SUBSECTION 8: PUMPING STATIONS MECHANICAL

1 General

This subsection covers general requirements of mechanical works for sewage pumping stations. All valves, MS pipes and specials used in the pumping stations shall conform to the specifications laid down in Subsection 5. The design criteria, material specifications, workmanship and testing of materials used for all civil works shall confirm to provisions laid down in section 4. Details of electrical works are covered in section 4. Pre-dispatch inspection, pre-commissioning tests, commissioning and trial runs shall be as detailed in Subsection 13 and 14.

1.1 All the Materials used shall confirm to the relevant BIS and should be delivered at site of work. The Contractor is responsible for safe custody of machinery and other equipments under this contract till handing over to the employer.

1.2 The rates should include all the minor items of civil works, if any required for installation complete.

1.3 All necessary civil works for erection of all equipments and accessories offered by the contractor under this contract should be done by the contractor

1.4 Test certificates for machinery and equipments should produced along with supply

1.5 The bidder should enclose the performance curve duly indicating the duty point for the size of the impeller selected (family curve should not be furnished). The Performance curve should furnish complete range of operation and the curve should be authenticated by the manufacturer or his authorized dealer. In the event of non compliance the offer shall be summarily rejected.

1.6 The contractor shall make necessary arrangements to get supply of electricity from RELIANCE ENERGY for operating the machinery and equipment. Necessary payment to be made to the EB shall be borne by the employer

1.7 Before supply of machinery, equipments and other accessories prior approval of the Engineer should be obtained giving the name of makes and other details required.

1.8 Obtaining approval of electrical layout diagram for the installation of all the equipments (transformers, generators, pumpsets and other accessories) and obtaining safety certificates on completion of work from competent state electrical authority should be arranged and got approved by the contractor at his cost.

1.9 All the materials should be supplied as per BOQ and should be of standard makes mentioned below:-

Sr. No.	Description	Make
1	Submersible Pump non clog	
2	Make of Motor	
3	Make of Transformer	
4	Diesel Generator	
5	Starter	
6	Switch Fuse and circuit breaker	
7	Cables	
8	Valves	

1.10 The right of choosing the make among the makes offered by the contractors rest with the employer only

1.11 The submersible pumps centrifugal pumps, turbine pumps, submersible motors, motors for turbine and centrifugal pumpset transformer, generators, Panel Boards, to be supplied by the firm will be inspected by the Inspecting Agency fixed by the Employer at the manufacturers premises and test certificate will be issued. The contractor should make necessary arrangements for the inspecting staff at his own cost for testing the above pumpsets.

1.12 If the complete plant or any portion thereof is found to be defective the Engineer shall give the contractor a notice in writing to verify such defects. If the contractor fails to rectify the defects within the specified period the Engineer will rectify the defects at the contractor's risk and cost.

2 Submersible Sewage pump

Non clog submersible pump set

The submersible sewage pump shall be of non-clog design. It shall be suitable for pumping raw unscreened sewage containing sludge, long fibers, plastic pieces, cigarette butts, etc. The pump shall be able to pass through soft solids of minimum 100 mm dia and capable of dealing with sewage / sludge with specific gravity of 1.05. Pumps shall be of 960 rpm for high duty pump and 960/1450 rpm for low duty pumpsets, efficiency of the pumpset 50/75 for Low/High duty.

Impellers shall be of single / double vane non-clog design. Additionally, a special contra-block cutting and tearing system should also be incorporated on the suction side of the pump for disposing off soft material which would otherwise clog the pump.

Maintenance free antifriction, permanently grease filled ball bearing shall be provided and this shall take care of all the axial and radial forces at any point of operation. The weights of the revolving parts of the pumps including the unbalanced hydraulic thrusts of the impellers shall be carried by thrust bearings provided in each pump assembly.

The pump installation design shall be such as to facilitates automatic installation and removal of the pump without having to enter into the sewage pit. Profile gasket shall be provided in automatic coupling system so to avoid metal to metal contact between the pump and delivery bend to ensure leak-proof joint.

Pump Construction

a. Pump Casing

Pump casing shall be of CI as per IS 210 Gr FG 200 with 2.0% to 3.0% nickel. The internal surfaces shall be free of rough spots. The casing shall have centre line discharge.

The high capacity pumps at New Pump house shall work in parallel two at a time to discharge peak flow. Third pump will be stand by.

b. Impellers

Impellers shall be of stainless steel (CF8M) construction. Impeller shall be of single/double vane non clog design. Additionally, a special contra-block cutting and tearing system should also be incorporated on the suction side of the pump for disposing off soft material which would otherwise clog the pump.

c. Pump Shaft

The pump shaft shall be of stainless steel (SS-410) as per manufacturer's standard. The shaft shall be of one piece

construction.

d. Pump Bearings

Pump bearings shall be of the antifriction type. The bearings shall be able to take normal thrust loads due to unbalanced hydraulic loads on the impellers plus the weight of all rotating parts of the pumps. Pump bearings shall be designed with a minimum life of 40,000 hours. The bearings shall be grease lubricated for life, and shall be maintenance free.

e. Guide Rail Assembly

The assembly shall have CI pedestal, bracket, delivery bend, MS Galvanised guide rail pipe of 50 mm NB of Class C, upper guide rail holder, etc. The pedestal and bracket shall provide automatic coupling between pump delivery flange and discharge bend (standard bend / duck foot bend). Alternatively, the guide system can be with wire rope and pedestal cast integrated with discharge bend.

f. Mechanical Seals

Double mechanical seal shall be provided to prevent pumped liquid entering into the motor winding. The seal shall be situated in oil chamber to ensure proper lubrication. The seals shall be fail proof at the depth of submergence involved in each case.

The face combination of lower mechanical seal shall be silicon carbide. Vs. Silicon

Carbide and upper mechanical seal shall be Carbon Vs Chrome Steel.

g. Moisture Sensor

Moisture sensor (seal monitor) shall be provided in the oil chamber to detect the failure of the mechanical seal.

The sensor will trip the pump-motor in the event of ingress of moisture into the oil chamber.

h. Lifting Chain

Each pump shall be provided with carbon steel lifting chain of adequate strength. The chain shall have rings of same size, fixed at an interval of about 1M for engaging the hook of the chain pulley block.

i. Foundation Nuts and Bolts

•foundation nuts and bolts shall be provided

•Protective Coating

The pumps shall be epoxy painted

k. Pump Balance

All rotating parts shall be statically and dynamically balanced as per the

relevant standards.

l. Submersible Motor

Motor shall have integral cable entry port and cable entry shall be properly sealed. It shall have provision for preventing reverse rotation.

Each phase of the motors shall be provided with thermic switches with bimetallic electromechanical temperature detectors. The motor shall operate satisfactorily at all operating levels in wet well.

Motor shall be sealed against entry of liquid being pumped by using two mechanical seals.

m. Submersible Motor Cable

Each pump shall be provided with submersible cables as specified in BOQ both for power and control cables.

n. Special Condition

The tender should also furnish the list of authorised dealers for the supply of spares for submersible pumps and list of authorised workshop for carry out repairs to the submersible pumps along with the address while tendering.

The submersible pumps shall be suitable for pumping contaminated effluents, industrial waste water, storm water, sewage etc.

The pump shall be vertical spindle type, having duties as specified below. The pumps shall be capable of handling 100 mm size solids. The impeller shall be non-clog and semi-open type. Double mechanical seals shall be provided. Pumpsets shall have double bearing between pump and motor. Pumps shall be provided with automatic coupling device and all necessary fixings for guiding the pumps during lifting/lowering. The pump shall not exceed 960rpm. Casing shall be of cast iron with 2%-3% nickel Impeller: SSCF8M, shaft SSAISI 410. Guide rail system – CI/SGI. Motor to be of appropriate rating for the proposed pump duty. Submersible squirrel cage induction motor suitable for coupling with the pump without overload conforming to specifications. Starting current shall not exceed 200% of rated full load current. Protection against increase in stator winding temperature (155 deg C) shall be provided.

Class of insulation shall be F. The degree of protection shall be IP68 as per IS 4691. Motors shall be suitable for continuous operation in fully submerged condition. The motor shall be supplied wit 25 metres of round submersible pre-insulated copper cable of appropriate capacity. The pumpset shall be supplied with guide rail system with guide pipe of length suitable to the system, duck foot elbow suitable for delivery nozzle and non return valve, dismantling joint etc. Including control panel with automatic start and automatic stop controlled by sewage levels in the suction well. Manual control shall also be provided. Painting may be done as per relevant Bureau of Indian Standard Specifications.

2 TECHNICAL SPECIFICATION FOR NON-CLOG

SUBMERSIBLE GRIT PUMP

MECHANICAL SPECIFICATION

3.1 General

The submersible grit pump shall be non-clog design. It shall be provided with agitator connected to the extended shaft to keep the silt in suspension. Pump shall be suitable to handle silt particles with specific gravity of 1.05. Pumps shall be of max. 1450 rpm. For ease installation, pump shall be provided with skirt base arrangement Submersible Motors have to be designed with maximum factor of safety to ensure non-overloading, while handling silt particles. Impellers shall be of single/double vane non-clog design. Additionally, a special contra-block cutting and tearing system should also be incorporated on the suction side of the pump for disposing off soft material, which would otherwise clog the pump. Maintenance free antifriction, permanently grease filled ball bearings shall be provided and this shall take care of all the axial and radial forces at any point of operation. The weights of the revolving parts of the pumps including the unbalanced hydraulic thrusts of the impellers shall be carried by thrust bearings provided in each pump assembly. The reverse rotation prevention system shall be incorporated in the pump design to ensure that the pump does not start rotating in the reverse direction due to wrong electrical connection.

3.2 Pump Construction:

a. Pump Casing:

Pump casing shall be of CI as per IS 210 Gr FG 200 with 2.3% Nickel the pump casing shall have protective coating from corrosion. The internal surfaces shall be free of rough spots. The casing shall have centreline discharge.

b. Impellers:

Impellers shall be of Stainless Steel (CF8M) construction. Impellers shall be of single/double vane Semi-open non-clog design. Additionally, a special contra-block cutting and tearing system should also be incorporated on the suction side of the pump for disposing off soft material, which would otherwise clog the pump.

c. Pump Shaft:

The pump shaft shall be of stainless steel (SS 410) as per manufacturers standard. The shaft shall be of single piece construction.

d. Pump Bearing:

Pump bearings shall be of the antifriction type. The bearings shall be able to take normal thrust loads due to unbalanced hydraulic loads on the impellers plus the

weight of all rotating parts of the pumps. Pump bearings shall be designed with a minimum life of 40,000 hours. The bearings shall be grease lubricated for life, and shall be maintenance free.

e. Mechanical Seals:

Double mechanical seal shall be provided to prevent pumped liquid entering into the motor winding. The seal shall be situated in oil chamber to ensure proper lubrication. The face combination of lower mechanical seal shall be Silicon Carbide Vs Silicon Carbide and upper mechanical seal shall be Carbon Vs Chrome Steel.

f. Moisture Sensor:

Moisture sensor (seal monitor) shall be provided in the oil chamber to detect the failure of the mechanical seal. The sensor will trip the pump-motor in the event of ingress of moisture into the oil chamber.

g. Lifting chain:

Each pump shall be provided with carbon steel lifting chain of adequate strength. The chain shall have rings of same sizes as chain, fixed at an interval of about 1M for engaging the hook of the chain pulley block.

h. Foundation Nuts and Bolts:

- Foundation nuts and bolts shall be provided.
- **Protective coating:**

The pumps shall be epoxy painted

h. Pump Balance:

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

i. Electrical Specifications:

a. Submersible Motor:

The submersible motor shall be dry, squirrel cage type, suitable for three phase supply, continuous duty, with class 'F' insulation. Winding of the motor shall be impregnated by resin. Motor shall have integral cable entry port and cable entry shall be properly sealed.

The pump motor may often require starting after intermittent clogging. The motor should therefore incorporate aluminum die cast rotors only to ensure better starting torque characteristics. The enclosure for motor shall be IP-68. Each phase of the motors shall be provided with Thermic switches or bimetallic electromechanical temperature detectors. The motor shall operate satisfactorily at all operating levels in wet well. Motor shall be sealed against entry of liquid being pumped by using two Mechanical seals.

3.3 MOTOR

3.3.1 TYPE OF MOTORS

The motors (suitable for submersible pump) shall be 415V AC squirrel cage induction motor with drip proof screen protected continuous rating. The motor shall be capable of working in the range of (380-440V) 3 phase 50 cycles at the speed of 1500 RPM.

3.3.2 OUTPUT OF MOTORS

The motor shall be capable of developing the mechanical output for the required conditions, shall have continuous normal rating to suit the maximum load when operated at the pump speed. The efficiency and power factor shall be to start the wide range of load conditions and shall be designed and manufactured in accordance with relevant BIS.

The motor HP shall be such that is should safely take the load when the total head is reduced by the rise of water level in rived during flood conditions in the rives. The HP of motor of offered shall have a margin 10% above the BHP absorbed by the pumpset at duty point and also above the maximum HP absorbed by the pump offered.

3.3.3. SPARE PARTS

Supply of spares and tools shall be made as per the list prescribed in BOQ with index card.

TOOLS

Standard tools for the maintenance of the equipments shall be supplied as detailed.

D/E spanners 6mm to 32mm	1 set Jhalani
Ring spanners 6mm to 32mm	1 set Jhalani
6 inches chain wrench	1 No Gudor
24 inches Pipe wrench	1 No Jhalani
200 mm insulated cutting plier	1 No Taparia Make
Hacksaw frame with blade	1 No Best Quality
Crow bar 5 feet	1 No TATA
Grease gun Liver type	1 No Best Quality
Ball peen hammers	1 No Best Quality
Screw Drivers 200,300,400 mm	1 set Taparia
Electrical tester	1 No Taparia

3.4 Dewatering / Drain Pumps

The capacity of the dewatering pumps at intake and clear water pumping station shall be 50 cum/hr minimum. The capacity of the drain pump for clear water pumping plant shall be 5 cum/hr minimum.

The pumps shall be electric motor driven. The pumps shall be vertical, centrifugal, non-clog type. The impeller shall be mounted on the extended shaft of the motor.

The pump motor shall be suitable for working with or without submergence in water. The motor rating shall be more than the maximum power required by the pump from shut off to run out.

Dewatering pumps shall be with flexible delivery piping of minimum 100 mm size. A common delivery pipe of minimum 50 mm size, as per IS 1239, is to be provided for a set of drain pumps.

Each drain pump shall be provided with a standby.

Acceptable indigenous makes are ABS Pumps, KSB Pumps Ltd., Kirloskar Brothers Ltd., Kishor Pumps Ltd. or equivalent, as approved by the Employer's Representative.

Drawings and information to be provided by Contractor

- Pump data sheets and performance curves
- Leaflets/ manufacturer's literature of pumps

3.4.1 Backwash, Cooling Water and Lubricating Water Pumps

The Contractor shall work out the pump parameters for the above pumps. Pump capacity shall be at least 10% more than the calculated figure.

3.4.2 Inspection Requirements

All pumps shall be assembled in the shop to ensure correct fitting of all parts and shall be match marked before shipment.

Impeller and pump rotating assembly shall be dynamically balanced as per ISO 1940 / Gr. 6.3 / VDI 2060.

Pump casings shall be subject to hydrostatic pressure testing as an assembly at 150% of the pump shut-off head or 200% of the pump rated head, whichever is higher. The hydrostatic pressure shall be held for not less than 30 minutes after all leaks have been stopped between attachments.

Standard running test shall be conducted at manufacturer's works to measure the capacity, total head, efficiency and power. These tests shall form the basis for pump acceptance except for vibration and noise. The pumps shall be tested over a range comprising shut off head to maximum flow. Minimum seven readings approximately equidistant shall be taken for plotting the performance curve. The following formula shall be taken for computing the pump efficiency:

(i) For horizontal pumps:

Pump efficiency %: Q x H / 367.2 x N

where, Q = Discharge in cum/hr

H = Total head in mwc

N = Power in put to motor * motor efficiency.

(ii) For vertical turbine pumps:

Pump bowl efficiency %: Q x H / 367.2 x N

where, Q = Discharge in cum/hr

H = Bowl head in mwc (Total head + loss in discharge elbow + loss in column pipe)

N = Power in put to motor * motor efficiency – (Thrust Bearing and transmission losses)

If the vibration and/or noise level readings taken during performance test are higher than that permitted, the Contractor and manufacturer shall guarantee that the permitted values shall be maintained at site after erection. Any cost of rectification needed on this count shall be borne by the Contractor.

If the tested pump efficiency is not within the acceptable negative tolerance limit, as set forth in the referenced Codes, the Contractor shall make such changes, modifications and/or additions as may be necessary at his own cost and expense to achieve the efficiency within the allowable tolerance. If, after such corrective measures, the pump is still unable to achieve the efficiency within the allowable negative tolerance, the Employer's Representative shall reject the pump.

Any other tests, including NDT (as applicable), as specified in the data sheets / drawings / specifications/ applicable standards and Codes.

3.4.3 EOT CRANE

The crane shall be electrically operated, bridge type complete with all accessories including down s conductor, crane rails and fixtures and shall conform to IS 3177 Mechanism Class M6.

The crane shall consist of bridge girders on which a wheeled trolley is to run. The bridge trucks and tro frames shall be fabricated from structural steel. Access walkway with safe hand railing is required al the full span length of the bridge girder. Steel shall be tested quality conforming to IS 2062 .The bridge

shall be designed to carry safely the loads specified in IS 807. All anti-friction bearings for bridge and trolley track wheels, gearboxes and bottom sheaves shall be lubricated manually by hand operated grease pump through respective grease nipples.

Wheel and structural frame of the wheel mounting of the end carriages shall be designed so as to ensure that the crane remains square and to prevent skewness. Bridge and trolley track wheels shall be of forged steel and shall be double flanged type. The wheel diameter and rail sizes shall be suitable for the wheel loads. The crane rails shall be manufactured from wear resistant steel. Mountings of the wheels shall be designed to facilitate easy removal for maintenance. Walkways shall be at least 500 mm clear inside width with a 6 mm thick non-skid steel plate surface. Steel rail stops to prevent rails from creeping and trolley from running off the bridge shall be abutted against ends of rails and welded to the girders. Bridge and trolley stops to match the wheel radius shall be provided before the buffer stops.

All exposed couplings, shafts, gears, wheels, pinions and chain drives, etc., shall be safely encased and guarded completely to prevent any hazard to persons working around. All bearings and gears shall have a design life of 10,000 hours. Electro-magnetic and hydraulic thrustor brake shall be provided for the main hoist. One electro-magnetic brake shall be provided for each of the cross travel and long travel motions.

Hook shall be solid forged, heat treated alloy or carbon steel suitable for the duty service. They shall have swivels and operate on ball/thrust bearings with hardened races. The lifting hooks shall comply with the requirements of IS 3815/5749 and shall have a safety latch to prevent rope coming off the hook.

Hoist rope shall be extra flexible, improved plough ungalvanised steel rope with well lubricated hemp core and having six strands of 36 or 37 wires per stand with minimum ultimate tensile strength of 1600000 kN/m2 of Right Hand Ordinary (RHO) lay construction. Rope drums shall be grooved and shall be either cast steel or welded steel conforming to IS 3177.

Gears shall be cut from solid cast or forged steel blanks or shall be stress relieved welded steel construction. Pinions shall be of forged carbon or heat treated alloy steel. Strength, quality of steel, heat treatment, face, pitch of teeth and design shall conform to IS 4460.

A capacity plate showing year of manufacture and rated capacity of hoist in figures not less than 150 mm height shall be placed on each side of the crane girder.

The maximum deflection under full load shall not exceed 1/900 of the span.

All accessory and auxiliary electrical equipment including drive motors, electrically operated brakes, controllers, resistors, conductors, insulators, current collectors, pendant push button station, protective devices, operating devices, cables, conduits, etc., necessary for the safe and satisfactory operation of the crane shall be provided.

Power to the crane shall be provided by down shop conductors manufactured from high conductivity hard drawn copper. Conductors shall be completely shrouded such that they have no exposed current carrying surfaces. Pendant type push button station shall be sheet steel enclosed and shall comprise the following push buttons and indicating lamps:

- `Start' and `Stop'.
- Long travel - `Right' and `Left'.
- Cross travel - `To' and `Fro'.
- Hook - `Hoist' and `Lower'.
- Red indicating lamp for supply `ON' indication.

Pendant type push button shall be supported independently of the electrical cable and shall be earthed separately, independent of the suspension. Automatic reset type of limit switches shall be provided to prevent over travel for each of the following:

- For `Up' and `Down' motions of the hook.

- Long travel motion
- Cross travel motion

Crane structures, motor frames and metal cases of all electrical equipment including metal conduit and cable guards shall be earthed. All motors, brakes, limit switches, panels, drum controllers, resistor unit sets shall be provided with two studs for earthing.

Acceptable indigenous makes are ACME Manufacturing Engineers, Batliboi Ltd., Electromech Engineers, Reva Industries or equivalent, as approved by the Employers Representative.

Drawings and information to be provided by Contractor shall include the following:

▪ Drawings showing general arrangement, clearance requirement, assembly, and materials of construction for:

- EOT Crane
- Crane rail fixing arrangement
- Run way conductor system details
- Trolley arrangement
- Drive and transmission details for bridge travel, trolley travel and main hoist.
- Design calculations for the following:
- Rope drum, wire rope, gearboxes, motor ratings, brake selection wheels etc.
- Characteristics and other data for each drive motor.

The Contractor shall provide a 10-ton EOT crane in each pumping station

3.4.3.1 Inspection Requirements

The cranes shall be completely assembled in the Contractor's or manufacturer's works and shall be subjected to the tests as specified in IS 807/IS 3177 or relevant internationally approved standard. The Contractor shall provide the test results for approval of the Employer's Representative.

3.4.4 DELIVERY AND SUCTION PIPES – DESIGN CONSIDERATIONS

For suction and delivery piping, the minimum thickness of the MS pipes shall be 10 mm (inclusive of 2 mm corrosion allowance) for 700 mm to 1000 mm diameters. SPECIFICATIONS OF VALVES

3.4.4.1 General

The construction features and other specifications of valves shall be as defined in Subsection 8, Valves.

3.4.4.2 Pressure Rating

The pressure rating of valves must at least be equal to the maximum expected pressure at the point of installation.

3.4.5 SIZE

The size of valves must equal the size of the respective main (suction, delivery) pipes.

3.4.6 VENTILATION AND COOLING OF PUMP HOUSE

3.4.6.1 Air Washer

For each pumping station, 2 nos. (both working) of rigid media pad type air washer system with all accessories shall be provided for supplying air to the pump room, along with all associated ducts, grilles, etc. Air ducts shall be fabricated as per IS: 655.

Make-up with float valve and quick-fill connections with isolating valve, drain with isolating valve and overflow connection, marine light and inspection door, etc., shall be provided.

The Contractor shall provide detailed calculations to determine the air washer system capacity conside Phase II requirements. The maximum permissible inside temperature shall not exceed 37 deg. C.

The Contractor shall submit relevant technical details for approval.

Acceptable indigenous makes are Aerovent Projects Pvt. Ltd., American Engineering and Systems, Batl Ltd., Voltas Ltd. or equivalent, as approved by the Employer's Representative.

3.4.7 EXHAUST FANS

3.4.7.1 General

In general, exhaust fans of appropriate rating shall be provided for pump houses and switchgear rooms, at floor level. Contractor shall submit the fan selection details for approval.

3.4.7.2 Technical Particulars

a) Operating conditions

1	Fan designation	Exhaust duty
2	No. of fans and design capacity	To be selected based on acceptable air changes per hour or maximum temperature rise (5 deg. C), whichever is higher.
3	Type	Wall Mounted, Centrifugal / Propeller

b) Features of construction

1	Impeller	Mild steel or Cast Aluminum
2	Hub	Cast Iron/Die Cast Aluminum
3	Casing	Mild Steel
4	Wall cowl	Galvanized Iron Sheet - 20 gauge
5	Bird screen	14 gauge Galvanized Iron with 12 mm square bird screen.
6	Motor	TEFC IP 54,with speed below 1000 rpm synchronous

Acceptable indigenous makes are Bajaj Electricals (P) Ltd., Crompton Greaves Ltd., General Electric Company Ltd., Khaitan Ltd. or equivalent, as approved by the Employer's Representative.

Leaflets/ manufacturer's literature of exhaust fans shall be provided by Contractor.

3.4.8 AIR CONDITIONER

3.4.8.1 General

Air-cooled package A.C. / ductable split type AC units, two numbers of 50% capacity each, shall be provided for the SCADA/ PLC room.

3.4.8.2 Technical Particulars

3.4.8.2.1 Operating Conditions

Location	SCADA/PLC Room
Room size	As per approved drawing
Outside temperature	Ambient 45 deg. C
Inside temperature requirement	24° C + or – 1.1 deg. C, RH 60 % + or – 5 %

Acceptable indigenous makes are Amtrex Ambience Ltd., Blue Star Ltd., Carrier Aircon Ltd., Videocon Ltd., Voltas Ltd. or equivalent, as approved by the Employer's Representative.

Contractor shall submit cooling load estimation, equipment selection and layout drawings for approval.

3.4.9 PIPE FITTINGS

Pipe fittings of size 50 NB and below shall be forged conforming to A 105. Fittings above 50 NB up to 200 NB shall be welded/seamless conforming to ASTM A-234 Gr. WP and dimensional standard ANSI B.16.9. Fittings and specials of size 250 NB and above can be fabricated from MS pipes fabricated as per specifications detailed in Subsection 3, Mild Steel Pipe and Coating Works.

All specials such as bends, tees, tapers, etc., shall be fabricated from MS pipes made as per specifications given in Subsection 3. Before fabrication the detailed drawings of fabrication of each special must be got approved from the Employer's Representative. All specials must be brought to site after inner and outer coating as specified in Subsection 3.

3.4.10 MISCELLANEOUS

3.4.10.1 Nuts, Bolts, Studs and Washers

Except as may be elsewhere specified, all nuts and bolts shall be of the best quality bright steel, machined on the shank and under the head and nut. Studs, bolts and nuts shall be galvanized. Nuts and bolts shall conform to IS 1363 and IS 1367. Washers, locking devices and anti-vibration arrangements shall be provided where necessary.

Where there is a risk of corrosion, bolts, nuts and studs shall be designed so that the maximum stress does not exceed half the yield stress of the material under any conditions. All bolts, studs, nuts and screws which are subject to frequent adjustment or removal in the course of maintenance and repair shall be made of SS 410.

The Contractor shall supply all holding down an alignment leveling bolts, complete with anchorages, nuts washers and packing required to fix the plant to its foundations, bed plates, frames and other structural parts

The Contractor shall procure and keep at site reasonable excess quantities to cover wastage of those materials which will be normally subject to waste during erection, commissioning and setting to work.

3.4.10.2 Gaskets

Gaskets shall be of Nitrile rubber and ready made matching with respective flanges. Gaskets cut out from rubber sheet are not acceptable.

3.4.10.3 Support for Pipe Work and Valves

All necessary supports, saddles, fixing bolts and foundation bolts shall be supplied to support the pipe work. Valves and other devices mounted in the pipe work shall be supported independent of the pipes to which they connect. Wherever necessary RCC supports shall also be provided.

3.4.10.4 Galvanizing

Wherever galvanizing has been specified the hot dip process shall be used. The galvanized coating shall be of uniform thickness. Weight of zinc coatings for various applications shall not be less than those indicated below:

(a) Fabricated steel

Thickness less than 2 mm but not less than	340 gm/sq. m.
Thickness 2 mm and above	460 gm/ sq. m.

(b) Fasteners

Up to nominal size M10	270 gm/ sq. m.
Over M10	300 gm/ sq. m.

Galvanizing shall be carried out after all drilling, punching, cutting bending and welding operations have been carried out. Burrs shall be removed before galvanizing. Any site modification of galvanized parts shall be covered well by zinc primer and aluminum paint.

3.4.10.5 Painting / Coating

The Contractor, in accordance with provisions in Subsection 3, shall carry out painting of exposed ferrous surface of all items of plant.

After satisfactory testing of pumps and approval from the Employer's Representative, hydraulic passage suction bell mouth, impeller guide, bowl / casing and impeller (for initial, intermediate and final units) s be coated with resin to smoothen surface to enhance pump efficiency. The materials used for such coa shall be suitable for use in equipment handling drinking water. The coating shall be highly abras resistant. The coating thickness shall be as per resin manufacturer's recommendation. Guarantee pumps shall also cover the coating provided.

Immediately on arrival at the site all items of plant shall be examined for condition of the primer coat/finish paint applied at the manufacturer's works and unsatisfactory portions shall be cleaned down to the bare metal, all rust being removed, and the surface made good with similar primer / paint.

After erection, such items, which are not finish painted, shall be finish painted. Items finish painted at the manufacturer's works shall be touched up for any damaged paint work.

No painting shall be carried out unless the item has been inspected and accepted by Employer's Representative or the person authorized by him. Employer's Representative shall approve shades of finish painting of equipment.

3.4.10.6 Lubrication

The Contractor, in the operation and maintenance manuals, shall furnish a complete schedule of recommended oils and other lubricants. The number of types of lubricants shall be kept to a minimum. In case of grease lubricated bearings for electric motors, lithium base grease is preferred.

The Contractor shall indicate the brand name of indigenously available equivalent lubricants, with complete duty specifications, to enable the Employer to arrange procurement in future. The Contractor shall furnish the schedule of quantities for each fill, frequency of filling and annual requirement.

Where lubrication is effected by means of grease, preference shall be given to a pressure system which does not require frequent adjustment or recharging. Frequent, for this purpose, means more than once in a month.

Where more than one type of special grease is required, a grease gun for each special type shall be supplied.

All lubricant systems shall be designed so as not to cause a fire or pollution hazard.

The Contractor shall supply flushing oil for such lubrication system when an item of plant is ready for preliminary running.