TECHNICAL SPECIFICATIONS

Name of work: Sewage Water Treatment Plant for Terna Sahyadri Specialty Hospital at Nerul, Navi Mumbai

SECTION-01: BASIS OF DESIGN

1. The capacity/ rating of pumps and equipment etc. shall hold good for the capacity of 150-180 cum / day i.e. 150-180 KLD and shall be good for meeting the treated parameters requirement as follows:

- Permissible limit as prescribed in IS: 2490 (Part-I) – 1974 and environment (Protection) Rules 1986.
- Water (Prevention and Control of Pollution) Act, 1977 and 1978.
- Environment (Protection) Rules, 1986.
- Hazardous Wastes (Management and Handling) Rules, 1989.
- Manufacturer, Storage and Import of Hazardous Chemicals Rules, 1989.
- Manufacturer, use import and storage and hazardous Micro-Organizers, Genetically Engineered organizations or Cell Rules, 1989.
- Manual on sewage and sewage treatment – CPHEEO
- The Public Liability Insurance Act, 1991.
- All standards as laid down by Central Pollution Control Board/ Maharashtra Pollution Control Board and any other relevant statutory authority.
- Any amendments laid from time to time by MoEFCC, MPCB, and CPCB etc as applicable till consent to operate is obtained.
- IS 10500-2012- drinking water standards.

SECTION-02: SEWAGE TREATMENT PLANT

1 GENERAL

The sewage treatment plant (STP) system outlined in this section specifies the system design, manufacture, supply and installation of a standard Combined Technology of Activated Sludge Process and Membrane Separation Process.

The Contractor may propose alternatives to this type of system, but these must be to a standard acceptable to Water and Sanitation Authority Requirement, Local Pollution Control Board Norms, World Health Organization Guidelines, the local Environmental and Pollution Control Authorities and subject to the approval of the Project Engineer/there representative. The contractor will have to highlight the benefits and disadvantages of system proposed as compared with other parallel main stream treatment systems in terms of technical and financial parameters including for design, built and operations- maintenance requirements.

The work shall be carried out in a manner consistent with Indian standards of specifications as applicable. In case of absence of relevant Indian standards, suitable BS/ASTM/EN codes will be applicable to this tender. The Contractor shall take into account all site conditions in designing the system and selecting the equipment.

The Contractor shall be responsible for engaging a STP specialist to perform the system design and obtain approval from relevant Authorities and Project Engineer's/ Project Engineer's representative. A qualified and experienced Engineer shall be engaged for the system design, preparation of system proposal submission, obtaining approval and site supervision.

The Contractor shall perform the system design based on the criteria/data and component technical requirements specified in this section/drawings and the local Authorities' regulation/requirement.

The Contractor shall furnish system which comprises products of manufacturers who have designed and made these associated products for a period of at least five years.

The Contractor shall submit complete catalogue information, design calculation and samples complete with full technical data and shop drawings for the entire system, test certificates, etc. for acceptance prior to commencement of installation.

The Contractor shall submit analytical test reports of influent water samples and treated (effluent) water samples after the commissioning or after the system is put into operation or as required by the Project Engineer/there representative. The scope of work under this contract will include assisting Project Engineer/there representatives to obtain necessary consent to operate from local pollution control government authority.

As a minimum the following items shall be measured and analyzed as indicated under clause 2.1 following.

1.1. Duration of Contract

The entire duration of this contract is 4 months, of which 3 months for associated civil works, plant design, manufacturing and installing and period of 1 month for test run and commissioning of the plant.

This duration will be measured from 15th day of issue of Letter of Intent or work order whichever is earlier.

The offers submitted shall be valid for the period of 90 days for acceptance by Project Engineer.

2 DESIGN CRITERIA

2.1 It shall be the Contractor's responsibility to ensure the quality of the treated effluent to comply with the local Authorities requirement and the following characteristics, whichever is stringent.
It is proposed to use minimum 35 KLD of treated water for chiller and cooling tower back up water. The treated water shall meet following conditions.

Parameter	Unit	Characters
Temperature	In Degree C	Less than 45.
PH		6.0-8.5
Colour		7 Lovibond units
BOD (5 D at 20 degree C)	mg/l	<5
COD	mg/l	<10
TSS	mg/l	<3
Nitrogen	mg/l	< 5
Phosphorus	mg/l	< 5
Oil and Grease	mg/l	Nil
Total Coliform Count	MPN/100 ml	<5
TDS	mg/l	500
Alkalinity	mg/l	300
TP	mg/l	< 1
TKN	mg/l	< 5
TN	mg/l	< 10
Detergents (linear alkylate sulphonate as methylene blue active substances).	mg/l	<15
Arsenic	mg/l	Absent
Barium	mg/l	<5

Tin	mg/l	<10
Beryllium	mg/l	Absent
Boron	mg/l	<5
Manganese	mg/l	<5
Phenolic compounds (expressed as Phenol)	mg/l	Absent
Cadmium, Copper, Lead, silver	mg/l	<0.1
Mercury	mg/l	<0.05
Nickel, Zinc, Free Chlorine,	mg/l	<1
Phosphate	mg/l	<5
Calcium	mg/l	<150
Magnesium	mg/l	<200
Metals in Total	mg/l	<1

The balance portion of treated water shall be used purpose of irrigation in the plot area. Hence, the treated water quality shall meet irrigation water standards of disposal, as informed by MPCB from time to time.

In future, entire treated water may be used for flushing water needs in the complex. Hence, in such scenario the system design should be such that as per requirements, additional capacity tertiary treatment shall be augmented without disturbing current operations and any other additional cost, except for additional tertiary treatment system procurement and installation.

2.2 Description of Process

The Sewage Treatment Plant shall be modular and packaged type installed on levelled ground. The treatment process shall comprise the following stages:

- Physical treatment: coarse bar-screening

Primary treatment: auto coarse bar-screen and Comminutor (grinder)

- Grease Trap Oil and Grease separation
- Equalization tank: flow equalization with air Mixing
- Flow measurement: flow meter
- Nitrates removal Required
- Biological treatment: MBBR/ FBR/SBR as suitable to waste water quality
- Final sedimentation: final settling tank with scraper
- Settling alum dosing
- Optional: Ultra violet treatment ultra violet system with Control.
- Disinfection: chlorination system : system with dosage control
- Digester: aerobic digestion with individually retrievable air diffuser system.
- Water reclamation: Partially tertiary filtration and sterilization for irrigation, cooling tower makeup purpose and Flushing. Balance water quantity meeting irrigation standards but with sterilization.
- Sludge disposal: sludge chemical conditioning, disinfecting, dewatering and disposal.

The parameters and process components indicated above are only indicative. It will be entire responsibility of contractor to add/amend and correct the design process to suit the treatment. However the performance characters mentioned under clause no 2 will remain valid and applicable under any circumstances.

2.3 Performance Criteria of the Plant

Raw sewage will be brought into the pumping room/collection chamber near Sewage Treatment Plant. The Contractor shall make arrangements to receive sewage from this point to the treatment plant for treatment process. The pumping or gravity delivery system required shall be designed by STP contractor.

The treatment plant shall be designed to treat the following basic characteristic expected in the raw sewage. The waste water characters are based upon sampling done at project site and for indicative purpose only. However, it will be entire responsibility of contractor's to reestablish the water characters and design system accordingly.

Description	Details
• Estimated daily flow	150-180m^3 / day
• Discharge period	20 hrs. / day
• Average flow	9 m^3 / hr.
• PH	5.75-7.50
• Influent BOD_5 concentration	200-300 mg/l
• Influent chemical oxygen demand	600-800 mg/l
• Influent suspended solids(TSS)	200-300 mg/l
• Oil and Grease	7-25 mg/l
• Total Hardness	110-150 mg/l
• E Coli	Present
• Faecal Coliform	600-1100 No/100ml

- Various other hospital wastes including cytostatic agents, anesthetics, antibiotics, disinfectants, iodinated contrasting media, hormones, various body fluids, E Coli, faecal coliforms and total coliforms etc.

These are tentative indicative figures; however, as a specialist in the field, contractor may envisage the raw sewage characteristic for hospital waste water. It will be entirely contractor's responsibility to confirm the waste water characters.

Contractor to submit his confirmation on the treatment parameter considered as an Annexure. The plant shall be capable of treating effluent to the following standards:

2.4 Process Description

The entire system shall be plug and play kind of system with semi-automatic control. The system shall consist of following components. The Contractor shall design the Sewage Treatment Plant to receive continuous sewage inflow at pump room/ collection chamber located near STP area as indicated on site plan. The ease of maintenance and operation is of utmost importance in the design of Sewage Treatment Plant.

The design of the Sewage Treatment Plant shall be of suitable technology based, it can be installed within the allocated space and shall be subject to the approval of the Project Engineer/there representative and of respective approving authorities like MPCB or other statutory agencies.

The plant will be modular type and will be housed on the ground, except for raw sewage and treated water tanks. The required civil works like foundations etc shall be included in the scope of work of STP contractor but shall be indicated separately in the BOQ.

These will be general components, for the purpose of indication, but not limited to, of the STP plant.

2.4.1 Inlet Screen Chamber

Raw sewage shall flow into the inlet screen chamber by suitable pumping only. The pumping shall be done from last sewage chamber close to proposed STP location. Large solids particles shall be intercepted by a fine step screen. A manual screen shall be installed in parallel with the screw screen as a standby screen when the step screen is under maintenance.

Bar Screen
A bar screen having 15 mm opening shall be inserted in a bar screen chamber (in RCC) at the inlet to the equalization tank. This screen will act as a guard and trap any large objects which may otherwise block the pumps. The screenings shall be removed by means of a manual rake arm for disposal.

2.4.2 Aeration Tank

Sewage shall be retained in the aeration tank for a minimum of 24 hours and subjected to biochemical oxidation by fine bubbles aeration.

Equalization Tank
The screened effluent will overflow into an equalization tank. The equalization tank is sized for a retention time of 6-8 hours. Since the generation of raw sewage is not uniform (typically peaking in morning and evening hours), this tank buffers the flow and ensures that the effluent inlet quantity and characteristics to the sewage treatment plant is uniform.

To avoid settlement of solids and septicity in the tank, aeration is provided through coarse bubble aeration grid consisting of perforated PVC pipes, individually retrievable. The perforations are designated to give uniform air distribution through the air grid. The equalized sewage will be pumped to the de-nitrification reactor.

2.4.3 Clarifier Tank

The sewage after bio-oxidation shall enter the rectangular flat bottom sedimentation tank where the sludge effectively settles to the tank bottom. The clear effluent shall weir into the chlorination chamber and/or ultraviolet chamber.

The activated sludge collected in the sludge tank shall be returned to the aeration tank for further oxidation of the incoming organic matter by means of automatic siphoning / pumping. Excessive sludge shall be wasted in the sludge holding tank.

Any scum formed on the surface of the clarifier tanks shall be returned to the aeration tank by automatic siphoning / pumping.

Chlorination Tank

Chlorine solution shall be metered in to the effluent by an electric dosing pump paced according to the sewage inflow. The effluent shall be retained in the baffle walled chlorine tank for a minimum of 30 minutes for effective disinfection prior to discharge.

Also Contractor is requested to submit offer for ultraviolet treatment as per following specifications.

2.4.5 Optional: Ultraviolet Treatment

Ultraviolet disinfection of water employs preferably with low-pressure mercury lamps. These lamps will generate short-wave ultraviolet in the region of 2537 Angstroms which is lethal to microorganisms including bacteria, protozoa, viruses, molds, yeasts, fungi, nematode eggs, and algae.

The mechanism of microorganism destruction is currently believed to be that ultraviolet causes molecular rearrangements in DNA and RHA, which in turn blocks replication.

UV dosage requirement varies with the type of micro-organism. Dosage requirements for bacteria, virus ranges from 2,500 to 22,000 microwatt-second/cm2. For Yeast, protozoa and nematode eggs dosage requirements may range from 6,600 to 17,600 microwatt-second/ cm2. Mold spore, fungi, and algae dosage requirements range from 11,000 to 330,000 microwatt-second/cm2. The destruction dosage for fecal coliform is 6,600 microwatt-second/cm2.

There are two basic design concepts either use flow over a submerged bank of germicidal lamps with quartz sleeves or Teflon Tube Flow systems, both fitted with UV lamps. If required contractor may recommend use of submicron filtration system to assist the effectiveness and performance of UV dis infection system. It is for contractor to specify the method/ system they wish to employ in the STP treatment process.

UV System validation shall be done preferably by using non-pathogenic surrogates to determine the Reduction Equivalent Dose (RED) ability of the reactors by third party, usually by employing non-pathogenic surrogate such as MS 2 phage or *Bacillus subtilis*. The validation parameters will depend upon the system design and contractor is required submit the design details and third party validation process for approval of Project Engineer's /Project Engineer's authorized representative. The validation

For wastewater systems, the NWRI [National Water Research Institute, USA], guidelines named "Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse" and /or AWWA [American Water Works Association, USA] guidelines, whichever are stringent shall be used for system design, construction, commissioning and third party validation including continuous performance monitoring.

2.4.5 Effluent Discharge Tank

The effluent tank shall hold the treated effluent, for independently holding treated water for HVAC make up water and water for irrigation works. Project Engineer will make necessary arrangements for shifting water further to respective locations and usages.

2.4.6 Sludge Thickening / Holding Tank

Excessive sludge shall be stored in the sludge holding tank for final dewatering, disinfection and disposal.

A polymer dosing system consisting of a polymer dosing tank and metering pump provided for online dosing of a polymer in the sludge holding tank. A small dose of polymer is provided to aid settlement and conditioning of the sludge.

3 EQUIPMENT

The following give the minimum requirements of the different components of the system. The figures indicated are for contractor's references. It shall be the Contractor's responsibility to select equipment for the plant proposed by them so that the capacities and performance of the Sewage Treatment Plant meet with the criteria set out in this specification.

All equipment and components of the system shall be of top quality construction and shall be corrosion resistant.

3.1 Coarse Screening Equipment

Bar screen shall be of CI material. Drip trays shall be provided for holding and drainage of the screenings. A manual by-pass screen of 30mm opening with stainless steel drip tray shall be provided. An isolation valve shall be provided to divert the flow to the by-pass screen when the screen requires service.

3.2 Air Blowers

Air blowers shall be provided in duplicate (i.e. one duty and one standby). Blowers shall be either of positive displacement or centrifugal with pressure vessel type complete with motor, base-plate, inlet filter, intake silencer and off-load starting system outlet silencer, anti-vibration damper, flexible coupling, filter restriction indicator, non-return valve, pressure relief valve, V-belt system or direct drive coupling. The casing rotor shall be of cast iron construction. Bearings and gears shall be grease lubricated. Motor speed shall be 1500 rpm.

The size and performance of the air blower shall be so selected that it can provide a minimum air flow rate 0.5 l /sec / diffuser to 1l/sec/diffuser maximum, and to maintain a minimum of 2.0mg/λ dissolved oxygen in the aeration tanks in operation.

3.3 Air Diffusers for Extended Aeration Tanks

Air diffusers shall be made to provide a uniform distribution of fine bubble air release performance in the system. The air diffuser shall be either made of elastomer rubber membrane or composed of crystalline fused aluminium oxide with a suitable ceramic bonding material. Membrane endurance shall be more than 180,000 expansion/contraction cycles.

Diffuser shall be of self-cleaning, non-clog disc or dome-shaped type. Oxygen transfer efficiency shall not be less than 20% at 3.5m submergence in clear water. Alternatives may be offered for consideration.

Diffuser hold down assemblies shall consist of a retainer bolt, a matching washer and gasket. Sealing gasket shall be composed of solid neoprene rubber and shall be conform to ASTM D-2000 and shall be suitable for withstanding the effects of wastewater high temperature up to 120°C.

The Contractor shall submit calculation to justify the diffuser selection and air requirement during the detailed design.

3.4 Equalization Tank

The equalization tank shall be designed to provide a minimum storage of 2 hours at peak flow while pumping. Two submersible pumps as per schedule shall be provided with level switch control and automatic cut-in of the standby unit.

An aeration system similar to the extended aeration tank shall be provided for mixing and aerating the sewage.

3.5 Sludge Collectors

The sludge collectors serve to scrape the settled sludge to the sludge pump pit and a skimmer shall collect the scum. Each shall be of mechanical drivers for full automatic operation.

All components such as chain, sprocket, etc. inside the tank shall be made of non-metallic material (such as cast nylon).

3.6 Sewage Pumps

Working and standby sewage pumps shall be provided. Contractor shall provide the pumping arrangements for sewage collected near collection chamber near STP.

Each shall be of submersible type c/w guide base to facilitate case of removal, lift chain and automatic discharge connection. Pump casing and impeller shall be of cast iron material. Shaft shall be of stainless steel material.

3.8 Final Settling Tank

Settling tanks shall include baffles to prevent short circuiting. Sludge withdrawal shall be by means of rotating sludge collectors. Four submersible sludge pumps shall be installed in the hopper bottom at inlet side of the settling tank for periodic sludge removal.

3.9 Tertiary Treatment

This tertiary treatment shall be provided for the effluent used for cooling tower make-up water tank and flushing system.

The tertiary treatment plant shall comprise of the pressure sand filters, activated carbon filters and out to inward entry sewage water designed membrane filtration system. This shall be sized to accommodate 100% of the effluent discharge flow rate and shall achieve the performance as outlined and described in Design Criteria.

Details of the equipment layout proposal shall be submitted for review by the Project Manager with tender documents.

The filters will be added in phases as demand arises and system shall be capable to add with additional tertiary filtration units without disturbing the existing operations of system.

3.11 Electrical Control

The operation of the treatment process shall be of semi-automatic.

A completely assembled and prewired control panel with mimic diagram consisting of weatherproof cabinet shall be furnished. The control panel shall contain all metering and status indicators, motor starters, program timbers, on-off-auto change-over switches and duty selectors for equipment.

Proper control sequence shall be designed according to system requirement and manufacturer standards,

3.12 Other Equipment

Any other necessary accessories, such as buffer, riser, scrum removal devices, partition, control panel, collection devices, etc. for all the tanks and pumps (where necessary) shall be provided in order to provide a fully working systems.

3.13 Piping Materials

SS304	-Submerged air piping
MS epoxy	-Air piping and pumped effluent riser (None submerged)

PVC piping Pumped effluent (submerged) and tank overflow pipe line.

GI (Heavy) interconnecting pipe line after delivery header of pump / filter.
Pump impellors For sewage and treated water pumps- impellors shall be of SS 304 grade and CI impellors for all other pumps.

3.14 Valves

The Contractor shall supply and install all isolating valves and control valves as indicated on the drawings and as required for the proper and efficient operation and maintenance of the entire systems.
All valves supplied shall be suitable for the working pressure and test pressure of the system as specified elsewhere in this specification.
Regulating valves shall be of similar materials as that specified for cast iron gate valves.
All regulating valves shall be lock shield type.
All valves shall be full line size.
Each valve shall have a purpose made reference number plate for label engraved or stamped indicating the manufacturer's catalogue number, pressure and temperature ratings. Valves shall be arranged so that clockwise rotation of the spindle will close the valve.
Furnish all valves and accessory materials necessary in the piping whether or not shown on drawings as flows.
All valves shall be packed with an approved packing and threads shall be coated with oil and graphite. Packings should be replaced when found deteriorated on site.
Where possible locate all valves at convenient positions of operation from the floor with valve stems upright.
Valves that are flanged shall have flanges to the table specified for the pipework.
Plastic or metal plates (rustless) shall be provided to indicate the open / close status as well as the use of each valve in the pump and tank rooms.

5 INSTALLATION

The Contractor shall check the associated civil work prior to the installation of any item of machinery and carry out all necessary additions alterations as necessary at no extra cost.

The machinery shall be accurately installed to correct dimensions, alignments, levels, etc., all as indicated on the final drawings. The machinery shall be mounted on flat steel packing pieces of thickness suitable to take up variations in level of the concrete foundations. Suitable packing pieces shall be located adjacent to each holding down bolt and shall be properly bedded by grinding the concrete surface to a smooth, level finish. The machinery shall be aligned and leveled and the nuts of the holding down bolts tightened with a spanner of normal length. The base plates shall be packed with grout after the machinery has been run and checked by the Project Manager for stability and vibration.

Installation shall include the provision and fixing of all necessary holding down bolts, washers, nuts etc.

All equipment and materials of the same type shall be products of the same manufacturer. Locally made equipment will not be accepted unless otherwise specified.

All similar items of plant and their component part shall be completely interchangeable. Spare parts shall be manufactured from materials similar to the originals and shall fit all similar items of plant. Where machining may be needed before fitting renewable parts, the machining fits with their tolerance shall be shown on the drawings accompanying the instruction manuals.

All motors and/or revolving parts shall be truly balanced both statically and dynamically so that when running at normal speeds and any load up to the maximum there shall be no significant vibration due to lack of balance. All parts which can be worn or damaged by dust shall be totally enclosed in dust-proof housings.

7. MAINTENANCE FACILITIES

Permanent work platform and catwalk shall be designed by the Contractor and provided by the Contractor for access to elevated equipment. The catwalk and platform for access shall allow a minimum width of 750mm.

Catwalk to maintenance platform shall be provided with railings and guards designed for safe movement of personnel in a restricted space including provision for gaining access and to accommodate maintenance personnel.

Hand railing and guards shall be designed by the Contractor and provided by the Contractor for all concrete tanks to allow safe movement of personnel.

Permanent I-beams, lifting eyes, etc. shall be provided by the Contractor over major equipment which requires lifting for overhaul and maintenance, if necessary.

Waterproof power sockets required for servicing shall be provided by the Contractor. The number and locations shall be proposed by the Contractor and approved by the Project Manager / Engineer. Power supply to these sockets shall be taken from control panel of the sewage treatment system.

The design of all permanent work platforms, hand rails, etc. shall be submitted to the Project Manager / Engineer for approval. The loading and fixing method of lifting facilitate shall also be submitted to the Project Manager / Engineer for approval and checking within 4 weeks on award of Contract or receipt of letter of intent.

8. TESTING

The performance of the system shall be demonstrated by taking hourly samples of the raw sewage and final effluent over a twelve hour period. The sample shall be taken at periods approximately the flow rates specified by the plant. The sample shall be combined and a 5-day BOD shall be run, the results of which must verify the capacity of the treatment plant prior to acceptance.

9. TRAINING

Provided training facilities courses to ensure that the Project Engineer/there representative's staff associated with the project may acquire full knowledge and appreciation of all aspects of the design, day-to-day operation, breakdown and routine maintenance, and fault diagnosis of all plant, equipment and systems.

Training to the Project Engineer/there representative's staff shall be held as appropriate at the Contractor's or manufacturer's premises and on site. A detailed syllabus for each of the training courses specified or proposed and the timing of the courses shall be submitted for approval. The Contractor shall recommend the desirable qualifications and experience of the trainees to optimally benefit from the courses. The plant operation training shall be done for minimum period of 7 calendar days, at the time of commissioning and at the time of handing over of plant.

The Contractor shall be deemed to have included in his tender price the cost of providing training facilities as specified.

In addition to the above, the Contractor shall submit to the Project Manager a list describing such other spares and special tools, their number, price and where appropriate the anticipated frequency of replacement as soon as possible along with minimum set of mechanical, electrical spares and chemicals required.

SECTION-3: TESTING, COMMISSIONING AND HANDING OVER

1 GENERAL

The entire works included in this Contract shall be fully tested in stages as the work proceeds and on completion of work as applicable. The plant testing will be primarily done at manufacturing unit prior to dispatch and then on site.

The Contractor shall provide during normal working hours, all necessary labours, instruments, equipment, materials, fuel, power and maker's representatives, to carry out such tests as may be necessary to satisfy the Project Engineer so that the installation meets the requirement and intent of the Specification as well as such tests required by Local Authorities.

All tests shall be made in the presence of the Project Engineer/ their representative and/ or any inspecting authority. At least seven working days' notice in writing shall be given to the inspecting parties before preforming any test.

Three copies of all test results shall be submitted to the Engineer in A4 size sheet paper within two weeks after completion of the tests.

Tests described hereinafter and including all tests prescribed by the Authority having jurisdiction shall be carried out. Any tests proved unsatisfactory shall be repeated to the satisfaction of the inspecting parties.

The Contractor shall provide skilled technicians/engineer to commission the plant and associated controls to the satisfaction of the Project Engineer/there representative. The technicians/ engineers will be required to demonstrate the correct procedures in starting and stopping the plant, running the various items of equipment under automatic and manual control and the correct maintenance of the plant.

Water flow rates of all equipment shall be adjusted to design conditions. Complete results of adjustments shall be recorded and submitted.

2. ON-SITE TESTING AND COMMISSIONING

The Contractor shall start up, operate, test and adjust the systems in accordance with the agreed programme. The setting shall be supervised by the manufacturer's representative, who shall remain on site until the equipment is operating satisfactorily and accepted by Project Engineer and/or their representative. The Contractor shall advice and co-ordinate with the manufacturer's representatives so that all testing is carried out according to the agreed programme.

The whole installation shall be given the following tests to bring the systems into running order. The Project Engineer/there representative shall be given reasonable notice together with a copy of recorded test results, generally not less than seven (7) days, regarding the nature of tests, the time and location. Acceptance tests will only be witnessed by the Project Engineer/there representative when the submitted tests results are found satisfactorily.

All instruments, tools, material and labour required to perform these tests shall be provided by this Contractor.

Before the tests are carried out, the Contractor shall remove connected equipment and components which are liable to damage under test, and shall provide and fix all the necessary gauges, blanking flanges, etc.

Prior to the system start-up, the following inspection, tests and pre-commissioning treatment shall be carried out by the Contractor:

A Tanks and Level Switches

Check sides and edges of sectional tanks for distortion. The tanks shall be thoroughly cleaned with water and drained before city mains supply will feed in.

Also before city mains supply will feed in, the level switch shall be simulated for the various cut-in and cut-out settings.

B Pressure Switches

The testing equipment arrangement for pressure switches and pressure gauges shall be as shown on the drawings or of an approved equivalent.

The pressure gauges to be tested shall be connected as shown on the drawing in lieu of the pressure switch. The gauges to be tested shall be regarded acceptable when the pressure readings of all three gauges are the same throughout the jacking pressure range varied by applying the hand pump.

C Hydrostatic Tests

All parts of the water circuit shall be filled with water before hydrostatic pressure testing, and pump running tests for verification of pressure and flow rate, are conducted.

The hand jacking pump shall be applied to increase the system pressure to 2 times the working pressure or 1.5 times the working pressure plus 3.5 bar whichever is the lower but in any case not less than 7 bars. The pressure shall be maintained for a period not less than 24 hours.

Where any section of pipework or equipment is found to be unable to withstand the maximum pipework test pressure, it shall be isolated during the pipework test then that section of pipework or equipment shall be made good and re-tested at the appropriate test pressure.

The working pressure for various systems shall be as shown on the drawings.

Drains shall be hydrostatically tested to a water head of 1.2 m at the high end and not more than 2.4 at the low end and shall show no appreciable loss of water after elapse of two hours.

In every test, water used shall be left in the pipes until they are covered with earth or other trench filling material to a depth of at least 1 m over the top of pipes and until permission is given by the Project Engineer/there representative for the water to be released. If after the Project Engineer/there representative has approved the sewer or pipeline and has given permission for the trenches to be refilled the pipes become damaged and loses water from any cause and/or admit subsoil water, the Contractor shall uncover the pipes and make good the defect made good and the pipes retested as before and all at the Contractor's expense.

E Cleaning, Flushing and Pre-Treatment

Prior to start-up and hydraulic testing, the Contractor shall clean the entire installation including all fitments and pipework and the like after installation and keep them in a new condition. All pumping systems shall be flushed and drained at least once through to get rid of contaminating materials. All pipes shall be rodded to ensure clearance of debris, cleaning and flushing shall be carried out in sections as the installation becomes completed.

All strainers shall be inspected and cleaned out or replaced.

When the entire systems are reasonably clean, a pre-treatment chemical shall be introduced and circulated for at least 8 hours. Warning signs shall be provided at all outlets during pre-treatment. The pre-treatment chemical shall:

- Remove oil, grease and foreign residue from the pipework and fittings;
- Pre-condition the metal surfaces to resist reaction with water or air;
- Establish an initial protective film;
- After pre-treatment, the system shall be drained and refilled with fresh water and left until the system is put into operation.
- Details and procedures of the pre-treatment shall be submitted to the Project Engineer/there representative for approval.

F Electrical Tests

Electrical tests shall comply with the current edition of IEE regulations and requirements enforced by Local Authorities.

Electrical insulation tests earth electrode resistance test and cost amenity test shall apply to bus bars, isolators and other equipment and wiring where applicable.

A 500V DC instrument shall be used to check the insulation resistance. The reading shall not be less than 1 mega-ohm in all instances.

Function simulation tests shall be performed to ensure that the systems have been installed to the control requirements as described in the Specification therein.

G Pump Drives

The direct coupling of the pump drives shall be dismantled before the pump motor control panel is energized.

The Contractor shall demonstrate to the Project Engineer/there representative of acceptable clearances of the coupling alignment for ensuring satisfactory power transmission.

The coupling shall not be re-mated again till the correct motor rotation has been demonstrated with power drawn from the energized pump motor control panel.

H Pump Operating Test

The Contractor shall ensure to the satisfaction of the Project Engineer/there representative that the installation or portion thereof which has been set to work complies with all requirements including the following:
That the plant and apparatus shall be of robust construction and of capacity for the duty specified.
That all valves, switches, controls and the like are properly regulated and capable of proper operation and in the case of valves are capable of being shut-off.
That all apparatus shall be silent.
That all instruments are correctly calibrated and read accurately.
That all services are tested in accordance with the details of the relevant clauses of this Specification.

2 STATUTORY AUTHORITIES' TESTS AND INSPECTIONS

As and when notified in writing or instructed by the Project Engineer/there representative, the Contractor shall submit shop drawing and attend all tests and inspections carried out by Local Pollution Control Board Authorities, Water Authority and other Statutory Authorities, and shall forthwith execute free of charge any

rectification work ordered by the Project Engineer/there representative as a result of such tests and inspections where these indicate non-compliance with Statutory Regulations.

The Contractor shall be responsible for the submission of all necessary forms and shop drawings to the Statutory Authorities which shall conform in layout to and kept by these Authorities.

The submission shall comply with the requirements set forth in the current Codes of Practice and circular letters of the Statutory Authorities. The shop drawings to be submitted shall be forwarded to the Project Engineer/there representative/Structural consultant for checking before submission. The Contractor shall allow for at least two submissions of complete sets of shop drawings to the Authorities, one to be made within six months after the award of the Contract but not less than six weeks before the inspection. The Project Engineer/there representative may at his discretion instruct the Contractor for additional submissions to the Local Authorities whenever necessary.

The Contractor shall notify the Project Engineer at least seven days in advance of his application for local Authority tests and inspections. On receipt of a confirmed date for test and inspection the Contractor shall inform the Project Engineer/there representative without delay.

3 COMMISSIONING

When the various installations have been completed and the preliminary commissioning checks carried out, the Contractor shall set to work, regulate and calibrate all system in the entire installation. Special attention shall be paid to the following items:

That all valves, switches, controls, etc. are regulated and capable of proper operation and in the case of isolation valves that they are capable of tight shut off.

That all apparatus is silent in accordance with the requirements of this Specification.

That all instruments are correctly calibrated and read accurately.

That all services are tested in accordance with the details in the relevant clauses of this Specification.

Operate pumps, pressure reducing sets, etc. to ensure that all control systems are functioning correctly and are properly set, sequenced or interlocked.

4 FINAL ACCEPTANCE TESTS

Following commissioning and inspection of the entire installation, and prior to issue of the Completion Certificate, the Contractor shall carry out final acceptance tests in accordance with a programme to be agreed with the Project Engineer/there representative.

Should the results of the acceptance tests show that plant, systems and/or equipment fail to perform to the efficiencies or other performance figures as given in this Specification, the Contractor shall adjust, modify and if necessary replace the equipment without further payment in order that the required performance is obtained.

Where acceptance tests are required by the relevant Authorities having jurisdiction, these tests shall be carried out by the Contractor prior to the issue of Completion Certificate to the acceptance of the Authorities.

Contractor will extend all technical help and do liasoning on behalf of Project Engineer to obtain necessary permit to operate / Consent to operate from authorities. The fees required will be paid by Project Engineer/

their representative directly. Though payments are made by Project Engineer, it will be entire responsibility of contractor's to obtain Consent to Operate from respective authorities.

5 REJECTION OF PLANT

Any item of plant or system or component which fails to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, erection or on completion at site may be rejected by the Project Engineer/there representative either in whole or in part as he considers necessary/appropriate. Adjustment and/or modification work as required by the Project Engineer/there representative so as to comply with the Authority's requirements and the intent of the Specification shall be carried out by the Contractor at his own expense and to the satisfaction of the Authority/Project Engineer/there representative.

After works have been accepted, the Contractor may be required to carry out assist in carrying out additional performance tests as reasonably required by the Project Engineer/there representative/Project Engineer.

6 WARRANTY AND HANDOVER/ DEFECTS LIABILITY PERIOD

The Contractor shall warrant that all plant, materials and equipment supplied and all workmanship performed by him to be free from defects of whatsoever nature before handover to the Project Engineer/there representative. The designed performance of plant shall be monitored for minimum period of 3 months. The defects liability period of 12 calendar months will commence from the date of receipt of approval from concerned authorities. The contractor shall handover all guarantees/ warrantees of all equipment's used in the plant and or transfer all such warrantees/guarantees on the name of Project Engineer. It will be obligatory on part of contractor to extend all exhausted guarantee/warrantee for further period of minimum 3 years, from date of obtaining authority approval in writing, at no extra cost to project Engineer.

Defects liability period will be considered as completed satisfactory, only after getting plant performance within prescribed design limits, for minimum plant up time of 85% of 1 calendar year for entire operations during defects liability period. Any deficiency noted during defects liability period or part thereof, will automatically extend the defects liability period equal to duration for which plant performance was not met with, at no extra cost payable to contractor on any account.

10. HANDING OVER OF DOCUMENTS

All testing and commissioning shall be done by the Contractor to the entire satisfaction of the Project Manager and all testing and commissioning documents shall be handed over to the Project Engineer/there representative

The Contractor shall also hand over all maintenance and operation manuals, all certificates and all other documentation as per the terms of the contract to the Project Engineer/there representative

11. OPERATION AND MAINTENANCE OF PLANT

The cost of operations and maintenance including mechanical, electrical spares, chemicals required etc as and when required along with necessary manpower on 24 hours basis, during the defects liability period of 1 calendar year or any extension thereof, shall be included in the cost and no extra cost will be payable to contractor on any account thereof.

Contractor shall indicate plant operation and maintenance cost along with routine mechanical, electrical spares and chemicals including round the clock manpower for plant operation for period of 3 years, to be counted from date of satisfactory completion of defects liability period. The Project Engineer will enter in to plant operation maintenance contract on successful completion of defects liability period at the rates quoted now. The

maintenance amount so quoted and approved will be payable every half yearly in advance at the beginning of half year period on receiving necessary supporting invoice from contractor.

Contractor shall provide list of optimal spares for the pant, that to be kept for entire period for plant maintenance, which will be maintained by him as optimal inventory at plant site at no extra cost to Project Engineer.