System. In such event the Owner shall, as soon as practicable after the occurrence of any such emergency, notify the Concessionaire in writing of such emergency, the work done and the reasons therefore. If the work done or caused to be done by the Owner is work that the Concessionaire was liable to do at its own expense under the Contract, the reasonable costs incurred by the Owner in connection therewith shall be paid by the Concessionaire to the Owner. Otherwise, the cost of such remedial work shall be borne by the Owner.

2.4.19 Work at Night and on Holidays

1. Unless otherwise provided in the Contract, no work shall be carried out at night and on public holidays of the Country without prior written consent of the Owner, except where work is necessary or required to ensure safety of the Sites, Existing Facility or the Water Supply System or for the protection of life, or to prevent loss or damage to property, when the Concessionaire shall immediately advise the Engineer-in-charge, provided that provisions of this document shall not apply to any work which is customarily carried out by rotary or double-shifts.
2. Notwithstanding this document, if and when the Concessionaire considers it necessary to carry out work at night or on public holidays so as to meet the Time for Completion and requests the Owner's consent thereto, the Owner shall not unreasonably withhold such consent.

2.4.20 Existing Facility Operation

Unless otherwise stated in the Concession Agreement, commencing on the Construction Starting Date and ending on the new operations starting date, the Concessionaire shall carry out all operations of the Existing Facility according to the developed Operations and Maintenance Contract between the CCMC and the Concessionaire (attached later in this Specification). The duties are to:

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1. Safeguard, use, manage and control the existing assets;
2. Provide water supply services;
3. Maintain and improve the system;
4. Charge and collect for services provided;
5. Maintain and keep records;
6. Prepare and submit business plans; and
7. Make reports to the authorities.

2.4.21 Test and Inspection

1. The Concessionaire shall at its own expense carry out at the place of manufacture or on the Site all such tests and inspections of the Plant and Equipment and any part of the Project as are specified. The Concessionaire shall, in addition to those tests and inspections set out in the Contract, develop a plan for all testing and inspection of the Project that is required in order to complete the Project in accordance with the Contract.
2. The Owner and the Engineer-in-charge or their designated representatives shall be entitled to attend any test or inspection, provided that the Owner shall bear all costs and expenses incurred in connection with such attendance including, but not limited to, all travelling and board and lodging expenses.
3. The Concessionaire shall obtain from any relevant third party or manufacturer any necessary permission or consent to enable the Owner and the Engineer-in-charge (or their designated representatives) to attend the test or inspection.
4. If the Owner and the Engineer-in-charge, or their designated representatives, fails to attend the test or inspection, or if it is agreed between the Parties that such persons shall not do so, then the Concessionaire may proceed with the test or inspection in the absence of such persons, and shall provide the Engineer-in-charge with a certified report of the results thereof.
5. The Engineer-in-charge may require the Concessionaire to carry out any test or inspection not required by the Contract, provided that the Concessionaire's reasonable costs and expenses incurred in the carrying out of such test or inspection shall be added to the Contract Price. Further, if such test or inspection impedes the progress of work or the Concessionaire's performance of its other obligations under the Contract, due allowance will be made in respect of the Time for Completion and the other obligations so affected.
6. If any Plant and Equipment or any part of the Project fails to pass any test or inspection,

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the Concessionaire shall either rectify or replace such Plant and Equipment or part of the Water Supply System and shall repeat the test or inspection upon giving a notice under this document.

7. If any dispute or difference of opinion arises between the Parties in connection with or arising out of the test or inspection of the Plant and Equipment or part of the Project that cannot be settled between the parties within a reasonable period of time, it may be referred to an Adjudicator for determination.
8. The Concessionaire shall give the Owner and the Engineer-in-charge, at the Owner's expense, access at any reasonable time to any part of the Project or any place where the Plant and Equipment are being manufactured or installed in the Water Supply System, in order to inspect
9. The progress of the work and the manner of manufacture or installation provided that the Engineer-in-charge shall give the Concessionaire a reasonable prior notice.
10. The Concessionaire agrees that neither the execution of a test or inspection of Plant and Equipment or any part of the Site and the Water Supply System, nor the attendance by the Owner and the Engineer-in-charge, nor the issue of any test certificate pursuant to this document, shall release the Concessionaire from any other responsibilities under the Contract.
11. No part of the Project or foundations shall be covered up on the Site without the Concessionaire carrying out any test or inspection required under the Contract. The Concessionaire shall give a reasonable notice to the Engineer-in-charge whenever any such parts of the Project or foundations are ready or about to be ready for test or inspection; such test or inspection and notice thereof shall be subject to the requirements of the Contract.
12. The Concessionaire shall uncover any part of the Project or foundations, or shall make openings in or through the same as the Engineer-in-charge may from time to time require at the Site, and shall reinstate and make good such part or parts.
13. If any parts of the Project or foundations have been covered up at the Site after compliance with the requirement of this document and are found to be executed in accordance with the Contract, the expenses of uncovering, making openings in or through, reinstating, and making good the same shall be borne by the Owner, and the Time for Completion shall be reasonably adjusted to the extent that the Concessionaire has thereby been delayed or impeded in the performance of any of its obligations under

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the Contract.

14. The Concessionaire shall provide a report for every test carried out to sign and certify that the test has been carried out and, the result. Tests witnessed by the Engineer-in-charge shall be countersigned. The Concessionaire shall collect and collate all data into a bound certified report.
15. The Concessionaire shall provide all labour, materials, electricity, fuel, stores and apparatus and instruments necessary to carry out the tests efficiently. Measuring instruments indicators and other apparatus shall be as approved by the Engineer-in-charge.
16. The type and number of performance and operational tests to demonstrate compliance of the installations with the output requirements shall be agreed between the Engineer-in-charge and the Concessionaire. At least 1 week before testing starts the Concessionaire shall submit the test schedule, detailed test procedures and method statements to the Engineer-in-charge for approval.

2.4.22 Pre-Commissioning Tests:

The following tests shall be compulsory but not necessarily sufficient for the Project and the test plan agreed between the Engineer-in-charge and the Concessionaire:

1. The Concessionaire will demonstrate the proper function and operation of all mechanical and electrical equipments and confirm compliance with the design and specifications, both individually and as part of a system.
2. Water will be fed through each stage in turn and each item of system shall be operated in a similar manner. Changeover of duties of all locations shall be demonstrated. Each item of the system shall take a proportionate share of the operating duty for a total minimum of 72 hours of continuous satisfactory operation.
3. The Concessionaire will systematically demonstrate completion of the system and that it is ready for Commissioning.
4. This process shall fulfil, the specific procedures for flushing and sterilizing pipelines complying with AWWA C 651, or other approved international standard, will apply.
5. All applicable Pre-Commissioning and Guarantee Tests shall be done by the Concessionaire only for the EPC Components include in the Scope of Work.

2.4.23 Guarantee Tests:

1. The Concessionaire shall demonstrate the ability of the system to meet Functional

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Guarantees for the entire distribution system. Complete the tests over 28 days of continuous operation immediately after completion of pre-commissioning.

2. Operate the system in accordance with the Operating Manual and vary outputs over the full operating range. Send results and analysis with all other data collected to the Engineer-in-charge each week for review at regular meetings with the Owner and the Concessionaire.
3. Sample water quality at locations identified in the works and in the field to ensure that all requirements are met. Use these samples for analysis by an approved laboratory or by approved portable analyzers.
4. Carry out system pressure tests on a systematic basis and always related to the time of day and to the water consumption rate to the service area.
5. The water quality test results shall fail if any of the following occurs:
   -More than one discrete sample exceeds the maximum value in any week; -More than three discrete samples exceed the maximum value during the 28 day test.
6. Supply and install metering and data logging equipment to monitor the power consumption (kWh) throughout the Tests.
7. The test shall fail if the power consumption exceeds the guaranteed value stated by the Concessionaire in the Schedules.
8. If a Performance Test fails, prepare and submit the Distribution system modification proposals to the Engineer-in-charge. When approved, carry out the modification work as quickly as possible, and as soon as complete, resume normal works operation and repeat the Guarantee Tests.
9. Pressure testing of pipes (together with all specials and valves incorporated) shall be strictly in accordance with BS 6700 or any other approved international standard.
10. All applicable Pre-Commissioning and Guarantee Tests shall be done by the Concessionaire only for the EPC Components include in the Scope of Work.

2.5 Completion of the Water Supply System

1. In compliance to GC, and as soon as the Construction Services have, in the opinion of the Concessionaire, been completed, excluding minor items not materially affecting the operation or safety of the Project, and the Project has satisfactorily passed all Tests on Completion, the Concessionaire shall so notify the Engineer-in-charge and the Owner in

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writing (the "Notice of Completion") and provide the 'as-built_ Construction Documents.

1. The Engineer-in-charge shall, no later than 30 days after receipt of the Concessionaire's notice under this document, either issue a Completion Certificate stating that the Project has reached Completion as of the date of the Concessionaire's notice under this document, or notify the Concessionaire in writing of any defects or deficiencies or both.
2. If the Engineer-in-charge is not satisfied that the Construction Services are complete, the Engineer-in-charge shall notify the Concessionaire in writing of any defects or deficiencies no later than 7 days after receipt of the Notice of Completion.
3. If the Engineer-in-charge notifies the Concessionaire of any defects or deficiencies or both, the Concessionaire shall then correct such defects or deficiencies, and shall repeat the procedure described in this document.
4. If the Engineer-in-charge is satisfied that the Construction Services have reached Completion, the IVA shall, no later than 7 days after receipt of the Concessionaire's repeated Notice of Completion, issue a Completion Certificate stating that the Construction Services have reached Completion as of the date of the Concessionaire's repeated Notice of Completion.
5. If the Engineer-in-charge fails to issue the Completion Certificate and fails to inform the Concessionaire of any defects or deficiencies 14 days after receipt of the Notice of Completion or 7 days after receipt of the Concessionaire's repeated Notice of Completion, then the Construction Services shall be deemed to have reached Completion as of the date of the Notice of Completion or repeated Notice of Completion as the case may be.
6. As soon as possible after Completion, the Concessionaire shall complete all outstanding minor items so that the Project are fully in accordance with the requirements of the Contract, failing which the Owner will undertake such completion and deduct the costs thereof from any monies owing to the Concessionaire.

2.6 Commissioning

Commissioning of the Water Supply System shall be commenced by the Concessionaire immediately after issue of the Completion Certificate by the Engineer-in-charge, pursuant to this document, or immediately after issue of the deemed Completion, under this document.

2.6.1 Tests on Commissioning

1. The Tests on Commissioning, and repeats thereof, shall be conducted by the

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Concessionaire during Commissioning of the Project to ascertain whether the project or the relevant part can attain the technical standards set out in the Contract. The Concessionaire's and Engineer-in-charge advisory personnel shall attend the Tests on Commissioning, and shall advise and assist the Owner. The Owner shall promptly provide the Concessionaire with such information as the Concessionaire may reasonably require in relation to the conduct and results of the Tests on Commissioning, and any repeats thereof.

2. If for reasons not attributable to the Concessionaire, the Tests on Commissioning of the Water Supply System cannot be successfully completed within 21 days after the period from the date of Completion specified in Appendix to GC or any other period agreed upon by the Owner and the Concessionaire, the Concessionaire shall be deemed to have fulfilled its obligations with respect to the Tests on Commissioning.

2.6.2 Operational Acceptance

1. Operational Acceptance shall occur in respect of the Project when the Tests on Commissioning have been successfully completed.
2. At any time after the successful completion of the Tests on Commissioning, the Concessionaire may give a notice to the Engineer-in-charge requesting the issue of an Operational Acceptance Certificate in respect of the Project.
3. The Engineer-in-charge shall, after consultation with the Owner, and no later than 7 days after receipt of the Concessionaire's notice, issue an Operational Acceptance Certificate.
4. If within 7 days after receipt of the Concessionaire's notice, the Engineer-in-charge fails to issue the Operational Acceptance Certificate or fails to inform the Concessionaire in writing of the justifiable reasons why the Engineer-in-charge has not issued the Operational Acceptance Certificate, the project shall be deemed to have been accepted as of the date of the Concessionaire's said notice.

2.7 Reporting during the Construction Period

In addition to the reports, the Concessionaire shall prepare First, Quarterly and Final Reports. All reports shall be prepared in the English languages in hard and electronic version for submission to the Owner.

2.7.1 Inception Report

Not later than in four weeks upon commencement of the assignment, the Concessionaire will prepare and submit to the Owner a first report. This report will include the information about

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the status of the Project preparation and implementation, any problems encountered during the project preparation, revised overall procurement plan and contracting strategy. The expected Project implementation schedule corrected in accordance with the realistic status will be attached to the report, as well as a confirmation on the Concessionaire's work schedule for the next quarter.

The report shall also propose content of the schematic design documents with e.g. projected water demand and water works inventory, design reports, detailed technical specifications, supervision procedures and supervision reports.

2.7.2 Design Report

Not later than Six months upon commencement of the assignment

2.7.3 Quarterly Reports

Throughout the assignment the Concessionaire shall submit Quarterly Reports to the Owner by the fifteenth day of the following month. Each report will show events and progress for the Concessionaire's activities of each of the main tasks.

The format of quarterly reports shall be agreed with the Owner and shall include, but not be limited to, the following:

1. Chart and description of work and goods of each stage: Design, production, transportation, construction, installation, testing, commissioning, guarantee test and acceptance;
2. Comparisons of actual and planned progress including percentage completion achieved for each activity;
3. Details of any aspects which may jeopardize the completion in accordance with the contracts, and the measures being (or to be) adopted to overcome such aspects;
4. Copies of the assurance documents, test results and certificates of materials;
5. Safety statistics, including details of any hazardous incidents and activities relating to environmental aspects and public relations;
6. Projected contractual payments for next four quarters;
7. Other information to be agreed with the Owner.

The quarterly progress reports should be short and whenever possible made in a table like for easy reference and comparison.

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2.7.4 Final Report

The Concessionaire will prepare a draft of the Final Report one month prior to the end of the Construction Contract and hand it over to the Owner. The Final Report will be in fact a review of the entire Concessionaire's tasks fulfilment and include the necessary conclusions. Upon receipt of the Owner's comments and suggestions the Concessionaire prepares the finalized version of the report.

2.8 Integration with Ongoing Activities

There are several other network improvement activities that are either ongoing or have been recently completed. The Concessionaire shall review all the reports and ensure that the Implementation Plan does not duplicate any measure already financed and implemented, but rather complements these other investments and highlight proven approaches/ techniques/ policies that could be utilized for the Implementation Plan to enhance project efficiency and effectiveness. The Concessionaire shall also ensure that investments proposed as part of Implementation Plan are independent of the other interventions so that it can be adequately implemented, managed, supervised, monitored and finally be able to be evaluated its impact.

2.9 Institutional Arrangements and General Compliance

The Concessionaire shall read, familiarize and understand the institutional arrangements and Applicable Laws and determine in detail which roles DJB, as the asset holding and operating entity play in the following:

i) Sanction of Water Connections,
ii) Implementation of water connections,
iii) Disconnections and reconnections and
iv) Services to Urban Poor areas as applicable.

The Concessionaire shall also ensure that the Implementation Plan is:

i) in compliance with the Comprehensive Development Plan of the Project City, Water Supply Master Plan
ii) fully coordinated with the ongoing and programmed activities

2.10 Assessment of the Billing and Collection Systems

The Concessionaire shall:

1. Prepare a profile of water service Consumers in the Service Area describing Consumer

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categories and for each category: number of Consumers, estimated average volume of water consumed per month; estimated average revenue per month.

2. Develop the basic procedure for
    a. for service connection
    b. preparing, issuing, and collecting a bill for water service;
    c. how water consumption is estimated for unmetered Consumers;
    d. Procedure for dealing with under payment or nonpayment.

3. Develop:
    a. meter reading procedures and arrangements;
    b. meter reader control; and
    c. Efficient and accurate meter reading practices.
4. Develop(or review and revise existing ones) for portable, battery powered, handheld, electronic meter reading collection and data storage device, complete with the interface to the existing, modified, or proposed billing software.
5. Set up in detail the revenue collection procedures, facilities for achieving the prescribed level of revenue collection efficiency.

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SECTION III – BILL OF QUANTITIES

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SECTION IV – GENERAL TECHNICAL SPECIFICATIONS

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CHAPTER 1

1.0. Civil Works

1.1. General

Tamil Nadu Building Practice (TNBP) shall be strictly followed for carrying out different items of the work for which no standard specifications are available and no alternate specification have been given under the description of works.

Where any provision of the TNBP is repugnant to or at variance with any provision under BIS or description of work, technical specifications and conditions of contract, the provisions of the later shall be deemed to supersede the provision of the TNBP.

1.1.1. Materials

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

1.1.2. Cement

The entire quantity of cement and steel required for the work will be procured by the contractor. The Contractor is responsible for all transport and storage of the materials and shall bear all related cost. The Employer shall be entitled at any reasonable time to examine the cement and steel supplied by the contractor.

The cement procured by the contractor shall comply with the requirements of IS:269/1976 with the latest revision thereof for ordinary port land cement and IS:8112/1989 with the latest revision thereof for 43 grade ordinary Portland cement each bag shall bear ISI Certification mark and as per **specification no.10 of TNBP volume 1.**

1.1.3. Cement Plaster (Internal & External)

a) **Preparation of Surface**

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The walls to be plastered to have all joints raked out to a depth of 10 mm, if not already done. R.C.C surface shall be properly hacked to get good key to the plaster. All dust and oily matter, if any, shall be brushed and cleaned and surface to be plastered shall be kept wet for 6 hours before plastering is commenced.

b) Proportion of Mortar

The plaster in walls, lintels, columns, ceiling, ceiling beams, projected slabs, rails, chajja, marquise, domes etc. shall be done with sand cement mortar in the proportion as described in the Schedule of Quantities). No more cement mortar shall be prepared than that can be used within half an hours.

Mortar for brick masonry shall be prepared as per IS : 2250. Manholes shall be constructed in brick masonry with cement mortar (1:4), 20 mm thick inside plaster with plasticized water proofing material consisting of 12 mm thick backing coat in in CM 1:3 and 8 mm thick finishing coat in CM 1:1 and 15 mm thick outside plaster in CM 1:3, unless otherwise specified in items. Gauge boxes for sand shall be of such dimensions that one bag containing 50 Kg. of cement forms one unit. The sand shall be free from clay, shale, loan, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be as approved by Engineer-in-charge. If so directed by the Engineer-in-charge sand shall be thoroughly washed, till it is free of any contamination.

For preparing cement mortar, the ingredients shall first be mixed thoroughly in dry conditions. Water shall then be added and mixing continued to give a uniform mix of required consistency. Cement mortar shall be used within 25 minutes of mixing. Mortar left unused in the specified period shall be rejected.

1.1.4. Storage of cement

Immediately upon arrival at the Site, cement shall be stored in silos designed for the purpose or in dry weather-tight and properly ventilated structures with floors raised 500 mm above ground level with adequate provision to prevent absorption of moisture. Each consignment of cement shall be kept separately and the Contractor shall use the consignments in the order in which they are received.

Cement of different types and from different sources shall be kept in clearly marked separate storage facilities. Cement delivered to the Site in drums or bags provided by

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the supplier or manufacturer shall be stored in the unopened drums or bags until used in the Works. Any cement in drums or bags which have been opened on the Site shall be used immediately or shall be removed from the Site.

Ceiling plaster shall be completed before commencement of wall plaster.

1.1.5. Steel

The steel bars shall comply with the requirements set forth in the IS:432 Part 1, IS:1139, IS:1786 as the case may be with the latest revision thereof and the test as described for ultimate tensile strength, bond test and elongation tests. Each band containing the bars shall bear the ISI Certification marks.

The Cement/steel shall be tested in nearby laboratories of Polytechnic or Engineering College by the Employer. Two samples should be taken by the Engineer in charge in the presence of the contractor or his authorized representatives or the technical personnel employed by the Contractor as in the Agreement. The contractor shall without extra cost, provide samples and cooperate in the testing of the cement/steel. One sample shall be got tested and the other sample shall be retained by making clear identification in the sample by the Engineer in charge so as to identify at a later date. The cost of such test shall be borne by the contractor.

1.1.6. Reinforcement

Main reinforcement shall generally be high yield deformed (Type 2) steel bars. Links to beams and columns may be high yield deformed (Type 2) or plain round mild steel bars. The following characteristic strengths shall be used in design calculations:

- plain round mild steel bars: 250 N/mm2
- high yield deformed steel bars: 41 N/mm2.

1.1.7. Bond and lap length

The minimum 'anchorage bond length' and 'lap length' to develop the force in the bars shall be as given in the following table:

Grade of concrete Anchorage and lap lengths in terms of bar diameter Ø

Tension Compression

Mild steel High yield steel Mild steel High yield steel

25 40 47 30 32

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30 37 41 26 28

In no case shall the lap length be less than 25 times the bar diameter plus 150mm for bars in tension and 20 times the bar diameter plus 150mm for bars in compression. Where lapped bars are of two different diameters, the lap length shall be calculated using the diameter of the smaller bar.

1.1.8. Codes and Standards

(a) Structural steelwork shall be designed in accordance with the following:

IS 800 Code of practice for general construction in steel (BS 5400).

Reference Standards

The following publications are referred to in this section;

SP 20(S and T) Handbook on masonry design and construction

BS 5628 Code of Practice for use of masonry

BS 1449 Part 2 Stainless and heat resisting steel plate, sheet and strip

IS 875(part 3) Windloads

IS 456 Code of practice–plain and reinforced concrete

IS 1893(part 1) Earthquake loads

BS 8110 Structural use of concrete, Part 1.

1.1.9. Aggregates

Sand & course aggregates

Sand for use in masonry and plaster works shall confirm in relevant specification in **TNBP (Specification No.7)** and IS:2116/1985, IS:1542/1977.

The course and fine aggregates for concrete shall conform to IS:383/1970 and as specified in the relevant clauses of IS:456/2000. The maximum quantities of deleterious materials in the aggregates, as determined in accordance with IS:2386/ (Part II/1963 shall not exceed the limits given in table 1 of IS:383. Unless otherwise specified all course aggregate in RCC shall be graded aggregate of 20mm nominal size. All aggregates shall be stored in hard impervious surface to ensure exclusion of all foreign materials and as per IS:4082/1977 and **specification no.5 of TNBP Volume 1.**

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1.1.10. Water required for Construction.

The water used in the construction shall be of potable quality and shall be tested at the contractor's cost. The contractor has to make his own arrangements at his cost for water required for construction, testing, filling, etc., either from local bodies or from elsewhere by paying the charges directly and arranging tanker etc., as per necessity. No claim for extra payment on account of non-availability of water near by extra lead for bringing water shall be entertained. Water for mixing and curing shall conform to the provisions in the class 4.3 of IS:456/2000.

Water for washing aggregates, for mixing concrete and for curing shall be clean and free from harmful matter and shall satisfy the recommendations in BS EN 1008; the concentration of sulphates and chlorides shall be such that the concrete mix as a whole complies with the specified limits of salts content.

In designing and establishing approved mixes of concrete for any part of the Works the Contractor shall keep within any limitations on free water/cement ratios which may be expressly stated in the Specification, or shown on the Drawings as applying to concrete for particular parts of the Works or (where not so stated or shown) as given in the Table of concrete grades.

1.1.11. Concrete

Concrete for use in the works shall generally comply with TNBP specification No.30 and the relevant BIS. The concrete mix shall be in specified proportions satisfying the maximum aggregate size, water cement ratio and required cube strength and workability as per IS 456-2000. Such concrete must be adequately vibrated to form solid mass without voids.

1.1.12. Mixing concrete

Concrete shall be mixed in batches in plant capable of combining the aggregates, cement and water (including admixtures if any) into a mixture uniform in colour and consistency, and of discharging the mixture without segregation. On commencing work with a clean mixer the first batch shall contain only half the normal quantity of coarse aggregate to compensate for the adhesion of the other materials to the drum. The moisture contents of the aggregates shall be determined before the commencement of each day's concreting and at such intervals during each day as may

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be necessary. The Contractor shall make due allowance for water contained in the aggregates when determining the quantity of water to be added to each mix, and shall adjust the amount of water added to each mix to maintain the approved free water/cement ratio of the mixed concrete.

1.1.13. Workmanship

Grades and Classes of concrete.

The Contractor shall design mixes for any or all of the grades of concrete in the Table below as required for the Works.

Grade	Typical Use	Minimum cement content(kg/m3)	max free water/cement ratio
Reinforced Concrete			
M35	General structural–major superstructures	380	0.4
M35	Pile cap and piles	400	0.4
M35	General structural–poured underwater	420	0.4
M30	Water retaining structures	400	0.4
M25	General structural–poured underwater	360	0.4
M20	General structural–minor structures(chambers, small building works)	330	0.45
Mass Concrete			
M35	Caisson/well bottom plug	330	0.4
M30	Caisson/well bottom plug	320	0.4
M25	Caisson/well staining	310	0.45
M20	Caisson/well top plug	nominal mix to IS	

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		456	
M10	General blinding/nonstructural fill	nominal mix to IS 456	

Concrete grade is that number which represents its characteristic strength at 28 days expressed in N/mm2, followed by the maximum size of aggregate in mm. Characteristic strength is that value of cube crushing strength below which not more than 5 per cent of all test results fall. This condition shall be deemed to be satisfied when the results comply with the specified test requirements.

1.1.14. Compaction

Concrete placed in situ shall be compacted with power driven internal type vibrators supplemented by hand spading and tamping, and shall be thoroughly worked around the reinforcement, tendons, duct formers and embedded items, and into the corners of the formwork, so as to form a solid mass free of voids. The vibrators shall at all times be adequate in number, amplitude and power to compact the concrete properly and quickly throughout the whole of the volume being compacted. Spare vibrators shall be readily on hand in case of breakdown.

Vibrators shall be inserted into the uncompacted concrete vertically and at regular intervals. Where the uncompacted concrete is in a layer above freshly compacted concrete the vibrator shall be allowed to penetrate vertically for about 100 mm into the previous layer. In no circumstances shall vibrators be allowed to come into contact with the reinforcement or formwork nor shall they be withdrawn quickly from the mass of concrete but shall be drawn back slowly so as to leave no voids. Internal type vibrators shall not be placed in the concrete in a random or haphazard manner nor shall concrete be moved from one part of the work to another by means of the vibrators.

The duration of vibration shall be limited to that required to produce satisfactory compaction without causing segregation. Vibration shall on no account be continued after water or excess grout has appeared on the surface.

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1.1.15. Curing of concrete

Concrete shall be cured by being kept continuously moist throughout the curing period and by protecting the newly cast surface from the effects of sunshine, drying winds, frost, rain, running water or mechanical damage.

The curing shall be maintained for a continuous period of at least

- 7 days when the cement used in the concrete is ordinary Portland cement;
- 3 days when the cement used in the concrete is rapid hardening cement.

If, during the specified minimum period of curing, the average temperature of the concrete

falls below 10°C, the period of curing shall be extended to allow for the concrete to react sufficient maturity. The protection shall be applied as soon as practicable after completion of placing and shall include one or more of the following methods as may best suit the circumstances:-

(a) By water sprays in continuous operation;

(b) By covering with hessian or similar absorbent material, or sand, kept constantly wet;

(c) After thorough wetting, by covering with a layer of waterproof fabric kept in contact with the concrete surface;

(d) by the application of an approved coloured non-staining liquid curing membrane which is either self-removing or easily removed following the curing period and which has a 75% moisture retention standard. The liquid shall be applied to formed surfaces immediately after stripping the formwork.

1.1.16. Precast concrete

Precast is a construction product produced by casting concrete in a reusable mold or "form" which is then cured in a controlled environment, transported to the construction site and lifted into place. In contrast, standard concrete is poured into site-specific forms and cured on site.

1.1.17. Construction Requirements

- Elements of control

Alignment, Verticality and Levels

- Tolerance level

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1. for Wall

- Vertical deviation +2 mm, -2 mm
- Horizontal deviation 0 mm

2. for Beam, Ladder & Slab

- Departure from intended horizontal position, +2 mm or –2 mm
- Departure from intended vertical position, +2 mm or – 2 mm

1.1.18. Quick Check

- Ensure the correct panel before hoisting
- Ensure the crane lifting capacity before hoisting the panel
- Ensure the desired crane's working radius
- Ensure the anchorage for the propping does not damage cast-in building services
- Estimated time to install a typical precast element is 1/2 to 3/4 hour

1.2. Testing

1.2.1. Sampling and testing of aggregates

The Contractor shall take samples of all aggregates and test them for grading, by the methods described in IS 2386, at least once in each week when concreting is in progress and additionally as the Engineer may require. Whenever the source of aggregate is changed and in any case at least once per month the Contractor shall carry out tests on aggregates relating to water absorption, potential alkali reaction, chloride content, sulphate content and shrinkage characteristics, all as specified.

1.2.2. Sampling and testing of concrete

The Contractor shall provide the necessary equipment and shall determine the compacting factor of the freshly mixed concrete by the method described in BS 1881: Part 103 on each occasion that a set of test cubes is made and at such other times as the Engineer may direct.

For each grade of concrete (except grade 10) works test cubes shall be made whenever required by the Engineer but not less frequently than as follows unless otherwise particularly specified:-

for concrete) : one set of cubes per 10 m3, or

of grade 40) part thereof, concreted per day.

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for concrete) one set of cubes per 25 m3, or

of grades 25, 30 or 35) : part thereof, concreted per day.

for concrete) one set of cubes per 50 m3, or

of grades 15 or 20) : part thereof, concreted per day.

Each set of cubes (three cubes per set) shall be made from a single sample taken from a randomly selected batch of concrete. One cube shall be tested 7 days after manufacture and two cubes 28 days after manufacture. The average of the two 28 day results shall be taken as the test result.

Where concrete of a particular grade is likely to be placed infrequently, and the above rates of sampling might not produce sufficient representative test cubes to enable the concrete quality to be monitored properly, the Contractor shall increase the number of standard samples taken during each day when concrete of that grade is being placed so as to ensure that enough representative test cubes are obtained.

1.2.3. Compliance with specified requirements

The concrete shall be deemed satisfactory if the conditions given in both (a) and (b) are

met:-

(a) The average 28 day strength determined from any group of four consecutive test cubes exceeds the specified characteristic strength by not less than 2 N/mm2 for grade Concrete and 3 N/mm2 for grades 20 and above;

1.3. Formwork

Steel /wooden form centering shall be used. It shall consist of MS Sheet not less than 3mm thick and with 60mm to 75mm strong wooden props / Jacks and Props. The timber for vertical prop /posts shall be best hard wood and got approved by the Engineer in charge. This shall be deemed to be included in the items of contract even otherwise specified.

Size of each Ms Sheets shall be 900 x 600 x 600mm and above as instructed by engineering in charge.

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1.3.1. Materials for formwork

Formwork shall be constructed of timber, sheet metal or other approved material. Ties shall be of the rod and cone or other approved proprietary type. Ties for use in water-retaining structures 300 mm thick or less shall incorporate a diaphragm not less than 50 mm dia. welded to the midpoint of the tie, designed to prevent water passing along the tie.

1.3.2. Erection of formwork

Faces of formwork in contact with concrete shall be free from all foreign matter such as water, dirt, projecting nails and the like, splits or other defects. Except where the surface is subsequently to be rendered, formwork in contact with the concrete shall be treated with a suitable non-staining release agent before the steel is fixed or the concrete placed. Care shall be taken to prevent the release agent from touching the reinforcement or concrete at construction joints. Surface retarding agents shall not be used unless specified.

All exposed exterior angles on the finished concrete of 90° or less shall be given 20 mm by 20 mm chamfers unless otherwise specified. Formwork shall be provided for the top surfaces of sloping work where the slope exceeds fifteen degrees from the horizontal unless otherwise specified, and shall be anchored so that the concrete can be properly compacted and to prevent flotation. Care shall be taken to prevent air being trapped.

Where ties are built into the concrete for the purpose of supporting formwork, part of any such supports shall be capable of removal so that no part remaining embedded in the concrete shall be within 50 mm of the surface in the case of reinforced concrete or 150 mm in the case of unreinforced concrete. Holes left after removal of such supports shall be neatly filled with epoxy or well rammed dry-pack mortar.

Openings for inspection of the inside of the formwork, for the removal of water used for washing down and for placing concrete shall be provided and so formed as to be easily closed before or during placing concrete. Before placing concrete all bolts, pipes or conduits or any other fixtures which are to be built in shall be fixed in their correct positions, and cores and other devices for forming holes shall be held fast by fixing to the formwork or otherwise.

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1.3.3. Removal of formwork

Formwork shall be designed to permit easy removal without resorting to hammering or levering against the surface of the concrete. The periods of time elapsing between the placing of the concrete and the striking of the formwork shall have regard to the following factors:

(a) concrete strength;

(b) stresses in the concrete during construction including for precast units any disturbance and handling stresses;

1.3.4. Scaffolding

The scaffolding must be of approved type strong and rigid stiffened with necessary cross bearers and safe to prevent injury to persons or materials. The contractor shall have to allow other trades to make reasonable use of his scaffolding as directed by the Owner/ Architects. If for the interest of work the contractor have to erect scaffolding in the other properties including local bodies or Corporation, the arrangement for the same including the cost of licensing fees etc. shall have to be borne by the contractor and the Owner should be kept free from any liability on this account. Put log holes shall be made good by bricks to match the face work when put logs are removed after ensuring that the holes behind are solidly filled in with 1:4:8 cement concrete.

1.3.5. Separator (Cover Block)

For bottom cover of beams, slabs etc., separators of pre cast cement mortar blocks of suitable size with wire embedment as directed shall be used and tied to the reinforcement. Between layers of reinforcements, separators consisting of pieces of bars of suitable diameter shall be used. The required cover shall be provided as per IS:456/2000 and IS 3370 Part I,II,III and IV/2010.

1.4. Earth Work

The excavation shall be carried out to correct lines and levels. This shall also include, where required, proper shoring to maintain excavations and also the furnishing, erecting and maintaining of substantial barricades around excavated areas and warning lamps at night.

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Excavated material shall be dumped in low lying land, regular heaps, bunds, riprap with regular slopes within the lead specified and leveling the same so as to provide natural drainage and avoidance of formation of any puddle of water near pipe alignment. Rock/soil excavated shall be stacked properly as approved by the Employer. As a rule, all softer material shall be laid along the center of heaps, the harder and more weather resisting materials forming the casing on the sides and the top. Rock shall be stacked separately.

Topsoil shall be stock piled separately for later re-use.

1.5. Excavations - support and working space

The Contractor shall provide effective support for the sides and ends of all excavations to prevent any fall or run from any portion of the ground outside the excavation and to prevent settlement or damage to structures adjacent to the excavation. If, for any reason, any portion of the bottoms, sides or ends of any excavations shall give way the Contractor shall immediately, at no extra cost to the Employer, take all necessary remedial measures including the excavation and removal of all the ground thereby disturbed both within and without the nominal limits of excavation and such extra excavations shall be held to be Excess Excavation.

Where the Contractor proposes to carry out excavations with sloping faces (other than sloping excavations shown on the Drawings or required as permanent features of the Works) and without shoring, excavated faces shall be to stable slopes and heights and the resulting extra excavation shall be held to be Excess Excavation.

The trench shall be so dug that the pipe may he laid to the required alignment and at the required depth. When the pipeline is under a roadway, a minimum cover of 1.0 m is recommended for adoption, but it may be modified to suit local conditions by taking necessary precautions. The trench shall be so braced and drained that the workmen may work therein safely and efficiently. The discharge of the trench dewatering pumps shall be conveyed tither lo drainage channels or to natural drains and shall not be allowed to be spread in the vicinity of the work site.

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1.5.1. Excavation- method

All excavation work shall be carried out by mechanical equipment unless, in the opinion of Employer, the work involved requires it to be carried out by manual methods.

1.5.2. Trial holes

The trial holes shall be excavated in advance of other excavation to such dimensions and depths as he shall order to obtain information required by him. Any further trial holes required by the Contractor to determine the position of underground services, sub-soil drains or for any other reason shall be excavated and reinstated at no extra cost to the Employer.

The Contractor shall arrange for the refilling and reinstatement of trial holes to be carried out immediately the required information is obtained. The reinstatement of the surfaces of trial holes shall be carried out to the satisfaction.

1.5.3. Excavation For Laying Pipe Along The Road

While laying the pipeline below ground along the roadside, the contractor shall observe the following:

The contractor shall not be allowed to take earth from the burrow pits if excavation required to take additional earth results in side slopes steeper than 1:1 in clay dominating soil and 1:1.5 in case of silty sand or sandy soils.

If invert of pipe is kept above the existing burrow pit level or part of pipe is above it, the minimum side slopes of 1:1 in clay dominating soil and 1:1.5 in case of silty sand or sandy soils shall be provided on the side towards the burrow pit area so as to provide required cover. The side slopes shall be properly compacted up to 95% of Procter density.

If earth is taken for providing required cover to pipe from the burrow pits, the burrow pits shall be so graded up to the nearest drain, that no impounding of water is possible in burrow pit area.

1.5.4. Width of Trench

The width of the trench at bottom between faces of sheeting shall be such as to provide not less than 200 mm clearance on either side of the pipe except where rock

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excavation is involved. Trenches shall be of such extra width, when required as will permit the convenient placing of timber supports strutting and planking, and handling of specials.

1.5.5. Provisions for Joints

Additional width shall he provided at positions of socket5 and flanges for jointing if he made properly. Depths of pits at such places shall also the sufficient to permit finishing of joints.

1.5.6. Lowering of Pipes and Fittings

Proper implements, tools and facilities satisfactory to the Authority shall be provided and used for the safe and convenient execution of the work All pipes, fittings, valves and hydrants shall be carefully lowered into the trench, piece by piece, by means of a derrick, ropes or other suitable tools or equipment, in such a manner as to prevent damage to pipes materials and protective coatings and linings. Under no circumstances shall pipes materials be dropped or dumped into the trenches. Pipes over 300 mm diameter shall be handled and lowered into trenches with the help of chain pulley blocks or Hydra / Lifting Cranes, crane. For chain block method Tripod supports used for this purpose shall be regularly checked to prevent all risks of accidents.

1.5.7. Laying Pipe

Every precaution shall be taken to prevent foreign material from entering the pipe while it is being placed in the line. If the pipe laying team cannot put the pipe into the trench and in place without getting earth into it, the Authority may require that before lowering the pipe into the trench, a heavy, tightly woven canvas bag of suitable size shall be placed over each end and left there until the connection is to be made to the adjacent pipe. Joints of pipe in the trench which cannot be poured shall be caulked with jointing materials to make them watertight. Alternatively, flanged pipe/threaded pipe may be used Number of Pipes Laid Before Jointing Wherever the jointing material specified is cement, six or more lengths of pipe shall be laid in place ahead of each joint before such a joint is finished. cutting of Pipe The cutting of pipe for inserting valves, fittings or closure pieces shall be done in a neat and workmanlike

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manner without damage to the pipe or cement lining so as to leave a smooth end at right angles to the axis of the pipe. For this purpose use of a pipe cutting machine is recommended. When pipe cutting machine is not available for cutting pipes of large diameters, the electric-arc cutting method may be permitted using a carbon or steel rod. Only qualified and experienced workmen shall be employed on this work.

1.5.8. Clearing

The area to be excavated / filled shall be cleared of fences, trees, plants, logs, stumps, bush, vegetation, rubbish, slush, etc. and other objectionable matter. If any roots or stumps of trees are encountered during excavation, they shall also be removed. The material so removed shall be disposed off as approved by the Employer. Where earth fill is intended, the area shall be stripped of all loose/ soft patches, top soil containing objectionable matter/ materials before fill commences.

1.5.9. Erosion protection grassing and site drainage

Surfaces that are not paved surfaces or an integral part of a structure shall be finished as follows:-

- Sloping surfaces of gradient steeper than 1 in 2.5 shall be pitched with grouted stone pitching. Weepholes shall be installed on pitched surfaces at 2 m c/c spacing;
- Sloping surfaces of gradients between 1 in 2.5 and 1 in 20 shall be topsoiled and seeded as per the Specification and shall be protected with an erosion control blanket of coir pinned into the subsoil at 2m intervals in two directions using biodegradable pegs of length not less than 400mm;
- flat surfaces shall be grassed as specified here-in. Flat surfaces shall have slopes not greater than 1 vertical to 20 horizontal and not less than 1 vertical to 50 horizontal;
- surface drains shall be installed at the intersections of sloped and flat surfaces and shall be sufficient in capacity to remove surface runoff of 100 mm per hour to the site drainage system;
- the site drainage system shall be installed to have sufficient capacity to drain water from all roofed, paved and sloping areas at a surface runoff rate of 100 mm/hour;
- the site drainage systems shall discharge into the overflow lagoons or into the overflow drain;

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• the Contractor shall install an automatic irrigation system to apply irrigation water to grassed areas.

1.5.10. Excess excavation (backfilling)

Excess excavation may normally be backfilled with material emanating there from, but where the Engineer has ordered such material to be removed from Site as being unsuitable the Contractor shall make good the excess excavation with such kind of fill material or in such class of concrete as may be reasonably required by the Engineer having regard to the circumstances.

1.5.11. Excavation by the Use of Explosives

Contractor shall ensure that all workmen and the personnel at site are excluded from an area within 200 m radius from the firing point, at least 15 minutes before firing time by sounding warning whistle. The area shall also be given a warning by sounding a distinguishing whistle.

The blasting of rock near any existing buildings, equipments or any other property shall be done under cover and Contractor has to make all such necessary muffling arrangements. MS plates may preferably do covering with adequate dead weight over them. Blasting shall be done with small charges only and where directed by Employer, a trench shall have to be cut by chiseling prior to the blasting operation, separating the area under blasting from the existing structures.

1.6. Piles

1.6.1. General Piles of all types

Bearing piles shall be designed to carry safely the working loads shown in the Drawings. The ultimate bearing capacity, as determined by test in accordance with Clause 10.6.1, shall be at least twice the working load. The ultimate bearing capacity is defined as the load which,

applied at the head of the pile, causes the head of the pile to settle a distance equal to one-tenth of the pile diameter. In the case of non-circular piles, 'diameter' shall be taken to mean the diameter of the circle having an area equal to the cross-sectional area of the pile or, in the case of steel H-piles, to the area bounded by the flanges and lines joining the edges of the flanges.

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The approximate length of bearing piles shall be determined from any geological information included in the Specification or obtained by preliminary site investigation or shall be determined from load tests carried out on non-working piles. The final length of driven piles shall be determined by driving to a 'final set', expressed as the penetration in millimetres per 10 blows. The final set may be calculated using an established pile-driving formula but shall not exceed the average of final sets recorded when driving non-working piles which have achieved the required ultimate bearing capacity.

The final length of bored or augered piles shall be not less than the average length of nonworking piles which have achieved the required ultimate bearing capacity.

Precast concrete piles and pile casings shall be designed to develop the strength necessary to

withstand without damage the stresses arising during transportation, handling and driving. The design shall be such that the compressive stress in the concrete during handling and pitching and under the working load does not exceed 0.275 fcu due to direct load or 0.366 fcu due to bending, where fcu is the 28-day works cube stress.

Where not otherwise specified herein, the design of all piles shall comply with the relevant recommendations of BS 8004 and/or IS2911.

The Contractor's method of working shall be such that the installation of the piles shall not cause any damage to adjacent structures or foundations. The Contractor shall select his method or times of working or both to limit the noise of driving to reasonable levels and to comply with environmental legislation.

Piles shall be constructed within the following tolerances:

(a) in plan, at the working level of the piling rig, 75mm in any direction from the position shown in the Drawings;

(b) 1 in 75 from the vertical for a vertical pile;

(c) 1 in 25 from the specified rake for a raking pile.

Where not otherwise specified herein, installation of all piles shall comply with relevant

recommendations of BS 8004.

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1.6.2. Bored cast-in-place piles

Bored cast-in-place piles shall have a casing of steel which shall be filled with concrete. The casing may, and where specified shall, be left in place as part of the Permanent Works. The casing shall be suitable for the method of installation and for the purpose of forming a pile.

Steel casing and concrete for filling it shall be as specified in Clause 2.11.6.Unless otherwise specified, piles shall be reinforced over the whole of their length as specified in the last paragraph of Clause 2.11.6.

1.6.3. Recording of pile installation

The Contractor shall keep records of every pile as follows:

— pile type;

— pile number;

— original ground level related to Ordnance Datum Newlyn;

— nominal diameter or dimensions;

— date driven or bored;

— date concreted;

— depth from ground level to toe of pile;

— depth or height from ground level to cut-off level of pile;

— depth or height from ground level to top of the concrete;

— final set for driven piles, weight and drops of hammer;

— details of any obstructions observed.

The Contractor shall also take a full driving record for all non-working piles and up to 20% of

all the driven piles as specified in the drawing. This full record shall include the number of blows for each 250mm of driving until the target toe level is approached or until the driving resistance increases to the calculated set value, whichever occurs first; thereafter the number of blows for each 50mm of driving.

All records shall be accurately kept in duplicate as the work proceeds and one copy shall be handed to the Engineer as soon as practicable after driving and not later than the completion of each day's work.

1.6.4. Testing

The Contractor shall carry out maintained load tests on piles as follows:—

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(a) Non-working piles, constructed for test purposes at positions selected by the Engineer, shall be tested to the ultimate bearing capacity as defined in Clause 2.12.2.These test piles shall be constructed in the same manner and to the same set (where applicable) as the working piles.

(b) Working piles (meaning piles forming part of the Permanent Works) will be selected at random and tested to a load of one and a half times the working load. Piles shall not be tested until crushing tests on control cubes from the same mix and cured in the same way as the piles, show strengths greater than the specified works cube strength at 28 days.

1.6.5. Dewatering

The Contractor shall ensure that the excavation and the structures are free from water during construction and shall take all necessary precautions and measures to exclude ground/rain water so as to enable the works to be carried out in reasonably dry conditions in accordance with the construction programme.

1.6.6. Depth and width of excavation

The earthwork for the pipe laying work shall generally conform to the details given below.

Sl. No.	Size of pipe in mm	Depth of Excavation (cm)	Width of trench at bottom (cm)
1	HDPE Pipe upto 140	105	60
2	For other pipes up to 150	105	75
3	For other pipes 200	110	80
4	For other pipes 250	120	80
5	For other pipes 300	135	80
6	For other pipes 350	145	90
7	For other pipes 400	155	90
8	For other pipes 500	185	100
9	For other pipes 600	205	110
10	For other pipes 700	230	120

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11	For other pipes 750	245	125
12	For other pipes 800	245	125
13	For other pipes 900	260	140

1.6.7. Timber Shoring

Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called 'polling boards'. These shall be of minimum 25 cm x 4 cm sections.

1.6.8. Cables

AC power cables shall be 3-core copper, PVC steel wire-armoured PVC 600/1000 volt grade. DC cables shall be single-core multi-strand copper, double-insulated and sheathed for cprotection against the aggressive soil environment. Minimum cable size shall be 10mm². Bonding cables and main DC current-carrying cables shall generally be 50mm². All cables shall be sized so that cable voltage drops will not reduce the capacity of the system.

1.6.9. Cable laying and pipeline connections

All cables shall be identified where they terminate in transformer-rectifiers or bond or anode boxes and potential marker posts. All cables shall be laid in trenches with a minimum cover of 750mm and with a surround of sand or selected fine backfill. Cables and connections shall be identified to the requirements of the Employer. Where necessary anode cables shall be insulated against chloride attack.

1.6.10. Cable joints

Epoxy-filled splicing kits are to be used at all anode/ring-main cable connections and all other cable connections underground.

1.6.11. Existing pipelines and buried cables

Where pipelines cross or run in close proximity to existing pipelines or buried cables, the crossings shall be constructed as shown in the Drawings, particular care being taken to avoid damage to the existing pipelines or cables. The Contractor shall give one month's advance notice of the work to the owners of the existing pipelines or

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cables, and shall comply with any special requirements of the owners for safety or security during progress of the work.

1.6.12. Cables sharing pipeline trenches

Where cables are detailed in the Drawings to be laid in pipe trenches the pipes shall be installed and fine backfill shall be placed to 150mm above the crown of the pipe. The cable shall then be laid as shown in the Drawings before the remainder of the trench is backfilled. Where ducts are detailed as being laid in large radius curves in either the horizontal or vertical planes these shall normally be not less than 50m radius, unless a smaller radius is specifically detailed. In no case shall a curve of less than 25m radius be installed. Ducts shall be laid in regular curves of the required radius by bending the pipe during installation.

Curves shall not be formed with angular deviations at flexible joints. The Contractor shall provide the cable duct and draw cord as specified and shall lay and joint the duct, complete with draw cord, in the pipe trench to the line and levels within the nominal dimensions of Trench Excavation. Joints in the draw cord shall be kept to a minimum; they shall be at least as strong as the cord and shall be so made as not to cause any jamming in use.

In refilling Trench Excavation, the Contractor shall ensure that the duct is not displaced or distorted and that, whatever its position in the pipe trench, it is surrounded by at least 150mm of well-compacted soft material (free from stones greater than 20mm in size). The cable duct shall pass through sleeves cast into anchor and thrust blocks and the walls of junction boxes and the like, but it shall not be buried in concrete surround to pipes.

1.6.13. Chambers and Manholes

Valve chambers, air valve chambers, flow meter chambers, manholes and similar structures shall be built into the pipeline where shown in the Drawings and shall be constructed in accordance with the Drawing. Valve chambers in which pipes are anchored shall be treated as specified for anchor and thrust blocks. If undisturbed ground has not been maintained next to a thrust-bearing surface, the gap shall be backfilled with mass concrete.

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1.6.14. Bed Concrete

The bed concrete for manholes shall be done in accordance with specification given in Section A-5 for concrete work. The concrete grade is 1:4:8.

1.7. Pipe fittings

All pipe work and fittings within the chamber shall be set to exact line and level prior to the construction of the chamber walls. Pipes, fittings and valves in chambers shall be protected from damage and soiling of coatings during construction. After construction all chambers and manholes shall be cleaned of any accumulation of silt, mortar, debris or any other foreign matter and shall be free of any such accumulation at the time of final inspection.

1.7.1. Brick works

Bricks used for construction of valve chambers shall conform to the relevant Indian Standards. They shall be sound, hard, homogeneous in texture, well burnt in kiln without being vitrified, table moulded, deep rod, cherry or copper coloured, of regular shape and size and shall have sharp and square and parallel faces. The bricks shall be free from pores, chips, flaws or humps of any kind. Bricks containing unground particles and/or which absorb water more than 1/6th of their weight when soaked in water for twenty-four hours shall be rejected. Overburnt or underburnt bricks shall be liable to rejection. The bricks shall give a clear ringing sound when struck and shall have a minimum crushing strength of 35 Kg/sq.cm. The class and quality requirements of bricks shall be as laid down in IS : 1077.

The size of the brick shall be 23.0 x 11.5 x 7.5 or unless otherwise specified; but tolerance upto (+) 3 mm. in each direction shall be permitted. Only full size brick shall be used for masonry work. Brick bats shall be used only with the permission of the Engineer-in-charge to make up required wall length or for bonding. Sample bricks shall be submitted to the Engineer-in-charge for approval and bricks supplied shall conform to approved samples. If demanded by the Engineer-in-charge, brick sample shall be got tested as per IS : 3495 by Contractor at no extra cost to the client. The bricks rejected by the Engineer shall be removed from the site of works within 24 hours.

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1.7.2. Pipe entering or leaving manhole

Whenever a pipe enters or leaves a manhole, bricks on edge must be cut to a proper form and laid around the upper end of the pipe so as to form an arch. All around the pipes, there shall be a joint of cement mortar (1:2) 13 mm thick between it and the bricks.

1.7.3. Manhole steps

Except where otherwise specified or shown on the Drawings, manhole step shall be of malleable cast iron in accordance with IS 5455. The shape and dimensions shall be to the figure of that BS.

1.7.4. Cast iron frame and cover

The cast iron frame and cover shall be of grey cast iron as per IS : 1728. The general requirements for casting and coating of CI frame and cover shall be as specified for CI steps in Clause. The locking device for cover shall be not less than 4 mm. The locking device for cover shall be provided.The CI covers for load test shall be selected at one for every lot of fifty or part thereof for each type and size manufactured and as directed by the Engineer-in-charge. The frame shall be fixed in cement concrete of M15 grade all round and finished with neat cement. The manhole frame shall have clear opening and shall weigh. including cover shall be as per the bill of quantity.

1.7.5. Sleeve joints & Butt joints

Pipes of diameter 711mm and greater shall be supplied with Type 1 Sleeve Joints with tapered sleeves as per Annex C of BS EN 10224:2002 or IS 3589. The permissible angular deflection at any sleeve joint shall be 2 degrees. The gap between sleeve and spigot at any weld location for internal welds on Type 1 joints shall nowhere exceed 3mm whether the joint is deflected or not and the average gap around the circumference of any weld shall not exceed 1mm. The gap between sleeve and spigot at external welds on Type 1 tapered sleeve joints may exceed 1.5mm where the pipe joint has been deflected subject to demonstration by weld procedure tests and air tests,

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and continued successful production: in this situation the weld gap may need to be 'buttered' by additional weld runs or 'filler metal'.

For gravity portion in the trunk main butt joints proposed with bevelled ends shall be beveled to angle of 30o +5/-0 degrees measured from a line drawn perpendicular to the axis of the pipe. The roof face shall be 1.6+/-0.8mm.

1.7.6. Site welding of joints

Welding of joints in trench for steel pipes shall be carried out manually by the metal-arc process complying generally with the requirements of BS 4515. Before starting the welding of pipe joints on Site, the Contractor shall submit for the Engineer's approval details of the plant, methods and materials he proposes to use, including make and size of electrodes, number of runs, current strength, and arrangements for air testing of individual joints.

The Contractor shall make test specimens on bare steel shells or pipes of the same size and thickness as the pipelines to be welded. The joints shall be tested in the presence of the Engineer for each procedure in accordance with requirements of A.P.I Standard 1104.

Welded joints in trench shall generally be of the parallel short-sleeve, spherical-spigot and socket type with a circumferential full-strength fillet weld both internally and externally. Welding gap tolerances shall be as specified. Full-strength fillet welds shall have a throat thickness not less than 0.7 times the thickness of the pipe to be welded. Welding gap tolerances for collar joints shall be as specified. All parts to be welded shall have scale, slag, loose rust, paint and other foreign matter removed by means of a mechanical brush and shall be left clean and dry immediately before welding. All scale and slag shall be removed from each weld run when it is completed and prior to air testing.

After completion of welding at each joint, magnetic crack detection tests shall be carried out on all fillet welds made and 100% radiographic examination carried out on all butt welds made. All such tests shall be carried out by the Contractor in the presence of the Engineer.

Where butt joints are being welded mechanically, the Engineer may permit the proportion of weld radiographically examined to be reduced to 20% if and when and for as long as he is satisfied with the results being obtained. The standard of

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acceptability of welds shall be in accordance with API 1104 Section 6. Where necessary, welds shall be repaired in accordance with Section 10 of API 5L. Weld repairs shall not be made more than once at any position on the joint.

1.7.7. Special joints

At joints between cement mortar lined steel pipe (or specials) and valves, the internal diameter of the steel pipe or special shall be finished to match the bore of the valve by gradually decreasing or increasing the thickness of the lining in the pipe or special, although the lining shall be nowhere less than 6 mm thick. Any increase or decrease in the thickness of the lining shall be gradual and smooth and the Contract Rates shall be deemed to include for all costs incurred in providing such a lining. Inserts, bolts, etc. Fabricated pipe, moulded, cast or fabricated frame inserts, bolts, plates, etc. shall be provided in masonry and concrete works as required. It is imperative that all inserts, bolts, fixtures and fittings shall be provided in their position very accurately. Such inserts and bolts shall be fixed by use of templates. If as a consequence of negligence on the part of the Contractor, the inserts, bolts, fixtures, fittings, etc. are out of alignment, the Contractor shall make arrangements to have the inserts and bolts removed and refixed in their proper position.

1.7.8. Air testing of sleeve- and spigot-welded joints

After each joint has been welded it shall be subjected to an air test in the presence of the Engineer. A tapped hole, not less than 6mm diameter, shall be provided in the sleeve end of each pipe, into which a suitable pressure gauge shall be fitted for purposes of the test. An air pressure of 4 bars shall then be pumped into the annular space between the sleeve and spigot and the pump disconnected. In the case of split collar joints, a tapped hole shall be provided at each end of the collar and each side of the joint shall be pressurised. If no drop in pressure occurs over the ensuing period of 15 minutes, the test shall be deemed successful. If the test pressure is not maintained for 15 minutes, the position of the leak shall be determined using soap solution. The Contractor shall provide all equipment necessary to test the joints.

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All defects in the weld shall be cut back and re-welded and the test re-applied until successful. After testing, the tapped test holes shall be sealed with screwed plugs. The requirements of this clause shall not limit the Contractor's obligations in achieving satisfactory results in the tests on completion as prescribed later.

1.7.9. Water supply and sanitary works - general

All plumbing works shall be carried out through a licensed Plumber and the pipes and fittings shall be as per the requirements of the Municipal water bye-laws. Contractor shall submit the name of the licensed Plumber to whom the work is to be entrusted for approval of the Engineer.

1.7.10. Fixtures and valves

All fixtures and valves shall be of types and in accordance with I.S. 6157. Stop valves which are generally concealed shall be made of brass or gunmetal. Stop cocks which are exposed and bib and pillar cocks attached to sanitary fittings shall be brass or gunmetal bodies chromium plated and marked "hot" or "cold" as required. Ball valves shall be brass in accordance with IS: 1703.

1.7.11. Refilling of the trenches for building works

After the foundations of any buildings or other works have been completed or the sewer or drain pipes have been laid and jointed or the inspection chamber manholes and vents completed and as soon as the joints have been inspected and passed by the Engineer, In re-filling the trenches, utmost care shall be exercised so as no to disturb, break or damage the jointed pipes. Immediately the finest selected material shall be put round the pipe or be thrown into the trenches until the same is completely protected by the finer material filling referred to above. The back filling shall be done in suitable layers and shall be rammed properly until it is thoroughly consolidated and watered in addition, if considered necessary additional care shall be exercised so that the trenches are filled in solidly with selected material without voids under the pipes and that no damage is done to the pipe during the process of filling and consolidation.

1.7.12. Anchor and thrust blocks

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Concrete anchor and thrust blocks in accordance with the details shown in the Drawings shall be constructed at all tees, bends, tapers, valves and hydrants for the anchorage of the pipeline as appropriate. Concrete shall be of the class shown in the Drawings. Unless otherwise detailed in the Drawings, thrust blocks shall be constructed with the bottom and thrust side surfaces bearing against undisturbed ground. If blinding concrete is required or allowed to be placed beneath any horizontal thrust block, shear keys shall be formed on its upper surface as shown in the Drawings.

1.7.13. Concrete bed and surround

Where specified or indicated in the Drawings, pipes shall be bedded and haunched or surrounded in concrete in accordance with the typical details shown in the Drawings. If not shown otherwise then the minimum extent of surround to any part of the pipe barrel shall be 150mm. Unless otherwise shown, concrete shall be unreinforced class M20. Any formwork required shall be of Class F1.Each pipe shall be supported on at least two purpose-made precast concrete blocks, which shall be left in place. Concrete, other than the precast blocks, shall not be placed until the joints at each end of the pipe have been completed. The full width and depth of bedding concrete shall be placed and carefully worked and compacted beneath the pipe, followed at once by the addition of any haunching and surround concrete. Unformed surfaces shall be of spade finish. The pipe shall be prevented from floating or otherwise moving during concreting.

The continuity of concrete bed, haunch or surround to pipes with flexible socket and spigot joints shall be broken at each flexible joint by 25mm thick fibreboard, placed against the face of the socket. The concrete bed, haunch or surround shall be discontinued at detachable flexible couplings, leaving a clearance of 75mm each side of the coupling. Where two or more pipelines are laid in the same trench, the joints shall coincide at the joints in the largest diameter pipeline where the continuity of the concrete bed, haunch or surround shall be broken. Any intermediate joints in the smaller diameter pipelines shall be surrounded in concrete.

1.7.14. Cutting of pipes

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Pipes which are to be cut to enable fittings to be accurately positioned or to form closing pieces in any portion of the pipeline or to terminate in manholes or other parts of the work shall not be cut until after adjacent pipes have been laid and jointed and accurate measurement of the length required can be made. The Contractor shall determine the length of each cut pipe and the required angle and shape of the cut. The cut shall be neatly performed by an experienced skilled man using tools or machinery appropriate for the type and diameter of pipe to be cut. The cut ends of the pipes shall be shaped up and trimmed so as to ensure an accurate joint or termination as the case may be. Any damage to wrapping, coating or lining shall be made good.

1.7.15. Work inside pipelines

The Contractor shall provide, operate and maintain adequate systems of access, lighting and ventilation to any part of a pipeline where work is in progress inside the pipes.

1.8. Bituminous macadam

The grading, composition and characteristics of bituminous macadam shall be as follows:

Aggregate Grading, 50mm graded:

IS Sieve Designation	Percentage Passing
50mm	100
40mm	60-100
25mm	30-70
20mm	20-70
6.3mm	10-20
2.36mm	0-5

Bitumen(Grade S65) 3.7 to 4.3% by weight of total mix

Aggregate Grading, 25mm graded:

IS Sieve Designation	Percentage Passing
25mm	100
6.3mm	10-40

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2.36mm	0-5
Bitumen(Grade S65)	3.7 to 4.3% by weight of total mix

Aggregate Grading, 12mm graded:

IS Sieve Designation	Percentage Passing
12mm	100
6.3mm	10-40
2.36mm	0-5
Bitumen(Grade S65)	3.7 to 4.3% by weight of total mix

1.9. Slab culverts

Concrete for Cast in-situ culverts shall be of reinforced M20 concrete unless otherwise shown. Masonry and brickwork shall comply with the section of this Specification concerning Building Works. Pre-cast concrete culverts as per the drawing No:

1.10. Water bound macadam course

1.10.1. Preparation of base

The sub-base shall be .prepared to the specified grade and camber and made free of dust and other extraneous material. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm.

1.10.2. Application

The bituminous macadam shall be laid by mechanical compactor and finisher, the final consolidation being by means of power roller weighing not less than 10 tonnes. The finished surface shall not vary by more than 12.5 mm above or below the designed level and the average thickness shall not be less than 65 mm after consolidation. The bituminous macadam may be prepared in a hot mix plant or the bitumen may be cut back with a suitable solvent so that the heated cut back bitumen

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may be mixed with the aggregate. In either case mixing shall be carried out in a power driven pugmill mixer and shall be continued until all the aggregate is coated.

1.10.3. Protection of pavement

During the period between initial compaction of the coarse aggregate and completion of the seal coat, the surface shall be protected from all traffic other than absolutely essential to its construction.

1.10.4. Premixed seal coat

After the aggregate has been rolled, the interstices shall be completely filled with pre-coated grit of the following composition: The premixed seal may be prepared in a hot mix plant or the bitumen may be cut back with a suitable solvent so that the heated cut back bitumen may be mixed with the aggregate. In either case, mixing shall be carried out in a power driven pugmill mixer and shall be continued until all the aggregate is coated. The premixed seal must be brushed to fill in the interstices, additional material being applied during rolling if found necessary. The quantity of premixed seal required for this purpose shall be 1.22 cu.m. per 100 sq.m.

1.11. Spreading coarse aggregate

Coarse aggregates shall be spread uniformly upon the prepared base and compacted to 80 mm. Spreading shall be done from stockpiles along the side of the roadway or directly from vehicles. In no case shall the aggregate be dumped in heaps directly on the surface prepared to receive the aggregate nor shall hauling over uncompacted or partially compacted base be permitted. The surface of the aggregates spread shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate.. No segregation of large or fine particles shall be allowed. Coarse aggregate shall not be spread more than 3 days in advance of the subsequent operations

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CHAPTER 2

2.0. Building Works

2.1. Materials and Workmanship

2.1.1. Cement/lime mortar

Mortar for brickwork, brickwork and stonework shall be prepared, in accordance with I.S.2250. Cement mortar shall consist of Portland cement and sand, in proportions specified elsewhere. Lime mortar for laying of tiles shall consist of one part of cement, 2 parts of lime and 6 parts of sand. Mortar shall be mixed on clean, hard, dry platforms protected from sun and rain. The constituents shall be measured using properly made gauge boxes and shall be thoroughly mixed dry before water is added. Any mortar not used 30 minutes after the water is added shall be discarded.

For lime mortar, lime from burnt stone shall be used. It shall be free from ash and impurities and be in the form of lumps and not powder when brought to Site. Lime which is damaged due to rain, soaking, moisture or air slaking shall not be used. Portland cement for mortar shall comply with I.S. 269. Sand for mortar shall comply with I.S. 2116 and shall be of the following grading:

I.S. Sieve Percentage passing by weight

4.75 mm 98 - 100
2.36 mm 80 - 100
1.18 mm 60 - 80
600 microns 40 - 65
300 microns 10 - 40
150 microns 0 - 10

Sand for mortar shall be from an approved source and shall consist of hard, coarse siliceous grains free from deleterious matter. It shall be stored separately from other sand or fine aggregate and shall be kept covered. Water for mortar shall comply with the specification for water for concrete.

2.1.2. Tests on cement mortar lining

Test blocks of the same material as used for pipe lining shall be made in 100 mm moulds and subjected to cube crushing tests. Each block shall be removed from its mould as soon

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as practicable and cured under conditions of temperature and humidity identical with in which lining of the pipe is cured. The cube strength of the test cube shall not be less than 31 N /mm2 after 28 days of curing or 17 N/mm2 after 7 days of curing. The density of the test cube shall not be less than 2100 kg/m3.

2.1.3. Curing

All concrete work shall be water cured for a minimum period of 7 days after concreting or as directed by Owner/Architects. Horizontal surfaces shall be kept covered.

2.1.4. Bricks

Bricks for common brickwork shall be whole, sound, well burnt clay bricks free from cracks and shall comply with the requirements of I.S. 1077.Clay engineering bricks shall comply with the requirements of I.S. 2180.Bricks shall not be tipped on the Site but shall be carefully stacked by hand in separate stacks. Broken or damaged bricks shall not be used in brickwork.

Crushing Strength	= 50 kg/cm2
Water Absorption	= not >25% for partition walls
Size	= Tolerance Allowed = 3.3% positively

2.2. Brick work

Brickwork shall be built in accordance with the requirements of I.S. 2212. Every brick shall be wetted and laid on a full and close joint of mortar on its bed, side and end in one operation, joints being, fully flushed up as the work proceeds. No previous course shall be wetted if it has dried and the walls shall be brought up evenly with no portion racked up (and not toothed) more than one metre higher than another. All brickwork shall be properly bonded together. Joints shall not exceed 10 mm in thickness and shall be raked out to a depth of 7.5 mm as a key for rendering or plastering. All courses shall be truly horizontal and all perpends shall be strictly plumb and square.

In the cavity walls the two leaves of brickwork shall be bonded with galvanised wall ties 150 mm to 250 mm long as required. The ties shall be built into the horizontal joints as the work proceeds and the space between successive ties shall not exceed 750 mm horizontally nor 250 mm vertically. Ties shall be staggered and shall be laid

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sloping down towards the outer leaf of the cavity. Cavities shall be kept free from mortar droppings by the use of suspended battens and temporary openings at the bottom of the wall. Every fourth vertical joint in the external face in the course immediately above the horizontal damp proof courses shall be raked out and left open to form a weep hole. Completed brickwork shall be kept wet for a minimum period of 14 days.

2.3. Concrete blocks

Concrete blocks whether made on or off Site shall be manufactured to the shapes, sizes and finishes as specified IS: 2185. The Contractor shall submit full details of his proposed manufacturing arrangements to making any blocks for use in the Works and shall submit such samples as may be needed to demonstrate the quality of the finished product. Production of blocks shall be of equal standard to the approved sample blocks.

Concrete for blocks shall be made such that the combined aggregate shall have a fineness modulus lying between 3.6 and 4 and shall conform with the following grading

I.S. Sieve	Percentage passing By weight
12.5 mm	100
10 mm	> 85
4.75 mm	> 60
300 microns	> 10

Concrete for blocks shall be minimum Class M-20. Hand mixing shall not be permitted. sample block from any batch shall be tested as specified in I.S. 2185.

Finished blocks shall be neatly stacked for storage on firm dry support and shall be covered to protect them from dirt, sun and rain. Damaged blocks shall not be used in the Works.

2.4. Machine Mixing :

Concrete shall be mixed in Mechanical Mixer. Mixing shall be continued until there is uniform distribution of materials and the mass is uniform in colour and

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consistency. The mixing time from the time of adding water shall be in accordance with I.S. 1791 of latest edition but in no case mixing shall be done for less than two minutes.

2.5. ***Tests For Concrete***

Tests shall be conducted in accordance with I.S. : 516 of latest edition.

2.5.1. ***Test Cubes***

a) Works tests cubes shall represent quality of concrete incorporated in the work and taken out in sets of 6 cubes. The concrete for preparation of one set of 6 cubes shall be taken from one batch of mixed concrete discharged from mixer. The cubes shall be moulded in accordance with Indian Standard Code of Practice.

b) A minimum of one set of 6 cubes shall be taken for every 20 cum or part thereof in case of beam, slabs & connected collums; one set for 5 cum or part thereof of concrete poured for columns and they shall be considered as representative for said quantity. This is an average figure, and may be increased to cater for special conditions at the discretion of the Owner/Architects at site.

c) The cubes shall be cured as per IS 456 code of Practice. The entire operation of casting, arranging and despatch of cubes to Laboratory will be carried out by the Contractor under the supervision of the Engineer. Out of 6 cubes, 3 cubes shall be tested at an age of 7 days and balance at an age of 28 days in an approved Laboratory.

d) The cubes shall be initialed, numbered, dated jointly by the contractor's representatives and the Site Engineer representative with a piece of wire or nail so that in indentation of the initials is left on the cubes.

e) The contractor shall arrange to transport the cubes to the approved laboratory and arrange to have the test results forwarded (in duplicate) directly from the laboratory to the Owner/Architects. The contractor shall bear all expenses in connection with the preparation of test cubes, i.e provision of moulds, cost of concrete, labour and transportation charges to the approved laboratory,

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laboratory testing charges etc and his rates for concrete items should be quoted accordingly.

f) A Register shall be maintained at site by the Contractor with the following details entered\ and initialed by the Contractor.

i) Reference to specific structural members receiving the batch of concrete from which the cubes were cast.

ii) Mark on cubes. iii) The mix of concrete. iv) Date and time of casting.

2.6. Uncoursed stone masonry

Uncoursed stone masonry shall be built in layers not exceeding 450 mm in height. No stone shall be less in breadth than 14 times its height and less in length than twice its height. Every stone whether large or small, shall be laid in its natural bed and set flush in mortar, and the small stones used for wedging or filling being carefully selected to fit the interstices between the large stones. Care shall be taken to see that no dry work or hollow space is left in the masonry. The stones shall be so arranged as to break joints at least every 80 mm and long vertical joints of joints shall be avoided. The joints at the face shall be finished off neatly, being struck and smoothed with a trowel while the mortar is fresh. The upper surface of the work shall be brought to a uniform level at the height of each course. The faces of masonry walls shall be kept in perfect plumb and where batter has to be given it shall be uniform. The stones at all comers and junctions of walls shall be of large sizes and hammer dressed to the correct angle. Each stone shall be thoroughly wetted before being used in the work. The masonry shall be kept thoroughly wet during the progress of the work, (care being taken to water it even on Sundays and Holidays, special labour being employed if so required for this purpose) until it has set. As far as practicable, the whole of the masonry shall be raised in one uniform level and no part of the masonry shall be allowed to rise more than 1 metre above the rest to avoid unequal settlement. If raising one part of wall before the other becomes unavoidable the end of the raised portion shall be racked back in steps to prevent cracks developing at the junction of the old and new work. Care shall be taken to see that the sides of the wall are not built separately from the hearting, the faces and internal filling being done simultaneously. The stones shall

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overlap and cross each other as much as possible. No course shall be laid unless the previous course is perfectly set.

At least one header or through stone per square metre of wall face shall be built into the work. The headers or through stones shall be at least 0.05 m2 in area at face and shall have at least 0.025 m2 area at the back face. Where the thickness of the wall is more than 600 mm a series of through stones shall be laid through the work so as to form a tie from front to back, breaking joints or overlapping each other for at least 150 mm. No stone whose length is less than 600 mm shall be used in such work as a header.

Sufficient number of headers shall be collected on site before commencing any masonry work. Quoins shall be 150 mm high and formed of header stones at least 300 mm long. They shall be laid lengthwise alternately along each face and square on their beds, which shall be dressed to a depth of at least 80 mm.

Weep holes 80 mm wide and 150 mm in height shall be provided in retaining walls at the rate of one per square metre as specified or directed. They shall be pointed with 1:2 cement sand mortar after raking the joints to a minimum depth of 25 mm.

Completed masonry shall be kept wet for a minimum period of 14 days. In wet weather newly laid masonry shall be protected from the effects of heavy rainfall by tarpaulins or other approved material.

2.7. Pointing of uncoursed masonry

Joints in exposed masonry faces shall be formed while the mortar is still green and shall be finished as flush joints, weathered joints, round-recessed joints or square-recessed. Masonry which is to be rendered or plastered shall have the joints raked out to a depth of 15 mm to form a key.

2.8. Stone pitching

Stone for pitching shall be obtained from an approved source and shall be hard, sound, durable, clean and generally as specified. The minimum dimension of any stone shall be at east equal to the specified thickness of the pitching.

After excavation and trimming, slopes to be pitched shall be spread with a 75 mm thick layer of crusher run rock or graded coarse aggregate ranging from 75 mm particle size to fines. The slope shall then be hand packed with hard broken rock to a

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total thickness of 150 mm, each stone being individually placed and rammed home, with smaller stones edged into the cracks. 50 mm dia weep-holes shall be provided at intervals not exceeding two metres in both directions. Joints in stone pitching shall be flushed up with sand/cement mortar on completion.

2.9. Rubble packing

Rubble used for packing under floors, foundations, etc. shall be hard and durable rock, free from veins, flaws and other defects. The quality and size of the rubble shall be 75mm to 200mm rubble shall be laid closely in position on the sub-grade. All interstices between the stones shall be wedged in with smaller stones of suitable size well driven to ensure tight packing and complete filling of interstices. Such filling shall be carried out simultaneously with the packing in position of rubble stones and shall not lag behind.

Small interstices shall be filled with hard clean sand and well watered and rammed.

2.10. Granolithic flooring

Granolithic concrete floor topping is adopted for floors of heavy engineering-factories, workshops, garages, warehouses, etc, where the floor is subjected to heavy loads, and severe abrasion combined with impact. The granolithic concrete essentially consists of a rich concrete made with specially selected aggregate of 'high hardness, surface texture and particle shape suitable for use as a wearing finish to floors. Although plain concrete as laid conforming to IS,:2571-1963* would be satisfactory for many purposes, granolithic concrete is chosen because of its high abrasion resistance and used for floor toppings wherever abrasion combined with impact is likely to be severe. In this standard the method of laying the granolithic concrete topping is only given and all other details up to the laying of base concrete or suspended slab shall conform to the procedure laid down in IS : 2571-1963* which is an adjunct to this standard.

2.11. Laying of Tiles

The bedding for the tiles shall be with cement mortar 1:3. The average thickness of the bedding mortar shall be 20 mm and the thickness at any place shall be not less than 10 mm. Cement bedding shall be spread, tamped and corrected to proper levels

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and allowed to harden before the tiles are set. Neat cement slurry of honey like consistency shall be spread over the bedding at the rate of 4.4 kg/m2. Tiles shall be washed clean and shall be fixed in this grout one after another, each tile being gently tapped with a wooden mallet till is properly bedded and in level with the adjoining tiles. The joints shall be kept as thin as possible not exceeding 1.5 mm and in straight lines.

2.12. Weathering course

A weathering course of brick jelly concrete is to be laid over R.C. Slab, when there is a storey over it, to protect the slab against alternative shrinkage and expansion, after 15 days of laying of the slab. A layer of 100 mm thick brick concrete (0.96 m3 broken brick of 20 mm gauge and 0.375 m3 slaked lime for every 1 m3 of weathering course) shall be laid over the slab and well beaten to 75 mm thickness with wooden hand beaters

2.13. Woodwork in doors, windows, partitions, louvers, railings, etc.

Wood used for all work shall be of approved quality of teak wood and properly seasoned by at least 6 months air drying, suitable for joiner's work, should be of natural growth, uniform in texture, straight grained, free from sapwood, dead knots, open shakes, boreholes, rot, decay and all other defects and blemishes.

The thicknesses specified for joiner's wrought timbers are, unless otherwise specified, prior to planning and 3 mm will be allowed from the thickness stated for each wrought faces.

All joining shall be wrought on all faces and finished off by hand with sand paper, with slightly rounded arises. Any joiner's work which shall split, fracture, shrink, or show flaws or other defects due to unsoundness, inadequate seasoning or bad workmanship, shall be removed and replaced with sound material at the Contractor's expense.

Doors, windows and ventilator frames shall be rebated. All dimensions shall be as approved. The top framing member of doors and top and bottom framing of windows and ventilators shall project about 150 mm in brickwork. The verticals of door frames shall project about 50 mm below finished floor. Surface coming in contact with brick work shall be painted with bitumen. Each of the door and

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window frames shall be provided with 3 Nos. M.S. 225 mm x 25 mm x 6 mm flat split hold-fasts on each side. These hold-fasts shall be embedded in masonry or concrete work. The work shall conform to I.S. 4021. Panelled doors shall comprise a 250 mm wide bottom rail, 150 mm wide middle rail and all other rails middle, top and vertical 100 mm wide. All rails shall be 40 mm thick. Panels shall be 20 mm thick. The panelled doors shall have minimum of 3 panels.

The workmanship of all door shutters shall conform to the requirements of I.S. 1003 (Parts I & 11) and I.S. 2202 (Part I). If required, flush door panels shall be tested as per I.S. 4020. Flush doors Shall be of 35 mm thick solid Core.

All doors shall have 15 mm thick, 40 mm wide teak wood architraves on both sides. Railing and architraves shall conform to the shape as approved and fixed by means of screws (counter-sunk or otherwise) or bolts.

The whole of the woodwork shall first be treated with two coats of anti-termite wood preservative chemicals of an approved make. All the wood shall thereafter be applied with primary coat of paint. The application of primer shall not be done within 24 hours of the application of the second coat of anti-termite treatment.

The doors shall have following fixtures.

2.14. Glazing for doors, windows and ventilators

(a) Glass in general

Glass shall conform to the requirements of relevant IS codes and shall be free from bubble, smoke wanes, air holes, scratches and other defects and shall be cut to fit the rebates with due allowance for expansion. Glass which does not have uniform refractive index or which is wavy shall not be used.

(b) Sheet glass

Sheet glass shall be flat, transparent and clear as judged by the unaided eye. It shall be free from cracks. Sheet glass shall be of B quality or ordinary quality and the thickness shall be as specified. Sheet glass used for glazing in building shall conform to I.S. 1761.

(c) Wired glass

All wired glass shall be 6 mm thick, polished Georgian or equivalent, with both faces ground and polished. The glass shall conform to I.S. 5437.

(d) Glazing

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Putty for glazing to wood shall be prepared in accordance with I.S. 1635. Glazing work in buildings shall conform to IS:3548.

Compound for glazing to metal is to be an approved special compound manufactured for the purpose.

2.15. Rolling Shutters

The specification of rolling shutter shall be as per the requirement of the client. Here I am trying to put general information about rolling shutter and its materials, fixing methods and other details.

Metal Rolling Shutters should conform to IS:6248. The rolling shutter accessories should be as specified and approved should be suitable for fixing in position as specified i.e. outside or inside; on or below lintel or between jambs of the opening. Rolling shutter can be hand operated or gear operated. Hand operated shutters are of push and pull type. Gear operated shutters are provided with reduction gear operated by mechanical device with chain, crank, shaft and handle. The shutter consist of 80 mm wide MS laths 1.25 mm thick or gauge as specified of mild steel sheet machine rolled. Laths are inter-locked together throughout its entire length and jointed together at the end with end locks. These are mounted on specially designed pipe shaft.

2.16. Steel windows, Ventilators and doors

Steel windows, ventilators and doors, including folding doors, shall be supplied complete with frames and fitted with standard fixtures such as hinges, locks, bolts, stoppers, handles as necessary. Steel used in fabrication of windows and doors shall have a minimum thickness of 3 mm. There shall be no distortion in the frames. The whole frame with the exception of lugs and external faces of channels shall be painted after manufacture as per specifications.

2.17. Whitewash and Colour Washing

Whitewash shall be prepared from fat lime conforming to IS : 712 - 1964t. The lime shall be slaked at site and shall be mixed and stirred with about five litres of water for 1 kg of unslaked lime to make a thin cream. This shall be allowed toe stand- for a period of 24 hours and this shall be screened through a clean coarse cloth. Add 1 kg of gum dissolved in hot water to each m3 of lime cream. About~ l-3 kg of sodium chloride dissolved in hot water may be added for every 10 kg of lime. Small quantity

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of ultra-marine blue (up to 3 g per kg of lime) shall also be added to the last two coats of whitewash solution and the whole solution shall be stirred thoroughly before use. For exterior work the whitewash or colour-wash that will adhere well to stone and masonry surfaces may also be prepared by scattering one part by weight of tallow in small lumps over 12 parts of quick lime, slaking it with only just sufficient water to form a thick paste, stirring occasionally to assist in dispersing the tallow, and allowing it to stand until cool. The resultant paste shall then be let down to thin wash, which is strained through a coarse cloth. If tallow is not obtainable, then linseed oil or caster-oil about 10 percent by weight of dry lime may be used. If the oil dots not sponify and incorporate with lime, it should be heated up until the oil disappears. The oil forms with lime an insoluble soap, which when once dry, will not wash off with heavy rain. In case of colour-wash, mineral colours, such as oxide of iron, red and yellow colours, .based on chromium oxide and carbon black not affected by lime may be added. Use of linseed oil is likely to give slight yellow tinge to whitewash.

Preparation of Colour-Wash - Sufficient quantity of colour-wash enough for the complete job shall be prepared in one operation to avoid any difference in shade. The basic whitewash solution shall be prepared in accordance with 5.1. Mineral colours not affected by lime shall be

added to the whitewash solution as prepared in 5.1.

2.18. Application of Whitewash And Colour-Wash

Application of Whitewash -Whitewash shall be applied with 'MOONJ' brush or other brush to the specified number of coats. The operation for each coat shall consist of a stroke of the brush given from the top downwards, another from the bottom upwards~ over the first stroke, and similarly one stroke horizontally from the right and another from the left-before it dries. Each coat shall be allowed to dry before the next coat is applied. No portion of the surface shall be left out initially to be patched up later on. The brush shall be dipped in whitewash pressed lightly against the wall of the container, and then applied by lightly pressing against the surface with full swing of hand.

The whitewashing on ceiling should be done prior to that on walls.

For new work, minimum two coats shall be applied so that the surface presents a smooth Andy uniform finish through which the plaster

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Application of Colour-Wash - The colour-wash shall be applied in accordance with the procedure given in 6.1. For colour-washing on new works, after the surface has been prepared as in 4.1, the first primary coat shall be of whitewash and the subsequent coats (minimum two) shall be of colour-wash; and the entire surface shall present a smooth and uniform finish. To start with 0.1 m? of the prepared surface shall be colour-washed with the first coat of whitewash and subsequent coats of colour-wash solution in full number of coats and the shade so obtained shall be examined before the entire work of colour-washing is taken up in hand. It shall be noted that small areas of colour-wash will appear lighter in shade than when the same shades are applied to large surfaces.

For colour-washing an old work, after the surface has been prepared as in 4.2, a coat of colour-wash shall be applied for the patches and repairs. Then the specified number of coats of colour-wash shall be applied over the entire surface. The colour-wash surface shall present a uniform colour shade. No primary coat is needed for old surface bearing colour of the same shade.

On surfaces requiring a change of colour, after the surface has been prepared as in 4.2.2, two coats of whitewash shall be applied before application of specified number (minimum two) of coats of colour-wash of the new shade.

2.19. Protective Measures

Surfaces of doors, windows, floors, articles of furniture, etc, and such other parts of the building not to be whitewashed or colour-washed shall be protected from being splashed upon. Such surfaces shall be cleaned of whitewash or colour-wash splashes.

2.20. Paints - general

Paints shall be supplied only by a manufacturer who has received the approval of the Engineer. Paints shall be supplied only by a manufacturer who has received the approval of the Engineer. All Paints to be applied to a particular surface as part of a paint system shall be obtained from a single manufacturer. Where priming of surfaces is executed before delivery to Site, the Contractor shall ensure (and obtain written confirmation from the appropriate supplier) that the primers used in these instances are obtained from the same manufacturer. Paints supplied for use on the Works are

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compatible with any timber preservation or fire proofing treatment which may be specified.

All paint shall be supplied in sealed containers bearing the following information in addition to any statutory requirements:-

(a) Manufacturer's name, initials or trade mark.

(b) Type of paint.

(c) Whether priming, undercoat or finishing coat.

(d) Whether for interior or exterior use.

(e) The colour and its reference number.

(f) The method of application (ie. brush, spray or roller).

(g) The batch number and date of manufacture or re-test.

(h) Storage instructions and shelf life.

(i) Appropriate safety instructions.

Containers for protective materials other than paints shall bear as much of the above information as appropriate. Paint containers shall not exceed 5 litres capacity with the exception of containers for emulsion, spraying paints, bituminous paints, stone, cement and road marking paints which may be of larger capacity.

2.21.1. Paint colours

All paint colours shall comply with BS 4800. Final coats shall be in accordance with colour schedules to be issued by the Engineer. Each coat shall differ noticeably in tint from the previous coat.

2.21.2. Thinners and solvents

The type and quality of thinners to be added to paint shall be that recommended by the manufacturer for the particular type of paint. White spirit shall comply with BS 245 Type `A'. Separate supplies of solvents shall be kept on site for brush or other cleaning purposes. Solvents for these purposes shall be tinted a different colour to thinners used for thinning paint.

2.21.3. Knotting and stopping

Knotting shall comply with BS 1336. Stopping for concrete or sand/cement plastering shall be of similar material to the background and Shall have a similar

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surface finish. Stopping for woodwork, hardboard and plywood shall be a proprietary spirit-based wood filler tinted to match the undercoat colour. Stopping for natural finished woodwork shall be a proprietary spirit-based wood filler tinted to match the woodwork.

2.22. Bitumen coatings

Bitumen coatings shall be formed of the appropriate grades of materials complying with BS 3416 or BS 6949 for cold application, or with BS 4147 for hot application.

2.22.1. Primers and linseed oil for wood

Priming paint for wood shall be aluminum wood primer to BS 4756 except where the lead priming paint to BS 7956 or, if narrow strips of galvanized steel and timber abut, calcium plumbate priming paint Type A to BS 3698, or a quicker drying equivalent. Linseed oil shall be refined linseed oil and shall comply with BS 6900.

2.22.2. Painting of pipes, fittings and valves

Factory-applied coatings on pipes, fittings and valves in chambers and other exposed areas shall be made good on completion of construction of those chambers as necessary to return the items to the appearance on leaving the factory. Paint systems for over-painting shall be compatible with any factory coatings including coatings made good on site.

2.22.3. Painting of Exposed Steel Pipelines

Exposed portions of steel pipelines shall be protected by a paint system of which the primer coat shall have been applied in the manufacture's works. Damaged primed surfaces shall be repaired in the field by cleaning and further priming with the same primer to at least the thickness of the works-applied primer coat. After the completion of pipe assembly in the field, damaged areas of the primed surface shall be fully repaired and the whole surface shall be cleaned of foreign matter. The finishing paint coat shall then be applied. The finishing coat shall be aluminium heat-resisting finish applied in sufficient layers (at least 2) to give a minimum dry film thickness of 50 micron. The primer and finishing coats shall be mutually compatible and shall be from the same approved manufacturer.

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All details of paint system application, including surface preparation, works environment, application techniques, intermediate drying times and repair of coatings. Paint shall not be applied to wet surfaces or during rain. The Contractor shall be deemed to have made full allowance in his Tender for the effects of weather.

2.22.4. Painting building surfaces

Painting work shall comply with the recommendations of BS 6150 and the instructions of the paint manufacturer, Except where otherwise specified or approved, at least 24 hours shall be allowed between the application of successive coats of paint. Each coat shall be dry before the next coat of paint is applied and each coat of paint shall be rubbed down with fine glass paper before the next coat is applied.

All wall and ceiling surfaces scheduled to be painted with emulsion paint, shall receive at least three coats. At least 4 hours shall be allowed between the application of successive coats of emulsion.The Contractor shall satisfy the Engineer as to the covering capacity of paints and emulsion

according to the absorption of varying surfaces. The method and application of paints and emulsions shall be sufficient to give solid cover in the number of coats specified. The Contractor shall clean off all paint stains from joinery, metalwork and floors on completion of the painting work.

2.22.5. Priming steel and iron

The main priming paint coat shall be applied to the steel as soon as practicable after fabrication and where possible shall be of the same general formulation as that used for the prefabrication primer, if one has been used. After prefabrication-priming of any steel plate or section, edges, corners, crevices or holes still present after fabrication, and not part of a welded joint or interior surface of a hermetically sealed void, shall be given an additional stripe coat of the appropriate main primer by brush to ensure continuity of protection of the steel across such edges and the like.

With reference to Clause 0, the inside surfaces of members and similar non-fabricated sections where blast cleaning is impracticable shall be cleaned to preparation grade St 2 as shown in BS 7079:

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2.22.6. Painting bolted connections

Joint areas for bolted connections shall be masked to maintain the surfaces free from any paint applied prior to making the connection. Masking shall be removed before erection. After installation and after all bolts have been tightened, the areas of the connection shall be cleaned to remove all dirt, dust, oil or other contaminant. Particular care shall be taken to ensure that all traces of oil and grease are removed from bolts, nuts and washers. Any surrounding areas of paintwork which have been damaged shall be repaired as specified in above clause Bolts, nuts and washers and any areas exposed at bolted connections shall also be primed as specified, particular care being taken to ensure that any crevices are fully sealed.

2.22.7. Painting and protection

After installation, valves protected with a bituminous coating which remain exposed or within chambers shall be thoroughly cleaned and given two further coats of the bituminous coating. Valves and associated equipment which are to be buried shall be wrapped with either polyethylene sleeving or self adhesive wrapping material. The wrapping material or sleeving shall be lapped over and taped to the sleeving or other protection of the adjacent pipeline.

2.22.8. Elastomeric Bearings Pad

These bearings are generally considered to be maintenance free. However, preliminary inspection are necessary. There may be signs of distress either due to initial inferior quality of manufacture or handling and installation. The inspecting officials should check the following:

- Correct position
- Excessive shear
- Excessive bulging
- Separation of rubber from steel lamination
- Cracking and tearing of elastomeric
- Flattening out

Elastomeric bearings are made of natural or synthetic rubber. They are very stiff in resisting volume change but are very flexible when subjected to shear or pure uni-axial tension. They are generally reinforced with steel plates in alternate layers to

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reduce bulging. When used with a steel or concrete girder these permit moderate longitudinal movements and small rotations at the ends.

Under the effect of loads and induced movements, the elastomeric bearing will

a) Compress (flatten)

b) Bulge and

c) Shear.

These are signs of normal functioning of the bearing and judgment regarding distress can be formed only on the basis of personal experience of the inspecting engineer. As a general guide, however, the following movements can be considered to be excessive:

a) Shear deformation more than 50% of height of elastomeric pad

b) Rotation leading to off-loading of an edge

c) Compression more than 5% of height of the pad.

Generally, malfunctioning of the elastomeric pad would result in distress either in the girder or in bed block and the area close to the bearing should be examined for cracking or spalliny of concrete.

These bearings require periodic cleaning. They may require replacement during service on condition basis, depending upon their usage.

2.23. Lighting

General requirements

The building internal lighting design shall take into account:

- the operating environment;
- the type and style of architectural finish;
- the activities to be performed in the areas;
- access for equipment maintenance;
- operating life.

The minimum service illumination levels shall comply with the minimum recommendations of the CIBSE Code for the appropriate building area and operational function, or as otherwise specified. Illumination levels shall apply to floor levels.

In no case shall the illumination be below that necessary to perform work or other essential activity in any particular location.

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In areas housing rotating machinery, lighting shall be arranged on multiple-phase circuits to prevent stroboscopic effects.

Where adjacent luminaries are connected to different phases of the supply, a label shall be fitted internally, warning of the presence of the phase-to-phase voltage.

2.24. External services — roadway lighting

Columns

Roadway lighting columns shall be constructed and installed in accordance with BS 5649-2:1978. The base compartment door/cover shall be fitted with a tamper-proof fastening.Columns shall have bolted base mounting plates for installation on concrete foundation blocks which shall incorporate bottom-entry cable ducts.

Columns shall be complete with baseboard, fuse unit and wiring between the fuse unit and luminaire.

The fuse unit shall have a non-hygroscopic plastic case designed to prevent the ingress of moisture and condensation, integral double-entry cable termination chamber with detachable front cover and enclosed-type fuse complying with IEC 60269-1:1998.

2.24.1. Lanterns

All lanterns shall be of the high-pressure mercury or sodium type fitted with high-efficiency lamps and complete with integral controlgear.

2.24.2. Building services — sockets and switches

Socket-outlets and couplers

Commercial-type socket-outlets shall comply with BS 1363-2:1995 and BS1363-3:1989 in concurrence with IS 1293:1988, and shall be supplied complete with boxes and fixing screws. Socket outlets shall be white plastic or metalclad pattern according to the installation area and as specified.

Socket-outlets shall be of the flush-mounting type in plastered and tiled areas. In all other areas, socket-outlets shall be of the surface-mounting type.

Industrial pattern socket-outlets and couplers shall comply with IS/IEC 309-1:1988 and IS/IEC 309-2:1989. Industrial-type switched socket-outlets shall be mechanically interlocked to prevent the plug being inserted or withdrawn unless the switch is in the 'off' position. It shall not be possible for the switch to be moved to the 'on' position unless the plug is completely inserted.

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Socket-outlets for indoor location in process or damp areas shall have a minimum degree of protection IP55 to BS EN 60529:1992. For outdoor locations, the degree of protection shall be not less than IPW55.

Socket-outlets for locations in chemical-handling areas shall have plastic enclosures resistant to the particular chemical.

In office and control-room areas, socket-outlets shall be installed at 0.5m above floor level. In plant areas, socket-outlets shall be installed at 1.2m above floor level.

2.24.3. Telephone System

General

The telephone system including the complete telephone distribution network and private telephone exchange system shall comprise of the following:

- telephone distribution installation
- electronic private automatic branch exchange (EPABX)
- main distribution frame (MDF)
- EPABX peripheral equipment
- operator's console
- telephone sets
- power supply equipment
- ancillary equipment
- all measures for approval by and connection to the local telephone company

A modern state-of-the-art telephone system based on digital signal transmission shall be installed.

The system shall be capable of being connected to the Employers proposed state wide IP telephony system.

The proposed telephone system including all components and installations shall comply with appropriate regulations and the requirements of national and international standards.

The operation voltage on site shall be 230 V/50 Hz.

EPABX and related equipment shall be tested at manufacturer's premises, and test certificates, certified by an official testing authority, are to be submitted to the Engineer before shipping and delivery to site.

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2.24.4. Telephone Distribution Components

Telephone distribution cabinets and Boxes shall be made of steel or metal alloy, general purpose enclosures, for surface or concealed mounting, of a suitable size with a spatial reserve of at least 30%, dust-proof, IP 42 protection for indoor mounting and IP 55 for outdoor mounting, with tamper-proof screwed covers for up to 50 pair capacity.

Terminal blocks shall be of the screw or plug-in quick connect type in moulded high insulation resistance phenolic base, fixed by two captive screws, with double-ended nickel-plated brass connectors, and plug-in or set-screw terminals for connection of conductors with diameters between 0.5 and 1 mm.

Telephone cabling shall be carried out with two-pair and multi-pair cables for indoor and outdoor cabling. The cabling shall be polyethylene insulated, tinned solid copper conductors, twisted into pairs, colour coded, minimum diameter of conductor is to be 0.8 mm.

Cables are to be rated for maximum operating voltage of 150 V with insulation resistance of 10,000 mega ohm/km, and tested at 500 V DC applied core-core and core-earth.

Telephone outlets are to have modular grid box and cover plates similar to other socket outlets and switches described elsewhere, with cord-grip cover and fixed mounting set-screw terminal block inside box.

2.24.5. Electronic Private Automatic Branch Exchange system (EPABX)

The EPABX-design shall permit station numbers to be assigned to lines at time of installation, in accordance with customer-desired numbering plan, and reassignment while in service to allow personnel moves without requiring number changes.

It shall be possible to assign to each extension, restriction for outward calls as follows:

- Non-restricted: having unrestricted access to external lines for outward calls either by direct dialling or through operator.
- Semi-restricted: having access to external lines only for local calls by direct dialling or through operator.
- Restricted: having no access to external lines neither through direct dialling nor through operator.
- It shall be possible to segregate external trunk lines as follows:

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- Lines for outgoing calls accessible only by operators.
- Lines for outgoing calls accessible by operators and by all remaining non-restricted and semi-restricted extensions.

The EPABX shall be fully electronic, digital stored program, microprocessor controlled with LSI switching circuits. Reed relays, mini-switches, cross-point switching and cross-bar techniques are not acceptable. The EPABX shall be designed for use as a universal telephone exchange system for all applications. It shall be possible to connect any combination of DTMF and rotary dial telephones to the EPABX, with the provision of manufacturer-made interface modules as necessary within the EPABX and without the need to modify the assembly.

The capacity has to be suitable to connect a sufficient number of telephones as specified in particular specification.

The power supply for the whole telephone system shall be supported by an Uninterrupted Power Supply (UPS).

2.25. Construction of Septic Tanks

The sewage collected from the building shall be partially treated in a septic tank and further treatment and disposal through leach pits

Construction of septic tank shall be as per IS: 2470 (Part-1) and IS: 2470 (Part-2). The sizes of the septic tank shall be based on number of users as per the above Indian Standards

2.26. Storm Water Drainage

- The design and installation of the storm water drainage system must comply with Indian Standard Codes and Tamil Nadu Building Practice
- Surface water drainage must be graded away from a building with a minimum gradient of 1 in 20 over the first metre;
- The finished slab height (measured at the slab edge) must be not less than 50mm above adjacent paving or concrete or 100mm above sandy well drained areas;
- Stormwater drains shall be minimum 110 mm Class 6 UPVC and have a minimum fall of 1:100 and 100mm cover under soil and paved areas;

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- Inspection openings (DN 150) shall be installed at each connection point, any change of direction and at not more than 30m centres;
- Inlet pits shall be provided to collect stormwater drainage and discharge into the surface water drainage system;

2.27. Road Works

Road works around the work place shall conform to the following specification Indian Road Congress Standards -IRC: 19 – Standard Specification and Code or Practice for Water Bound Macadam

Asphaltic Concrete work shall conform to IRC 29-1988.

2.27.1. Breaking of concrete, brickwork, blockwork and stone masonry

The waste material from breaking shall be at once removed from the location and dumped at a suitable location or transported and disposed off as directed by the Engineer. The Contractor shall observe all precaution by way of necessary propping, strutting, etc. to the satisfaction of the Engineer, to ensure that the adjacent framework is not damaged.

2.27.2. Locks

All the doors and gates shall be provided with locks of approved quality available locally and in accordance with I.S. 2209 or I.S. 275 as appropriate. The locks shall be provided

with keys in duplicate.

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CHAPTER 3

3.1. Pipes, Specials and Valves

3.1.1. General

All types of pipes required for the works should be of good quality conforming to relevant BIS and should be procured from reputed manufacturer or his authorized dealer. Each pipe should bear the trade mark of the manufacturer, the nominal diameter, class, weight, batch number and the last two digits of the year of manufacture suitably and legibly marked on it. The Engineer shall have the right to conduct any test to ascertain the quality of the pipes supplied by the contractor. The contractor should make all necessary arrangements for testing the pipes. All the charges and expenses towards the testing shall be borne by the contractor. The materials, which are classified for ISI marking, should be supplied with ISI marking only.

If on examination of any sample from any portion of the supply, the material is found to be sub standard and not fully in accordance with the relevant specification, the entire consignment shall be rejected.

3.2. PVC Pipes

- The unplasticised PVC rigid pipes shall strictly conform to IS:4985/1988 and as amended from time to time and shall carry ISI marking in every pipe.
- The contractor should procure the PVC rigid pipes from a reputed manufacturer.
- The contractor should furnish the test certificate issued by the manufacturer.
- The manufacturer's test certificate and third party inspection certificate should be produced by the contractor for the pipes used in the works.
- In addition to third party inspection, wherever felt necessary, the Engineer shall have the power to test the PVC pipes for its quality such as specific gravity, impact strength, internal hydraulic pressure test, diameter, thickness etc, in authorized laboratory.
- The PVC pipes joints shall be with solvent cement of good quality, conforming to IS:14182/1994.
- The Engineer in charge, shall verify, in addition to the test certificate, whether the pipes are as per BIS, by visual examination, diameter, weight, wall thickness, flexibility, Colour etc.,

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3.2.1. PVC Specials & Fittings

The Specials and fittings should be in conformity to the relevant BIS specification.

3.3. GI pipes

GI pipes should be procured by the contractor from reputed manufacturer or from their authorized dealer of reputed manufacturer and should conform to IS:1239/part 1, namely the inner and outer diameter, length and weight. The pipes which are found to be not conforming to relevant specification shall be rejected by the Engineer-in-charge.

3.3.1. GI Specials and Fittings

The Specials and fittings should be in conformity to the relevant BIS specification.

3.4. CI pipes

- The Cast Iron pipes shall strictly conform to IS:1536/2001 and as amended from time to time and shall carry ISI marking in every pipe.
- The contractor should procure the CI Pipes from a reputed manufacturer.
- The contractor should furnish the test certificate issued by the manufacturer.
- The manufacturer's test certificate and third party inspection certificate should be produced by the contractor for the pipes used in the works.
- In addition to third party inspection, wherever felt necessary, the Engineer shall have the power to test the CI pipes for its quality such as specific gravity, impact strength internal hydraulic pressure test, diameter, thickness etc, in authorized laboratory.
- The CI pipe joints shall be push-on joint for Spigot & Socket pipes conforming to IS 1538 & IS: 13382.
- The Engineer in charge, shall verify, in addition to the test certificate, whether the pipes are as per BIS, by visual examination, diameter, weight, wall thickness, flexibility, Colour etc.,.

3.5. CI DF Pipes, Specials and Fittings

The Specials and fittings should be in conformity to the relevant BIS specification

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3.6. DI pipes

Following IS Standards shall be applicable for DI Pipe

SN	Particular	IS Standard
1	Specifications for DI Pipes	IS 8329-2000
2	DI Fittings and Specials	IS 9523-2000
3	Rubber Gasket for DI Pipes	IS 5382-1985
4	Laying & Jointing of DI Pipes	IS 12288-1987

All the DI Pipes shall be of minimum K-7 class as per IS 8329-2000. The DI pipes shall be supplied with internal cement lining as per IS: 8329-2000. The minimum lining thickness shall be accordingly.

Ductile pipes to be used in the contract shall be centrifugally cast (spun) Ductile Iron Lined pipes suitable for Water and Sewage & conforming to IS 8329 with internal cement mortar lining, and bituminous outer coating. The manufacturer must have BIS license for manufacturing DI pipes.

3.7. Ductile iron pipelines

Ductile iron pipes and fittings shall comply with BS EN 545 or ISO 2531. Unless otherwise specified pipes shall be Class K9 and fittings shall be to Clause 9 of BS EN 545. All pipes shall be manufactured by the centrifugal casting process. Except where flanged or other types of joints are specified or detailed in the Drawings, pipes and fittings shall have push-in socket and spigot joints. The joints shall permit pipes to be deflected angularly by up to 2° axially for diameters up to 900mm and by up to 1.5° axially for diameters over 900mm. Self-anchored couplings and flange adapters shall not be used for transmission of axial loads. Except where specified otherwise in the Drawings, all detachable flexible couplings on buried ductile iron pipelines shall be of the sleeve type with a ductile iron collar and two bolted-gland joints. Bolts for use with bolted gland joints shall be spheroidal graphite in accordance with BS EN 1563

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3.8. *Internal Cement Mortar Lining*

The DI pipes shall be supplied with internal cement lining as per IS:8329-2000. The minimum lining thickness shall be accordingly

3.9. **Working Lengths and Tolerances**

For all purposes, the lengths of the pipes provided by the department shall be the length as defined in IS: 8329. The pipes will be supplied in standard lengths as per the provisions in the standards IS 8329 to which the manufacturing confirms (IS: 8329). The ends shall be suitably rounded and/or chamfered ends. Any tolerance in the stipulated lengths will be as per the provision of the standards to which it has been manufactured (IS: 8329).

The tolerance in diameter, thickness, ovalty & permissible deviation from straight line shall be as per the standards to which the pipe is manufactured (IS 8329)

3.10. **Standards for Rubber Gasket**

Each pipe of the push on joint variety will also be supplied with a rubber EPDM gasket. The gaskets will confirm to the provisions of IS 5382:1985. Material of rubber gaskets for push-on mechanical or flanged joints shall be compatible with working pressure and temperature at which the water is to be conveyed. Rubber gaskets for use with flanged joints shall conform to IS: 638. While conveying potable water the gaskets should not deteriorate the quality of water and should not impart any taste or foul odour

3.11. **Protective outer coating**

The contractor shall carry out soil survey along the alignment and in the sections/reaches where encountered resistivity of soil is less than 1000 ohm-cm, POLYETHYLENE SLEEVING shall be provided as per the specifications laid down in Annex-D of IS 8329-2000. In other reaches /sections the pipe with factory coated outer coating shall be laid.

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3.12. DI Fittings & Specials

All the DI fittings and specials shall conform to IS 9523 and shall be manufactured at well equipped foundries. The minimum requirements for all the foundries shall be as below.

ISO 9001 certification.

3.13. Inspection and Testing:

The DI Double Flanged pipes supplied by the contractor will be subjected to following tests as per IS 8329 for acceptance:

Visual and dimensional check as per IS 8329.

Mechanical Tests as per IS 8329.

Hydrostatic Test as per IS 8329.

Any other tests required as per the provisions to which the supplied pipe confirms i.e (IS 8329)

The test reports for the rubber gaskets shall be as per acceptance tests of the IS 5382 .

The sampling method for testing shall be as per the provisions of the standards to which they are manufactured.

3.14. Lubricant for ductile iron pipes and specials

The requirements for lubricant for the assembly of Ductile Iron pipes and specials suitable for Tyton push-in EPDM rubber ring joints shall conform to the following specification

- The lubricant has to have the following characteristics:
- must have a paste like consistency and be ready for use
- has to adhere to wet and dry surfaces of DI pipes and rubber rings
- to be applied in hot and cold weather; ambient temperature 0 - 50 °C, temperature of exposed pipes up to 70 °C
- must be non toxic
- must be water soluble
- must not affect the properties of the drinking water carried in the pipes
- must not have an objectionable odour
- has to inhibit bacterial growth

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- must not be harmful to the skin
- must have a shelf live not less than 2 years

3.15. *T*ransportation /storage of pipes and specials

The contractor has to transport the pipes and other materials from manufacturer to the site stores and from the site stores to the site of laying. Pipes should be handled with care to avoid damage to the surface and the socket and spigot ends, deformation or bending. Pipes shall not be dragged along the ground or the loading bed of a vehicle. Pipes shall be transported on flat bed vehicles/trailers.

3.16. Laying and Jointing of DI pipes

Pipes should be lowered into the trench with tackle suitable for the weight of pipes. For smaller sizes, up to 200mm nominal bore, the pipe may be lowered by the use of ropes but for heavier pipes suitable mechanical equipment have to used.

All construction debris should be cleared from the inside of the pipe either before or just after a joint is made. This is done by passing a pull-through in the pipe, or by hand, depending on the size of the pipe. All persons should vacate any section of trench into which the pipe is being lowered.

On gradients of 1:15 or steeper, precautions should be taken to ensure that the spigot of the pipe being laid does not move into or out of the socket of the laid pipe during the jointing operations. As soon as the joint assembly has been completed, the pipe should be held firmly in position while the trench is back filled over the barrel of the pipe.

The designed anchorage shall be provided to resist the thrusts developed by internal pressure at bends, tees, etc.

Where a pipeline crosses a water course, the design and method of construction should take into account the characteristics of the water course to ascertain the nature of bed, scour levels, maximum velocities, high flood levels, seasonal variation, etc. which affect the design and laying of pipeline. The pipe shall be laid accordingly with adequate protection.

3.17. Inspection and Testing

Visual and dimensional check as per IS 8329.

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Mechanical Tests as per IS 8329.

Hydrostatic Test as per IS 8329.

3.18. HDPE *and MDPE* pipes

- The High and Medium density polyethylene pipes shall strictly conform to IS: 4984/1987 and as amended from time to time.
- The contractor should procure the HDPE and MDPE Pipes from a reputed manufacturer.
- The contractor should furnish the test certificate issued by the manufacturer.
- The manufacturer's test certificate and third party inspection certificate should be produced by the contractor for the pipes used in the works.
- In addition to third party inspection, wherever felt necessary, the Engineer shall have the power to test the HDPE and MDPE pipes for its quality such as specific gravity, impact strength, internal hydraulic pressure test, diameter, thickness etc, in authorized laboratory.
- The HDPE and MDPE pipe joints shall be Butt fusion welding/Electro fusion welding & Mechanical Joints
- The Engineer in charge, shall verify, in addition to the test certificate, whether the pipes are as per BIS, by visual examination, diameter, weight, wall thickness, flexibility, Colour etc.,

3.19. HDPE *and MDPE* Specials and Fittings

The Specials and fittings should be in conformity to the relevant BIS specification. The contractor shall flush the Pipeline with air to remove dust, water, mud etc. before fusing the joints. Before jointing, the Contractor shall place packing sand under the pipes on both sides of the joint to keep the pipes in line and at the correct alignment during the jointing process. Alignment clamps with the correct size shells should be used to align the pipe during the electro-fusion cycle.

The Contractor shall ensure that polyethylene pipe is only cut with an approved plastic pipe cutting tool. Before fusion is attempted he shall remove the oxidized surface of the pipe to be inserted into the electro-fusion coupling. The tool must remove a layer of 0.1 mm to 0.4 mm from the outer surface of the

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polyethylene pipe. It may also be noted that no fusion will be allowed without clamping device and only the approved cutting tools (Hack Saw shall not be allowed for cutting the Pipe) shall be used.

The contractor has to supply all the consumables required for carrying fusion of the joints (like cloth/ paper napkin, acetone etc.).

3.20. Backfilling

Backfilling shall be done after ensuring that appurtenance have been properly fitted and the pipe is following the ditch profile at the required depth that will provide the required cover and has a bed which is free of extraneous material and which allows the pipe to rest smoothly and evenly. Dewatering shall be carried out prior to backfilling. No backfilling shall be allowed if the trench is not completely dewatered. Prior to backfilling it should be ensured that the post padding where required of compacted thickness 150mm is put over and around the pipe immediately after lowering.

3.21. MS Pipe Line

This part of the specification covers the manufacturing, supply, delivery, lowering, laying, jointing, internal coating, and outer coating, testing and commissioning mild steel pipes.

3.22. Applicable standards

The following specifications, standards and codes are applicable for the fabrication of the pipe stock and fittings. All standards referred to shall be the latest editions, including all applicable amendments and revisions. Other authoritative standards that ensure substantial equivalence to the codes listed below will be acceptable.

1. IS 10221 Code of practice for coating and Wrapping of Underground Mild steel pipes
2. IS 4533 – Submerged Arc welding of mild steel and low alloy steels
3. IS 3613 – Acceptance tests for wire flux combinations for submerged arc welding.

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4. AWS A 5-17 – Specification for bare mild steel electrodes and fluxes for submerged arc welding.
5. IS 816 – Code of practice for use of metal arc welding for general construction in mild steel.
6. IS 4353 – Submerged arc welding of mild steel and low alloy steels recommendations.
7. IS 817 – Code of practice for training and testing of metal arc welders.
8. IS 1182 – Recommend practice for Radiographic examination of fusion weld Butt joints in steel plant.
9. IS 3658 – Code of practice for liquid penetration flaw detection.
10. ASTM E 94 – Guide for Radio Graphic Testing.
11. ASTM E 165 – Test method for Liquid Penetrant Examination.
12. IS 3600 –Method of testing fusion welded joints and weld metal in steel (Parts 1 to 9)
13. IS 4853 – Recommended practice for Radiographic inspection of fusion welded butt joints in steel pipes.
14. IS 3589 – Seamless or electrically welded steel pipes for water, gas and sewage (168-3 to 2032 outside diameter)
15. IS 2598 – Safety Code for industrial radiographic practice.
16. IS 2062 – Steel for general structural purposes grade FE 410
17. IS 814, IS 3613, SI 6419 and IS 7280 – Welding consumables – such as electrodes, filler rods and wires.
18. IS 1785, IS 432 – Steel for Reinforcement (Parts I & II)
19. IS 2825 – Code for unfired pressure vessels.

3.23. Technical Specification:

The MS pipes shall be of spirally welded, manufactured conforming to IS 5504 -1997 with mild steel HR coils conforming to IS 10748 grade 3

Following tolerances are applicable even if found stringent than the applicable codes

Wall thickness	: As per IS 3589
Ovality	: As per IS 3589
Straightness	: 2 mm per mtr of pipe

Pressure rating:

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Pipes shall be suitable for an internal maximum working pressure as per IS 3589.

Length of pipe:

Pipes shall be supplied in 12 to 12.5 m length.

Pipe Ends:

Pipe ends shall be beveled and end faces shall be at right angle to pipe axis. Beveling shall be done as per standards suitable for but-welding joints.

Internal lining:

Pipes shall be lined internally with cement mortar coat as per IS 3589 -2001 Hazen William coefficient of friction "C" should not be less than 150. Thickness of lining shall be 12.5 mm. The outer coating shall be 25 mm thick cement mortar guniting for the underground pipes and enamel coating for above ground level piping conforming to relevant BIS/BSS.

Pipe fittings:

Pipe fittings shall be manufactured in accordance with IS 3589, and lined internally.

Welding Procedure:

The welding procedure shall be as follows:

Submerged arc welding in accordance with IS 4353 (SAW)

For submerged arc welding, alloying is not permitted via the flux.

3.24. Welding Electrodes and Consumables

All welding electrodes/consumables shall comply with IS 814, IS 3613, IS 6419 and IS 7280.The electrode/consumable chemistry shall meet the requirements of the base material, and shall be selected such that the deposited weld metal exhibits mechanical properties equal to or in excess of the base material. All welding electrodes/consumables shall, as a minimum, be stored and used in accordance with the manufacturer's recommendations.

3.25. Non-destructive Examination (NDE)

All NDE shall be performed by a qualified personnel to recognized National or International Standard (E.g. PCN, ASNI Level 11, etc.).A document listing the relevant NDE procedures, methods and technique for the item, shall be submitted to us for review. Any subsequent revision to the document shall be approved by the Purchaser.Purchaser have right to review certification of NDE personnel at you works.

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3.26. Pipe Marking

All pipes shall be marked with unique serial number. The number shall be hard stamped in letters or numbers not less than 15 mm high on the external face 200 mm from the pipe end and clearly stenciled in Red or White paint in letters or numbers not less than 200 mm high on the internal and external face of the pipe close to the pipe end.

Diameter and length of pipe
Date of Manufacture
Manufacture's name
Identification mark/number as certified by our representative stationed at suppliers premises.

The pipe thickness shall be designed to withstand Maximum working pressure plus the surge pressure. Field test pressure i.e. 1.5 times the working pressures Collapse pressure
Min. thickness for handling

3.27. *Qu*ality Assurance

During the whole process of manufacturing, department's representative shall be present to supervise the Quality Assurance process and witness the test performed.

3.28. Testing At Work Site

Ten percent of the field joints shall be tested radio graphically (Samples at random) as per IS: 4853, in case of failure 20% field joints shall be selected. In case of second failure, 100% field joints shall be radiographed. Five percent of the field joints shall be tested ultrasonic test as per IS: 4260. The welding of pipes in the field should comply with IS 816-1965 and electrode used should comply with IS 814-1967. Welded joints shall be tested in accordance with procedures laid down in IS 3600-1966 and one test specimen shall be taken from at least one field joint out of 10.

3.29. *F*ield Hydraulic Test

After erection at site and after the concrete anchor/ thrust blocks have been constructed, the pipe section shall be put to sectional testing. The pipe line shall be

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tested for site test pressure of 1.5 times the maximum working pressure. Before start of the testing the pipe shall be kept filled at low pressures for minimum 24 hours to allow absorption of water by lining in case testing is allowed after lining by EIC. In any case the field welded joints shall be lined only after successful testing of the section. Pressure building shall be gradual at a rate of 0.1 N/mm2 per minute The duration of the test shall be 24 hours after attaining full pressure. If a drop in pressure occurs, the quantity of water added in order to re-establish the test pressure should be carefully measured. This should not exceed 0.1 liter/ mm of pipe diameter per km of pipeline per day for each 30 m head of pressure applied. Additional water will be pumped in the pipeline whenever drop in pressure is 10% of test pressure or 0.5 kg/cm2, whichever is less or continuously maintaining the test pressure with required system.

The test will be declared successful only if the quantity of water thus added is within permissible limit, as prescribed above. Length of a section for testing shall not be more than 1.0 km. Field Joints shall be kept open during testing. Adequate anchorages shall be provided to avoid any movement of pipes. If any joint leaks during testing, the section shall be put to retest after repair of the joint by contractor. The contractor shall provide and maintain all requisite facilities, instruments, for the field testing of the material. All pipes, specials, valves and civil works shall be replaced by the contractor free of cost if damaged during testing. All pipes, specials, valves and Civil Works shall be replaced by the contractor free of cost if damaged during testing.

3.30. Failure to pass the test

All pipes or joints which are proved to be in any way defective shall be replaced or remade and re-tested as often as may be necessary until a satisfactory test shall have been obtained. Any work which fails or is proved by test to be unsatisfactory in any way shall be redone by the Contractor.

3.31. Disinfection of mains

Upon completion of a newly laid main or when repairs to existing pipes are made, the main shall be disinfected by heavily chlorinated water. After final flushing and before the water main is placed in service, a sample or samples shall be collected from the end of the line and tested for bacteriological quality and shall show the absence of coliform organisms.

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3.32. Fill, Backfilling and Site Grading

Trenches shall be backfilled with approved selected excavated material only after the successful testing of the pipeline. The tamping around the pipe shall be done by hand or other hand operated mechanical means. The water content of the soil shall be as near the optimum moisture content as possible. Filling of the trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressure does not occur. Each layer shall be consolidated by watering, ramming, care being taken to avoid damage to the pipeline.

3.33. Material

To the extent available, selected surplus soil from excavations shall be used as backfill. Backfill material shall be free from lumps, organic or other foreign material. All lumps of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not larger than 150 mm size, mixed with properly graded fine material consisting of murum or earth to fill the voids and the mixture used for filling.

If fill material is required to be imported, the Contractor shall make arrangements to bring such material from outside borrow pits. The material and source shall be subject to the prior approval of the Employer. The approved borrow pit areas shall be cleared of all bushes, roots of trees, plants, rubbish, etc. Top soil containing foreign material shall be removed. The materials so removed shall be disposed of as directed by Employer. The Contractor shall provide the necessary access roads to borrow areas and maintain the same if such roads do not exist.

3.34. Sand Filling

Where backfilling is required to be carried out with local sand it shall be clean, medium grained and free from impurities. The filled-in-sand shall be kept flooded with water for 24 hours to ensure maximum consolidation. The surface of the consolidated sand shall be dressed to required level or slope. Construction of floors or other structures on sand fill shall not be started until the Employer has inspected and approved the fill.

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3.35. *Refilling of trenches*

On completion of the pipe laying operations in any section, for a length of about 100m and while further work is still in progress, refilling of trenches shall be started by the Contractor with a view of restricting the length of open trenches. Pipe laying shall closely follow the progress of Trench Excavation and the Contractor shall not permit unreasonably excessive lengths of trench excavation to remain open while awaiting testing of the pipeline. If the Employer considers that the Contractor is not complying with any of the foregoing requirements, he may prohibit further trench excavation until he is satisfied with the progress of laying and testing of pipes and refilling of trenches. Only soft earth and murrum of good quality free from stones boulders, roots, vegetation etc., shall be utilized after the lumps are broken for filling in around the pipes for at least 30cm all around for pipes.

Filling shall be done in layers not exceeding 150mm and compacted to 70 to 80% of max. dry density percent of the maximum dry density as per part VII of IS:2720. The excavated material nearest to the trench shall be used first. Care shall be taken during backfilling, not to injure or disturb the pipes, joints or coating. Filling shall be carried out simultaneously on both sides of the pipes so that unequal pressure does not occur. Walking or working on the completed pipeline unless the trench has been filled to height of at least 30cm over the top of the pipe except as may be necessary for tamping etc., during backfilling work.

The remaining portion of the trench may be filled in with a mixture of hard and soft material free from boulders and clods of earth larger than 150mm in size if sufficient quantity of good earth and murrum are not available. Filling in shall be done in layers not exceeding 225mm in thickness accompanied by adequate, ramming etc., so as to be compacted to 70 to 80% of the maximum dry density as per part VII of IS:2720. Water contents of the soil shall be as near the optimum moisture content as possible. The trench shall be refilled so as to build up to the original ground level, keeping due allowance for subsequent settlement likely to take place.

To prevent buckling of pipe shell of diameters 1200mm and above, pipes shall be strutted from inside while the work of refilling is in progress, for which no separate payment shall be made separately.

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Strutting shall be done by means of strong spiders having at least 6 arms which shall be sufficiently stiff to resist all deformation. Spiders shall be provided at a maximum interval of 2m.

The Employer shall, at all times, have powers to decide which portion of the excavated materials shall be for filling and in which portion of the site and in what manner it shall be so used.

If any material remains as surplus it shall be disposed of as directed by the Employer, which includes loading, unloading, transporting and spreading as directed within a distance of 5 km. If the Contractor fails to remove the earth from site within 7 days after the period specified in a written notice, the Employer may arrange to carry out such work at the Contractor's risk and cost or may impose such fine for such omission as he may deem fit. Particular care shall be taken to keep the trench dry during the entire refilling operation.

If suitable material for refilling is not available for excavation the Contractor shall bring earth, murrum of approved quality as directed by the Employer.

No mechanical plant other than approved compacting equipment shall run over or operate within the trench until backfilling has reached its final level or the approval of the Employer has been obtained.

In case of excavation of trenches in rock, the filling up to a level 30 cm above the top of the pipe shall be done with fine materials such as earth, murum, etc. The filling up to the level of the centre line of the pipe shall be done by hand compaction in layers not exceeding 8 cm whereas the filling above the centre line of the pipe shall be done by hand compaction or approved means in layers not exceeding 15 cm. The filling from a level 30 cm above the top of the pipe to the top of the trench shall be done by hand or other approved mechanical methods with broken rock filling of size not exceeding 15 cm mixed with fine material as available to fill up the voids.

Filling of the trenches shall be carried out simultaneously on both sides of the pipe to avoid unequal pressure on the pipe.

Subsidence in filling: Should any subsidence take place either in the filling of the trenches or near about it during the maintenance period of 12 months from the completion of the Contract Works, the Contractor shall make good the same at his own cost or the Employer may without notice to the Contractor, make good the same

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in any way and with any material that he may think proper, at the expense of the Contractor. The Employer may also, if he anticipates occurrence of any subsidence, employ persons to give him timely notice of the necessity of making good the same, and the expenses on this account shall be charged to the Contractor.

3.36. Fixing Sluice Valve

The valves shall be placed on the pipeline and valve chambers constructed according to drawings. The depth at which the valve is to be laid and the dimensions of concrete and masonry shall be varied when necessary under the orders of the Engineer.

3.37. Fixing Scour Valve

Scour valves shall be fixed at places shown in the drawing No:, and the scour connections from the main shall be carried out completely as per drawings.

3.38. Fixing Air Valve

Air valves shall be fixed at the summits of pipe lines or at places as per the LS section. The air valve connections etc. shall be carried out as per drawing.

3.39. Interconnection Work

The Interconnection Work between the existing main and proposed main to be laid under this contract shall proceed from the new main to the existing main any required for the work.

3.40. Cleaning of Mains

During the execution of the work the contractor shall keep the interior surface of the mains free from cement, brick, soil or other superfluous matter and shall hand over the mains perfectly clean and free from deposit on completion.

3.41. Masonry chambers

Chambers for sluice valves, inspection, scour valves, air valves shall be constructed on the pipes in the positions as shown in the drawings.

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3.42. Restoring Road Surface

The surface of the road or ground up to the WBM level for the width of the trench shall be finished off to the proper level with the same kind of materials the surface consisted of before the excavation commenced, except in the case of superior roads and tarred roads in which case the surfaces should be finished off with water bound macadam surface.

3.43. River crossings.

All the supporting structure for pipeline to be taken above M.F.L. (Maximum Flood Level) in river. The contractor shall furnish detailed drawings showing the type of bedding needed to support the pipe.

3.44. Railway Crossings

Required permission for laying, jointing and testing the pipe line across the railway lines will be obtained by the Employer. The contractor will carry out the work according to the specifications and stipulations made by the Railway authorities.

3.45. Road Crossings

Wherever pipeline has to cross roads or cart tracks, it shall be done through a culvert or bridge, wherever necessary.

3.46. RCC Pipes

RCC (Reinforced cement concrete) pipes that are used for water supply schemes, drainage works, culverts and other purposes. Produced by centrifugal spinning process & tested on various parameter. RCC Spun Pipes which are manufactured as per Indian Standard specification 458:2003. That Rcc Pipe pile has to cross the Roads, culverts, nalla etc, that the specified sizes are 200mm to 400mm is mentioned in schedule.

3.47. Design of Lining

General

Composition of mortar for the lining shall be composed of cement, sand and water mixed to such consistency as to produce a dense and homogenous lining that will adhere firmly to the pipe surface. Contractor should get approval of the details of the admixtures he proposes to use.

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3.48. Proportion

Dry proportions of cement and sand shall be 1 part of cement to 1½ parts of sand by volume. Slight modifications in composition could be made at site to suit the characteristics of the sand used. Each bag of cement shall be weighed and converted into volume for its use. Admixtures, if permitted, shall be used in strict accordance with the manufacturer's recommendations.

3.49. Water Content

Water content shall be the minimum that is required to produce a workable mix, with full allowance made for water collecting on the interior of pipe surface. Water cement ratio will not exceed 0.51.

3.50. Mixing

Mortar shall be well mixed and of proper consistency to obtain a dense, homogenous lining. Where premixed mortar is used, it shall be done so before initial set.

3.51. Thickness of Cement Mortar Lining

A. Insitu Cement Mortar Lining: The minimum thickness of cement mortar lining shall be as per IS 11906 for respective nominal dia (Inner Diameter) as mentioned below.

SN	Nominal Diameter (mm)	Minimum Mean Thickness (mm)	Minimum Thickness at One Point (mm)
1	100-300	5	3

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2	350-900	8	6
3	1000-1500	10	8
4	1550 and above	15	12

The tolerances shall be as per IS-11906.

B. Shop Applied Cement Mortar Lining: The minimum thickness of lining shall be as per IS 3589:2001 as mentioned below.

SN	Outside Diameter (mm)	Minimum Thickness (mm)	*Tolerance (mm)
1	168.3-323.9	6	+2
2	355.6-610	7	+2
3	660-1219	9	+2
4	1321-2540	12	+3

*No Negative Tolerance shall be acceptable.

3.52. Support for Pipe Work & Valves

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

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

3.53. Wide river crossings

At river where there is existing crossing bridge for vehicles or passengers, the span supports for the pipeline pipe bridge shall match the supports of the existing bridges. For other wide river crossings, 8m span supports shall be used and be constructed in accordance with the Drawings.

3.54. Culvert, small river and nalla crossings

At river where there is existing crossing bridge for vehicles or passengers, the span supportsfor the pipeline pipe bridge shall match the supports of the existing bridges.

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For other culvert, small river and nalla crossings where pipe bridges are used, 5 m span supports shall be used and be constructed in accordance with the Drawings. Construct all supports, piers and appurtenances for above ground river, nalla and culvert crossings. Supply and install pipe bridges to install any pipeline that is required to cross rivers, nallas, culvert and the like.

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CHAPTER 4

4.1. Mixers and Flocculators

4.1.1. General

Chemical mixing shall use either hydraulic or mechanical energy and shall provide uniform mixing of the chemical in the main flow of water at all times over the entire range of chemical doses applied and flows through the works. A high degree of local turbulence is considered necessary for satisfactory mixing. The electrical power or headloss requirements to achieve efficient mixing shall be optimized to ensure minimum energy consumption at each mixing location.

4.2. Sand

Filter sand size shall be defined by its effective size and uniformity coefficient. The effective size is defined as the size of the aperture through which 10% by weight of sand passes, and the uniformity co-efficient is defined as the ratio of the size of aperture through which 60% of the sand passes to the effective size.

Filter sand shall be substantially free of fine and coarse material and at least 95% by weight shall be between the grading limits specified.

4.3. Packing gravel

Filter sand shall be supported by a layer of suitable graded packing gravel. The packing layer shall be not less than 50mm depth and be such as to ensure adequate and uniform distribution of washwater and air after leaving the nozzles, with the minimum risk of mixing sand with the layers of packing media, or of fines in the sand penetrating the nozzle apertures.

The gravel shall be washed to remove all carbonaceous matter, clay and silt, and loss on acid washing shall be less than 4% by weight. Acid washing shall be of the water-washed and dried sample with 24 hours contact in 10% by volume of hydrochloric acid.

4.4. Media placing

Following installation and satisfactory testing of filter floors and as per the approved drawing and the installations are complete, the Contractor will be given

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written permission to commence charging the filters, which shall be carried out to the procedures set out in section 23 of the AWWA Standard for Filtering Media (AWWA B100-80) with the exception that the wash rate may be varied.

Filter media shall be carefully placed and not charged by dropping or dumping, or any other method which, in the opinion of the Engineer, will be detrimental to the media, nozzles, floors and sealants. Chutes may be employed only after 300mm of covering has been placed over the floor.

After placing each layer of media it shall be thoroughly back washed to clear debris, mud and other impurities. This shall be followed by an air distribution test to check that nozzles have not been damaged during the placing of the media.

Prior to setting the filters to work, the media in each filter shall be backwashed in-situ and skimmed to remove fines so that, in the top 150mm of the media, the proportion of fines does not exceed 5% any time up to the end of the Period of Maintenance. Fines are defined as the particles which pass through an aperture 0.9 times the effective size of the media. The depth of material removed in skimming shall be replaced by an equal depth of media to the specified grading.

4.5. Safety Equipment

4.5.1. Safety showers

Safety showers shall be purpose-designed proprietary units suitable for indoor or outdoor use as specified.

The showers shall incorporate nozzles specially designed to create a deluge of water overhead for rapid decontamination and an additional spray at approximately waist height to direct water onto the lower body and legs. The water supply valves shall be mechanically operated by means of a grab handle. Where specified, the units shall be fitted with limit switches with volt-free changeover contacts for initiation of a remote alarm when the shower is operated.

4.5.2. Eye baths

Eye baths shall be either self-contained units or integrated with safety showers as appropriate. They shall be of a purpose-designed proprietary type suitable for indoor or outdoor use as specified.

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4.6. Protective clothing

General requirements

Protective clothing shall be supplied in sets in the quantities specified and shall comprise those articles appropriate to routine operations and maintenance work in the designated areas of the Works.

Where articles are manufactured in various sizes and are not readily adjustable, then each set shall include a range of at least two fittings covering medium and large sizes unless otherwise specified.

Helmets

Helmets shall be of the general purpose industrial safety type complying with BS 5240 and incorporating an adjustable harness. The colour of the helmets shall be yellow unless otherwise specified.

Overalls (chemical resistant)

Overalls for chemical handling shall be of the boiler suit pattern manufactured from plasticised PVC or PVC proofed nylon with welded seams and integral hood. Front fastening shall be by means of a zip with button-over protective flap. The overalls shall be impervious and resistant to acids and alkalis at the maximum concentrations used in the Works.

Gauntlets (chemical resistant)

Gauntlets for chemical handling shall be of the heavy duty pattern with an overall length of at least 400 mm and manufactured from PVC. The external finish shall be smooth.

Gloves

Gloves for general use including the handling of steel drums and cylinders shall be of heavy duty leather and fabric construction complying with BS 1651.

Boots

Safety boots shall be in moulded polyvinyl chloride complying with BS EN 345 Part 1 .The boots shall have protective mid-soles and safety toe-caps.

Storage lockers

Storage lockers for protective clothing shall be of the floor standing single compartment type constructed from 22 swg steel with concealed hinges and key operated locks. Each locker shall have a hat shelf and double coat hook. Lockers

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shall be located away from hazardous areas but within convenient reach thereof. The lockers shall be suitably labelled as to purpose.

Self contained breathing apparatus

Self contained breathing apparatus shall provide complete respiratory protection from the surrounding atmosphere for a period of 60 minutes at normal breathing rate. The apparatus shall comply with relevant IS and shall be type approved by the Health and Safety Executive.

Face masks

Face masks for protection against dust shall comply with BS EN 149 and shall be fully disposable.

Masks shall be supplied in packs of at least 20.

Eye protection

Eye protection against gas, liquids and dust shall comply with BS EN 166.

The protection shall be of the goggle type with polycarbonate front lens and anti-mist acetate rear lens.

Ear protection

Ear protection shall be of the ear muff type complying with BS EN 352 and tested in accordance with BS 5108.

Ear muffs shall be accommodated in purpose-designed wall mounting cabinets of a non-locking type which shall be suitably labelled. Cabinets shall be located immediately outside areas where sound attenuation is required.

First aid kits

First aid kits shall be contained in wall mounting boxes designed to protect the contents from dampness and dust and marked with a white cross on a green background.

Unless otherwise specified, each box shall contain the following items:

- First aid guidance card;
- 20 individually wrapped sterile adhesive dressings of assorted sizes;
- 2 sterile eye pads with attachments;
- 6 individually wrapped triangular bandages;
- 6 safety pins;
- 6 medium sized individually wrapped sterile unmedicated wound dressings (approximately 100 x 80 mm);

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- 2 large individually wrapped sterile unmedicated wound dressings (approximately 130 x 90 mm);
- 3 extra large individually wrapped sterile unmedicated wound dressings (approximately 280 x 175 mm).

Additionally, where eye wash bottle sets are not provided separately in the immediate vicinity,

- 3 No. 300 ml of sterile water or sterile normal saline solution (0.9%) in sealed disposable containers.

Additionally, where soap and water of drinking quality are not available in the immediate vicinity,

- 2 individually wrapped moist cleansing wipes.

Fire blankets

Fire blankets shall be of the heavy duty industrial type complying with BS 7944 or BS EN 1869 and contained in wall mounting cabinets suitably labelled with white lettering on a red background.

Ventilatory resuscitators

Ventilatory resuscitators shall comply with BS 6850 and shall be contained in a carrying case suitably labelled with white lettering on a green background.

Safety signs

All labels and signs providing health and safety information or instructions shall comply with BS 5378. Fire safety signs shall comply with BS 5499 Part 1.

Signs which are not integral parts of the safety equipment and which are fixed separately to cabinets or to nearby surfaces shall be manufactured in accordance with Part 3 of this Specification.

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CHAPETR 5

5.1. Water Retaining Structures

Elevated Service Reservoir/Ground Level Service Reservoir/Sump etc

1. All structural reinforced concrete shall be of a minimum M30 grade with a maximum 40 mm aggregate size for footings and base slabs and with a maximum 20 mm aggregate size for all other structural members.
2. The reinforced concrete for water retaining structures shall have a minimum cement content of 300 kg/m3 with a maximum 20 mm size aggregate and 330 kg/m3 with a maximum 40 mm size aggregate.
3. The minimum reinforcement in walls, floors and roofs in each of two directions of right angles within each surface zone shall be as per 7.1 of IS: 3370 part 2.
4. The nominal cover of concrete for all steel, including stirrups, links, sheathing and spacers shall be as per 7.2 of IS: 3370 Part 2.
5. Each service reservoir shall be executed as per the drawings
6. The service reservoirs shall be provided with suitable size C.I D/F Pipes for inlet, delivery, overflow and scour connections and painted with two coats of anticorrosive paint as per BOQ/Drawing.
7. Suitable size sluice valves with gear arrangements wherever necessary shall be provided for all inlet and outlet connections with valve pits.
8. Water level indicators enamel painted with float and painted with graduations in metric units shall be provided to indicate water level inside the reservoir.
9. Suitable size and required number of ventilators, manhole covers shall be provided as directed by the Employer.
10. RCC spiral staircases shall be provided for outside and access ladder inside the service reservoirs as per Specifications.
11. The finishing colour of the service reservoirs shall be aesthetically selected after its approval.
12. Letterings to indicate the capacity and other details as directed by the Employer shall be written on the side wall of the service reservoirs.
13. Valves shall be provided with valve pits and cover to bear the loads coming on it as per departmental type design and plans.

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5.2. Testing for Water Tightness

For water retaining structures above ground level, the requirement of the test shall be deemed to be satisfied if the external face shows no sign of leakage and remain apparently dry over a period of observation of seven days after filling upto maximum water level and allowing seven days period for absorption.

In case of underground structures with top covered the tanks shall be deemed to be water tight if the total drop in water level over a period of seven days does not exceed 40mm.

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

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

The fact carrying out water tightness test should be recorded in M.Book. The last part bill should be passed only after above certificate is issued. However the contractor shall be permitted to execute an indemnity bond in lieu of the recovery of 40% in each bill in prescribed form in stamp paper for a value of Rs.22.50 towards water tightness and structural stability of the reservoir/water retaining structure. The period of guarantee required by the contract shall be two years from the date of completion and commissioning (with filling of water upto maximum water level in the case of service reservoir/over head tank/water retaining structure). If defects are noticed within the stipulated period of 24 months of satisfactory performance, the defects should be rectified by the contractor at his own cost and the performance period again shall be reckoned from the date of completion of the rectification of defects by the contractor. In the case of service reservoir/over head tanks and other water retaining structures during this period, structure under full working head of water should show no sign of leakage. The test for water tightness should be arranged to be carried out and completed within 30 days from the date of intimation, by the Engineer. The testing of the service reservoir/OHT/and other water retaining structures should be done by the contractor at his own cost inclusive of all necessary equipment, water etc., complete. The test for water tightness of the structure as well as materials of construction used shall be conducted in conformity with the standard specification as per IS:3370 (Part-

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1)-1965 as amended from time to time and the other specifications as mentioned in the bid document.

5.3. C.I. Pipe Connections

The vertical pipe connections shall be hoisted and fixed true to plumb without any deviation from the verticality. The jointing of pipes shall conform to the requirement and all required jointing materials shall be arranged by the contractor at his cost.

5.4. Scour

Scour and overflow arrangements should be connected and let to a common pit from where it will lead to the nearest open drain.

5.5. Maintenance

During the maintenance period, the contractor should clean the elevated Service Reservoir and sump at the intervals.

5.6. Water level indicator (Float)

The service reservoirs contains water level indicators are float operated target type suitable for liquid level gauging of fixed roof, floating roof, open type vertical storage tanks and underground sumps for water. The tank level indicators are of simple construction and are easy to install. They are very sturdy and require no maintenance. A float operated tank indicator comprises of a float that is located within guide cables. The guide cables whose ends are fastened on to an anchor bar are kept straight and wrinkle free by tension devices. The anchor bar is either grouted or welded to the tank bases.

The float cable is wound over a set of pulleys, which are secured in the pulley housing. One end of the float cable bears the float and the other end carries a pointer assembly with a counter weight for balance. Tank level indicator float operated type is for fixed roof, floating roof, open top and underground storage tanks.The details as per various types of service reservoirs shown in drawings.

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CHAPTER – 6

6.1. Appurtenances

6.2. Valves

General

Valves shall be suitable for use with the water being conveyed at the temperatures and pressures required for the application. Unless otherwise approved, pressure designation shall not be less than PN 10.

Valves shall have integral flanges drilled as per relevant BIS where applicable. Flanges to other standards shall be used only if approved and provided that any differences do not affect mating dimensions. Back faces of flanges shall be machined.

Sluice valves and butterfly valves shall be suitable for flow in either direction.

Sluice valves shall comply with IS: 14846 as appropriate

Butterfly valves shall comply with IS: 13095-91/BS 5155 / AWWA-C-504/1980

Reflux/check valves shall conform to IS: 5312(Part I)/BS 5153

Valves shall be suitable for frequent operation, and for infrequent operation after long periods of standing either open or closed.

Rubber used in valves shall be ethylene propylene rubber (EPDM or EPM) or styrene butadiene rubber (SBR). It shall comply with the requirements of Appendix B of BS 5155, be suitable for making a long term flexible seals, and be resistant to anything causing deterioration of the flexible seal.

6.3. Gate Valves (Sluice Valves)

Gate valves shall comply with IS 14846 and be of the solid wedge-gate type with non-rising stems. Valves less than 250mm diameter may be of the resilient-seated type

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unless otherwise specified.

Valve spindles shall be of the internal non-rising type. The valve spindle seal shall be replaceable with the valve fully open and the main under pressure. Valves used with potable water shall not use any brasses which contain more than 5% zinc. Valves 450mm and over shall be fitted with integral by-passes and gate jacking screws. All valves shall be provided with reduction gear arrangement for easy manual operation. Where specified, electric actuator shall be specified as per specification for electric actuator.

6.4. Reflux /Check valves

Reflux/check valves shall comply with IS: 5312(Part I) and shall be for rapid closing without slamming no later than the moment forward flow stops. The valve size and design shall be chosen to give the best performance possible, taking account of the system where the valve is installed. The effect of any surge vessel in the system as well as the static and dynamic heads shall be included in the assessment.

If self-closing without slamming cannot be achieved, external mechanisms may be used to control the closure rate. Valves shall preferably be fitted with resilient faces or seats.

Check valves used in raw water systems shall not be installed vertically, or positioned so that water-borne solids can settle against the valve flap when the flap is closed.

6.5. Butterfly valves

Butterfly valves shall comply with IS: 13095-91. Unless otherwise specified, valve body and disc shall be of close-grained grey cast iron. and valves shall be mounted with shafts horizontal.

Valves shall be fitted with indicators to show the position of the disc, clearly marked with 'open' and 'closed' positions.

Valves shall not contain any brasses containing more than 5% zinc. Gunmetal to BS 1400 Grade LG2, aluminium bronze, or nickel components may be used for internal components.

Resilient-seated valves shall have nitrile rubber seals. For valves of 900mm and above, retaining rings shall be provided to enable the sealing ring to be replaced

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without the need to remove the valve body from the pipework.

Metal-seated valves of 900mm and above, shall be have seat clearances adjustable to obtain as near a watertight condition as possible, without the need to remove the valve body from the pipework.

6.6. Pressure and flow control valves

General

Pressure-control valves and flow-control valves shall be designed for the operating conditions specified.

Valves shall be capable of controlling the required flow or pressure within plus and minus 5 percent of the set value. The rate of response of opening and closing of the main valves shall be controllable at the valve. External indication of the position of the valve element shall be provided.

Hydraulic control systems shall include isolating valves to allow maintenance or replacement without interrupting the supply.

6.7. Automatic air-relief valves

Air valves shall be provided as specified or shown on the Drawings, to achieve the following:-

(a) To exhaust air automatically during filling, the air being released fast enough to prevent back pressure restricting water inflow.

(b) To ventilate pipework automatically during emptying, the air inflow being fast enough to prevent the development of any significant negative pressure.

(c) To release air automatically during normal working.

Conditions (a) and (b) shall be met by using an orifice capable of handling large volumes of air at a high-flow rate in either direction. Condition (c) shall be met by using a small orifice capable of discharging small volumes of air as they accumulate.

Valves shall have approved screens to prevent the ingress of foreign matter.

Air valves shall be of one of the following types;-

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(a) Double valves shall combine both large and small orifices in one valve. The large orifice shall be sealed by a float and the valve shall be designed to avoid premature closing of the valve by the discharging air. The small orifice shall be sealed by a float at all pressures above atmospheric, except when air accumulates in the valve body.

(b) Single large orifice type for automatic ventilation or exhaust of pipework.

(c) Single small orifice type for automatic release of air under normal working pressure.

Large orifice air valves, including those incorporated in double air valves, shall be constructed so that the air flow holds the valve open during discharge of air at all flows possible in service. When coupled to their respective isolating valves, they shall be capable of admitting or exhausting the required quantities of free air without the pressure differential across the combined air valve and isolating valve exceeding 0.5 bar.

Small orifice air valves, including those incorporated in double air valves, shall be capable of discharging not less than 0.5 m^3/min of free air when the pressure in the pipeline is at the maximum working pressure.

Balls or floats shall be of ABS, vulcanite, rubber-covered metal, stainless steel, or other approved materials, and shall operate automatically at all pressures up to the test pressure. Orifices shall be bronze or stainless steel.

Air valves shall be designed so that each float seats against its orifice or causes the orifice to be closed without leakage at all pressures between 0.2 bar g. and the specified test pressure. Balls and seats shall be designed to minimise adhesion of the ball to the seat. They shall be of a type proven to be suitable for the specified duties.

Each air valve shall be provided with an isolating valve, which shall be an integral

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lever-operated isolating ball valve.

Each small orifice or double air valve shall be fitted with a test cock in the valve body for verification that the small orifice air valve is operating properly.

Body ends shall be flanged with raised faces and drilled to BS 4504 for the nominal pressure specified.

The materials for valves shall be not inferior to the following:

- body cover and cowl: cast iron;
- small orifice: cast iron with gunmetal seat;
- small orifice ball: rubber-covered or other approved;
- large orifice: cast iron with rubber seat;
- large ball: Vulcanite covered or other approved.

6.8. Penstocks (Sluice gates) and headstocks

General

Penstocks shall be of cast iron or plastic construction as specified and suitable for either on-seating or off-seating as specified. Apertures may be rectangular or circular.

On-seating penstocks shall be drop tight at their operating seating pressure, unless otherwise approved.

The leakage rate for off-seating penstocks shall be stated by the Contractor and will be subject to approval.

6.9. Penstocks — cast iron

Penstocks shall be cast iron complying with IS: 11639 /BS 1452 not less than Grade 12 and to the dimensions specified.

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Penstocks shall be flat-backed for wall mounting or be provided with short spigots for building into an opening, Penstock apertures shall be rectangular or circular.

Seating surfaces shall be gunmetal to BS 1400 LG2, or bronze to BS 2874, hand-scraped and securely fixed to frame or door.

Penstocks shall be suitable for either on-seating or off-seating pressures as required by the application, and shall be drop-tight at their operating seating pressures.

Rising or non-rising shafts shall be provided, as specified.

Rising shafts shall be mild steel, connected to the door and working through a gunmetal nut rotated by the operating gear. Rising-shaft penstocks shall be provided with head and foot brackets, or foot brackets only as required.

Non-rising shafts shall rotate in a gunmetal nut in the door, and shall be of manganese bronze or phosphor bronze. For long shafts, only the screwed portion need be of manganese bronze or phosphor bronze.

Extension shafts shall be provided with sockets which engage the penstock shafts. A securing bolt, locked in position, shall unite the 2 shafts.

Guide brackets shall be provided wherever necessary.

Operating handwheels shall be big enough diameter to enable the required duty to be achieved.

Hand-operated weir penstocks shall be lockable in any position.

6.10. Valve Operation

Shafts and caps for tee-key operated valves

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Operating and extension shafts for valves operated by tee key shall be capped.

Extension shafts shall be circular section. For valves installed in chambers, extension shafts shall be provided with split bearings, rigidly held on brackets spaced no more than 1,500 mm apart. For buried valves, the shaft shall be supported inside a protecting tube held on a purpose-made support, which shall be fixed to the top of the valve and provided with a shaft guide.

Bearings and shafts shall be suitably protected against corrosion.

Extension shaft couplings shall be provided with locking arrangements.

6.11. Manual operating mechanisms

Manual closing of valves shall be by the clockwise rotation of a tee key or handwheel.

Tee-key operated valves shall be provided with detachable cast iron shaft caps, with keys to match the cap. One key shall be supplied for every five valves installed, with a minimum requirement of two keys in any one size.

Handwheels shall be shaped to give a safe grip without sharp projections, clearly marked with the direction of opening and closing and shall be fitted with integral locking devices. A padlock and chain will not be acceptable for locking.

Manually-operated valves and penstocks shall be capable of being opened and closed by one person, when the specified maximum unbalanced pressure is applied to the valve or penstock. Under this condition the total force required at the rim of the handwheel or at the tee key to open the valve or penstock from the closed position shall not exceed 30 kg (15 kg each hand). Where necessary, gearing and bearings shall be provided and the handwheel sized to fulfil this requirement. Gearboxes shall be totally enclosed oil bath lubricated. Thrust bearings shall be provided so that the gearcase may be opened for inspection or be dismantled

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without releasing the stem thrust or taking the valve or penstock out of service. Oil and grease lubricated gearing, bearings and glands shall be protected against the ingress of dust and moisture.

Operating mechanisms shall be of the weatherproof type and those parts subject to submergence shall have a degree of protection IP68 to BS 5490 at a depth of submergence of 5 m. Where practicable, operating mechanisms shall be fitted with mechanical position indicators clearly visible from the operating position.

Headstocks of the non-rising shaft type shall each have an index pointer working over a graduated, open-to-closed position indicator fixed to the side of the pillar.

6.12. Solenoid-operated valves

Solenoid-operated valves shall be of the direct acting type, full bore and balanced. They shall not depend upon pressure differential for their operation.

Valve bodies shall be of cast iron or stainless steel as specified with screwed or flanged ends. Sealing shall be by `O' rings.

Solenoids shall have direct current coils and an integral rectifier for use on a 220 V A.C. supply unless otherwise specified. The coils shall be encapsulated in epoxy resin.

Limit switches with voltage-free changeover contacts shall be provided for remote signalling of open and closed positions.

Enclosures shall have a minimum degree of protection IPW 67 to BS 5490.

A manual mechanical override shall be fitted.

6.13. Electric actuators

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Electric actuators shall operate valves and penstocks at opening and closing rates that will not impose unacceptable surge pressures on the pipework.

Actuators shall be rated at not less than 20 percent in excess of the power required to operate the valve or penstock under maximum working conditions.

Actuator enclosures shall have a minimum protection IP 67 .

For non-modulating type actuators, the motor short-time rating (STR) shall allow the successive full travel operation of the travel from open to closed and vice versa but shall be not less than 15 minutes. For modulating type actuators the motor shall have a duty-type rating (DTR) to meet the varying cyclic load requirements of the valve.

Electric motors shall be provided with built-in thermal protection complying relevant BIS.

Actuators shall be complete with:

(a) An alternative system for manual handwheel and reduction gear operation which shall be lockable.

(b) An interlock, to prevent engagement of the handwheel whilst the actuator is being power driven and to disengage the manual drive positively when the power drive is started.

(c) Reversing type motor starter complete with isolating switch.

(d) Local and remote control selector switch when specified, which shall be lockable.

(e) Open, stop and close push-buttons.

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(f) Potentiometer for remote valve position indication when remote control is specified.

(g) Torque switches for mechanical disengagement of the drive at the extremes of valve operation to limit excess torque.

(h) Supply failure and remote control available monitoring relays. The supply failure relay shall operate under single phasing and phase reversal conditions.

(i) Auxiliary and interposing relays as necessary.

(j) Voltage-free changeover type contacts for the remote indication of:

-Motor tripped on overload
-Fully open
-Fully closed
-Operating
-Supply failed
-Remote control available

The rating of volt-free contacts shall be not less than 15 A at 240V a.c. and 2 A at 50V d.c. unless otherwise specified. The contacts shall be suitable for inductive load switching.

(k) Anti-condensation heater

Separate or segregated terminal boxes shall be provided for the connection motor, heater and control cables.

6.14. Valve packaging and installation

Marking and packing

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Each valve shall be indelibly marked with the diameter and pressure rating and shall carry a unique reference number to enable each item to be clearly identified with works fabrication records, works test certificates, delivery notes and the like.

Wherever possible, the identification marks shall be painted on the outside of the item but where there is not enough smooth surface area for the identification marks they shall be put on rust-proofed metal tags secured to the item with galvanised wire or chain (not through flange holes).

Valves shall be packed in the `closed' position except that uncrated resilient seat gate valves for transport to tropical areas shall be in the `open' position.

Valve handling

The Contractor shall provide all equipment needed to handle and install valves and associated equipment without damage. The equipment shall include lifting beams, reinforced canvas slings, protective padding, cradles and the like. Unprotected wire rope or chain slings shall not be used for handling.

Temporary packing, coverings or crates provided for protection in transit shall not be removed (except for inspections, after which they shall be replaced) until immediately before installation.

Valve installation

Valves shall be installed and commissioned in accordance with the manufacturer's instructions. After installation, valves shall be cleaned, and gates, discs, seats and other moving parts closely inspected, foreign matter removed, and the valves checked for ease of operation. Moving parts shall be lightly greased or otherwise treated in accordance with the manufacturer's recommendations.

Unless otherwise specified, butterfly valves shall be enclosed in chambers, installed with the shaft horizontal, and supported as detailed on the Drawings. They shall be

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installed so that when the valve is opening the lower portion of the disc moves in the direction of the main or normal flow.

Unless shown otherwise on the Drawings, gate valves shall be installed with their shafts vertical.

Jointing, sleeving, external wrapping, anchor and thrust blocks, valve chambers, valve marker posts and the cleaning and disinfection of valves shall be executed as specified for the associated pipeline.

CHAPTER 7

7.0. Mechanical equipment and Works

7.1. Centrifugal Pumps

7.1.1. General

The pumps shall be designed to operate satisfactorily without detrimental surges, vibration, noise, or dynamic imbalance over the required head range. The head-capacity curve of the pump shall have a continually rising head characteristic with decreasing capacity over the whole range of total head. The shut off head of the pump shall be at least 135 % of the total head. The Pump shall have the maximum efficiency at the specified duty point.

The Contractor shall guarantee that adequate required Net Positive Suction Head (NPSH) is available to ensure that pumps can operate without cavitation under the worst operating condition. The required NPSH at duty point and throughout the range shall be at least 1.0 M, and 0.5 M less than the available NPSH respectively at the lowest water in the sump.

Each pump must be capable of running satisfactorily in parallel with other sets in the system without throttling and by itself, without cavitation or overload under all operating conditions within the system resistances indicated.

The unit shall be designed to operate safely at the maximum speed attainable in the reverse direction of rotation due to water returning through the pump at times when the

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power supply to the motor is interrupted and the discharge valve fails to close. The first critical speed of the pump set shall be at least 30 % above the operating speed.

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

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

All pumps shall be provided with mechanical seals of working life not less than 20,000 hours of operation.
A stationery coupling guard shall be provided for the coupling conforming to all relevant safety codes and regulations. Guard shall be designed for easy installation and removal, complete with necessary support, accessories and fasteners.

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

Pump design shall be as per IS:6595 and pump performance shall be as per IS:5120.

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

(i) 115 % of the power required by the pump at the duty point.

(ii) 105 % of the maximum power required by the pump from zero discharge to run off point total head.

Materials of Construction

Casing	:	CI IS210 Gr FG 260
Impeller	:	SS ASTM A743 Gr CF8M
Shaft	:	ASTM A276 SS 431
Shaft Sleeve	:	ASTM A 743 CF8M
Casing ring	:	SS AISI 410

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Gland	:	Bronze conforming to IS 318 Gr LTB 2
Gland Packing	:	Graphited Asbestos
Base Plate	:	CI/Epoxy Coated MS

Testing:

Material Test Certificate	:	Casing, Impeller and shaft
Hydrostatic Test	:	1.5 times the shut-off head or twice the rated discharge head, whichever is greater
Performance Test	:	As per IS:5120 &: at full speed
NPSH Test	:	"Type" test certificate for the offered model
Mechanical Balancing	:	As per ISO:1940, Gr. 6.3 or better
Visual Inspection	:	Pumps shall be offered for visual inspection before shipment. The pump components shall not be painted before inspection
Field Tests	:	Field performance tests required for satisfactory operation

7.2. Vertical Turbine Pumps

The pump shall be vertical wet pit type complete with bowl, column and head assemblies comprising of a unitary embedded sole plate, motor stool and bearing housing.

The pumps shall be designed to operate satisfactorily without detrimental surges, vibration, noise, or dynamic imbalance over the required head range. The capacity Vs bowl head characteristics shall be stable, continuously rising towards shut off with the highest at shut off. The shut off head of the pump shall be at least 135 % of the total head.

Each pump must be capable of running satisfactorily in parallel with other sets in the system without throttling and by itself, without cavitation or overload under all operating conditions. Components of the identical pumps shall be interchangeable.

The impeller adjustment shall be such that the impellers run free in any installed condition despite extension of line shaft (caused by hydraulic down thrust) the weight of shafting and weight of impellers.

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The unit shall be designed to operate safely at the maximum speed attainable in the reverse direction of rotation due to water returning through the pump at times when the power supply to the motor is interrupted and the discharge valve fails to close. The design of the shaft shall also take into consideration that the natural frequency in both transverse and torsional mode of vibration shall be at least 30% above the pump operating speed.

Pumps shall run smooth without undue noise and vibration. Unfiltered vibration of the pump at the thrust bearing shall be limited to 3.2 mm/sec RMS and at discharge elbow shall be limited to 4.5 mm/sec at duty point. Noise level shall be limited to 85 dBA at a distance of 1.86 m.

The pump shall be suitable for withstanding reverse rotation due to back flow water without mechanical damage to any component of the pump.

The discharge elbow shall be designed to directly connect to the discharge pipe without using expander / reducer.

All the pumps shall be supplied with machined pads to allow the fitting of portable vibration monitoring transducers.

The pump shall be designed for ease of operation, maintenance and inspection. The pump shall have high reliability.

The pump shall be non-pullout type with enclosed impeller. The impeller shall be properly machined with liquid passage hand finished and dynamically balanced. Impeller shall be adjustable vertically by means of an adjusting nut in the head assembly. Impeller shall be securely fastened to the impeller shaft with keys, taper bushings or locknuts.

The pump set shall be designed to operate up to a period of 5 minutes at shut-off head without causing damage to any part of the pump set.

The pump shall be provided with nut at the coupling end for adjusting axial clearance of impeller. The bowl assembly shall consist of rotating impellers, which are housed in stationary bowls having guide vanes. The bowl shall also include the housing of the bottom pump shaft bearing.

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The bowl shall be equipped with replaceable wearing ring on suction side of enclosed impellers. Liquid passage shall be smooth finished and enameled. The bowls shall contain bushes to serve as bearings for the impeller shaft. Suction bell shall be designed for smooth inflow of water with minimum losses.

The column pipe and shafts shall be in suitable sections of length to facilitate ease of handling.

The impeller shaft shall be made of stainless steel containing minimum 12% chromium. It shall have a surface finish between 0.75 microns or less. It shall be guided by bearings above and below each impeller. The butting faces of the shaft shall be machined square to the axis and the shaft ends shall be chamfered on the edges. The shaft shall be straight within 0.125 mm for 3 meters length total dial indicator reading.

The maximum permissible error in the axial alignment of the thread axis with the axis of the shaft shall be 0.05 mm in 150 mm. The design of the Line shaft shall take into consideration the critical speed of the shaft, which shall be at least 30 percent lower, or above the operating speed. The Line shaft shall be furnished with interchangeable sections. The butting faces of shaft shall be machined square to the shaft axis and the shaft ends shall be chamfered on the edges.

Line shaft bearings of low galling tendencies with corrosion and abrasion resistance properties shall be used. Where resilient materials are used they shall be integral with replaceable metallic backing sleeves of compatible material with suitable securing arrangement in the bearing housing.

Line shaft coupling shall be designed with a safety factor of 1.5 times the shaft safety factor and shall have threads to tighten during pump operation.

Shaft shall be provided with shrunk or snug fitted shaft sleeves of compatible wear / corrosion resistant material precision ground and polished, where they pass through bearings.

Thrust bearing shall have a minimum life of 25,000 hours.

Flanges shall be machined on faces and edges and conform to ISO 7005 / IS 6392 / BS 4504. Back faces of flanges shall where necessary be machined to ensure they are parallel to the front faces and that flange bolts can be fitted flush to the flanges.

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The discharge nozzle size shall be same as the discharge piping & valve size. The discharge head shall have an arrow indicating the direction of rotation of shaft.

One set of standard and special tools, cantering tools, lifting lugs, pipe and shaft clamps, etc. required for erection and maintenance shall be supplied.

7.3. Cranes

7.3.1 General

Electric driven, short headroom, wire rope hoists with motor driven, traveling trolley and I-beams for suspension shall be provided at chlorine room and chemical house. The construction of the hoists, its components, the design, testing and commissioning shall conform to IS 3938, Class II duty.

7.3.2 HOT and EOT

Hand operated crane for Clear water Pump house 1 No. 3 MT capacity Hand operated Over head travelling crane with a span of 8 meter complete with travelling trolley, pulley block, operating chain and suitable size MS girder suitable for the pump room.

For 1 No. 7.5 MT capacity Electric Over head travelling crane with a span of 10 meter complete with travelling trolley, pulley block, operating chain and suitable size MS girder suitable for the Raw water pump room .

7.4. Mechanical details

The specifications of the hoists are as follows:

- Rope drums shall be of cast steel or fabricated from rolled steel plates, conforming to the relevant Indian Standards. Fabricated rope drums shall be stress relieved before any machining takes place. The drum grooves shall be smooth finished and the rope drum shall be flanged at both ends. The drum shall be designed for a single layer of ropes. A precision machined rope guide to suit the drum grooves shall move over the drum like a nut, guiding the rope into the grooves and preventing an overlapping of the rope.
- Brakes shall be D.C. electromagnetic type/thrust type. Brakes shall be designed to hold the load at any position whenever there is a current interruption, either intentionally or by main power supply failure.

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- The wires shall be hemp cored and galvanised. Ropes shall be of regular right hand lay as per IS 2266. The rope construction shall be 6 x 37 with a factor of safety specified as per IS.
- The sheaves shall be fully encased in close fitting guards fabricated from steel plate. Smooth opening shall be provided in the guards to allow for free movement of the rope. Holes shall be provided for oil drainage. The lifting hook shall be supported on a bearing for 360 ° swivel under load.
- Straight and helical spur gearing shall be used for all motions. All first reduction gears shall have helical teeth. All pinions shall be integral with the shaft. All gears shall be hardened and shall be of tempered alloy steel having metric module. Overhung gears shall not be used. All gearing shall be totally enclosed and grease lubricated.
- Single flanged wheels shall be mounted in anti-friction roller bearings housed in "L" shaped bearing brackets for ease of removal during routine maintenance. Solid wheels shall be of forged/rolled steel or cast steel.
- 415 V, 50 Hz, heavy duty motors suitable for hoist and trolley operation, suitable for reversible motion, frequent acceleration and mechanical breaking, totally enclosed, fan cooled, wound rotor motor shall be used. Class of insulation shall be "F", with temperature rise limited that for "B". The pullout torque shall not be less than 225% of full load torque, corresponding to 40% CDF (Cycle Duration Factor of the motor). 200 switching per hour shall be considered for the selection of motors. The hoist shall have the following speed ranges:

  a) trolley travel : 10 m/min; micro travel: 2 m/min

  b) hoisting : 2 m/min

  Roller operated, resetting limit switches shall be provided for all motions. Limit switches shall be fitted to prevent over traveling and over hoisting.
- A flexible traveling cable system mounted on a retracting support system shall be used. The conductor shall consist of insulated multi-conductor cable with permanent termination on the connection box and on the trolley. The flexible trailing cable shall have ample length and shall be supported by means of properly designed movable clamps. These clamps shall be fitted with rollers and shall run freely on a guide rail along the beam. The flexible copper cable shall be butyl rubber or EPR insulated CSP sheathed type 650/1100 V Grade.

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- From fixed control panel from where the entire operation area can be overlooked or from a pendant push button control block hanging on a cable from the hoist. Control voltage is 110 V from a single phase step-down transformer. The following control is possible:
  a) Key operated ON push button - standard green button.
  b) ON signal lamp - green lens.
  c) Emergency OFF push button - standard red button.
  d) Hoisting push button - standard black button.
  e) Lowering push button - standard yellow button.
  f) Micro hoisting push button - standard black button.
  g) Micro lowering push button - standard black button.
  h) Cross traverse forward push button - standard black button.
  i) Cross traverse reverse push button - standard black button.
  j) Micro cross traverse forward push button - standard black button.
  k) Micro cross traverse reverse push button - standard black button.
  l) Long traverse forward push button - standard black button.
- The beam shall be suitable for the trolley, complete with end stops, holding down bolts and taper washers and shall be suitable for connection to the station earth. It shall be designed according to the capacity of the hoist, the beam fixation/support points, length and alignment. It shall be of galvanised mild steel. All fixation elements shall be of galvanised steel.

The following documents are to be furnished after award of work.

- General arrangement drawing of crane with details
- Note on erection and testing
- Test certificate for hook, chain and chain pulley block assembly.

7.5. Full Bore Electromagnetic Flow Measuring System

a. For flow measurement full bore electromagnetic flow measuring system shall be provided.

b. The full bore electromagnetic flow measuring system shall comprise of flow tube, flow transmitter cum computing unit, panel mounted digital flow indicator cum integrator and any other item required to complete the flow measurement system.

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c. To avoid the effects of disturbances in the velocity profile, a straight and uninterrupted run, upstream as well as downstream from the location of the flow tube shall be provided, as required by the flow meter manufacturer.

d. Flow Tube

i.	Type	:	In line full bore electromagnetic
ii.	Size of the flow tube	:	Same as pipe size
iii.	Material of internal lining of flow tube	:	Rubber / Neoprene / Polyurethane
iv.	Minimum flow	:	As per process requirement
v.	Maximum flow	:	As per process requirement
vi.	Maximum pressure	:	As per process requirement
vii.	Weather protection class	:	IP 68
viii.	Electrode material	:	SS 316
ix.	Coil housing	:	SS 304 / CS / Die cast aluminium
x.	Prefabricated integral cables for connecting flow tube to flow transmitter cum computing unit	:	Required
xi.	Process connection	:	Flanged

e. Flow Transmitter cum Computing Unit

i.	Type	:	Microprocessor based with facility to configure the flow meter
ii.	Type of display	:	Digital seven segment back-lit LCD/LCD display
iii.	Unit of display	:	Flow rate - m^3 / hr Totalised flow – ML
iv.	Input	:	From flow tube
v.	Output	:	4-20 mA DC (isolated) proportional to flow rate
vi.	Zero and span adjustment	:	Required

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vii.	Enclosure material	:	Die cast aluminium / non-corrosive
viii.	Enclosure protection class	:	IP 65
ix.	Battery backup for totalised flow	:	Required
x.	Facility for on line diagnosis	:	Required
xi.	Mounting	:	Separate from flow tube

f. Digital Flow Indicator cum Integrator

Refer specifications of digital flow indicator cum integrator elsewhere.

7.6. ULTRASONIC FLOW METER

7.6.1. Codes and Standard:

The Ultrasonic Flow meter shall be of non-contacting sensor type, suitable for measuring flow rate in open channel and of proven reliability, accuracy and repeatability requiring a minimum maintenance. The design and materials used for the components shall also comply with the relevant national.

7.6.2. Technical requirement

The Ultrasonic Flow meter and accessories shall be suitable for continuous operation under an ambient temperature of 10 to 50 °C and relative Humidity of 0-95% and suitable for measurement of flow in open channel.

All accessories required for mounting/erection of the instrument shall be furnished as necessary to completeness of the system.

7.6.3. Flow measurement

The Ultrasonic Flow Transmitter shall be based on transit-time flow measurement technique uses a pair of transducers with each transducer sending and receiving coded ultrasonic signals through the fluid. When the fluid is flowing, signal transit-time in the downstream direction is shorter than in the upstream direction; the difference between these transit times is

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proportional to the flow velocity. The Ultrasonic Flow Transmitter measures this time difference and uses programmed channel parameters to determine the flow rate and direction. Transmitters shall be non-wetted Clamp-on type.

7.6.4. Accessories

All mounting hardware clamping fixtures, mechanism to remove sensors on line, interconnecting cables etc complete. Weather canapy for protection from direct sunlight and diect rain shall also be supplied. Material of all fittings shall be SS-316.

7.6.5. Guarantee and Performance

The guarantee of flow measuring assembly shall be 18 months from the date of supply ot 12 months from the date of commissioning whichever is earlier.

7.7. Ultrasonic Level Measuring System

7.7.1. General

(i) The level transmitter shall be mounted in suitable weatherproof lockable pedestal enclosures near the level sensor.

(ii) Level monitoring devices (the level sensor equipment shall be secured to prevent interference by unauthorized personnel)

(iii) The necessary brackets secure the instruments to be mounted near sump and surge tank.

(iv) Ultrasonic type level measuring devices shall comprise of a transducer, a transmitter, remote level indicator and all other items required to complete the control system.

(v) The level sensor and the field-mounted transmitter shall be separate and interconnected by integral cable of sufficient length.

(vi) The transducer shall be suitable for flange or bracket mounting as required and shall be environmentally protected as per IP65. It shall have ambient temperature compensation and adjustable datum setting facilities.

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

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

(ix) The transmitter will be provided an isolated 4-20mA 2 wire o/p.

(x) To remove the effect of water turbulence in the system averaging facility should be provided in the transmitter unit.

7.8. Pressure Gauges

a. Pressure gauges shall comply with IS 3624. Where the gauge is subject to pressure pulsations and/or vibration, it shall be provided with either snubber or glycerin filled dial.

b. The minimum diameter for round pressure gauges shall be 150 mm unless specified otherwise or as per the equipment manufacturer's standard practice when the gauge forms part of the equipment.

c. Technical Requirements

i. Service :
- Raw water (diaphragm seal assembly with SS 316 diaphragm shall be provided)
- Waste wash water (diaphragm seal assembly with SS 316 diaphragm shall be provided)
- Alum dosing tanks (diaphragm seal assembly with SS 316 diaphragm shall be provided)
- Chlorine (diaphragm seal assembly with silver diaphragm shall be provided)
- Clear water

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			• Air
ii.	Range	:	As per process requirement
iii.	Accuracy	:	±1% of full scale
iv.	Dial size	:	150 mm
v.	Glass	:	Shatterproof
vi.	Over range protection	:	125% of maximum pressure
vii.	Housing material	:	Die cast aluminium
viii.	Material of sensor and other wetted parts	:	SS 316
ix.	Blow out disc	:	Required
x.	Process connection	:	As per process requirement
xi.	Material of dial	:	Aluminium with white back ground and black numerals
xii.	Accessories		• 3 way isolation valve • Impulse tubing, fittings • Snubber • All other installation hardware

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CHAPTER 8

8.1. Electrical Works

8.2. General

1.1 Approval by Sectional Committee: The equipment supplied along with its accessories shall be those approved for use in electrical installations by the Fire Sectional Committee of the Insurance Association of India.

1.2 Standardization: As far as possible, components to be utilized in the manufacture of equipment supplied under this Contract, standardization consistent with cost and other consideration shall be provided.

1.3 Compliance to Indian Electricity Rules: The equipment supplied as well as the installation work carried out shall comply in all respects with Indian Electricity Act and Indian Electricity Rules (1956) as amended up-to-date.

1.4 Codes and Regulations: The work shall be governed by this specification in conformity with relevant Indian Standard Codes and Regulations of latest editions, issued by the Bureau of Indian Standard.

1.5 Competency of Electrical Staff: Accepted norms of good workmanship shall be followed. The Works shall be done by qualified and trained staff having sufficient competency in electrical works and under the overall supervision of electrical Contractors licensed by the Government Department for such works.

1.6 Bid Proposal Drawings: Drawings attached to the tender documents are indicative only showing general scheme to be followed in the various sub heads.

1.7 Drawings After Award of Contract: to be submitted as described under Sub section – II of Employer's Requirement.

1.8 Safety Precautions: The Contractor shall take all reasonable safety precautions during construction and testing of the works. Particular attention shall be paid to the following:

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(a) Precaution shall be taken to prevent any conductor or apparatus becoming accidentally or inadvertently charged when persons are working there on.

(b) Prior to the electrical installation (or part thereof) being connected to the mains supply the Contractor shall ensure that all main switches on equipment are padlocked off.

(c) During testing and commissioning or any other time when live conductors may be temporarily exposed (e.g. panel doors open), the Contractor shall provide danger boards and warning signs to prevent any possibility of accidental electrical shock.

1.9 Statutory clearance: Before energizing the plant (or part thereof) the Contractor shall take clearance from the concerned Electrical Inspectorate Authority.

1.10 The scheme of electrical works described in the following specifications is tentative only. The Contractor is to ensure that he provides a most efficient, effective and economical electrical system. The various capacities/rating etc. given in these specifications are indicative only and shall be checked at Contractor's end to ensure that electrical system is suitable for efficient, smooth and trouble free operation of the Water Treatment Plant. Equipment / material conforming to ISO 9001 shall be preferred.

The design ambient air temperature for all equipment shall be considered as 50°C.

The percentage variation of voltage, frequency and combined voltage & frequency at all levels shall be considered as ± 10%, ± 5% and ±10% (absolute sum) respectively.

In designing of the equipment, 11 KV systems shall be considered effectively earthed and 415 V system solidly earthed.

For any other voltage required for equipment other than 415/240 V, suitable transformation unit shall be provided by the Contractor to achieve the required voltage.

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8.3. Transformer

General: The intent of this specification is to define the general requirements for power transformers.

Standards: The transformers shall comply with the latest edition of the following and other relevant Indian Standards

IS : 335	:	Insulating oil
IS : 1271	:	Classification of Insulating Materials
IS : 2026 (part I)	:	Power Transformers - General
IS : 2026 (part II)	:	Power Transformers - Temperature Rise
IS : 2026 (part III)	:	Power Transformers - Insulation level and dielectric tests
IS : 2026 (part IV)	:	Power Transformers - Terminal marking, tapping and connection
IS : 2099	:	High voltage porcelain bushing
IS : 3639	:	Power Transformer fittings and accessories
IS : 6600	:	Guide for loading of Oil Immersed Transformers

8.4. Construction:

The transformer shall be outdoor oil immersed type. Transformer tank shall be welded sheet steel construction and provided with gasketed steel cover plates. Base shall be suitably reinforced to prevent any distortion during lifting. Base channels shall be provided with skids and pulling eyes to facilitate handling. All covers and seals shall be oil and air-tight and shall not be affected by mineral or synthetic oil action. The radiators shall be of fixed type. All fasteners and bolts etc., shall be galvanised or zinc passivated. All surfaces to be painted shall be thoroughly cleaned, de-scaled, made free from rust and given a priming coat of rust resisting paint followed by two finishing coats of approved shade, to withstand specified atmospheric conditions. Unless otherwise stated the tank together with filter pipes and other fittings shall be designed to withstand without permanent distortion:

a) Full vacuum of 760mm of Hg for filling of oil by vacuum.

b) Internal gas pressure of 0.35 kg/cm2by with oil at operating level.

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Terminals and Cable/Marshalling Box: Winding shall be brought out and terminated on bushings/ cable box as specified in the data sheet. Cable box shall be supplied with cable lugs and glands. The neutral of the star connected winding shall be brought out to a separate bushing terminal inside cable box. All doors, covers and plates shall be 600mm from floor level and provided with gland plate and cable glands as required. Top surface shall be sloped. An extra neutral bushing shall be provided for neutral grounding of transformer having a secondary voltage of 433 V. The neutral bushing shall be mounted before bifurcation of the neutral, on the tank side to facilitate leading the earth conductor down to the ground level.

Marshalling box shall be provided as required

Cooling: Type of cooling shall be oil natural air natural (ONAN)

Oil: Transformer shall be supplied with first filling of oil and extra 10% oil shall be supplied in non-returnable drums.

Accessories: Accessories as specified in the parameters shall be included in the scope of supply. Conservator shall be complete with oil filling plug and cap, oil drain valve, purging device and plain oil level gauge in addition to magnetic oil level gauge. Explosion vent shall be rotatable in all directions and provided with sight gauge and equalizer pipe connection. Bottom drain valve shall be of suitable diameter to drain off 90 % of the oil in ten minutes. Thermometer pocket shall be with mercury in glass thermometer (00 - 1200C).

Core and Winding: Transformer shall be double wound, core type with cold rolled grain oriented silicon steel laminations perfectly insulated and clamped to minimize vibration and noise. Care shall be taken to insulate core fastening bolts and to reduce losses and avoid hot points. The insulation structure for the case to bolts and case to clamp plates shall be such as to withstand a voltage of 2000V for one minute. The complete case and coil assembly shall be dried in vacuum and shall be immediately impregnated with oil after the drying process to ensure elimination of air and moisture from the insulation. All parts of magnetic circuit shall be bounded to earth system.

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Winding of transformer shall be of copper and shall be designed to withstand the 11 KV system dynamic and short circuit stresses.

Tapings and Control: These shall be on high voltage side and connected to off circuit tap changing gear as specified in data sheet. The tap changing arrangement shall change over taps on all the phases simultaneously. Under conditions of external short circuit, the tap changing equipment must be capable of carrying the same current as the windings. Off circuit tap changing gear shall have an external operating handle preferably mounted on the transformer side with locking arrangement and position indicator.

Noise: The audible sound level measured at 1 meter from the external surface of the transformer shall not exceed 80 dB(A).

Earthing: Transformer shall be provided with two main frame earthing terminal on opposite sides which shall be separate from the neutral terminal of star connected winding. Cable/Marshalling box etc. shall be provided with one earthing terminal in addition.

Performance Requirements: The performance requirements for the transformer shall be as follows:

- Transformer shall operate without injurious heating at the rated KVA at any voltage within + 10% of the rated voltage of particular tap.
- Transformer shall be designed for 110% continuous overloading capacity.
- Overloads shall be allowed within the conditions defined in the loading guide of the applicable Standards. Under these conditions, no limitations by terminal bushings, tap changers or other auxiliary equipment shall apply.
- The neutral terminal of windings with star connection shall be designed for the highest over-current that can flow through this winding.
- Every care shall be taken to ensure that the design and manufacture of the transformer shall be such as to reduce noise and vibration to the level obtained in good modern practice. The supplier shall ensure that the noise level shall not be more than 80dB(A).

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- For transformer with tappings, full power tappings shall be provided.

If the commissioning of the plant is likely to be delayed by the rejection of transformer, the Engineer reserves the right to accept the rejected transformer until the replacement of transformer is made available. Transporting the rejected and replacement of transformer as well as installation and commissioning of both transformers shall be at the Contractor's cost.

Inspection: Category A

8.5. Power Capacitors

General: Power capacitor banks of suitable KVAR rating shall be provided across the main bus bar of PMCC with Automatic Power Factor Correction Relay (APFC) for maintaining the power factor of the installation at not less than 0.98 lagging. Contractor shall submit detailed calculations for arriving at the correct KVAR rating.

Standards: Unless otherwise specified, the units shall conform to the following Indian Standards:

IS: 2834	:	Specification for Shunt Capacitors for Power Systems
IS: 5553 (Part II)	:	Shunt Reactors

st certificates for similar capacitor units shall be furnished.

Inspection: Category A

8.6. High voltage distribution switchboards

High voltage switchboards for new transformers shall have rated voltage of 33kV and equipped with 3 phase vacuum circuit breakers (VCBs), and ancillaries in accordance with the single line diagrams. It may be noted that at RWPS, indoor VCBs are withdrawable where as at WTP; VCBs are outdoor type non withdrawable (Refer SLD) The switchboard shall comply with the following requirements and the requirements of the site specific details:

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- Protection shall be provided by a self powered microprocessor based numerical type relays as detailed on the single line diagram;

- Control functions shall be centralized on the module front;

- Bus bars shall be insulated;

- In addition to the interlocks identified in the specific requirements for each site. Alternative interlocking arrangements, which are standard to a particular switchgear manufacturer, shall be submitted to the Engineer for approval;

- Indicator lights shall be provided to indicate voltage presence;

- Anti-condensation heaters and panel illumination lamp shall be provided;

- Voltage-free changeover type contacts shall be provided for remote indications as follows:-

  - Circuit breaker open/closed;
  - Circuit-breaker tripped on fault;
  - Auto position.

- The contacts shall be wired to a common marshalling box. The outputs shall be wired to the ICA compartment of the switchboard/motor control centre.

8.7. High-voltage circuit breakers

High-voltage circuit breakers shall be of the as specified, complying with IEC 62271-100:2003.

Circuit breakers shall be of the withdrawable/non-withdrawable, vertical or horizontal isolation type. Circuit breaker trucks shall be of rigid fabricated sheet steel construction.

Circuit breaker carriage racking/withdrawal facilities and operating positions shall be

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fully labelled and interlocked to ensure correct and safe operation. Busbar and circuit isolating spout safety shutters shall be labelled and colour coded to the approval of the Engineer.

Unless otherwise specified, circuit breakers of the same rating shall be interchangeable.

The operation of vacuum circuit breakers shall not give rise to over-voltages harmful to insulation when switching inductive loads such as motors, transformers and capacitors.

Vacuum circuit breakers shall be fitted with surge suppressor.

Circuit-breaker operating mechanisms shall be of the independent manual or power-operated spring-charged stored-energy type as specified.

For power-operated mechanisms, the recharging of the closing spring shall be automatically initiated after discharge. All limit switches for automatic control shall be an integral part of the mechanism.

Power-operated mechanisms shall be provided with the facility for manually charging the closing spring.

Spring release shall not be possible unless it is fully charged and the means for charging has been removed or disconnected.

Unless otherwise specified, power operated closing mechanisms shall be fitted with a manual release with means for locking.

Vibration and mechanical shock shall not release the closing mechanism spring.

All mechanisms shall have mechanical 'on', 'off', 'spring charged' and 'spring discharged' indicators, manual and electrical trip facilities, and voltage-free contacts wired to terminals for external 'spring charged' and 'spring discharged' indication. The manual trip facility shall have means for locking.

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Circuit-breaker operating mechanisms shall be trip-free to prevent the contacts being held closed under overload or short-circuit conditions.

Circuit-breaker auxiliary switches shall comply with the requirements of BS EN 60947-5-1:1998 Class 1. They shall be readily accessible and enclosed in a transparent plastic cover. A minimum of four spare auxiliary switches, two normally-open and two normally-closed shall be provided.

Circuit breakers shall be provided with interlocks as per BS EN 60298:1996.

Where mechanical key interlocking is fitted, circuit-breaker tripping shall not occur if an attempt is made to remove a trapped key from the mechanism.

Spring-charging motor, electrical closing release coil and trip-release coil voltages shall be as specified.

8.8. LT Switch Boards and Control Cabinets

General

The control philosophy for Water Treatment Plant operation shall be as follows:

- Water Pumps and Booster Pumps shall be controlled either locally through local push button station or from PMCC.
- Clarifier scrapper drives and re-circulation pumps shall be controlled either from PMCC or from remote local control panel on clarifier.
- Air blowers shall be controlled from PMCC, all filter consoles and also from local push button station.

Necessary selector switches shall be provided on PMCC and LT Panels with appropriate control circuits to achieve the above controls

8.9. 415 V Power cum Motor Control Centre (PMCC)

General: The PMCC shall be metal clad totally enclosed, rigid, floor mounted, air insulated, cubicle type for use on 415 V, 3 phase, 50 Hz system. The PMCC shall be single front, non-draw out type compartmentalized. Each vertical panel of PMCC

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shall consist of several compartments. The equipment shall be designed for operation in high ambient temperatures and high humidity tropical atmospheric conditions. The equipment shall be for indoor installation.

10% spare feeders with minimum one (1) no. of each type and rating shall be provided in PMCC, complete in all respects.

Standards: The equipment shall be designed to conform to the requirements of:

IS : 8623 and IEC : 439	Factory built assemblies of switch gear and control gear.
IS : 4237	General Requirements for switch gear and control gear not exceeding 1000 volts
IS : 2147	Degrees of protection provided by enclosures for low voltage switch gear and control gear
IS : 375	Marking and arrangement of bus bars
IS : 2959	AC conductors of Voltage not exceeding 1000 volts
IS : 4064 (part II)	Air break switches and fuse combination units for voltage not exceeding 1000 volts
IS : 694 and IS : 8130	PVC insulated cables and aluminium conductors
IS : 1248	Direct action electrical indicating instruments
IS : 9224	Low voltage fuses
IS : 2516	Alternating current circuit breakers
IS : 2705	Current transformers
IS : 3156	Voltage transformers

8.10. Moulded Case Circuit Breaker (MCCB)

MCCBs shall be of the air break, quick make, quick break and trip free type and shall be totally enclosed in a heat resistant, moulded, insulating material housing.

MCCBs shall have an ultimate short circuit capacity not less than the prospective short circuit current at the point of installation.

MCCBs shall have a service short circuit breaking capacity equal to the ultimate short-circuit capacity.

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Each pole of MCCB shall be fitted with a bi-metallic thermal element for inverse time delay protection and a magnetic element for short circuit protection. Alternatively, they shall be fitted with a solid state protection system. Such a protection system shall be fully self-contained, needing no separate power supply to operate the circuit breaker tripping mechanism. Thermal element shall be adjustable. Adjustments shall be made simultaneously on all poles from a common facility. Thermal elements shall be ambient temperature compensated.

The MCCBs shall be provided with the following features.

- Common trip bar for simultaneous tripping of all poles
- Shrouded terminals
- Time for clearing short circuit current of 20 sec.
- 2 NO + 2 NC auxiliary contacts
-

8.11. Miniature Circuit Breaker (MCB)

MCB shall be hand operated, air break, quick make, quick break type.

Operating mechanisms shall be mechanically trip-free from the operating knob to prevent the contacts being held closed under overload or short-circuit conditions. Each pole shall be fitted with a bi-metallic element for overload protection and a magnetic element for short-circuit protection. Multiple pole MCBs shall be mechanically linked such that tripping of one pole simultaneously trips all the other poles. The magnetic element tripping current classification shall be of the type suitable for the connected load. Where this is not specified, it shall be Type C.

The short circuit rating shall be not less than that of the system to which they are connected.

8.12. Starters

i. 1. D.O.L. STARTER shall conform to IS 13947 and IEC 947 and shall be suitable for motor offered for operation in AC / 3 Phase / 50 HZ ± 5%/ 415V ±10% Supply/ with the following components.

ii. Under voltage release with no volt coil – 1 set.

iii. Over load relay.

iv. Push button switches.

v. Mounted on Ammeter.

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vi. Air Break contactors suitable for next standard higher KW rating.

vii. Single phasing preventor.

viii. Dry running preventor (If it is for submersible pumpset).

2. FULLY AUTOMATIC AIR BREAK STAR DELTA STARTER shall conform to IS 13947 & IEC 947 and shall be suitable for operation in AC-3 Phase/50 HZ ± 5%/ 415 V ± 10% supply conforming to IS 13947 & IEC 947 with the following components suitable for the ---KW motor offered.

i) Star-Delta contacts with timer.

ii) Under voltage release with no volt coil.

iii) Air Break contacts suitable for next standard higher KW rating.

iv) Mounted on Ammeter.

v) Over load relay.

vi) Push button switches.

vii) Single phasing preventor.

viii) Dry running preventor (If it is for submersible pumpset)

3.FULLY AUTOMATIC AUTO TRANSFORMER STARTER shall conform to IS 8544 Part IV and shall be suitable for the motor offered, Floor mounting type air/Oil cooled auto transformer starter with tapings at 50%/65%/80% housed in robust steel chamber with arc and main contacts conforming to IS 8544 Part IV for operation in AC /3 Phase/ 50 HZ ± 5% / 415V ±10% Supply/ with the following components etc. complete.

i. Under voltage release with no volt coil..

ii. Over load relay with oil dash pot arrangements.

iii. Single phasing preventor.

iv. LED ON/OFF switches.

v. Mounted on Ammeter.

vi. Earth leakage relay.

vii. Contactor assembly suitable for next standard higher KW rating.

viii. incoming and outgoing cable entry provisions, transformer tank including

ix. first filling of oil etc.

4. FLUX COMPENSATED MAGNIFIED AMPLIFIER SOFT STARTER shall be suitable for squirrel cage induction motor shall be of Floor Mounted type FCMA air

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cooled and suitable for the motor offered for operation in AC -3 Phase/ 50 HZ ± 5% / 3.3 kV and 415V ±10% supply/ with the following components etc. complete.

1. The soft starter drive shall consist of the following
   I. Flux Compensated Magnetic Amplifier (FCMA) unit
   II. Surge Suppressor
   III. All the line and motor protection will be taken care by others in the main switching CB. Soft Starter shall have its own protection as follows
      a. Temperature Protection for FCMA unit
      b. Supervisory Protection
2. Soft Starter panel shall be provided with following Indicating, Metering & control devices
   i. Phase current indication with suitable ammeter & selector switch
   ii. Auxiliary relays as required
   iii. Audio – Visual alarms / fault indicators
   iv. Alarm acknowledge / reset/ test push buttons
   v. Provision for wiring external sequential/process interlock/signals for starting permissive / running permissive / tripping etc.
   vi. Terminals for remote control/feedback/ indication

3. Performance Requirements:
   i. The soft starter shall be designed for operation at design temperature of 50oC
4. Construction:
   i. Soft Starter panel shall be Industrial type (Non – hazardous), totally enclosed, dust and vermin proof, floor mounted, free standing cubicle type of construction confirming to the degree of protection (IP 4X) as per standard
   ii. The panel cubicle shall comprise rigidly structural frame enclosed completely by sheet steel of 14SWG (cold rolled) thickness, smooth finish, leveled and free from flaws. All doors and removable covers shall be provided with neoprene gasket all around to make the cubicle dust & vermin proof.
   iii. Panel shall be fitted with a label and serial number on the front & rear. All devices shall be provided with separate labels to indicate the function

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iv. Main equipment of the panel shall be accessible for maintenance from the front & rear.

5. Equipment specification:
   a. FCMA Current controller:
      i. The Medium Voltage Soft Starter for LT motor will be Flux Compensated Magnetic Amplifier (FCMA) type/harmonic Free Series Reactor and shall be installed on Line side of the LT motor
      ii. The Soft starter shall be designed for Supply Voltage Variation of ± 10% & Frequency variation +3 and -5 %.
      iii. The Flux Compensated Magnetic Amplifier (FCMA) shall be rated equivalent to the motor rated power and shall be capable of operating satisfactorily with the motor under various loading and starting condition of the motor over the entire operating range. Soft Starter rating shall not be less than rated KW of the motor.
      iv. The Flux Compensated Magnetic Amplifier (FCMA) shall work on the principle of unsaturated core in the working zone and shall not lead to generation of harmonics
      v. The Soft Starter starting duty shall be rated for at least 4 starts per hour equally spaced
   b. Measuring Instruments:
   c. Suitable measuring instrument shall be provided as per IS / IEC standards
   d. Control Wiring and terminals
      i. Feeders for control (DC) / Auxiliary supply shall be provided at one point of the panel. Terminals to receive AC/DC control and auxiliary power shall be provided in cubicle and the terminals shall be adequately rated
      ii. Adequate rated 2 poles MCB's shall be provided for each of the AC/DC control circuits.
      iii. All wires shall be bunched together and routed through wire ways inside cubicle.
      iv. Low watt consumption LED type indicating lamps shall be provided
   e. Earthing

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i. An earth bus having suitable cross section shall be provided and extended through the length of the panel. All equipment shall be connected to this earth bus.

ii. Hinged doors shall be earthed through flexible copper wire of adequate size

iii. Bolted joints, splices, taps etc. to the earth bus shall be with at least two bolts.

6. Accessories

a. Cooling:

i. Soft Starter panel shall be Air Natural Cooled.

ii. Plug point:

iii. A 230 V, 1 Phase, 50 HZ AC plug point shall be provided on the door of each soft starter with an ON-OFF switch.

b. Painting:

i. Oil grease, dirt and rust from the sheet shall be thoroughly cleaned and removed by sand blasting or acid cleaning.

ii. The under surface shall be prepared by applying a coat of phosphate paint and a coat of yellow zinc chromate primer

iii. After application of primer, two coats of finish epoxy paint shall be applied with each coat followed is stowing. Colour shade shall be RAL-7032 (Siemens grey).

iv. Panel shall be painted with anti-corrosive paint or powder coated

7. Inspection and testing:

a. Routine tests shall be carried out at works in presence of PHED staff as per relevant IS / IEC standards

b. Vendor shall furnish all test certificates for CTs, PTs, and Instruments etc to Employer for review.

c. Type Test certificates within last 5 years as per relevant clauses of IEC 62271-200(2003) should be submitted for similar rating soft starter.

i. Line contactors suitable for next standard higher KW rating.

ii. Over load relay.

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iii. Start/stop push button.

iv. Indicator lamps 6 Nos. LED ON/OFF type.

v. Instrument panel with frequency meter/Ammeter/Volt Meter.

Control/Selector Switches: All control/selector switches shall be flush mounted on module door and shall be rotary, stay put, maintained contact type with phosphor bronze contacts. Ammeter selector switches shall have make before break feature. The selector switches shall have four positions for reading three phase currents and fourth shall be 'OFF' position. The voltmeter selector switch shall have five position - three for the phase-to-phase voltage, the fourth for phase to neutral voltage and fifth shall be 'OFF' position. Remote /Local / Off selector switches for motor feeders shall be lockable in 'OFF' position. Properly designated escutcheon plates clearly marked to show the operating position shall be provided with all switches.

Current Transformers (CTs): Current transformers shall be cast resin wound primary or bar primary type and shall be able to withstand the thermal and mechanical stresses arising from the maximum short circuit and momentary duties of the equipment. The secondary rating of current transformers shall be 1A. The polarity markings shall be clearly marked on the CTs and the lead termination of the terminal block. The core laminations of the CTs shall be high-grade silicon steel. Magnetization characteristics, performance calculation and protection settings of the CTs shall be provided. The accuracy class for CTs shall be 1.0 and 5 P-20 for metering and protection purposes respectively. Where multi-ratio current transformers are provided, VA ratings of the current transformers shall be indicated; a label shall be provided, clearly indicating the connection required for alternative ratios. These connections shall also be shown on panel wiring diagrams. Identification labels shall be fitted giving type, ratio, output and serial numbers and duplicate rating labels shall be fitted on the exterior of the mounting chamber suitably located to enable reading without the removal of any cover or metal sheeting forming part of the structure of the switch board.

Indicating Lamps: Panel mounting type low power consumption LED type status indicating lamps suitable for specified voltage shall be used. Lamps shall be provided with suitable current limiting series resistors. Translucent lamp covers shall be provided to diffuse light.

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Push Buttons: Start/stop push buttons shall be suitable for panel mounting and comprise of a contact element and actuator. The contacts shall be of silver alloy of 10 A continuous current rating at 240V AC. Each push button shall be provided with 2 NO + 2 NC contacts. Colour of push buttons shall be as per relevant IS/standard code of practice. Emergency stop push buttons shall be lockable in operated position. Push button knob for emergency stop push buttons shall be shrouded to prevent accidental operation.

Space Heaters: Each individual cubicle shall be provided with space heaters to prevent moisture condensation and maintain cubicle temperature 50 C above the ambient. The space heaters shall be located at the bottom of the switchboard and shall be controlled through a thermostat with an adjustable setting and a manually operated switch. For space heater 6 A DP switch and two HRC fuses shall be provided. Each vertical panel shall also be provided with 6A plug socket & switch for hand lamp connection.

Contactor: Power contactors shall be air break type, having three power contacts and 2 NO + 2 NC auxiliary contacts conforming to IS: 2959. Contactors provided shall be AC3 duty type as per IS: 3947 part 4. It shall be capable of making and breaking starting current of motors of corresponding rating. Auxiliary contacts shall be rated for at least 6 A and shall be break before make type. Insulation class of coil shall be minimum class B. Contacts shall drop out at voltage down to 70% of rated coil voltage and pick up at 85% of rated coil voltage.

Fuses: All power and control fuses shall be of link type. Screw type 'DZ' fuses will not be acceptable. All fuse links shall be HRC cartridge type and shall generally conform to IS: 2208. Rewirable fuses will not be acceptable. Fuses shall be provided with visible indicators to indicate operation status. Current vs time characteristics of all types of fuses shall be furnished for approval of the Engineer. Fuses shall comply with the requirements of IS:9224, part 2. All fuses shall be readily accessible for replacement. It shall not be necessary to remove any piece of equipment or to disconnect wiring for replacing the fuses. Fuse carriers and solid link carriers and bases shall be made of plastic moulded insulating material of an approved make. Ceramic materials will not be accepted. Fuses and links functionally associated with the same circuit shall be mounted side by side.

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Switches: Switches shall be air break type as pre IS: 4047. The switch operating handle shall be front mounted and interlocked with the door such that the door cannot be opened when the switch in 'ON'. The live parts shall be shrouded with suitable insulating barriers so as to prevent accidental contact with the live parts after opening the module front door. Motor control switches shall be suitable for reliable and safe starting and stopping of 3 phase AC motors even under heavy starting locked rotor conditions. Switches shall be heavy duty, quick make and quick break type AC 3 duty. Switch contacts shall be silver plated and contact springs shall be of stainless steel. Switch handles shall have provision for locking in both open and closed positions. Mechanical ON-OFF indication shall be provided on the switches.

Indicating Meters: Ammeters and voltmeters shall be of moving iron industrial type grade of accuracy class 1.5. The size of the instrument shall be 144 mm sq. for starter and fuse switch compartments. Ammeter with suppressed scale current rating shall be provided for specific requirements. Indicating instruments shall be mounted flush on the module doors. Instrument dials shall be white with black numbers and lettering. Dials shall be parallax free. All indicating instruments shall have provision for zero adjustment outside motor cover. Normal maximum meter reading shall be of the order of 60% of normal full scale deflection. Watt-hour meters shall be of the induction type and shall be provided with reverse running stop. One no. power factor meter shall be provided for the incoming feeder of PMCC.

Internal Wiring: Internal wiring for control circuits shall be made with 650 V grade single or multistrand copper PVC wires. The minimum size of control wiring shall be 2.5 sq. mm copper for power & CT circuits and 1.5 sq. mm copper for other circuits. The wiring shall be terminated in the respective terminals with suitable crimp type sockets. There shall not be more than two wires connected to a terminal. Horizontal as well as vertical wire ways shall be provided. At the top, a horizontal wire way shall connect the inter panel wiring.

Internal wiring terminal blocks shall be of 650 V grade with contacts of rating not less than 10 amps. They shall be of the screw type with barriers between adjacent contacts.

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The wire termination to the terminal block shall be of the screw type suitable for crimp type sockets.

Power Cable Termination: Gland plates of adequate size & thickness shall be provided at the bottom of cable chamber to facilitate cable entry from bottom. Compression type gland shall be provided. Crimp type sockets made of tinned copper or aluminium shall be provided for terminating cables. Suitable shrouds shall be provided to prevent accidental contact with live outgoing terminations of other feeders while carrying out maintenance of one feeder. The individual cores of power and control cables shall be neatly dressed and supported at regular intervals inside the cable chamber, before connecting them to the relevant terminals. Termination kits for cable terminations shall be provided, as required.

Labels: Labels shall be anodised aluminium with white engraving on black background. They shall be properly secured with fasteners.

Control / Auxiliary Power Circuits: Control circuit voltage shall be 110 V AC achieved through suitably rated control transformer. Two (2) nos. control transformers, each 100% rated shall be provided with selector switch and control buses. Auxiliary power supply voltage shall be 240 V AC, tapped from before the switch-fuse unit of the incomer with isolating switch and fuses.

All wiring for control & auxiliary power circuits shall be colour coded as follows:

AC circuits	-	Red, Yellow or Blue determined by the phase with which the wire is associated.
AC phase wire	-	White
AC neutral	-	Black
DC circuits	-	Grey
Earth connections	-	Green

Engraved core identification ferrules, marked to correspond with the wiring diagram shall be fitted to each wire and each core of multi-core cables terminated on the panels. Ferrules shall fit tightly on the wires, without falling off when the wire is removed. Ferrules shall be of white colour with black lettering. All wires forming part of a tripping

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circuit shall be provided with an additional red ferrule marked 'T". Each wire shall be identified by a letter to denote its function followed by a number to denote its identity, at both ends. Unused cores of multi-core cables shall be ferruled U1, U2 etc., at both ends and connected to spare terminals. Spare auxiliary contacts of electrical equipment shall be wired to terminals blocks.

Control Wiring Terminal Blocks: Terminal blocks shall be of the 650 V grade, stud type of rating not less than 10A. Brass studs of at least 6 mm dia with fine threads shall be used and securely locked within the mounting base to prevent turning. Each terminal shall comprise two threaded studs, with a link between them, washers, matching nuts and locknuts for each stud. Insulated barriers shall be provided between adjacent terminals. Not more than two wires shall be connected on any one stud. Where duplication of terminal block is necessary, suitable solid bonding links shall be incorporated in the design of the terminal block. Provision shall be made to insert terminal labels or shrouds between two successive insulating barriers. Connections to the terminals shall be at the front. Terminals shall be numbered for identification and grouped according to function and engraved black-on-white labels shall be provided on the terminal blocks describing the function of the circuit. Terminals for circuits with voltage exceeding 125 V shall be shrouded. Terminal blocks at different voltages shall be segregated into groups and distinctively labeled. Current transformer secondary leads shall be brought to terminal blocks, where a facility shall be provided for short circuiting and grounding the secondary. Terminal blocks shall be arranged with at least 100 mm clearance between any two sets. Separate terminal stems shall be provided for internal and external wiring respectively. All wiring shall be terminated on terminal blocks, using crimping type lugs or claw type terminations. 20% spare terminals shall be provided in each terminal block.

Test Terminal Blocks: Test terminal blocks shall be provided for secondary injection and testing of relay equipment. A suitable metering block shall be provided for the connection of a portable precision instrument to be operated when required, for specific plant testing purposes.

The terminal blocks shall be provided with suitable shorting links or alternatively shall be of the type suitable for use with a portable test plug-in arrangement.

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Earthing of Switchgear / Distribution boards: Each switchgear / Distribution board shall be provided with an earth bus running along its entire length. The earth bus shall be located at the bottom of the board / panel.

Earth bus shall be of copper. Earth bus shall be adequately sized to carry the rated symmetrical short circuit current of the associated board / panel for one second. Earth bus shall be supported to withstand stresses generated by the short circuits & momentary current of the associated switchgear / distribution boards.

Positive connections of all non-current carrying metallic parts and the frames of equipment mounted in the switchgear / distribution board to the earth bus shall be maintained through insulated conductors of adequate size. Earthing of draw out equipment frames shall be achieved through a separate plug-in contact.

All instrument and relay cases shall be connected to earth bus by means of 650 V grade, PVC insulated, stranded, and tinned copper, 2.5 sq.mm conductor, looped through the earth terminals of the case.

The scope of work will also include the rubber mat required to be spread in front of all the panels. The mat shall have a thickness of 12.5mm and shall have dielectric strength suitable for the panel voltage ratings.

8.13. Sub-Distribution Boards

Technical features, constructional details and components for 415 V sub-distribution boards e.g. Main Lighting Distribution Board (MLDB), LT Panels for clarifiers & chemical house and Filter Consoles shall be similar to Filter House PMCC. However, LT Panels for clarifiers shall be outdoor type with double enclosure and canopy on top. The clarifier equipment shall be operable after opening of the door of 1st enclosure.

Each of the Filter Consoles as described under Instrumentation Section shall comprise of the following additional equipment:

- 16 A switch-fuse for incoming power supply with power supply "ON" indicating lamp

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- Open/close indicating lamps for individual valves
- Start/stop push buttons with on/off indicating lamps for air blower's remote operation.
- Wash water flow indicator.

The locations of above sub-distribution boards shall be as follows:

MLDB	:	MCC Room
LT Panel for clarifier	:	Clarifier superstructure
LT Panel for chemical house	:	Chemical house building
Filter Consoles	:	Operating platform for filters

Sub Lighting Distribution Board (SLDB) shall be suitably rated 415 V, 3 phase, 4 wire 50 Hz (10 KA for one sec) wall mounted type MCBDB with incoming Residual Current Circuit Breaker and outgoing SPN MCBs as per enclosed electrical single line diagram.

Inspection: Category B

8.14. Motors

Materials, workmanship and standard: All the materials used in the manufacture of motors shall be of high grade, free from defects and imperfection. The motors shall be built to conform to the Indian Standard Specification as listed below along with other relevant codes.

IS : 325	:	Induction Motors
IS : 1231	:	Dimensions of 3 phase foot mounted induction motors
IS : 4691	:	Degrees of protection provided by enclosure for rotating electrical machinery.
IS : 4729	:	Measurement and Evaluation of vibration of rotating electrical machines.
IS : 6362	:	Methods of cooling of rotating electrical machines

Workmanship shall be first class and all work shall be done by workmen, skilled in their trades. Machining of fits and finish shall conform to the best modern shop practice.

Type: Squirrel cage, horizontal shaft mounting, induction motor suitable for Sewage Treatment Plant environment shall be offered. The motors for indoor duty shall be TEFC with IP-44 protection. Motors for outdoor duty shall be TEFC with IP-55 protection.

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Insulation: Motors shall be provided with class F insulation with temperature rise limited to class B insulation. The insulation shall be given tropical and fungicidal treatment for successful operation of motor in hot, humid and tropical climate as per applicable standard. For motors for outdoor duty, account shall be taken of heating due to direct solar radiation.

Speed: Speed shall not be more than 1500 RPM. The manufacturer shall furnish the recommended standard and the economical speed.

Cooling: Motors shall be cooled by self ventilation only.

Bearings: Motors shall preferably have grease lubricated ball or roller bearings. The bearings shall be adequate to absorb thrust produced by the motor and driven equipment assembly. Bearings shall be lubricated by grease injection from outside, in motor running condition without removal of bearing covers. Labyrinth seal shall be provided to prevent loss of grease and to protect entry of dust.
In case of oil lubricated bearings, a drain plug and oil level sight glass shall be provided.

Terminal Box: Terminal box of the motor shall be suitable for top and bottom entry of cables and capable of being rotated through 3600 in step of 900. The box shall be of weather proof construction with gasketted joints and complete with stud type terminals, plain washer, spring washer, check nuts, cable glands and lugs. The terminal box shall have sufficient space for installation of termination kit. Separate terminal box shall be provided for space heater etc.

Overloads: The motor shall have the standard short time overload capacity permitted by the applicable standard. The motor rating shall be at least 15 % over the BHP required by pump / equipment at duty point or 10 % above the maximum HP required by the pump / equipment in its entire operating range, whichever is higher.

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Variation withstand capacity: The motor shall be capable of producing rated output without reduction in life span when operated under either of the following variations in supply conditions:

- Variation of supply voltage from rated value + 10%
- Variation of supply frequency from rated value + 5%
- Combined Voltage and frequency variation 10% (absolute sum)

The motor shall be capable of starting and accelerating the driven equipment with applicable method of starting without exceeding the temperature rise limit at 85% of rated voltage at motor terminals.

Noise and Vibration: The motor shall be designed to operate with least noise and vibration. Special precaution shall be taken for smooth running of the motor. The noise level must be within the limit of international standards.

Shaft: The rotor shaft shall be forged to shape from open hearth carbon or alloy steel and heat treated to obtain high rigidity. The shaft shall be designed to rotate without vibration and distortion at 25 % over the rated speed and shall have ample strength and stiffness to resist twisting on short circuit. The normal speed and the critical speed of the shaft shall be stated.

Fans: For TEFC motors axial flow fans shall be mounted on rotor shaft for efficient circulation of air. Fans shall be of corrosion resistant die cast Aluminium or Polypropylene. They shall be suitable for rotation in either direction without affecting motor performance.

Lubrication System: The bearing shall be equipped with all accessories and devices for lubricating the bearings while the motor is in service. Oil cooling/grease cooling arrangement shall be provided.

Number of Starts: The motor shall be designed to allow the required number of consecutive starts for the application envisaged with at least 1 hot restart.

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Space Heater: All outdoor motors and indoor motors rated 30 KW & above shall be provided with space heater.

Balancing: All rotating parts of the motor shall be balanced both statically and dynamically so as to run perfectly, smoothly vibration-free. Site balancing of the motor and driven equipment shall also be done during trial running before commissioning.

Earthing: Two earth terminals shall be provided for the motors on base. One separate earth terminal shall be provided inside the terminal box.

Painting: External parts shall be finished and painted to produce a neat and durable surface which will prevent rusting and corrosion. The surface shall be degreased and all rust, scales, sharp edges removed and treated with red oxide primer and two coats of finish paint as per shade 632 of IS:5.

Tests: The following routine tests in accordance with IS: 325 of latest edition, shall be performed in presence of the Engineer.

- Insulation resistance test
- Measurement of no load current and speed at rated voltage and rated frequency.
- Measurement of locked rotor current at reduced voltage or rated voltage and at rated frequency
- High voltage test
- Reduced voltage running up test at no load to check the ability of motor to run upto full speed at no load in both the directions of rotation with one third of rated line voltage applied to stator terminals.
- Test for measuring noise level of the motor at the works and at the site.

  The following additional test shall be performed to verify the performance, characteristics and guarantees. They shall be in accordance with IS: 325 of latest edition.
- Measurement of stator resistance.
- Temperature rise test
- Momentary overload in torque test

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- High voltage test
- Over speed test

Each type and rating of the motors should have been type tested in accordance with IS: 325. In absence of type test certificates, type tests shall be carried out without any extra cost to the Employer.

Inspection: Category A

8.15. Power and Control Cables

HT Cable

Cable of 11 KV/6.35 KV(E) grade shall be armoured & conform to IS:7098(Part II). The size of the cable shall be suitable for adequate electrical loading with multi-stranded, compacted, circular shaped, aluminium conductors. The conductor screen and insulation screen shall both be of extruded semi-conducting compound and shall be applied along with the XLPE insulation in a single operation of triple extrusion so as to obtain continuously smooth interfaces. The metallic screen of each core shall consist of copper tape with minimum overlap of 20%. The manufacturer shall suitably design the semiconducting screen and shall clearly indicate the thickness and resistively of screen for both conductor and insulation. The thickness of this screen and resistivity shall be as per requirements of relevant IS. The eccentricity of the cores shall not exceed 10% and ovality more than 2%. Method of curing for cable shall be dry curing / gas curing/ steam curing.

XLPE insulation shall be suitable for a continuous conductor temperature of 900C and short circuit conductor temperature of 2500C. The cable shall have distinct extruded PVC inner sheaths and out sheaths of black colour as per IS:5381. The armouring shall be of galvanised steel as per relevant IS.

LT Cable

Cables for low & medium voltage and industrial heavy duty application, shall be multi-core PVC insulated PVC sheathed and armoured of voltage grade 1100 V conforming to IS: 1554 part I. Conductor shall be stranded Aluminium/Copper for power cables and stranded Copper of size 2.5 mm^2 for control cables. Cable for internal wiring purpose in conduits shall be single core stranded copper conductor,

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PVC insulated conforming to IS: 694. All cables shall be delivered to site as complete coils with wrapping in non-returnable drums and seals intact, accompanied by manufacturers test certificate and indicating the date of test. The length of cable on each drum shall be determined by the manufacturer considering the transport limitations from works to site. The Contractor shall obtain Employer's approval for the drum length before packing cables on drums. No joints shall be allowed unless the actual length required is more than a drum length.

8.16. Wiring for Illumination System

General: Wiring shall include switches, small power receptacles, lighting distribution boards, complete with junction boxes, pull boxes, terminal blocks, glands, conduits & accessories and supporting & anchoring materials. All materials, fittings and appliances used in the installation shall conform to the relevant IS specification and shall be suitable for application in Sewage treatment plant areas.

Type: Wiring is to be done in the looping system without any jointing. Phase wires shall be looped in switch control points and neutral shall be looped at outlet points. For recess conduit system MS conduit and for surface conduit system GI conduit shall be used. Recess conduit system shall be used in office, laboratory, control room etc.

Point wiring: Point wiring shall include all works necessary to complete wiring of a switch circuit of any length from the tapping point on the distribution circuit to the following via switch with

- Ceiling rose and connector: for ceiling / exhaust fan points
- Back plate: for fluorescent fittings with down rods etc.,
- Socket outlet: for socket outlet points
- Lamp holder: for wall brackets, bulk head and similar fittings.

The following shall be included in point wiring:

- Switch board
- Ceiling rose or connectors as required
- Any special or suitable round block for neatly housing the connector and covering the fan hook in case of fan point.

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- Wooden box, bushed conduit, porcelain tubing where cable passes through wall etc.,
- Metallic covering on conduit upto 1.5 m from floor.
- Earth wire from six pin socket outlet point/fan regulator/fixture to common conduit earth wire system.
- All wood or metal blocks, boards and boxes, sunk or surface type for mounting fan regulator etc.
- All fixing accessories such as clips, rails, screws, pin plugs, wooden plugs etc., as required.
- Connection to ceiling rose, connectors, socket outlet, lamp holders, switch and fan regulator etc.,
- Looping the same switch board and inter connections between points on the same circuit
- Providing fish wire in conduits for recessed conduit works.

Load on Circuit: Lighting circuits and small power circuits for sockets, exhaust fans/axial flow fans shall be separate. Each circuit shall not be loaded more than 60% of MCB rating. It shall, however, be ensured that in one switchboard, wiring of one circuit is only provided.

Size of Conductor: The smallest copper conductor to be used for lighting circuits shall be 1.5 mm2 and for power circuits 2.5 mm2. Neutral conductor and earth continuity wire shall be brought to each switchboard situated in rooms and halls. These shall be terminated inside the switchboards with suitable connectors. The switchboard shall be of adequate size to accommodate one number 5 amps socket outlet and required nos. of piano key type control switches with spares for future use.

Conduit capacity: PVC insulated cables conforming to IS: 694 - 1977 drawn in one conduit shall not occupy more than 60% of conduit capacity.

Rigid Steel Surface Conduit: Rigid conduits shall be solid drawn on ERW, finished with galvanised surface. No conduit less than 16 SWG for 32 mm diameter and below and 14 SWG for above 32 mm diameter shall be used. Minimum diameter of steel

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conduit shall be 20 mm. The conduit wiring shall be complete in all respect including accessories. Conduit shall conform to IS: 9537. Conduit pipes shall be joined by means of screwed couplers and screwed accessories only. In long distance straight run of conduit, inspection type couplers at reasonable intervals or as directed by the Engineer for easy maintenance, shall be provided. Thread of all conduits shall be between 13 mm to 19 mm long, sufficient to accommodate pipes to full threaded portion of coupler accessories.

The layout of conduit shall be such that any condensation or sweating inside the conduit is drained out. Suitable precautions shall be taken to prevent entry of insects inside the conduits.

The outer surface of conduit including all accessories forming part of conduit system shall be protected against rust when such system is exposed to weather by being painted with two coats of oxide paint, before they are installed. After installation, all accessible surfaces of conduit, pipes, fittings, etc., shall be painted with approved finish colour.

Suitable junction inspection boxes according to requirements shall be provided to permit periodical inspection and to facilitate replacement of wires. If necessary, the boxes shall be mounted flush with the wall of ceiling. Minimum 65 mm depth junction boxes shall be used in roof slabs and depth of boxes in other places shall be as per IS: 2667 - 1977.

Rigid Steel Recessed Conduit: In this system of wiring, no bare or twist joints shall be made in through run of cables. If the length of final circuit / sub-main is more than the length of the standard coil, joints shall be made by means of approved mechanical connectors in suitable and approved junction boxes.

The chase in the wall shall be neatly made and in ample dimensions to permit the conduit to be fixed in the manner desired. In case of buildings under construction, conduits shall be buried in the wall before plastering. These shall be grouted and covered with 1:4 cement and mortar, neatly finished at the plane of the un-plastered brick work and cured. Under no circumstances finished plastered surfaces shall be

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allowed to be chased for the conduit work. The horizontal chase shall be avoided as far as possible. In case of exposed brick / rubble masonry work, special care shall be taken to fix the conduit and accessories in position along with the building work.
MS Conduit pipes shall be fixed by heavy gauge saddles secured to suitable wood plug or other approved manner at an interval of not more than one meter but on both ends of couplers or bends or similar fittings. Saddles shall be fixed at a distance of 30 cm from the centre of such fittings. The saddles shall not be less than 20 gauge for larger diameter of conduits.

All conduits after erection shall be tested for electrical continuity.

Fixing of standard bends or elbows in roof slab shall be avoided and all curves shall be maintained by bending the conduit itself with a long radius which will permit easy drawing of wires.
Suitable junction / inspection boxes according to requirement shall be provided to permit periodical inspections and to facilitate replacement of wires. Such boxes shall be located and arranged suitably so that they are not in irregular positions. These locations shall also be specifically shown in the conduit layout of the shop drawings and approval shall be obtained before installation. However, number of such boxes shall be minimized. The boxes shall be mounted flush with the wall or ceiling.
Minimum 65 mm depth junction boxes shall be mounted flush with the wall or ceiling and depth of boxes in other places shall be as per IS: 2667 - 1977.

All outlets such as switches, wall sockets, etc., shall be flush mounting type.
Inspection: Category C

8.17. Earthing and Lightning Protection System

8.17.1. Earthing

General: Earthing system for the plant shall be carried out in compliance with the requirements of IS:3043 and the following specifications:

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Pipe Electrode: GI pipe electrodes shall be of medium class, 40 mm dia and 3 m in length. Galvanizing of the pipe shall conform to relevant Indian Standard. GI pipe electrodes shall be tapered at the bottom and provided with holes of 12 mm dia drilled not less than 75 cm from each other and upto 3 m height from bottom. The electrode shall be buried in the ground vertically with the top not less than 200 mm below ground level.

Plate Earth Electrode: For plate electrodes, minimum dimensions of the electrode shall be 600 mm x 600 mm x 6 mm thick. Heavy duty CI/MS frame with cover shall be suitably embedded in the masonry enclosure.

Location: Normally earth electrodes shall not be situated less than 2 m from any building. Minimum two (2) nos. of earth electrodes shall be provided for each building. Care shall be taken that the excavation for earth electrodes may not affect the column footing or foundation of the building. The location of the earth electrode shall be such that the soil has reasonable chances of remaining moist, as far as possible. Entrances, pavement and roadways shall be avoided for locating the earth electrodes.

Earthing Lead Connection: In case of plate earth electrodes, the earthing lead shall be securely bolted to the plate with two bolts, nuts, check-nuts and washers. In the case of the of pipe electrodes, they shall be connected by means of bolt, nuts, washers and cable socket. All connecting materials shall be of GI construction. The earthing lead will be securely connected at the other end of above ground main earthing grid.

Equipment Earthing Connection: Each transformer body and neutral, GOS & lightning arrestor shall be connected to separate earth electrodes by two separate distinct earth lids. LT motors, switchgear, distribution boards and other electrical equipment shall be earthed at two separate points and connected to earth electrodes through above ground main earthing grid (65 x 10 mm GI Flat) and 65 x 10 mm GI flat risers (from earth electrodes to above ground main earthing grid).

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Size of Earthing Conductor: The earth strips shall be of galvanised steel and shall be of the following sizes:

Main earthing grid	:	65 mm x 10 mm
LT Switchgears / Switchboards / Capacitor Panels	:	50 mm x 6 mm
Motors, Lighting Distribution Boards	:	25 mm x 6 mm
Junction Boxes, lighting fixtures, PB stations, small motors, exhaust fans etc.	:	12 SWG

The earthing system shall be designed in such a way that overall earth resistance is less than one ohm. The soil resistivity shall be measured at site by the Contractor. If required, number of earth electrodes to be increased by the Contractor to achieve the required earth resistance.

Earthing Pit: Earthing pit shall be of minimum 1200 mm x 1200 mm. An inspection chamber of size 300 mm x 300 mm x 300 mm in cement concrete of 1:3:6, 50 mm thick for side walls and 100 mm thick for bottom, shall be **provided**. The chamber shall be provided with CI cover on MS frame. The cover shall be hinged to the frame and shall be with padlocking arrangement. The frame and cover shall be painted with anticorrosive paint.

Testing: The Engineer may ask the Contractor to carry out earth continuity tests, earth resistance measurements and other tests in his presence. The Contractor shall have to bear the cost of all such tests.

8.18. Lightning Protection

For tall structures & buildings, lightning protection system shall be provided as per relevant IS with horizontal & vertical air terminations, down conductors with test links and separate earth electrodes.

Inspection: Category C

8.19. Trial Run

General

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Prior to the commencement of Trial Run the Contractor shall submit for approval the following:

- Dry test reports for all equipment
- As-Built Drawings;
- Operation and Maintenance Manuals.

Trial shall not be commenced until the aforementioned documents are approved.

8.20. Dry Test Requirements

General

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

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

8.21. Civil and Building Works

As a minimum requirement presence of foreign bodies in pipe work and structures shall be checked.

8.22. Mechanical Works

As a minimum requirement preliminary running checks shall be carried out on all the mechanical works as far as permitted by circumstances in order to ensure smooth operation of Plant.

8.23. Electrical Works

The following commissioning tests are to be carried out on all the equipment/systems, as applicable.

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- Insulation resistance measurement of equipment, accessories, cabling/wiring etc.
- Dielectric tests on equipment, accessories, cabling/ wires etc.
- Phase sequence and polarity
- Voltage and current ratios
- Vector group
- Resistance measurement of winding, contacts etc.
- Continuity tests
- Calibration of indicators, meters, relays, etc.
- Control and interlock checks
- Settings of equipment and accessories
- Checking of accuracy/error
- Checking of operating characteristics, pick-up voltages and currents, etc.
- Operational and functional tests on equipment, accessories, control schemes, alarm/trip/indication circuits, etc.
- Measurement of guaranteed/approved design values including lighting levels, earth resistance measurement, etc.
- Complete commissioning checks of the system

8.24. Instrumentation & Control System

The following dry tests shall be carried out on the instrumentation & control system:

- Continuity check on all signal/ control/ power supply cables.
- Check instrument loop integrity, functionality and calibration; A written report on each instrument in the format required by the Engineer/ Purchaser shall be provided certifying that the instruments have been calibrated to published specified accuracy.
- Check functionality of the instrument control panels/ consoles.

8.25. General

On successful completion of Dry Test the Contractor shall carry out trial run for the entire plant for **three** months. The contractor shall make all the necessary arrangements so that plant operation is continuous and uninterrupted. These tests shall be used to prove the operation of the Works at varying flows and with varying water

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quality. Each part of the Works shall be considered separately as far as the tests are concerned.

During the tests the Contractor shall take samples to demonstrate that each part of the Works is performing in accordance with the Employer's Requirements. Samples shall be taken at locations and intervals. The results of the Trial Run shall be compared and evaluated by the Employer and Contractor.

The Contractor shall be required reasonably to co-operate and co-ordinate his activities with those of the Employer and other contractors.

The Contractor shall provide all facilities and equipment not supplied under the contract and which are deemed necessary to carry out and monitor the Trial Run.

8.26. Criteria for Passing Trial Run

Treated water Criteria

The Works shall be considered to have passed the performance trial run only if the results comply with the criteria set out below in Table

8.27. Performance Run

The electricity power cost as related to the normal operation and maintenance of the Works for 3 months shall be borne by the Employer However, the electricity power being used by the Contractor to carry out any outstanding pre-commissioning tests, final commissioning tests or to repeat these tests as a result of failure during the "Test on Completion of the Works", shall be borne by the Contractor.

During the performance run, the Contractor will train the personnel appointed by the Corporation for day to day operation and maintenance of the scheme .

Unless otherwise stated in the Conditions of Particular Applications, monthly progress reports shall be prepared by the Contractor and submitted to the Engineer in six copies. The first report shall cover the period up to the end of the first calendar

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month following the commencement date. Reports shall be submitted monthly thereafter, each within 7 days after the last day of the period to which it relates. Reporting shall continue until the Contractor has completed all works of the Works, which are known to be minor outstanding at the completion dates stated in the Taking-Over Certificate for the Works.

8.28. Each report of the Works shall include:

a) Photographs showing status of each equipment, plant, civil structures at all sites of the Works;

b) Logs of all alarms, events, trends that can be obtained to show the operational status of the Works;

c) Logs to show the maintenance record to all equipment;

d) Logs to show the replacements of damage and defective components of each equipment or the whole equipment of a Plant;

e) Comparisons between the recommendations from the Operation and Maintenance Manual with the actual maintenance, defective parts replacement records as described in (c) and (d) above.

8.29. Plant Reliability Criteria

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

- a single item of Plant fails more than twice during the test;
- more than four individual Plant items fail during test.

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

8.30. Performance Certificate

The conditions for issuance of a Performance Certificate as detailed in the Conditions of Contract shall inter alia comprise:

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- The completion of trial run and performance run of the Works to the satisfaction of the Engineer in charge;
- The O & M Manuals have been updated following three months operational experience and get approved by the engineer in charge;
- All defects identified prior to identified during the trial run and performance run of the Works have been rectified;
- All training detailed in the Employer's Requirements has been completed.
-

8.31. Operation Manual and As-Built Drawings

The submission of the as-built drawings and the operation manual for the system is the precondition for the final payment.

8.32. Operation manual

The Contractor has to submit an operation manual after the physical completion of the Work. This manual will be submitted as draft at the date of physical completion and as final version 1(one) month after commissioning, including all the experiences made during the tests and the training given to the operators during the commissioning period. This manual will be established by the Contractor in cooperation with his suppliers and subcontractors and after consultation with the Employer's Representative.

8.33. As-Built Drawings

The Contractor shall submit to the Engineer within two months of actual completion, "Completion" Drawings as specials below. These Drawings shall be accurate and correct in all respects and shall be shown to and approved by the Employer's Representative.

Completion Drawings as below on two prints shall be supplied by the contractor, along with a soft copy in a CD.

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CHAPTER 9

9.1. Environmental Management Plan

Sl. no	Potential Negative Impacts	Mitigation Measures	Time frame	Responsible agencies
	PRE-CONSTRUCTION STAGE			
1	Clearances	All clearance required for Environmental aspects during construction shall be ensured and made available before start of work.	Before construction	ULB / PIA / Concerned Departments & agency / Contractor
2	Tree Cutting	i) Try to save the trees by changing the alignment ii) Provide adequate protection to the trees to be retained with tree guards (e.g. Masonry tree guards, Low level RCC tree guards, Circular Iron Tree Guard with Bars) as required. ii) Identify the number of trees that will be affected with girth size & species type along the sewer mains, pumping / lifting station sites and sewerage treatment plant site. The details to be indicated in a strip map plan. iii) Trees shall be removed from the construction sites before commencement of construction with prior permission from the concerned department. iv) Undertake afforestation in nearby areas. v) Compensatory plantation by way of Re-plantation of at least twice the number of trees cut should be carried out in the project area.	Pre-construction & construction phase	Contractor / PIA
3	Utility	i) Identify the common utilities to be affected	Pre-	PIA /

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Sl. no	Potential Negative Impacts	Mitigation Measures	Time frame	Responsible agencies
	Relocation	such as: telephone cables, electric cables, electric poles, water pipelines, public water taps, etc ii) Affected utilities shall be relocated with prior approval of the concerned agencies before construction starts.	construction & construction phase	Concerned departments
4	Baseline parameters	Adequate measures shall be taken and checked to control the Baseline parameters of Air, Water and Noise pollution. Base line parameters shall be recorded and ensured conformance till the completion of the project.	Pre-construction, construction and post-construction phase	Prospective contractor / PIA
5	Planning of temporary Traffic arrangements	i) Temporary diversion will be provided with the approval of the engineer. Detailed traffic control plans will be prepared and submitted to the engineers for approval, one week prior to commencement of works. ii) The traffic control plans shall contain details of temporary diversion, details of arrangements for construction under traffic, details of traffic arrangement after cessation of work each day, SIGNAGES, safety measures for transport of hazardous materials and arrangement of flagmen.	Pre-construction & construction phase	Prospective contractor / PIA
6	Disposal of waste water.	i) The waste water quality shall comply with the standards of TNPCB to let out into the stream / nullah /open land /irrigation purposes, and necessary permission to be obtained from the concerned department.	Pre-construction & construction phase	PIA

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Sl. no	Potential Negative Impacts	Mitigation Measures	Time frame	Responsible agencies
		ii) Ensure efficient working condition of treatment plant.		
7	Storage of materials	The contractor shall identify the site for temporary use of land for construction sites /storage of construction materials, etc.	Pre-construction & construction phase	Prospective contractor / PIA
8	Construction of labour camps	Contractor shall follow all relevant provisions of the Factories Act, 1948 and the Building and the other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 for construction and maintenance of labour camp. The location, layout and basic facility provision of each labour camp will be submitted to Engineer prior to their construction. The construction will commence only upon the written approval of the Engineer. The contractor shall maintain necessary living accommodation and ancillary facilities in functional and hygienic manner and as approved by the Engineer. All temporary accommodation must be constructed and maintained in such a fashion that uncontaminated water is available for drinking, cooking and washing. The sewage system for the camp must be planned. Adequate	During the construction	Prospective contractor

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Sl. no	Potential Negative Impacts	Mitigation Measures	Time frame	Responsible agencies
		health care is to be provided for the work force. The layout of the construction camp and details of the facilities provided should be prepared and shall be approved by the engineer.		

No.	Systems / Impacts	MitiGation Measures	Responsible agencies	Time frame for implementation
1	**Distribution Network and OHTs**			
1.1	Shifting of community utilities	Ensure community consensus and minimum impact to community utilities like telephone cable, electric cables and electric poles, water taps. Proper clearance to be obtained from the concerned authorities and sent to the CCMC before commencement of works.	Prospective contractor	Pre-construction and Construction
1.2	Laying of distribution pipelines	i) Traffic regulation: Adequate actions to direct and regulate traffic shall be taken in consultation with CCMC, Dept. of Police to prevent jamming of roads during construction. While planning alternative routes, care to be taken to minimize congestion and negative	Prospective contractor	During construction

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No.	Systems / Impacts	MitiGation Measures	Responsible agencies	Time frame for implementation
		impacts at sensitive receptors such as Schools & hospitals. ii) Adequate precautions should be taken while laying the water distribution lines to avoid possibility of cross connection with the sewer lines.		
1.3	Using of modern machineries	Using of modern machineries such as JCBs, backhoes etc, shall be used to minimize the construction period.	Prospective contractor	During construction
1.4	Disposal of construction debris and excavated materials.	i) A suitable site should be identified for safe disposal, in relatively low lying areas, away from the water bodies, residential and agricultural fields etc., and got approved by the Engineer. ii) Care should be taken that dumped material does not affect natural drainage system. iii) Minimize the construction debris by balancing the cut and fill requirements. iv) All vehicles delivering material to the site shall be	Prospective contractor	During construction

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No.	Systems / Impacts	Mitigation Measures	Responsible agencies	Time frame for implementation
		covered to avoid material spillage.		
1.5	Dust Pollution near settlements	i) Unpaved haul roads near / passing through residential and commercial areas to be watered thrice a day. ii) Trucks carrying construction material to be adequately covered to avoid the dust pollution and to avoid the material spillage	Prospective contractor	During construction
1.6	Vehicular noise pollution at residential / sensitive receptors.	i) Idling of temporary trucks or other equipment should not be permitted during periods of loading / unloading or when they are not in active use. The practice must be ensured especially near residential / commercial / sensitive areas. ii) Construction activity induced noise level shall be mitigated at the residential and sensitive receptors. The Contractor shall employ mitigation measures as directed by the CCMC. iii) Stationary construction equipment will be kept at least 500m away from	Prospective contractor	During construction

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No.	Systems / Impacts	MitiGation Measures	Responsible agencies	Time frame for implementation
		sensitive receptors. iv) All possible and practical measures to control noise emissions during drilling shall be employed. CCMC may direct to take adequate controls measures depending on site conditions.		
1.7	Protection of residential / sensitive receptors.	i) Noisy construction operations in residential and sensitive areas should be restricted between 7.30 am and 6.00 pm. ii) Preventive maintenance of construction equipment and vehicles to meet emission standards and to keep them with low noise. iii) Provision of enclosing generators and concrete mixers at site. iv) Sound barriers in inhabited areas shall be installed during the construction phase. v) Adequate barricading / other measures to protect dust pollution near sensitive receptors like schools and hospital etc to be ensured.	Prospective contractor	During construction

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No.	Systems / Impacts	MitiGation Measures	Responsible agencies	Time frame for implementation
1.8	Barricading site	The construction site should be barricaded at all time in a day with adequate marking, flags, reflectors etc. for safety of general traffic movement and pedestrians	Prospective contractor	During construction
1.9	Safety Aspects	i) Adequate precautions shall be taken to prevent the accidents and from the machineries. All machines used shall confirm to the relevant Indian standards Code and shall be regularly inspected by CCMC. ii) Provide temporary crossing / bridges wherever necessary to facilitate normal life and business iii) Where loose soil is met with, shoring and strutting shall be provided to avoid collapse of soil. iv) The contractor shall supply all necessary safety appliances such as safety goggles, helmets, safety belts, ear plugs, mask etc to workers and staffs. v) A readily available first aid unit including an	Prospective contractor	During construction

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No.	Systems / Impacts	MitiGation Measures	Responsible agencies	Time frame for implementation
		adequate supply of sterilized dressing materials and appliances as per the Factories Rules in every work zone vi) Availability of suitable transport at all times to take injured or sick person(s) to the nearest hospital		
2.0	**Environmental enhancement and special issues:**		**Implementing Agency**	**Location**
2.1	Flora and Chance found Fauna	The contractor will take reasonable precaution to prevent his workmen or any other persons from removing and damaging any flora (plant/vegetation) and fauna (animal) including fishing in any water body and hunting of any animal. If any wild animal is found near the construction site at any point of time, the contractor will immediately upon discovery thereof acquaint the Engineer and carry out the Engineer's instructions	Prospective contractor	Project area

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No.	Systems / Impacts	MitiGation Measures	Responsible agencies	Time frame for implementation
		for dealing with the same. The Engineer will report to the near by forest office (range office or divisional office) and will take appropriate steps/ measures, if required in consultation with the forest officials.		
2.2	Chance Found Archaeological Property	All fossils, coins, articles of value of antiquity, structures and other remains or things of geological or archaeological interest discovered on the site shall be the property of the Government and shall be dealt with as per provisions of the relevant legislation. The contractor will take reasonable precautions to prevent his workmen or any other persons from removing and damaging any such article or thing. He will, immediately upon discovery thereof and before removal acquaint	Prospective contractor	Project area

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No.	Systems / Impacts	Mitigation Measures	Responsible agencies	Time frame for implementation
		the Engineer of such discovery and carry out the SC's instructions for dealing with the same, waiting which all work shall be stopped. The Engineer will seek direction from the Archaeological Survey of India (ASI) before instructing the Contractor to recommence the work in the site.		
2.3	Monitoring of environment parameters	The contractor shall undertake seasonal monitoring of air, water, noise and soil quality through an approved monitoring agency. The parameter to be monitored, frequency and duration of monitoring plan shall be prepared	Prospective contractor	Corridor of Impact
2.4	Sensitive Areas	The sensitive areas like Schools, hospitals to be provided with suitable noise barriers and safety measures, prior to the start of work in order to minimize the dust	Prospective contractor	Corridor of Impact

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No.	Systems / Impacts	MitiGation Measures	Responsible agencies	Time frame for implementation
		and noise impacts due to vehicle movement during construction and their effectiveness to be checked during operation phase.		
2.5	Clearing of construction of camps and restoration	Contractor to prepare site restoration plans for approval by the engineer. The plan is to be implemented by the contractor prior to demobilization. On completion of the works, all temporary structures will be cleared away, all rubbish cleared, excreta or other disposal pits or trenches filled in and effectively sealed off and the site left clean and tidy, at the contractor's expenses, to the entire satisfaction of the engineer.	Prospective contractor	All construction workers camps
2.6	Tree Protection, Tree Planting,	• Giving due protection to the trees that fall in the shoulders /corridor of impact shall be the prime focus during Construction/post construction	Concerned agency/Contractor / PIA	All tree plantation / greenery areas of the project

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No.	Systems / Impacts	Mitigation Measures	Responsible agencies	Time frame for implementation
		• Masonry tree guards, Low level RCC tree guards, Circular Iron Tree Guard with Bars, use of plate compactors near trees may also be considered where necessary • Re-plantation of at least twice the number of trees cut should be carried out along the project road. Since the major portion of the project road may pass through open lands, planting of trees along the entire stretch of the road is recommended as an enhancement measure. • Growth and survival of trees planted shall be ensured and monitoring done at least for a period of 3 years .Survival status shall be reported on monthly basis to Engineer in-charge.		

Environmental Monitoring Plan

To monitor the extent of environmental impact of the proposed /implemented project, the contractor has to periodically monitor the ambient environmental quality along the proposed

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project area. The monitoring requirement for the different environmental components is presented in table below

Environmental Monitoring Plan

Air Quality Monitoring	
Project stage	Pre Construction , Construction & operation period (as agreed)
Parameter	SPM, RPM, SO_2, NO_x, CO and Pb
Sampling Method	Use method specified by CPCB for analysis
Standards	Ambient Air Quality Standards, CPCB, 1994, Air (Prevention and Control of Pollution) Act,1981
Frequency	Once before start of work & once every season of the year during construction period & upto 18 months (operation Period)
Duration	Continuous 24 hours / or for 1 full working day
Location	Sensitive locations, especially in the downwind direction along the pipe laying work, pumping / lifting station locations, WTP site.
Measures	Wherever air pollution parameters increase above specified standards, additional measures as decided by the engineer shall be adopted
Implementation	Contractor through approved monitoring agencies
Supervision	Implementing agency
Water quality Monitoring	
Project stage	Pre Construction, Construction & Operation period (as agreed)
Parameter	• pH, BOD, COD, DO, TDS, Pb, Oil & Grease and Detergents for Surface water. • Water pH, TDS, Total hardness, Sulphate, Fluorides, Chloride, Fe, Pb for groundwater. In addition to parameters (E.coli) determining drinking water quality.
Sampling Method	Grab sample collected from source and analysis as per Standard

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	Methods for Examination of water and Waste water.
Standards	Indian standards for Inland Surface Water (IS; 2296, 1982) and for Drinking water (IS; 10500,1991)
Frequency	Twice a year (pre monsoon and post monsoon seasons) during the construction period
Duration	Grab sampling
Location	Locations representing water quality at • source & surface water quality in the vicinity • transmission lines • storage points, • distribution at representative locations including tail end.
Measures	At locations of variation in water quality/increased pollution, remedial measures to be adopted /all inflow channels shall be checked for pollution loads and channels delivering higher pollution load to the source shall be terminated from feeding the water source.
Implementation	Contractor through approved monitoring agencies
Supervision	Implementing agency
Noise Level Monitoring	
Project stage	Pre Construction , Construction & operation period (as agreed)
Parameter	Noise levels on dB (A) scale.
Special guidance	• Free field at 1 m from the equipments whose noise level are being determined. • Equivalent noise levels using an integrated noise level meter kept at a distance of 15m from edge of pavement
Standards	National Ambient Air Quality Standards in respect of Noise, Noise Pollution (Regulation and Control) Rules, 2000
Frequency	Once every season (except monsoon) for each year of construction
Duration	Reading to be taken at 15 seconds interval for 15 minutes every hour and then averaged
Location	• Wherever the contractor decides to locate the equipment yard. • At sensitive locations such as school, hospitals etc
Measures	In case of noise levels causing disturbance to the sensitive receptors,

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	management measures as suggested in the EMP shall be carried out.
Implementation	Contractor through approved monitoring agencies
Supervision	Implementing agency
Soil Quality Monitoring	
Project stage	Pre Construction, Construction & Operation (as agreed)
Parameter	Monitoring of Pb, SAR and Oil & Grease
Sampling Method	• Sample of soil collected to be acidified and analysed using absorption spectrophotometer
Standards	Threshold for each contaminated set by IRIS database of USEPA until national standards are promulgated
Frequency	• During the pre monsoon post monsoon seasons each year for the entire construction and operation phase
Duration	Grab sampling
Location	• At pumping / lifting station, WTP locations, OHT/distribution points etc
Measures	At location of increased in pollution levels, source shall be identified and shall be diverted.
Implementation	Contractor through approved monitoring agencies
Supervision	Implementing agency

Apart form the above mentioned monitoring requirements, any major accidents /spillage during bulk transport of hazardous materials by the contractor, depending on the type of spillages / accidents, the parameters to be monitored will be decided by the engineer and should be carried out by the contractor through approved monitoring agencies and supervised by the Implementing agency at their own cost.

FORMATS FOR REPORTING:

Formats for reporting / monitoring the progress / parameters achieved will be finalized in consultation with the successful bidder.

Environmental Compliance Report

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The contractor shall submit a monthly progress report as per the reporting format approved by the engineer, on the status of the implementation of the EMP, and get it duly approved by the engineer for its compliance and for proceeding with the work. The Engineer and the Environmental and Social Safeguard (ESS) Manager, who will have access and authority to monitor the status based on the same and for which necessary facilities shall be made by the contractor.

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CHAPTER 10

10.1. List of Acceptable Makes or equivalent

S. No.	Equipments	Makes	Category I/II	Short Form
1	Pumps	Kirloskar Brothers Limited Mather & Platt (I) Ltd Jyoti Ltd Becon Wier Ltd Worthington India Ltd Bharat Pumps & Compressors Ltd KSB Pumps Or any other approved vendors by CCMC		KBL MP JYOTI BEACON WORTHIN BPCL KSB
2	Motors	Kirloskar Electric Co. Ltd New Government Electric Factory Ltd Siemens India Limited Jyoti Ltd Bharat Heavy Electricals Ltd Crompton Greaves Ltd Or any other approved vendors by CCMC		KEC NGEF SIEMENS JYOTI BHEL CGL
3	Gate Valves	Kirloskar Brothers Ltd Indian Valve Company Upathyaya Valves Manufacturers P Ltd Jash Or any other approved vendors by CCMC	I I II	KBL IVC UVML
4	Non-return Valves	Kirloskar Brothers Ltd Indian Valve Company Upathyaya Valves Manufacturers P	I I II	KBL IVC UVML

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S. No.	Equipments	Makes	Category I/II	Short Form
		Ltd	II	SIWL
		Shiv Durga Iron Works P Ltd		
		Or any other approved vendors by CCMC		
5	Sluice Gates	Jash Engineering P Ltd	II	JASH
		The Indian Valve Co.	I	IVC
		Oriental Castings	II	OC
		Bharat Industrial Corporation	II	BIC
		Shiva Durga Iron Works P Ltd	II	SIWL
		Hydraulic & General Engineers	II	HEG
		Macha Tech Industries	I	MECHA
		Yashwant Engineering		
		Or any other approved vendors by CCMC		
6	Cast Iron Pipe & Fittings and Dismantling Joints	Baroda Rollings Mills	II	BRM
		The Indian Iron & Steel Company Ltd	I	IISCO
		Bharat Indusrial Corporation	II	BIC
		Oriental Castings	II	OC
		Upadhayay Castings, Calcutta	II	UCL
		Electric Steel Castings	I	ESC
		Tata Iron & Steel Co.	I	TISCO
		Or any other approved vendors by CCMC		
7	a) Crane	W H Brady & Co. Ltd		BRADY
		Hercules Hoists Ltd		INDEF
		Delta Engineering Works		DELTA
		Sharps Engineering Pvt Ltd		SHARPS
		Reva Engineering		REVA
		Electrotechnics		ELECTRO
		Avon Cranes		AVON

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S. No.	Equipments	Makes	Category I/II	Short Form
		Or any other approved vendors by CCMC		
	b) Chain Pulley Block	Reva Engineering Hercules Hoists Ltd W H Brady & Co. Ltd Or any other approved vendors by CCMC		REVA INDEF BRADY
8	Sump Pump Set	Kirloskar Brothers Ltd SU Motors Pvt Ltd Jyoti Ltd Modi Industries (FC) Pvt Ltd Flyght Grand Fox Or any other approved vendors by CCMC		KBL SU JYOTI MODI
9	Dewatering Pump Set	Kirloskar Brothers Ltd Modi Industries (FC) Pvt Ltd SU Motors Pvt Ltd Kishore Pumps KSB Pumps Or any other approved vendors by CCMC		KBL MIPL SU KPL KSB
10	Exhaust Fan	Bajaj Electricals Ltd Crompton Greaves Ltd Jay Engineering Works ALSTOM General Electric Company Ltd Or any other approved vendors by CCMC		BAJAJ CGL JAY ALSTOM GEC
11	415 V Switchgear Control Gear	Larsen & Toubro Ltd Siemens India Limited		L&T SIEMENS

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S. No.	Equipments	Makes	Category I/II	Short Form
	components / Bus Duct	Voltas Ltd English Electric Ltd Jyoti Ltd Control and Switchgear Bhartia Cutler Hammer Electrical Control Gear Ltd ASPL Or any other approved vendors by CCMC		VOLTS EEL JYOTI C&S BCH H.H.ELCON ASPL
12	Power Transformer	Bharat Bijlee Ltd New Government Electric Factory Ltd Kirloskar Electric Co. Ltd VOLTAMP ETC (Thana) VOLTAS Ltd Or any other approved vendors by CCMC		BBL NGEF KEC VOLTAMP
13	11 KV / 3.3 KV Switchgear	Jyoti Ltd New Government Electric Factory Ltd Siemens India Limited Asian Brown Boveri ALSTOM Kirloskar Electric Ltd Bharat Heavy Electricals Ltd Crompton Greaves VOLTAS Ltd Or any other approved vendors by CCMC		JYOTI NGEF SIEMENS ABB ALSTOM KIRLOSKAR BHEL CGL VOLTAS
14	Lighting Fixtures	Bajaj Electrical Ltd		BAJAJ

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S. No.	Equipments	Makes	Category I/II	Short Form
		Crompton Greaves Ltd Philips Wipro Ltd Klipsal Or any other approved vendors by CCMC		CGL PHILIPS WIPRO KLIPSAL
15	415 V Air Circuit Breaker	English Electric Ltd Larsen & Toubro Ltd Siemens India Ltd Or any other approved vendors by CCMC		EEL L&T SIEMENS
16	Cables	Indian Cables Ltd Fort Gloster Industries Ltd Cable Corpn. Of India Universal Cables Indian Cable Co. Asian Cables Corporation Ltd Gemscab Finolerx Cables Ltd Delton Cables Polyeab Or any other approved vendors by CCMC		ICL FGI CCI UNISTAR ICC ASIAN GEMSCAB FCL DELTON
17	Power Capacitors	Crompton Greaves Ltd Universal Cables Ltd NGEF Bharat Heavy Electricals Limited MEHER (L&T) DULATI Manohar Brothers		CGL UNIVERSAL NGEF BHEL MEHER DULATI MB

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S. No.	Equipments	Makes	Category I/II	Short Form
		Madhav Khatau & Junker VOLTAS Ltd Or any other approved vendors by CCMC		MADHAV KHATAU VOLTAS
18	Instrument & Meters	Universal Electrics Ltd Automatic Electric Ltd Meco Instruments P Ltd Industrial Motors P Ltd Havells Pvt Ltd Gollica Electricals P Ltd Or any other approved vendors by CCMC		UEL AEL MEL IML HAVELLS GOLLICA
19	Motor Starters	Bharat Heavy Electriclas Ltd Perimal Engineering Ind. Enterprising Engineering Pan Asia Or any other approved vendors by CCMC		BHEL PEI EE PAN
20	Push Buttons and Indication Lights	Larsen & Toubro Siemens Bhartiya Cutler Hammer Vaishnov Or any other approved vendors by CCMC		L&T SIEMENS BCH VAISHNOV
21	Relays (for 3.3 KV 11 KV Switchgear)	English Electric Ltd ALSTOM Universal Electrics Ltd Easun Reyrolles Relays Larsen & Toubro		EEL ALSTOM UEL ERR L&T

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S. No.	Equipments	Makes	Category I/II	Short Form
		Asian Brown Boveri JYOTI Or any other approved vendors by CCMC		ABB JYOTI
22	Battery	Standard Batteries Ltd Chloride India ltd Amco Batteries Ltd Exide Or any other approved vendors by CCMC		SBL CIL ABL EXIDE
23	Voltage & Frequency Stabilizer	Applied Electronics Ltd Jindal Electric Surya Electro Servocon Logicstat Or any other approved vendors by CCMC		APLAB JINDAL SURYA SERVOCON LOGICSTAT
24	Lightening Protection Unit	National Radio & Electronics Co. Ltd Or any other approved vendors by CCMC		NELCO
25	Instrument Transformers (CT's & PT's)	Mysore Electrical Industries Automatic Electric Pvt Ltd Kappa Electricals Or any other approved vendors by CCMC		MEI AEP KAPPA
26	Vacuum Pump	Kirloskar Brothers Ltd SLM Manek Lal Industries Ltd Or any other approved vendors by CCMC		KBL SKM
27	Battery Charger	Uptron Powertronics (Shreetron)		UPTRON

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S. No.	Equipments	Makes	Category I/II	Short Form
		Statcom Automatic Electric Ltd Chabi Kerela State Electricity Crop. APCO Or any other approved vendors by CCMC		STATCOM AEL CHABI KSEC APCO
28	Fire Extinguishers	Steelage Industries Kooverji Devshi & Co. Ltd Vijay Fire Protection System Pvt Ltd Or any other approved vendors by CCMC		MINIMAX FIREX VIJAY
29	Nuts & Bolts	GKW TATA Or any other approved vendors by CCMC		GKW TATA
30	Ceiling Fans	Bajaj Orient Usha Crompton Or any other approved vendors by CCMC		BAJAJ ORIENT USHA CROMPTON
31	Multimeter	Excrop Motwane Or any other approved vendors by CCMC		EXCROP MOTWANE
32	Push Button for Non-flame-proof Flame Proof Weather Proof	Siemens FCG BALIGA Or any other approved vendors by		SIEMENS FCG BALIGA

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S. No.	Equipments	Makes	Category I/II	Short Form
		CCMC		
33	Switch / Fuses	GE Power Larsen & Tubro Ltd Siemens HPL Or any other approved vendors by CCMC		GE L&T SIEMENS GE
34	Motors contactors	Bhartia Cutler Hammer Larsen & Tubro Ltd Siemens GE Power Or any other approved vendors by CCMC		BCH L&T SIEMENS GE
35	Gear Reducers	Essen Pro Radicon Elecon Greaves Or any other approved vendors by CCMC		ESSEN RADICON ELECON GREAVES
36	Bus Duct	Best & Crompton Eng. Ltd Power Gears Pvt Ltd Control & Switchgear Zeta Switchgear Or any other approved vendors by CCMC		B&C PGPL C&S ZETA
37	Control System Instrumentation, PLC & SCADA System	AIMIL Ltd Johnson Controls I Pvt Ltd Landis & Staefa I Pvt Ltd TATA Honeywell Rockwell Automation GE FANUC		AIMIL JCPL SIEMENS TATA RAIL GE FANUC

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S. No.	Equipments	Makes	Category I/II	Short Form
		Alstom Or any other approved vendors by CCMC		ALSTOM
38	Ultra Violet Radiation System	Trozan Wedico Suntech INFILCO Or any other approved vendors by CCMC		TROZAN WEDICO SUNTECH INFILCO
39	Centrifuge	Humbolt Penavolt Alfa Level Flottweg Guinard Broadbent Or any other approved vendors by CCMC		HUMBOLT PENAVOLT ALFA LEVEL FLOTTWEG GUINARD BROADBENT
40	PCC / MCC	Advance Electro Control Vidyut Control Tricolite Larsen & Toubro Siemens Jakson Associated Electrical Bharatiya Cutler Hammer Control & Switch Gear G E Power Chavare Engineering Spark Electro Or any other approved vendors by CCMC		AEC VC TRICOLITE L&T SIEMENS JAKSON ASPL BCH C & SG G E POWE

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S. No.	Equipments	Makes	Category I/II	Short Form
41	Optic Fibre Cables	Delink Cords R R Cale Icon Aksh Or any other approved vendors by CCMC		DELINK CORDS RR ICON AKSH
42	Flow Meters	Krone Marshall ABB Schlumburger Endress Hauser YBL Yokogawa Magnetrol Or any other approved vendors by CCMC		KM ABB SB EH YBL
43	Butterfly valves	Kirloskar AUDCO TYCO IVC Or any other approved vendors by CCMC		KBL AIL TYCO IVC
44	Actuator	Marsh L&T Rotork Or any other approved vendors by CCMC		MARSH L&T ROTORK
45	Pressure Switches / Pressure transmitters	Danfoss Switzer Fiebig Varna Trifag H Guru		DANFOSS SWIT FIEBIG VARNA HG

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S. No.	Equipments	Makes	Category I/II	Short Form
		High Tech (Orion) Or any other approved vendors by CCMC		HT
46	Level Switch	Endress Hauser EIP Nivo Control ABB Level Cone Mangetrol Or any other approved vendors by CCMC		EH EIP NIVO ABB LEVEL CONE
47	Electronic Ballast	Philips Opal Washlow Or any other approved vendors by CCMC		PHILIPS OPAL WASH
48	Micro Processor Based Relays for Motor Protection	GE Power Rockwell L&T Siemens Or any other approved vendors by CCMC		GEP RAIL L&T SIEMENS
49	Scrubber	Excellent Engine Pilani Enuirotec Or any other approved vendors by CCMC		EXCEL PILENV
50	UPS	Tata Emerson Merlin Gerin Mitsubishi Or any other approved vendors by		EMER M & G MITS

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S. No.	Equipments	Makes	Category I/II	Short Form
		CCMC		
51	Fine Bar Screens	Jash Johnson Contrasher Huber Or any other approved vendors by CCMC		
52	MS pipes	Jindal Jain Alloys Unisteel PSL Limited Bansol Pole P Ltd Or any other approved vendors by CCMC		
53	HDPE / MDPE pipes	Dura line Jain Pipes Surya pipes Balaji indistrials GSK irrigation Shree Dharshan pipes Or any other approved vendors by CCMC		
55	HSC Connections (Compression Fitting)	Kimplast GSK irrigation Shree Dharshan pipes Or any other approved vendors by CCMC		

Note: CTS & PTs of the makes, guaranteed by switchgear manufacturer for its performance and as per specification shall be acceptable subject to approval by Corporation. Any

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other equipment whose make is not approved will be got approved from CCMC before supply.

S. No.	Equipments	Makes	Category I/II	Short Form
1	PH / Conductivity Meter	Forbes Marshall Polymetron Orion Analytical Instruments Chemtrols DR. Lange Royce Endress Hauser		FMP ORION AI CHEMITROLS DR. LANGE ROYCE EH+
2	DO (Dissolved Oxygen)	Orion Chemtrols Analytical Instruments Forbes Marshall Polymetron DR. Lange Royce Endress Hauser		ORION CHEMITROLS AI FMP DR. LANGE ROYCE EH

Note: The aforementioned list is only an indicative and not an exhaustive list of manufacturers. This list shall be used only for reference purposes and does not bind the Owner into necessarily approving the listed manufacturer / vendor / dealer in this list for supply and other installation related activities.

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PART II – OPERATION AND MAINTENANCE MODULE

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1.1 Scope of Work

The O&M stage would primarily focus on operation management and maintenance of the 24x7 water supply system, broadly consisting of the following activities:

a. Operation of the 24X7 water supply system consisting of activities such as:

- Storage and distribution of water to customers within the agreed boundary
- Billing, collection and entire customer service

b. Management and Maintenance of the 24x7 water supply system consisting of the following activities

- Leakage detection and prevention
- Providing new connections
- Repair and replacement of existing/newly created assets
- Monitoring and reporting

Generating bills of the customers on behalf of, collection of moneys from such customers and depositing the same into an escrow account as well as timely submission of reports containing the details of the defaulters to for necessary action

2.1 Components

2.1.1 Distribution Network – Components

The Concessionaire shall be responsible for the operation and maintenance of the entire Water Distribution Network Components from Master Service reservoirs to the House service Connections. The key components are Feeder Mains. Service Reservoirs, intermediate Pumping Mains, Distribution Networks and house service connections. The Operation and Maintenance Components are stated below.

Sl. No.	Key Components
I	**Feeder Mains**
	Pillur System
1	Feeder Main I from Proposed MSR at Ramakrishnapuram to Proposed SR at Bharathi Nagar (Gravity)

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Sl. No.	Key Components
2	Feeder Main II from Existing MSR at Ramakrsihnapuram to Proposed SR at Lakshmi Nagar Mill Colony (Gravity)
3	Feeder Main III from Existing MSR at Ramakrishnapuram to Proposed sump at Rakkatchi Garden (Gravity)
4	Feeder Main IV from Proposed Sump at Rakkatchi Garden to Existing SR at Jai Nagar (Pumping)
	Siruvani System
5	Feeder Main I - From Existing MSR at Bharathi Park to Proposed SR at Housing Unit (By Gravity)
6	Feeder Main II - From Existing MSR at Bharathi Park to Proposed Sump at Sanganur Chinthamani (By Gravity)
7	Feeder Main III - From Proposed Sump at Sanganur Chintamani to Existing SR at Revathi Layout (By Pumping)
	Interlinking of MSR of Pillur & Siruvani System
8	From Existing MSR at Ramakrishnapuram to Existing GLSR at Bharathi Park (By Gravity)
II	**Sumps & Pump Rooms**
	Pillur System
9	10.00 LL Sump at Rakatchi Garden with Pump Room – 2 Nos (8m x 8m x 5m Size) with Ladder and Pipe Connection Works
	Siruvani System
10	7.00 LL Sump at Sanaganur Chinthamani with Pump Room - 1 No (8m x 8m x 5m Size) with Ladder and Pipe Connection Works
	Interlinking of MSR of Pillur & Siruvani System
11	10.00 LL Sump at Bharathi Park with Pump Room – 1 No (20m x 10m x 6m Size) for MSR Interlinking with Ladder and Pipe Connection Works
III	**Pumpsets & Generators**
	Pillur System
12	At Rakatchi Garden - 5640 Lpm x 27 m x 44 HP - Horizontal Split Case – 2 Nos (1W+1S) & 5460 Lpm x 49 m x 78 HP - Horizontal Split Case – 3 Nos (2W+1S) & 200 KVA Diesel Generator Set
	Siruvani System

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Sl. No.	Key Components
13	At Sanganur Chinthamani – 960 Lpm x 20 m x 6 HP – Submersible – 2 Nos (1W+1S) & 2580 Lpm x 27 m x 20 HP – Submersible – 2 Nos (1W +1S) & 4080 Lpm x 35 m x 42 HP – Horizontal Split Case – 3 Nos (2W +1S) & 80 KVA Diesel Generator Set
	Interlinking of MSR Pillur & Siruvani System
14	At Bharathi Park – 17400 Lpm x 24 m x 122 HP – Horizontal Split Case – 3 Nos (2W+1S) & 250 KVA Diesel Generator Set
IV	**Distribution System**
15	North Zone
16	South Zone
17	West Zone
18	East/Demo Zone– I
19	East/Demo Zone–II
V	**Special Components**
20	Automatic Hand Held Meter Reading System (5 Nos – 1 No for each Zone) & Data Collection Software (5 Nos – 1 No for each Zone)
21	Any Time Payment Machines
22	Bulk Water Meter with Data Logger for Flow & Pressure Measurement & Pressure Control Valve & Data Logger Room (1 No for each D'System Zone)
23	Gas Chlorination Disinfection (2 Nos – 1 No for each MSR)
24	House Service Connection Meters
25	Rider Mains in all 5 Zones
VI	**Common Components**
26	Water Quality Test Laboratory & Equipments (1 No)
27	SCADA System for Monitoring (1 No)
VII	**Service Reservoirs & Pipe Connections**
	North Zone
28	20 LL –2 Nos
29	20 LL –1 No
30	18 LL –2 Nos
31	9 LL – 2 Nos
32	7 LL – 1 No

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Sl. No.	Key Components
	South Zone
33	19 LL –1 No
34	16 LL – 2 Nos
35	12 LL – 1 No
36	9 LL – 1 No
37	7 LL – 1 No
38	4 LL – 1 No
	West Zone
39	20 LL – 2 Nos
40	20 LL – 1 No
41	18 LL – 1 No
42	12 LL –1 No
	East / Demo Zone I
43	18 LL – 1 No
	East / Demo Zone II
44	20 LL – 1 No
45	13 LL – 1 No
46	11 LL – 3 Nos
47	10 LL – 2 Nos
48	4 LL – 1 No

The Operation and maintenance requirements of distribution network like establishments, consumables, fuels, Power charges ATP facilities are stated below.

Sl No	Key Components
I	**Establishments**
1	Pump operator
2	Supervisor / Asst Manager for Feeder Mains
3	Fitter I Class for Pumping main, Gravity main, MSR & Sump cum Pump rooms
4	Electrician / Mechanic
5	Plumbers for distribution system
6	Helpers for Distribution system

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Sl No	Key Components
7	Watchman for MSR & SRs
8	Water meter reader
9	Water supply Bill collector
10	Water supply bill collection superintendent
11	Tap Inspectors
12	Meter repairer / Maintenance Assistant
13	Assistant meter repairer
14	Water Analyst (Chemical)
15	Water Analyst (Bacteriological)
16	Laboratory Technician / Attendant
17	Typist cum Clerk
18	Water Sample Takers
19	Laboratory Cleaners
20	SCADA Operator
II	**Chemicals**
III	**Consumables**
IV	**ATP Facilities**
V	**Power Costs**
VI	**SCADA**
VII	**Maintenance, Repair and replacement of the Water meters**

Notwithstanding to the above components, the Operation and Maintenance Plan formulated by the concessionaire shall fulfill the needs of the Establishments, Consumables, provision of regular as well as back-up power required for the Operation and Maintenance of the entire Distribution Network Components. The repairs and replacements of the existing Water meters in the House service connections are also included in the scope of the Operation and Maintenance.

2.1.2 Billing and Revenue Collection Systems

The Concessionaire shall create and operate a billing and collection system by providing the necessary man power, information technology facilities.

The Concessionaire on studying the present billing and collection system prevailing in the City shall undertake improving the revenue management and recommend either improving

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the present billing system or installing a new improvised billing system. The Concessionaire shall provide the necessary software and hardware for the implementation of the billing and collection system with administrator level access to all the information stored in such systems to both Authority as well as the Independent Engineer.

The Concessionaire shall undertake improving revenue collection system by introducing different measures for improving the access to Consumers as well as simplifying payment procedures. The collection system shall be capable of online update with the billing system so that the account receivables are monitored in real time basis.

The improved revenue management system shall be with facility for easy upgrade and improvement this shall include but not limited to

1. an effective water billing practices and procedures;
2. an effective revenue collection practices and procedures; and
3. a simple and efficient connection, disconnection, and reconnection procedure;

The Concessionaire further acknowledges that it will, from the Initial Take over Date of Construction Period, take over full responsibility for billings and collection in the Service Area for and on behalf of the CCMC.

The Concessionaire shall:

1. Collect all amounts due to the CCMC as Revenues related to the Water Services. through the CCMC's/Concessionaire billing offices; through banks, electronic transfer; and by other means as may be agreed to by the CCMC;
2. identify and record all outstanding accounts and take all necessary measures to collect outstanding accounts;
3. Provide the details of the defaulters to the CCMC with a summary and analysis of the unpaid accounts [every month] for necessary action.
4. Manage all aspects of Consumer services with the Consumers including complaint monitoring and redressal system.

2.1.3 Meter Reading

The Concessionaire shall:

1. read all Consumer Revenue Meters in accordance with the general instructions of the CCMC;
2. register all Consumer Revenue Meters readings in the appropriate computer data base;
3. develop a monitoring programme of random spot-checks to ensure the accuracy of the meters and the meter reading process and provide written reports to the CCMC on the

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results;

4. develop and implement a plan the intent of which is to ensure that:
    a. all Consumer Revenue Meters are accurate;
    b. all Consumer Revenue Meters are read;
    c. all Consumer Revenue Meters are in suitable locations;
    d. problems related to unprotected and unsealed Consumer Revenue Meters are resolved; and
5. develop and implement a program to estimate consumption in circumstances where metering problems exist;
6. provide advice as to methods to improve the meter reading process to ensure greater accuracy;
7. convert all Consumer Revenue Meters readings to billings to Consumers;
8. identify Consumer Revenue Meters which have not been read; and
9. Respond to reports of malfunctioning Consumer Revenue Meters from Consumers.
10. Satisfy consumers' queries regarding water meter reading results by testing it on meter test bench.

2.1.4 Deposit of Consumer Payments in Escrow Account

With respect to the collection of Consumer Payments under the sole responsibility of the Concessionaire, the Concessionaire shall directly deposit all of the collected Consumer Payments, whether in the form of cash, cheques or other form, into the Escrow Account

2.1.5 Management Information System (MIS)

The Concessionaire shall set up a simple, easy to understand and easy to scale up Management Information System (MIS) for prudent Asset Management Planning, Asset Registry, recording of maintenance episodes or events or interventions, financial management, accounts including generating the reporting requirements.

On the scheduled COD, all the legal Consumers shall be provided with safe, continuous and pressurized water supply through Consumer service connections at the Minimum Services Levels prescribed in the Agreement and the Concessionaire shall have achieved the Performance Targets in complete.

2.2 Specific Exclusions from the Scope of Work

2.2.1 Bulk Water Charges

The Charges payable for the intake of bulk raw water from sources shall be the responsibility of CCMC.

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2.2.2 Escalation of Tariff in Electricity Consumption

The Operation and Maintenance scope of the Concessionaire is inclusive of the power charges at the raw water Pumping locations, Treatment Plants, Clear water Pumping locations, Intermediate Pumping Stations, SADA and ATP arrangements and any other facility coming under the purview of the scope of the O&M. The Power Charges will be as per the bills generated and issued by the Tamil Nadu Electricity Board. In case of increase in the Tariff Rates for the usage of the Power, the incremental cost (the difference in charges from the existing tariff and the additional charges due to revised tariff rates) shall be borne by CCMC. Further, the power costs for pumping water between the Pillur and Siruvani interlinking shall be the responsibility of the Authority.

2.2.3 Operation and Maintenance of Pillur – 1 Water Supply Scheme

The Operation and Maintenance of the entire Pillur – 1 Water Supply Scheme is excluded from the Scope of work and that comes under the Authority's responsibility.

2.2.4 Additional house service connections

The Scope of work includes the House service Connections during the construction period to the Consumers. As per the scope the Concessionaire shall provide 1,50,000 connections as part of EPC works. The additional House Service Connections which are more than the stated numbers in the tender documents shall be considered as additional scope of Work. The extra house service connections shall be provided by the concessionaire as on a chargeable basis. The charges for the provision of additional service connections shall as per the Item wise rate quoted in the approved Capital Investment Plan submitted by the Concessionaire with an annual escalation of 6% per annum. The projected number of connections during the Concession Period is as follows:.

Year	Projected no. of Connections
2014-15	1,50,000
2015-16	1,52,299
2016-17	1,54,632
2017-18	1,57,000
2018-19	1,59,405
2019-20	1,61,846
2020-21	1,64,325
2021-22	1,66,841
2022-23	1,69,397

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Year	Projected no. of Connections
2023-24	1,71,991
2024-25	1,74,625
2025-26	1,77,300
2026-27	1,80,016
2027-28	1,82,773
2028-29	1,85,573
2029-30	1,88,415
2030-31	1,91,300
2031-32	1,94,230
2032-33	1,97,205
2033-34	2,00,225
2034-35	2,03,292
2035-36	2,06,406
2036-37	2,09,566
2037-38	2,12,776
2038-39	2,16,035
2039-40	2,19,343
2040-41	2,22,702

The design by the Concessionaire shall anticipate at least 5% more connections than those projected for the respective year and the O&M quote of the Concessionaire shall cover the cost for the O&M of such additional connections. Any increase beyond the projected 5% in a given year shall be considered as a Change of Scope event and the cost for the necessary design / network modifications and the incremental O&M costs for the same shall be borne by the Authority.

2.2.5 Assets Replacement

In case of the requirements for replacing of the existing assets, the installation of the asset, working condition, possibility of rehabilitation, repair, and rejuvenation shall be studied and an analysis report shall be submitted to 12 months in advance from the end of the lifetime. Such report shall be considered and agreed by the CCMC by physical inspection of the officials and detailed discussion with the concessionaire. The complete cost for the replacement of such assets shall be borne by the CCMC in all aspects like supply, stock, install and commission. The concessionaire shall replace the assets as approved by the CCMC and produce proper bills, documentary proof for the complete process of replacement of such assets to claim for the reimbursement of the expenditures. The reimbursement of such

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additional claims shall be done as per the norms of CCMC. The Asset replacement does not include the replacement of Water Meters for House service connections. In other words, repair and replacement of house service connection meters shall be the responsibility of the Concessionaire.

2.2.6 Major Maintenance

The Major maintenance of the assets in Civil/ Electrical/ Mechanical components of the entire system shall be informed to the CCMC officials as soon as the same is observed/ anticipated by Concessionaire. Joint Inspections and detailed study shall be done and a detailed estimation shall be prepared. A maintenance activity, in addition to other requirements to the satisfaction of CCMC, shall be considered under Major Maintenance only if the maintenance costs exceeds 30 % (thirty percentage) of the replacement/reconstruction cost of the asset or 10% (ten percent) of the Monthly Annuity Payment of the corresponding year for the Concessionaire, whichever is lower ("Major Maintenance Threshold Value") for the reimbursement to the concessionaire along with the subsequent scheduled payment. In case of the Additional Project Facilities, the payment made by the Authority for any Major Maintenance activity shall be the difference between the actual cost incurred by the Concessionaire and the Major Maintenance Threshold Value. While in case of the Existing Project Facilities, any single maintenance event wherein the aggregate expenses incurred exceeds Rs. 5 (five) lakhs, such activity shall be considered as Major Maintenance activity and the entire expenses shall be reimbursed by the Authority based on the certification of invoices by the Independent Engineer.

In the event the Parties are unable to agree to the estimate of any expenses towards a Major Maintenance activity, the Authority may, after giving notice to the Concessionaire and considering its reply thereto, award the works or services, to any person on the basis of open competitive bidding; provided that the Concessionaire shall have the option of matching the first ranked bid in terms of the selection criteria, subject to payment of 2% (two percent) of the bid amount to the Authority and thereupon securing the award of such works or services. It is also agreed that the Concessionaire shall provide assistance and cooperation to the person who undertakes the works or services hereunder, but shall not be responsible for rectification of any Defects and/ or maintenance of works carried out by other agencies. Complete Documentary proof including , Approved Detailed estimate with proper Rate analysis, Details of Market Rates, Log books for the work with complete progress of the work, stage wise photographs, completion report shall be produced while claiming for the reimbursement.

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O&M Obligations of the Concessionaire

2.11 Construction Period

The Scope of Services during the Construction Period shall essentially comprise operations and maintenance of the existing water supply facilities along with execution of the Implementation Plan in the Service Area which shall include but not limited to the following.

2.12 Operations and Maintenance of Water Supply Services

From the Initial Take over Date, the Concessionaire shall take over the management responsibilities of the Operations and Maintenance (O&M) of the water supply facilities in the Service Area. The O&M tasks essentially comprise but not limited to the following.

a. Providing water supply to the Consumers at the prevailing service levels without further deterioration
b. Water Demand Management
c. Emergency water supply
d. Network Operations and Management
e. Valve operations for intermittent water supply
f. Flow and pressure monitoring
g. Repair of leaks and bursts and valves
h. New Connections, Disconnections and Re-Connections as approved by CCMC
i. Consumer Services including attending to complaints and their resolution
j. Meter reading, preparation and issuing bills
k. Constructing water meter test bench & perform meter testing
l. Collection of revenue and deposit into escrow accounts
m. Debt management
n. Information management and reporting

2.13 Implementation Plan

The Implementation Plan shall be in accordance to industry standards and sufficient care shall be taken by the Concessionaire in minimizing the supply interruptions, traffic disruptions and ensuring good and timely communications with the Consumers in the

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Service Area. All the works, interventions proposed as part of Implementation Plan shall be in conformity with the Construction requirements as mentioned in Part I - Construction Module (Section II – Detailed Scope of Work, Section III - Bill of Quantities and Section IV – Technical Specifications) and O&M Requirements Part II – Operation & Maintenance. The Implementation Plan components essentially comprise of but not limited to the following.

2.13.1 Improving Consumer Connections

The Concessionaire shall undertake improving the Consumer connections by replacing the existing house service connections with consumer water meter (AMR enabled) including cost of Earth work Electrofusion Saddle piece, Metal inserted male threaded elbow, Double compression elbow, UPVC ball valve, MDPE pipe, including labour charges, all taxes duties, loading unloading fright stacking transit, installation of right size ferrules/saddles, installation of accessories and meter chamber at the nearest point inside the Consumer property boundary.

2.13.2 Services to Unauthorized Colony

It shall be provided as per the applicable policy of CCMC. For unauthorized colony included in government list, water supply shall be provided subject to technical feasibility.

2.13.3 Bulk Water Supply Connections

In case of bulk water supply connections of sizes equivalent or higher than 25mm dia to the apartments, housing societies or private layouts within the Service Area, the Concessionaire shall install a suitable size and accurate consumption meter.

2.13.4 Illegal Connections

The Concessionaire based on the findings from the Consumer Survey, shall identify the illegal or unauthorized connections and inform to CCMC and as per instruction of CCMC for approval/ non approval and after payment of prescribed charges by the Consumer, shall then rehabilitate the connection with good plumbing materials and a Consumer meter.

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2.13.5 Network Improvements

a. Based on the approved Implementation Plan, the Concessionaire shall undertake detailed engineering design of the network improvement works and implement the same on site in accordance to the technical specifications and prudent industry practices. Efforts shall be made to optimize the performance of the existing assets duly assessing the extendable residual life of the assets. The primary objective of the Network Improvements is to ensure rationalized, equitable, continuous and pressurized water services to the Consumer in the Service Area.

b. The improved network shall exhibit increased hydraulic carrying capacity to meet the demand needs for the year 2044 and shall deliver water at a minimum pressure of 7 meters at any of the Ferrule Points as measured at the Critical Measurement Points. The network shall be fitted with isolation valves such that any intervention for maintenance like extensions, connections, leak repair etc shall not affect more than 100 consumer connections. However, as part of CIP, the Concessionaire shall study the entire Distribution network to arrive at the exact number of isolation valves and propose the modifications in the network design aspects.

2.14 Financial Management

The Concessionaire shall implement a comprehensive Financial Management Plan in respect of all matters including but not limited to:

a. financial management, including accounting systems;
b. the billings and collection systems;
c. Consumer Services, including data bases relating to complaints and questions and response times with respect to complaints and questions
d. information systems; and
e. Asset registers from the perspective of maintaining a prudent asset management system and accounts.

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2.15 Billing and Revenue Collection Systems

a. The Concessionaire on studying the present billing and collection system prevailing in the City shall undertake improving the revenue management and recommend either improving the present billing system or installing a new improvised billing system. Necessary software and hardware shall be installed in the designated space in the Service Area with a facility to transfer the data and report online with the existing revenue management servers in CCMC.

b. The Concessionaire shall undertake improving revenue collection system by introducing different measures for improving the access to Consumers as well as simplifying payment procedures. The collection system shall be capable of online update with the billing system so that the account receivables are monitored in real time basis.

c. The improved revenue management system shall be with facility for easy upgrade and improvement this shall include but not limited to.

    i. an effective water billing practices and procedures;
    ii. an effective revenue collection practices and procedures; and
    iii. a simple and efficient connection, disconnection, and re-connection procedure;

d. The Concessionaire further acknowledges that it will, from the Initial Take over Date of Development Period, take over full responsibility for billings and collection in the Service Area for and on behalf of the CCMC.

e. The Concessionaire shall:

    i. Collect all amounts due to the CCMC as Revenues related to the Water Services.
        a. through the CCMC's/Concessionaire billing offices;
        b. through banks, electronic transfer; and
        c. by other means as may be agreed to by the CCMC;

    ii. Identify and record all outstanding accounts and take all necessary measures to collect outstanding accounts;
    iii. Submit to the CCMC a summary and analysis of unpaid accounts [every month];

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iv. manage all aspects of Consumer services with the Consumers

2.15.1 Meter Reading

The Concessionaire shall:

a. read all Consumer Revenue Meters in accordance with the general instructions of the CCMC;
b. Register all Consumer Revenue Meters readings in the appropriate computer data base;
c. develop a monitoring programme of random spot-checks to ensure the accuracy of the meters and the meter reading process and provide written reports to the CCMC on the results;
d. develop and implement a plan the intent of which is to ensure that:
    i. all Consumer Revenue Meters are accurate;
    ii. all Consumer Revenue Meters are read;
    iii. all Consumer Revenue Meters are in suitable locations;
    iv. problems related to unprotected and unsealed Consumer Revenue Meters are resolved;
e. develop and implement a programme to estimate consumption in circumstances where metering problems exist;
f. provide advice as to methods to improve the meter reading process to ensure greater accuracy;
g. convert all Consumer Revenue Meters readings to billings to Consumers;
h. identify Consumer Revenue Meters which have not been read; and
i. Respond to reports of malfunctioning Consumer Revenue Meters from Consumers.
j. Satisfy consumer's queries regarding water meter reading results by testing it on meter test bench.

2.16 Deposit of Consumer Payments in Escrow Account

With respect to the collection of Consumer Payments under the sole responsibility of the Concessionaire, the Concessionaire shall directly deposit all of the collected Consumer

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Payments, whether in the form of cash, cheques or other form, into the Escrow Account in accordance with Article 23 of Volume II Concession Agreement.

2.17 Management Information System (MIS)

The Concessionaire shall set up a simple, easy to understand and easy to scale up Management Information System (MIS) for prudent Asset Management Planning, Asset Registry, recording of maintenance episodes or events or interventions, financial management, accounts etc including generating the reporting requirements as detailed in Part II – Operation & Maintenance Module, Clause 4.2.7.

On the Scheduled Development Period Completion Date, all the legal Consumers shall be provided with safe, continuous and pressurized water supply through Consumer service connections at the Minimum Services Levels prescribed in the Agreement and the Concessionaire shall have achieved the Performance Targets in complete.

3 O&M Period

a. During this period, the Concessionaire shall continue to provide water supply services to the legal Consumers in the Service Area at the prescribed Minimum Service Levels. This shall include but not limited to all the tasks, operations, maintenance activities as listed above including attending to any new requirements for new connections within the Service Area etc. complete.

b. The Concessionaire shall ensure continuous, pressurized water supply to all the Consumers and any interruptions shall be within the permissible limits as specified in the Volume – II Concession agreement, Schedule 5.

c. The Operator shall also implement all rehabilitation or service improvement works required in any extended area of the Service Area or as necessary due to Change in Law as mutually agreed between the Parties.

4 O&M Requirements

The Concessionaire shall perform all the obligations under the Agreement with utmost care, effective and efficient and adapt the best practices in all operations and maintenance activities in accordance to the industry standards and in confirmation to the guidelines

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provided in the Manual on Water Supply and Treatment and the Manual on Operations and Maintenance of Water Supply Schemes published and amended from time to time by CPHEEO, Government of India.

The Concessionaire shall undertake the operations and maintenance activities including but not limited to the tasks detailed herein as General O & M requirements & Specific O & M requirements.

4.1 General requirements:

4.1.1 Operating Functions

Basic Operating Functions

Area of Operations	Key Operating Functions
Conveyance	• Conduct routine O&M • Facility management • Asset maintenance • Flow and pressure monitoring
Storage and Distribution	• Conduct routine O&M • Valve inspection • Compliance monitoring for pressure and quality • Flow monitoring • Leak detection and repair • Storage tank inspection • Repairs, rehabilitation, expansion of networks • Replacement of assets as per maintenance schedule
Consumer services	• Install new connections • Conduct meter installations • Meter reading

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	• Billing and collection • Consumer complaints redressal, and monitor • Consumer satisfaction • Debt management
Water Safety	• Water safety plan • Monitoring water quality
Administration	• Planning and coordination with other authorities • Procurement of materials, works and services • Project Management and supervision • Accounts and financial management, and training • Information recording and management • Regulatory reporting • Water Meter Test Bench • Stores and Inventory Management

In the above table, the key basic operating functions are only listed and there are many more routine O&M functions which the Concessionaire has to undertake at different time frequencies.

4.1.2 Asset Replacement

The general asset replacement schedule is shown in the following Table. Asset Replacement Schedule

Item	Scheduled Replacement
Painting of Buildings and OHTs, Pumping Machinery	Once in [3] years
Electrical Motors	Once in [15] years or as and when required
Chlorination Equipment	Once in [5] years or as and when required
Instruments	Once in [5] years or as and when required
Pipe lines	As and when required
Valves	As and when required

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Bulk Meters and Pressure Loggers	Once in [5] years or as and when required
Consumer Meters	Once in [4] years or as and when required
Computers Hard Wares and Software	Once in [3] years or as and when required

4.1.3 Preventive Maintenance

The preventive maintenance tasks generally required in O&M of distribution systems are given in the following Table.

Chart Indicating Preventive Maintenance Schedule

Component	Daily Maintenance Tasks	
Chlorination	Routine Maintenance • Check leakage of Chlorine • Cleaning of chemical deposits • Check fuses and contacts • Check dosing pumps • Check condition of safety equipment	
Pipelines	Routine Maintenance Check residual chlorine Surveillance for leakage – pipe breaks and leaks Pipe flushing once Swabbing and scraping once	 Weekly Daily 6 months 3 years
Valves	Routine Maintenance (A) Sluice valve and Knife gate valve • Check gland packing of the valve at least once in a month. • Ensure that packings inside the stuffing box are in good trim and impregnated with grease.	
	• If necessary change the packing as often as necessary to ensure that the leakage is within limit. • Grease should be applied to reduction gears and grease lubricated thrust bearing once in three months. • Check tight closure of the valve once in 3 months.	

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Component	Daily Maintenance Tasks
	• A valve normally kept open or closed should be operated once every three months to full travel of gate and any jamming developed due to long disuse shall be freed. • Inspect the valve thoroughly for flaws in guide channel, guide lugs, spindle, spindle nut, stuffing box etc. once in a year. • Do not operate with oversize hand wheel or cap or spanner. • Do not operate under throttled i.e. partially open condition (B) Reflux (non-return) valve
	• Check proper operation of hinged door and tight closure under • No flow condition once in 3 months. • The valve shall be thoroughly inspected annually. • Condition of dampening arrangement should be thoroughly examined once in year • In case of dampening arrangement, check for oil leakage and replace oil once in a year. (C) Butterfly Valve • Check seal ring and tight shut-off once in 3 months. • Lubricate gearing arrangement and bearing once in 3 months. • Inspect the valve thoroughly including complete operations once in a year. • Change oil or grease in gearing arrangement once in a year.
Connections	Routine Maintenance
Water Meters & Test Bench	Routine Maintenance • Check for meter accuracy – once in 6 months or

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Component	Daily Maintenance Tasks
	as per requirement • O & M of water meter test bench • Replace Consumer meters – once in 4 years • Replace bulk meters – once in 5 years

4.2 Specific O & M Requirements

Specific O & M requirements to be performed by the Concessionaire are described as following:

4.2.1 General Provisions

The Part II – Operation & Maintenance Module incorporates the mandatory requirements of CCMC regarding Operation & maintenance of distribution system of the project area. O & M will be carried out by the Concessionaire as per the Concession Agreement as approved by CCMC.

O & M plan which shall meet the CCMC requirements as stipulated in Part II – Operation & Maintenance.

4.2.2 Concessionaire's obligation

4.2.2.1 General Obligations

The Concessionaire shall have the following general obligations as they may be applicable during the term of the Contract.

a. The Concessionaire shall perform the Services in accordance with this Contract, and carry out its obligations with all due diligence, efficiency, and economy, in accordance with generally accepted professional techniques and international best practices, and shall observe sound management principles, and employ appropriate advanced technology and safe methods. The Concessionaire shall always act in good faith, in respect of any matter relating to this Contract or to the Services, to

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the CCMC and shall at all times support and safeguard the CCMC's legitimate interest in any dealings with the Customers, sub-contractors or third parties;

b. The Concessionaire shall ensure that all materials and workmanship used in the course of the Contract shall be in accordance with the standard specifications. In absence of and appropriate specification, in accordance with the Indian National Standards or the International Standards Organization as the case may be.

c. The Concessionaire shall develop, install, commission and maintain efficient and effective Integrated Information' Management System (IIMS) comprising of all management needs including customer contact management, commercial services including billing, collection, debt management, new connections, disconnections, reconnections, consumption and flow monitoring, demand management, financial management, asset management, inventory management, human resources management, monitoring .of operating efficiency etc complete as' required for efficient and effective operations and management of the water supply services.

d. In accordance with the obligations in the Concession Agreement, the Concessionaire shall establish and operate a 24-hour customer service center to carry out the functions of customer relations, support and complaints in terms of this Contract including but not limited to response and redressal of complaints concerning leakages in the distribution system, water reduction, water quality, low pressure, and provide assistance in imparting education concerning use of water supply, installation of new connection, water usage and plumbing. The customer service center should be operational during all times of year round the clock with appropriate staff.

e. (ii) Open House Quarterly Meeting:-

(1) Public Grievances Redressal / Open House Quarterly Meetings shall be conducted by the Concessionaire for public to discuss the water related issues and to aware about water conservation..

(2) Public, all Voluntary Organisations, Consumer Action Groups, Residents Associations & Representatives of all other concerned Interested Groups working in the city shall be invited for the meeting through press release.

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(3) Open House Meeting shall enable the participant public/ customers to interact with the Concessionaire to present their grievances as well as sharing and contributing in the decision making by offering opinion/advice and suggestions for system improvement wherever necessary.

(4) Minutes for the Open House Meetings shall be prepared and redressal of petitions / complaints received in the Open House Meeting shall be registered & monitored.

f. The Concessionaire shall install Customer metering on all points of Customer supply and randomly check the calibration of meters installed for accurate reading to establish accurate water balance and monitor water losses;

The Concessionaire shall supply water to CCMC properties with metered connection

g. The Concessionaire shall permit the persons appointed and / or authorised by the CCMC to conduct. time to time audit of accounts and records of the Concessionaire relating to performance of the Concessionaire under the Contract after the Appointed Date subject to receipt of prior written intimation from the CCMC in this regard and shall fully co-operate with such auditors in the conduct of audit and review exercises and checks and shall provide all requested information to the auditors;

h. The Concessionaire shall on a periodical basis update the record of Facilities.

i. Neither the Concessionaire nor its employees shall indulge, either directly or indirectly, in any of the following activities:

   i. during the term of this Contract, any business or professional which would conflict with the activities assigned to them under this Contract;

   ii. NA

j. Any complaints received from the consumer/ CCMC shall be recorded and the appropriate remedial measures shall be effectively implemented to the satisfaction of the CCMC duly documented.

k. Any leakages observed in the distribution line, rising main and feeder main shall be attended immediately and water supply restored within 12 Hours of the receipt of complaint for leakage .

l. The billing and collection of water revenue shall be ensured as per the performance targets during the entire term of contract.

m. The Concessionaire shall be responsible to maintain required quantities of spares for preventive maintenance, periodical maintenance and breakdown maintenance as

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enlisted hereafter in this document. The Concessionaire must also keep the minimum stock of spares for emergency repairs as required for prudent operational practices.

4.2.2.2 Specific Obligations of the Concessionaire for Operations & Maintenance

A. The Concessionaire shall have the following obligations:

a. Review of operating and maintenance manuals if any, prepared by the Original Construction Contractor (OCC), spare parts lists, recommended spares , warranty period from equipment suppliers and connected matters;

b. Identifying and procuring laboratory and workshop equipment and capital spares as may be required, at his cost.

c. select suitably qualified Suppliers of Spares, Consumables, Chemicals and the external Contractors required during Operations.

d. Set up a fully functional office with computers, personnel, equipment, furniture and communications and 24-hour customer service desk at convenient locations as per the General Conditions of the Contract.

e. Set up a fully functional water quality laboratory within the CCMC area and provide personnel, equipment and chemicals for quality control and monitoring. Concessionaire shall perform water meters testing at test bench as per the requirement or as directed by CCMC. Space for the test bench shall be provided by CCMC.

f. The Concessionaire shall assist the CCMC in evaluating and verifying the reasonableness of the Operations and Maintenance Plan and answer all queries, explain the assumptions, projections, calculations etc. and shall make available all the concerned staff who had prepared the respective plans.

B. Notwithstanding the above obligations the Concessionaire shall have the following obligations during Operation & Maintenance

a. Provide prudent management, operation and maintenance services as per the prescribed-standards of performance;

b. Undertake efficient demand management and meet the entire demand for water as required during the time of operation;

c. Comply with Performance Standards at all times, in accordance with the terms of

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the Contract;

d. Undertake customer commercial services including reading meters, raising invoices for services, giving water connections, disconnecting defaulters, reconnecting as per the general conditions of contract.

e. Manage and maintain the Integrated Management Information System (IMIS) to ensure efficient and transparent information, record keeping, financial management and accounting and decision making. Under IMIS, set up a robust integrated information system comprising of the following areas:

i. technical services such as service levels of water quality, consumption, pressure, losses, monthly real time water balance;

ii. commercial services such as customer contact, complaint redressal, customer consumption, billing, revenue collection, debt management;

iii. business services comprising accounts, financial management, procurement, inventory management and human resource management;

iv. Hydraulic network Modeling: A hydraulic network model representing the Coimbatore water supply system shall be developed using suitable software such as Water GEMS. The model shall be calibrated, reconciled and established and fully functional for continuous updating for management of the system;

v. Asset Management Program including covering each type and category of asset, its servicing schedule, replacement frequency, etc. for all assets in water system including but not limited to:

A. Valve inspections

B. Tank inspections

C. Pipeline inspections

D. Leak detection process

E. Preventive maintenance of all mechanical, electrical and instrumentation equipment

vi. Set up operating and maintenance procedures for each of the unit operation including Standard Operating Procedures, Standard Maintenance Procedures, Emergency Procedures, Health and Safety Procedures etc incorporating Original Construction Contractor's Operating and Maintenance Manuals;

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f. Maintain effective and efficient customer complaints redressal system, at the prescribed performance standards;

g. Undertake timely and cost effective asset management program

h. Maintain the automated water quality surveillance system

i. Operate and maintain all mechanical, electrical, instrumentation and information technology installations, equipment, machinery etc as per the respective standard operating and maintenance procedures;

j. Undertake preventive and breakdown maintenance for all pipelines, appurtenances, mechanical, electrical and instrumentation equipment in relation to the above referred Facilities, along with appropriate documentation to facilitate warranty and insurance claims, if required;

k. Ensure effective and efficient planning, procurement and inventory management for all spares, chemicals, consumables etc;

l. Provide robust security arrangements for all the facilities within the scope of this project, including restriction of entry of unauthorised persons;

m. To organize for monthly reading of customer meters, consumption, updating the records, preparing a bill based on the water tariff fixed by CCMC from time to time and issuance of bill to the customers in the prescribed time;

n. To collect the revenue through cash, cheques, demand drafts, electronic clearing services etc and issue receipts of acknowledgement for payment to the customers on behalf of CCMC;

o. To remit cash, cheques and all other forms of payment collected into the designated accounts of CCMC within 12:00 hours of the next business day with appropriate reconciliation accounting system;

p. To prepare monthly accounts of demand, collection and balance and report to CCMC on the revenue management;

q. Manage and maintain the water distribution management system (WDMS) for the entire water supply in the project area, including all pumping stations, water and storage facilities, flow measurement and quality surveillance systems etc. complete;

r. Comply with all relevant local laws including environmental, industrial and labour laws;

s. Maintain healthy working relations with all stakeholders including the customers, CCMC, State Pollution Control Board, and power utilities; etc.

t. Maintain detailed documentation and prepare periodical reports including

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monthly, quarterly and yearly reports for submission to CCMC including data on quality of raw and treated water, leakage levels, flow and pressure of water at designated check points, service level, billing, collection, debt management etc. complete as set out in.

u. Submit Monthly invoices to CCMC including accounts receivable, adjustment for errors in billing, accounting for realization and generation of overdue receivables;

v. Training of the operating personnel from CCMC or any other designated authority for taking over the system at the end of Contract Term;

w. To undertake emergency chlorination measures at times of outbreak of epidemics and any such emergency situations;

x. Rectify all defects attributable to the Concessionaire and notify the CCMC of defects, developed within defect liability period of the commissioned components of Water supply system;

y. Follow all reporting requirements

z. Maintain the Performance Indicators, Quality Assurance, Safe Operation Procedures (SOPS);

aa. To summarize, the services provided by the Concessionaire shall include the following:

- Operation of all Facilities;
- Provision for 24 hours a day operation and emergency cover;
- Maintenance of all the Facilities;
- Ground and buildings maintenance;
- Unscheduled and emergency maintenance;
- Responding to customer enquiries;
- New service connection surveys and estimates;
- Making new service connections;
- Investigation of illegal connections and disconnections;
- Responding to requests from utilities and others for water supply lines;
- Quality control and assurance;
- Data collection and reporting;
- Holding emergency exercises;
- Incident management;

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- Safety inspections;
- Supervision of subcontractors, enforcement of specifications;
- Operational liaison;
- Updating of the IMIS;
- Preparation of all plans, procedures and budgets relating to operational matters, as required within the Contract.
- Any other work necessary to ensure the continued operation and availability of the system.

bb. Maintenance Work for the pumping stations/ BPS/tubewell is divided into four categories Preventive, Corrective, Replacement, Minimal Maintenance;

cc. Preventative maintenance (PM) is defined as those maintenance procedures that are implemented repetitively at regular interval. The works carried out shall consist but not be limited to:

- Greasing, oil changing, provide fuel, distilled water, recharging gas;
- Cleaning from dust, mud and sediments, testing, calibrating, checking of tightness of all
- connections, general cleaning for the body, charging, cleaning filters;
- Check gauges, adjust gland-packing and repair or replace if required;
- Replace worn-out drain lines, fittings replace fuses, bulbs and similar, if required;
- Inspecting all fans, compressors, motors wiring, switches, controls, protection devices;
- Check for correct operation;
- Any other related works in accordance with manufacturer specifications and instructions.

dd. Corrective Maintenance is defined as those maintenance works performed to repair parts to correct the situations. The works carried shall include but not be limited to:

- Dismantle the unit;
- Check the body (casing) and covers and clean it. If the casing is

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corroded, the Concessionaire shall submit the filling material, coat it with suitable paint to the CCMC's approval;

- Check all connections and fittings and repair the corroded and closed fitting wherever needed;
- Clearance work should be to the manufacturer instructions and specifications. If the clearance is above the range, the Concessionaire shall replace wearing and any other fittings or materials to keep the unit in its range;
- All wearable parts such as gland packing, packing bushes, oil seals, O-rings, gaskets, rubber parts, fuses, bulbs shall be replaced;
- Repair the part which is needed to be repaired according to the work orders;
- Assemble the unit and check for proper operation;
- Any other related works in accordance with the manufacturer specifications and instructions.

ee. Replacement Maintenance is defined as those maintenance works applied in response to situation that cause equipment to be out of service and beyond repair.

ff. Minimal Maintenance comprises a suitably qualified person visiting a pumping station and carrying out an inspection possibly with basic items of maintenance such as greasing and bulb changing. Such work can be expected to be completed by one person, within an hour.

gg. All instruments shall be maintained, checked, calibrated and serviced periodically and will always be kept in operating condition. The calibration shall be checked whenever necessary and corrected. Calibration data shall be submitted to the CCMC for approval. As a minimum, all instruments shall be calibrated once per year.

hh. For the purpose of complying with the requirements of this contract, the Concessionaire will need to provide.:

i. An adequate and skilled workforce, supervisors, managers and technical support staff;

ii. Administrative and financial support staff and computer and business support systems;

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iii. All necessary mobile plant and equipment, vehicles and incidental equipment;

iv. Health and Safety equipment and staff protective clothing as well as traffic and footpath barriers and signs;

v. Necessary chemicals and fuel;

vi. Stores suitably stocked with adequate spare parts and replenished within a store policy that recognizes frequency of use and delivery periods;

vii. Suitable depot and office premises.

ii. The Concessionaire shall carry out the complete cleaning & disinfection of ground service reservoirs, master balancing reservoirs etc. once in a year.

jj. The Concessionaire shall carry out operation and maintenance of meter testing facilities.

4.2.3 Standard Operating Procedures (SOP)

Operating Instructions and Safe Operating Procedures (SOP) shall be formulated for each Site comprising of process equipment schedules, operation & maintenance data, sampling and analysis with frequencies etc. The operating parameters shall be optimised based on the data collected on commissioning of the facilities. All the activities in the preventive maintenance schedule shall be followed without any lapse. Indicative functions that are expected to be performed at each site are given below:

1. Water Supply

Water pumping stations/ BPS and transmission main

a) Check operation of all pumps
b) Take all relevant meter readings
c) To ensure compliance with agreed withdrawals and to bring to notice of the CCMC any excess or short withdrawal
d) Check operation of all valves along the transmission main
e) Flow and pressure measurement
f) Checking operations of electrical & mechanical equipment
g) Check the power factor and power consumption

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Feeder main pumping

Stations

a) Inspect the overflow devices
b) Check operation of all pumps
c) Take all meter readings at such times of the day, as agreed with the CCMC
d) Check distribution of flows to feeder mains
e) Checking operations of electrical & mechanical equipment

Supply

Network

a) Take all relevant meter, flow and pressure readings
b) Check operation of all equipment
c) Periodically check water meters, test bench and take readings
d) Check for Chlorine residual, flow and pressure at the Critical Measurement Points (CMPs)
e) Checking operations of electrical & mechanical equipment

4.2.4 Maintenance and Repairs (Mechanical, Electrical and Instrumentation)

4.2.4.1 Management and Maintenance Plan

A properly designed water system shall be capable of delivering desired output at all times. Considering that every mechanical system shall have to be given a downtime for maintenance purposes, the CCMC may schedule a plant downtime of the facilities to the upstream of MBR/MSR in consultation with the Concessionaire so as to minimise disruption in services. It is clarified that despite the best efforts of the Concessionaire, if a disruption in the services results due to such downtime by CCMC, the Concessionaire shall not be penalized.

4.2.4.2 Routine Inspection and Maintenance of Equipment

The Concessionaire shall carry out routine monitoring of the equipment and ensure that the

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equipment is properly maintained to meet the desired output. Typical tasks that shall be undertaken are :

(A) Mechanical

(a) Checking the lubrication and necessary follow-up
(b) Replacing of glands that are leaking
(c) Servicing as per supplier's instructions
(d) Stripping down of pumps to observe clogging if any
(e) Checking for unusual vibrations and noise

(B) Electrical

(a) Checking electrical contacts and wiring
(b) Checking motor heating and noise level
(c) Assessing efficiency of electrical equipment

(C) Instrumentation

(a) Cleaning and calibration of probe / sensors
(b) Fault diagnosis

These maintenance tasks shall be issued on a weekly basis through computer aided management system and the Concessionaire shall incorporate it in operating work schedule. All observations shall be recorded in the properly designed record system and would be analysed for initiating corrective actions, if any.

4.2.4.3 Planned and Scheduled Maintenance (Preventive)

A work schedule chart listing identification of critical equipment, work assignment, timing shall be prepared. Critical equipment is defined as those items where failure would adversely affect the quality and quantity of output or those that risk the safety of employees or customers. The schedule shall identify the responsible person / agency who shall be intended to complete the task e.g. in - house technician or specialist contractor etc.
The overall yearly plan schedule shall be issued to all parties to enable forward

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planning of anticipated manpower requirement and equipment down time. The indicative maintenance schedule is provided further in the following table. This shall be finalised during the preparation of the Operation and Maintenance Plan.

4.2.4.4 Breakdown Maintenance

The aim of routine and preventive maintenance is to keep breakdown to minimum for items of critical equipment which shall directly affect the performance of treatment processes. However certain breakdown may occur in spite of proper maintenance. The Concessionaire shall take the breakdown maintenance on top priority to keep disruption to the systems at a minimum level.

The Concessionaire shall have an option to call other available staff and also the services of the local skilled contractors should the breakdown occur.

4.2.4.5 Spare Parts

The Concessionaire shall store spares of all the critical equipment on respective sites and the inventory shall be assessed according to anticipated usage and in conformity with Annual Operating and Maintenance Plan and Annual Budget.

The Concessionaire shall obtain consumable items required for maintenance e.g. grease, gaskets etc. from local suppliers, as and when required.

Annual reports on the cost of replacement spare/million litre of water supplied shall be provided to the CCMC, for the purpose of monitoring usage and cost control.

4.2.4.6 Maintenance Report

To assist the Concessionaire in the management of the maintenance activities, a Computer Aided Maintenance Management (CAMM) shall be implemented by the Concessionaire which shall be integrated with the IMIS system. Appropriate proprietary CAMM packages shall be utilised by the Concessionaire for maintenance purposes. This package shall incorporate features such as Facility details, maintenance history records, and scheduling of maintenance activities. The use of such package shall allow the Concessionaire to predict when the maintenance activities need to be carried out.

Record of maintenance jobs carried out shall be reported in the record system, which shall

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provide the CCMC the past history, time and cost involved for each category. The report shall include:

(a) Details of number of jobs completed

(b) Frequency of breakdown, time required repairing and costs involved.

(c) Personnel involved / contractors used

Input data along with the base data and license, if assignable, would be made available to the CCMC.

4.2.5 Emergency Action Plan

i. The Concessionaire shall provide Emergency Plan of Action , as per the following:

a. The CCMC may, at its election, intercede and take, or direct the Concessionaire to take, any and all actions reasonably necessary to respond to an Emergency.

b. The Concessionaire shall, upon learning of an Emergency or the probable occurrence of an Emergency, (1) immediately provide oral notice to the CCMC or its Authorized Representative of the same and (2) as soon as possible, but no later than twelve (12) hours, provide Notice to the CCMC or its Authorized Representative of such event or probable event; provided however, if Applicable Law shall provide for a more expeditious oral or written notice of any Emergency to the CCMC, the Concessionaire shall so comply by providing such notice to the CCMC or its Authorized Representative.

c. The CCMC and Concessionaire or their Authorized Representatives shall coordinate with each another prior to, during and after the occurrence of an Emergency including 1) the planning and implementation of actions designed to prevent or mitigate damage to the System and the environment and (2) the attendance of all meetings related to such planning and implementation.

d. The Concessionaire shall interact and cooperate with appropriate

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departments of the public entities comprising the CCMC and other jurisdictions.

e. The Concessionaire shall supply standby employees from normal system staff ready to address an Emergency in an expeditious manner.

ii. Response Times and Emergencies:-

The Concessionaire commits itself to a high standard of effective response. To indicate commitment, the Concessionaire shall establish 'Standards of Service' which shall define the Concessionaire's response to any emergency with the intention of minimising the possible impact of an emergency or failure on the output of the Facilities. These standards shall be agreed with the CCMC and would typically include:

Situation	**Response**	**Target Time**
To any alarm or non-conformity during normal work time, or when the Facilities are being manned .	Any threat to public or personal health.	Immediate
	To attend to and assess the required action and the resources needed to effect remedial action. Effect first call repairs where possibl e	Immediate
	If the problem requires further resources, to have remedial work on site rectifying the problem	2 Hours
To any alarm Or non-	Any threat to public or	Immediate

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Situation	Response	Target Time
conformity occurring outside normal Operating hours or when Facilities are unmanned	personal health.	
	To attend to and assess the required action and the resources needed to	1 Hours
	effect remedial action. Effect first call repairs where possible	
	If the problem requires further resources, to have remedial work on site	2 Hours

A dedicated problem solving team shall be appointed by the Concessionaire and this team shall have the responsibility of tracking problems through to a satisfactory outcome. Major events that threaten public, employee or process safety or security shall be managed directly by an Concessionaire's Representative, who shall have full authority to utilise whatever resources he considers fit to rectify any emergency situations. In performing these duties, this manager shall have full responsibility for ensuring proper and adequate communications with the CCMC and other relevant bodies.

4.2.5.1 Permits

1. Both the CCMC and the Concessionaire will be responsible for obtaining various permits, authorizations and consents to enable them to carry out their duties. These will include, but not be limited to the following:
2. Permits to be obtained by CCMC
   a) Abstraction licences from various department
   b) Planning permissions
   c) Public way leaves that may be required from time to time
   d) Building permits
   e) Discharge consents
   f) Disposal licenses for sludge
   g) Permissions to enter public and industrial properties
3. Permits to be obtained by the Concessionaire

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a) Vehicle and plant licenses
b) Licenses to store and use chemicals
c) Licenses to use machinery
d) Waste management licenses
e) Health and Safety certificates
f) Fire certificate
g) Approval from Labour Inspector
h) Approval from District Health
i)Insurance as appropriate
j)Licenses to carry out water operations
k) Right to use Electrical power

4.2.6 Sampling, Testing, Reporting Requirements

4.2.6.1 Laboratory

A laboratory equipped to perform all quality control, sampling, testing and analysis as required will be set up by Concessionaire within the CCMC area in a location approved by CCMC. All equipment including glassware and instruments will be provided by Concessionaire as part of this Contract.

4.2.6.2 Sampling and Analysis

The Concessionaire shall collect all water samples related to the system required by Applicable Law and provide and submit in a timely manner all such samples to the CCMC for analysis unless otherwise directed by CCMC or its Authorized Representative. All results of analysis shall be certified and provided to the CCMC Authorities (and to the applicable Governmental Authorities) if required by Applicable Law) in a timely manner and in accordance with the requirements of this Agreement.
It should be noted that the measures referred to above are to ensure that the quality of supplied water from SR/Sump within standard norms. Other parameters will be monitored on a regular basis to determine performance against a number of determinants to determine whether the Concessionaire is liable to pay Liquidated Damages. It is clarified that the Concessionaire shall be solely responsible for ensuring the quality of water supplied. However, the Authority might carry out random tests on its own to ensure that the water quality is in accordance with the applicable norms.

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4.2.6.3 Reporting Problems

The Concessionaire shall immediately notify and provide the CCMC or its Authorized Representative with any and all information as the same becomes available related to any activity, problem, event or circumstance that is an abnormal condition, including overflows and bypasses on the System, that threatens or may threaten compliance with the requirements of this Agreement, the public health, safety or welfare of the residents of the CCMC's Service Area as identified in Schedule 1 or disrupts System operations or requires notifications to Governmental Authorities. To the extent the Concessionaire, is required by Applicable Law to notify the applicable Governmental Authorities, it shall do so in compliance with the timeframe required by Applicable Law provided, however, the Concessionaire shall always endeavor to notify the CCMC or its Authorized Representative of such abnormal condition before it notifies the applicable Governmental Authorities, if required, of such condition. The Concessionaire shall continue to update and provide any and all information regarding such act or event to the CCMC's Authorized Representative and, to the extent required of the Concessionaire by Applicable Law, to the applicable Government Authorities, as such information becomes available. The Concessionaire shall take all reasonable steps necessary under the circumstances to develop and provide to the CCMC's Authorized Representative within four (4) hours after becoming aware of the abnormal condition, the reasons or events giving rise to the abnormal condition, a full and complete assessment of the situation based on such available information, provide recommendations as to the responses that are and should be undertaken by the Concessionaire to address and cure the abnormal condition and continuously update the CCMC or its Authorized Representative of the same as information becomes available. Further, the Concessionaire shall immediately, but in no event later than period of time prescribed, as applicable, above, commence (1) all necessary investigative, corrective and mitigative actions required by Applicable Law, (2) implementation of the Emergency plans as required, to the extent it is applicable to the situation, (3) implementation of the activities required by this Agreement, (4) implementation of Capital Repairs or Replacements, Material Capital Repairs or Replacements and Emergency repairs and (5) physical inspection and gathering of information and other data from field locations as may be necessary and appropriate to assess the range of responses that may be available and appropriate to the situation, including that information and data as may be requested by the CCMC or its Authorized

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Representative.

4.2.6.4 Failure to Comply

Failure of the Concessionaire to comply with the requirements shall lead to withholding the performance fee due to the Concessionaire.

4.2.6.5 Service indicators

Level of service (LOS) Indicators which measure the effectiveness of service and operation levels will be developed and monitored as per following Table.

Level of Service Indicators			
No.	**Level of Service Indicators**	**Frequency of Monitoring**	**Response Repair Time**
1	Bursts in the transmission mains and-feeder mains of water supply system.	Weekly	Response time within 6 hrs
2	Bursts in the distribution network pipelines	Weekly	Response time within 4 hrs
3	Billing complaint	Monthly	Response time within 3 days
4	Downtime of pumps/ T/w at all pumping stations.	Monthly	Repair time within one day except for major repairs and replacement which shall be within 7 days

4.2.7 Integrated Management Information System (IMIS)

The Concessionaire shall establish, develop and maintain all Integrated Management Information System (IMIS). The IMIS shall have capabilities for facility management, inventory management, billing and collection management, operational job management and records and data management as well as all capabilities necessary for safe and efficient management, operation and maintenance of the Facilities.

4.2.7.1 The Concessionaire's and the CCMC Responsibilities.

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A. The Concessionaire shall be establishing, keeping and maintaining the IMIS in consultation with the CCMC. The Concessionaire shall collect and keep up to date information on the facilities, both above and below ground.

B. All Facilities taken over by the Concessionaire shall be entered into the IMIS.

C. The Concessionaire shall verify all information in accordance with procedures agreed with the CCMC.

D. The Facility Register shall be supported by operational information on compliance with Performance Standards, part wise.

E. The Concessionaire shall be responsible for operating the Facilities and the Conveyance System in the correct manner and for maintaining them in a professional manner.

F. The Concessionaire shall use the data to plan the Annual O&M Plan in consultation with the CCMC.

G. CCMC may use the information to gain an overall view of the Facility's value, performance and condition.

4.2.7.2 Facility Register

The Facility Register shall be a schedule (a computerized database, but also available on prayer for ease of inspection) of all the Facilities and the Conveyance System to be maintained under the responsibility of the Concessionaire as agreed with the CCMC. The Facility Register shall be used to perform, or support, the Services carried out by the Concessionaire

The format of the Facility Register shall be designed in consultation with the CCMC.

The CCMC shall have the right to verify the Facility Register and Concessionaire's procedures for keeping it up to date.

4.2.7.3 Facility Numbering

Each above ground Facility shall be given a unique number within the Facility register. Numbering system shall be designed in consultation with the CCMC. The number shall refer to the site and the type of Facility.

4.2.7.4 Performance and Condition Grades

Performance grades shall define whether the Facility is meeting the required quality standards or levels of service standards or is suitable for its function. Condition grades shall

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define the structural condition of the Facility. This may be from an assessment of the structural condition or from recording of the frequency of failures of the Facility. Following Table describes the meaning of some of the Grades of the Facilities. Detailed definition of these Facilities shall be formed within six months of appointed date of Operations Period, for each Part, in consultation with the CCMC.

Definition of Facilities		
Grade	**Description**	**General Meaning**
1	Good	Of sound structure with components that are operable and well maintained
2	Fair	As 1, but showing some minor signs of deterioration Routine repair, refurbishment and maintenance required with review of condition in the medium term
3	Adequate	Functionally sound, but affected by minor cracking, staining or minor leakage. Some reduced efficiency and minor failures. Review of condition required in the medium term with action likely to be needed in the medium term to prevent deterioration to Grade 4
4	Poor	Condition has a significant effect on performance of the Facility with components requiring significant repair or maintenance to remain operational. Shall require major overhaul/replacement with in the mediumterm.
5	Bad	Condition of the Facility has a serious effect on its performance. Effective life of mechanical and electrical plant and other components is exceeded and incurring excessive repair and maintenance costs due to unreliability. Shall require major overhaul/replacement in the short term.

4.2.7.5 Timing Definitions and Differentiation between Facility Types

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a) Performance Aspects

The Concessionaire shall develop a clear understanding of the exact meaning of the phrases 'Immediately', 'Short Term' and 'Medium Term' used in association with the performance Grades with the CCMC, within six months of appointed date of the Operating Period.

b) Condition Aspects

Different Facilities shall have different expected life span. Buildings or Civil (usually reinforced concrete structures) Facilities are expected to have a Facility life of 30 years. Electrical and Mechanical Facilities are expected to have a Facility life of 15 years. Bulk water mains would be expected to have Facility life in excess of 30 years, or may be taken as having an indefinite life.

The terms 'immediate', 'short term', 'medium term' need to describe approximately when major work shall be required related to the Facility's normal life.

4.2.7.6 Records to be Produced and Maintained

The scope of the Facilities to be included are summarized in following Table:

Scope of the Facilities	
Type	Facilities
Management and General	Workshops Stocks Computers and associated equipment Land Vehicles Plant & machinery BPS

4.2.7.7 Operational Job Management

The Concessionaire shall establish and maintain a suitable job management system, in consultation with the CCMC. This job management system shall provide detailed information on Facilities such as the type and make of motors, maintenance schedules etc.

4.2.7.8 Record Drawings

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Data on Facilities shall be mentioned on Record Drawings.

The CCMC shall ensure that the Concessionaire is given available Drawings of all Facilities. The Concessionaire shall accept the As-Built Drawings as per the scales and standards utilised by the Original Construction Contractor(s). The data can then be extracted and summarised on the IMIS. The Concessionaire shall establish and maintain up to date Record Drawings for both above ground and below ground Facilities.

The Concessionaire shall update the Record Drawings and Facility Register to include the Facilities taken over , together with any works that are subsequently undertaken. The Record Drawings shall be updated by the Concessionaire within 3 months of any modifications being carried out in the Facilities.

4.2.7.9 Accuracy of Data.

The Concessionaire shall assign 'Confidence Grades' to the data to validate its accuracy. The Concessionaire shall develop the definitions of these grades and how they are to be used in consultation with the CCMC.

4.2.7.10 Inventory Management

The Concessionaire shall operationalise a computer based inventory management system to enable effective control of spares and consumables on the commencement of the Operations Period. This system shall use standard proprietary software and shall be linked by the Concessionaire to IMIS. The Concessionaire shall provide monthly reports from this system to the CCMC in support of the expenses incurred.

4.2.8 Customer Service Management System

Customer service encompasses a broad range of activities. The Customer Service Management System shall have an interface with the Customer's premises to ensure required performance parameters are met (e.g. water pressure and flow) and proper response are given to customer enquiries. The following provisions shall be integrated into the customer service management system:

i. At least 24 hours advance warning of planned supply shut off for repairs and

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renewals

ii. Advice Customers during emergencies

iii. Recording and Responding to Customer Complaints.

iv. The Concessionaire shall develop a Customer management strategy with a view to establish world class quality of Customer Services.

v. The strategy prepared by the Concessionaire shall include, but not be limited to, a comprehensive strategy to establish a Customer Service Centre.

vi. The Concessionaire shall receive and handle all customer queries and complaints, including, but not limited to, queries and complaints related to

- water bills;
- malfunctioning or inaccurate meters;
- meter readings;
- water quality;
- water pressure;
- leakage and damaged pipes;
- change in meter location;
- changes in customer names; .
- cancellation of connection by the customer

4.2.8.1 Systems and Procedures for Creating and Updating Customer Database

In terms of the Concession Agreement, the Concessionaire shall operationalise a Customer Database, with which all customer contacts with respect to billing and provision of services can be controlled.

Information held shall include the Customer name, reference number, mailing address, telephone number and account history information. The supporting data shall be made available by the CCMC sufficiently in advance. The Concessionaire will update the database from time to time.

4.2.9 Meters and Meter Reading

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The Concessionaire's personnel shall read bulk water supply meter and the end use meters on a periodic basis. The Concessionaire shall enter the meter reading into hand-held data entry machine (ITRON or PSION or similar) provided by him. The individual readings shall be downloaded at a central terminal at regular intervals to create a billing schedule. All bills shall have digital photograph of meter reading printed on the consumer bill.

The Concessionaire shall:

i. read all Customer Meters in accordance with the general instructions of the CCMC;

ii. register all Customer Revenue Meters readings in the appropriate computer data base;

iii. develop a monitoring program of random spot-checks to ensure the accuracy of the -meter calibration and the meter reading process and provide written reports to the CCMC on the results of the monitoring programme;

iv. develop and implement a plan the intent of which is to ensure that:

- all Customer Meters are accurate;
- all Customer Meters are read;
- all Customer Meters are in suitable locations;
- problems related to unprotected and unsealed Customer Meters are resolved;

v. provide advice as to methods to improve the meter reading process to ensure greater accuracy;

vi. convert all Customer Meters readings to billings to Customers;

vii. identify Customer Meters which have not been read; and

viii. respond to reports of malfunctioning Customer Meters from Customers.

4.3 Customer Service

Pursuant to article 27 of General Conditions of the contract, a 24 hour customer service desk shall be established by the Concessionaire. The customer service desk will be integrated with the IMIS. All enquiries and customer complaints shall be recorded into the system along with resolution mechanism, time of resolution, action taken and feedback procedures.

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4.4 Financial Management and Customer Services

4.4.1 Financial Management

The Concessionaire shall prepare a comprehensive Financial Management Plan in respect of all matters including but not limited to:

i. financial management, including accounting systems;
ii. the billing and collection systems;
iii. Customer Services, including data bases relating to complaints and questions and response times with respect to complaints and questions;
iv. information systems; and
v. asset registers from the perspective of maintaining a prudent asset management system and accounts.

4.4.2 Billing and Revenues Collection

4.4.2.1 Billing & Collection system

The Concessionaire shall develop a robust billing, collection and revenue management system with facility for easy up gradation and improvement. This shall include but not be limited to;

i. Effective water billing practices and procedures;
ii. Effective revenue collection practices and procedures; and
iii. a simple and efficient connection, disconnection, and re-connection procedure.

4.4.2.2 Billings and Collection of Revenues

The Concessionaire further acknowledges that it will take over full responsibility for billings and collection in the Service Area for and on behalf of the CCMC.

The revenue collection system shall support all CCMC standard payment methods at the minimum and would be designed to incorporate additions. In addition it will cover the following:

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- Preparation and issue of a debtor statement
- Timetable for the issue of reminders and recovery notices shall be established and issued to consumers at the regular intervals based on the inputs.
- Intimation to the CCMC of continued debtors for the CCMC's action like disconnection etc.
- Additional charges such as disconnection/reconnection fees , damage cost and late payment penalties shall be billed.

The Concessionaire shall:

i. collect all amounts due to the CCMC as Revenues related to the Services.
   a) through the Concessionaire's billing offices;
   b) through banks, electronic transfer;
   c) by other means as may be agreed to by the CCMC.

ii. Identify and record all outstanding accounts and take all necessary measures to collect outstanding accounts;

iii. submit to the CCMC summary and analysis of unpaid accounts (every month);

iv. manage all aspects of customer services with the Customers.

4.5 Environment Management Plan

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Environmental Management Plan Project Activity	Environmental Impacts	Mitigation Measures	Primary Responsibility
Bursts	Flooding and leakage of water in the influence Area during implementation	Appropriate shut off or bypass and leak control arrangements shall be ensured	Concessionaire
Replacing the valves	Temporary disruption of water supply to the consumer	Alternative supply arrangements such as supply through tankers shall be provided.	Concessionaire
Leak repair and replacement of mains New pipelines or extensions Working in roads or restrictive places Repair of pipelines Construction or installation of new structures or equipments	Disruption of water supply to the consumers during execution Disruption of traffic during execution Safety hazards to labour Disturbance to other utilities such as telephone cables and sewer lines etc. Increased noise levels during construction	-Alternative supply arrangements such as supply through tankers shall be provided. -Appropriate traffic diversion plans shall be prepared and implemented during construction -Adequate safety precautions such as helmets, safety shoes, gloves, etc. shall be provided to the labours -Scheduling activities in consultation with the other utility agencies and ensuring minimum disturbance to the utilities -Use of low noise generating equipment for all the activities, provision of personal protective equipment, ear muffs, etc. for the construction labour and	Concessionaire Concessionaire Concessionaire Concessionaire Concessionaire

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		avoiding construction activities during nights	
Replacement of service connection	Temporary disruption of water supply	Alternative supply arrangements such as supply through tankers shall be Provided.	Concessionaire
Provision of appropriate water meters & taps	Temporary disruption of water supply	Alternative supply arrangements such as supply through tankers shall be Provided.	Concessionaire

This Concession Agreement Contains

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Water, Recycling and Specialty Technologies

CERTIFIED TRUE COPY OF THE RESOLUTION PASSED IN THE MEETING OF THE BOARD OF DIRECTORS OF SUEZ PROJECTS PRIVATE LIMITED (FORMERLY KNOWN AS SUEZ ENVIRONNEMENT INDIA PRIVATE LIMITED) HELD ON FRIDAY, 15TH DECEMBER 2017 AT 11:00 AM AT 16 PLACE, DE L'IRIS, TOUR CB 21, LA DEFENSE CEDEX, PARIS, FRANCE, 920140.

"**RESOLVED THAT** Mr. Shyam Jee Bhan, Managing Director of SUEZ Projects Private Limited ("Company") and Mahendra Ananthula, S/o Mr. Venkat Reddy Ananthula, aged about 47 years, Assistant Vice President- Sales & Business Development of the Company, be and are hereby authorized, jointly and /or severally, to execute the concession agreement and all other instruments / documents on behalf of the Company that may be necessary for the execution of the contract for the purpose of the work for the Coimbatore Corporation- AMRUT Scheme- "Implementation of 24*7 Water Supply System for the city of Coimbatore" awarded to the Company by the Coimbatore City Municipal Corporation, vide its letter of award no. ROC No. 2896/08/JN5 dated 24th November, 2017."

FURTHER RSOLVED THAT the Common Seal of the Company be affixed on the aforementioned documents, as may be required, in the presence of Mr. Shyam Jee Bhan, Managing Director of the Company and/ or Swaratmika, Company Secretary of the Company."

Certified True Copy
For SUEZ Projects Private Limited

Swaratmika

SUEZ Projects Pvt. Ltd. suez New Delhi

Swaratmika
Company Secretary
Membership No.:A39450
876, R. K. Puram, Sector 4, New Delhi.

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