

PACKAGE- 2

TENDER FOR SETTING UP OF WATER TREATMENT STATION, TERTIARY SEWAGE TREATMENT, DRINKING WATER STATION AND RELATED PLUMBING WORKS FOR PROPOSED PERMANENT CAMPUS(PHASE I)

OF

NALANDA UNIVERSITY, AT RAJGIR, BIHAR.



NOTICE INVITING TENDER

NALANDA UNIVERSITY, RAJGIR, BIHAR.

Every care has been taken while preparing this document to cover all necessary information, matters, specifications, general conditions, special conditions & provisions for smooth and complete execution of works. However, in case of any omission in the tender/ contract document, the most recent version of correction aslips (as on 31st January 2018) of Specifications of CPWD Works, Latest Release shall be the reference manual.

A. TECHNICAL SPECIFICATIONS.

General conditions:

- The scope of work of the tenderer covers design, engineering, manufacture/fabrication, painting, shop testing, transportation, packing, transit, insurance, loading, unloading, storage at site, watch and ward, handling at site, erection, site testing, final painting and commissioning of the entire civil work, mechanical, steel structural (if required), handling and hoisting equipment, electrics, instrumentation and control, utilities etc and all that is necessary to complete the system and smooth functioning of the system.
- The tenderer shall study the specification, visit the site and satisfy himself regarding the workability of the proposed system and shall take full responsibility for the equipment/ system/sub system, quality of material, workmanship, guaranteed operation and smooth performance of the system.
- This technical specification is intended to provide general guideline for the tenderer.
- Contractor to share the service manual for each component and the operation manual for the entire plant to the engineer in charge.
- As built/completion drawings to be submitted by the contractor in 4 set hard copies and 2 set soft copies in burnt disk.
- Successful contractor to provide foundation bolts, anchors etc and all that is required for the equipment installation.
- Laboratory test shall be conducted by the contractor once every 3 months after the completion of the plant till the defect liability and warranty period. The maintenance for the period speculated shall be provided by the tenderer including the consumables for a period as mentioned in the NIT.
- Before commencement of work, contractor to submit shop drawing and technical data sheets for the approval to the engineer in charge for his approval.
- Raw water analysis to be done by the successful contractor, based upon which the plant to be designed and installed. The details of which to be shared and verified with the engineer in charge/Architect consultant. The outlet parameter to be as per the IS 10500.
- The civil work associated with the treatment station is excluded from the scope of the tenderer.
- The contractor to take the sole responsibility of bringing the material to the site and installing it at the designated location.
- The contractor to install all associated items necessary to complete the operation
- Fire protection extinguisher are part of tender package initially allotted (Tender Package 1 and 2).
- Motor Bearing detail to be as per the OEM.
- All piping and allied works inside the plant room space shall be in the scope of the contractor. A Tap-off point shall be provided to the contractor at the inlet and it would be his responsibility to provide a tap off at the outlet.
- Electrical incoming line shall be provided to the contractor for the main panel. The scope of the contractor shall be to do the internal electrical works from the panel to each electro-mechanical equipment.
- Handling and hoisting equipment for all the pump houses shall be considered in the scope of supply of the tenderer. Type, capacity and height of lift shall be as per technical requirement. The civil beam and rail on which the chain, pulley arrangement shall be mounted will not be in the scope of this tender. The successful contractor shall supply the hoist arrangement of adequate capacity only.
- Treated sewage from the DEWAT STP shall be available under pressure to the clear water tank. The clear water tank of tertiary treatment is under the scope of this package.

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- The treated water from tertiary treatment plants shall be made available under pressure at TOP, which is 5 mtr. from the retaining wall/boundary of the Tertiary treatment Plant. The same shall be applicable for central treatment station, drinking water treatment station at academic spine, student housing, campus amenities, faculty housing 1 and 2.
- **Design Philosophy for Central treatment Plant:** The incoming water from the kamal sagar is being feed into the filter feed pump and then passed into the filtration equipments comprising of multigrade filter and activated carbon filter. Respective filter feed pumps(1W+1S) shall feed the water through the filter feed pump into the filtration equipments comprising of multi-grade filter and activated carbon filter. Ph correction and chlorine dosing is being dosed at pre and post the treatment. Active and free chlorine meter shall be considered and provided post the treatment for monitoring and controlling the free and active chlorine content. UV unit and electronic ozonator for the disinfection to be considered and provided at the outlet of activated carbon filter and prior to treated storage water tank. The entire plant will run on automation which will be PLC based and shall be HMI Compatible. The design brief to be referred from the drawings, Tender documents and specifications, however the tenderer while quoting shall consider all required sensor, interlocks with respect to auto operation of pumps, indication at PLC panel, along with auto control mechanism complete in all respect for smooth operation of the system and same shall be explicitly confirmed in their offer. Successful tenderer shall prepare and submit the necessary operation control philosophy, interlock diagrams, I/O Summary and P&ID for approval from engineer in charge/architect consultant..
- **Design Philosophy for STP Tertiary treatment Plants viz Academic spine, campus amenities, faculty housing, student housing 1 and 2:** The incoming treated sewage water from the DEWAT is being feed into the clear water tank at respective locations of the STP Tertiary treatment plant. Respective filter feed pumps(1W+1S) shall feed the treated sewage water collected at the clear water tank into the filtration equipments comprising of multi-grade filter and activated carbon filter. Ph correction and chlorine dosing is being dosed at pre and post the treatment. Active and free chlorine meter shall be considered and provided post the treatment for monitoring and controlling the free and active chlorine content. UV unit for the disinfection to be considered and provided at the outlet of activated carbon filter and prior to tertiary treated storage water tank. The entire plant will run on automation which will be PLC based and shall be HMI Compatible. The design brief to be referred from the drawings, Tender documents and specifications, however the tenderer while quoting shall consider all required sensor, interlocks with respect to auto operation of pumps, indication at PLC panel, along with auto control mechanism complete in all respect for smooth operation of the system and same shall be explicitly confirmed in their offer. Successful tenderer shall prepare and submit the necessary operation control philosophy, interlock diagrams, I/O Summary and P&ID for approval from engineer in charge/architect consultant..
- **Design Philosophy for Drinking treatment Plant:** To be referred under relevant head below under head 11 reverse osmosis unit.
- **Design Philosophy for Pumping system from the balancing Pond to kamal sagar:** Submersible pumps installed in the balancing pond to pump water from the balancing pond to the kamal sagar as and when required manually from the control desk. The operation shall be manual and shall be from the main control centre. Cable from the control centre and electrical supply shall be in the separate tender package.

Design and Technology references:

Central treatment station and STP Tertiary treatment station

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- Pumps to be automatic in operation linked with the level indicator of the tanks. Operation will cut in when the level goes beyond low level and shall cut off as soon as the level reaches high level.
- If the tank overflows due to malfunctioning of the level indicator, the water will overflow out into the drain channel and ultimately into the drainage sump.
- Sump operation would be such that once the water reaches the mid level, one pump will start and if the water reaches the high level, both pumps will be operational together. If the level goes upto the low level, then both pumps operation will stop.
- The ph correction dosing system and the ph meter will be linked in a way to control the amount of dosing. Alarm to be raised as soon as the ph falls below 6.5 and rises above 8.5.
- Filter backwash to be controlled by a differential pressure transmitter which is to be connected in parallel to the multiport solenoid valve. The function to be for autorinsing, backwash of the filters based on the differential pressure at the two ends.
- Differential pressure gauge to be connected across the y-strainer for indication on the differential pressure across the two ends for its cleaning operation. The indication shall be in the Panel with a light bulb for the identification.
- The hydro-pneumatic pumps will be fixed speed type will shall cut off as soon as the pressure in the line increase beyond 5 bar.
- Active and free chlorine meter to be linked with the chlorine dosing system to measure the free chlorine available and to control the dosage in the system.
- The UV unit shall be with a control module which will display the life cycle remaining since commissioning, Lamp replacement indicator, lamp failure indicator etc.
- The entire digital feed to be given in the main Plumbing panel kept in the plant room. The panel to be PLC controlled and BMS and HMI compatible. The outgoing signals shall be in separate tender Package pertaining to BMS systems.
- All the meters shall have localized display and shall be compatible to transmit the signal of the values to the main MCC panel.
- Backwash from the filters and treatment process to go into the sump and finally into the sewage line running near the facility. This is under the scope of the tenderer to connect the riser pipe from sump to the nearest chamber. The item will be paid as per the length of the pipe material used.
- The incoming water for the tertiary treatment process will have the following parameters.

BOD < 10 mg/litre
COD < 50 mg/litre
Suspended Solids < 20 mg/litre
Color unobjectionable
Oil and Grease < 5 mg/litre

The parameters to be achieved after the treatment process shall be as below:

BOD < 10 mg/litre
COD < 50 mg/litre
Suspended Solids < 10 mg/litre
Color unobjectionable
Oil and Grease < 5 mg/litre

1 . Filter Feed Pumps (MR-1, 2, 3 and 4)

- Pumps shall be vertical, centrifugal, multistage directly coupled to motor. Pump to be with with SS AISI 316 stage casing, AISI SS 316 impellers, SS Suction chamber, SS 316 Pump shaft, steel base plate, carbon mechanical shaft seal and suction and discharge casing as per IEC standards, connected to TEFC Ventilated induction motor of 2 pole, 2900 RPM, suitable for 400/440 Volts, 3 phase, 50 Hz A.C.. Impeller shall

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be hydraulically balanced and keyed to shaft. Pump shall be mounted on a concrete foundation, projecting at least 150 mm above finished floor level. The pumps base shall be set on a vibration elimination pad. The pump shall be lubricated in strict accordance with the manufacturer's instructions and shall be factory aligned prior to shipment. All motors and bases shall be painted with approved finish shop coat of paint. The pump shall be selected for the lowest operating noise level and shall be complete with flexible connections, valves, and pressure gauges. The pumps shall include cost of foundation channel complete.

- The Contractor shall supply and install pumps of the type and performance as shown on the drawings and as mentioned in the Bill of quantities. All duties of pumps given in the Tender Drawings shall be checked and where necessary corrected before ordering. All the parts of the pumps that are in contact with water e.g. shaft, impeller etc. shall be of stainless steel construction.
- Pumps shall be so selected that the design duty point is within 5% of the maximum efficiency point. The pump casing so selected shall have ample space to take an impeller one size larger than that capable of performing the design duty.
- The pump shall have a speed of not more than 1500 rpm. However pumps of 2900 rpm with high efficiency and low noise motor can be selected and noise data submitted for approval. All pumps and motors shall be of minimum vibration and noise level during operation. Vibration isolators shall be provided for all pump sets.
- Facilities shall be provided to prevent starting of pumps when the water tank is at low water level. An indicator for this low water level alarm shall be provided.
- Facilities to select which pump to be duty pump and standby pump shall be provided and be interchangeable. Pump to be working in cyclic operation with auto switching feature after every 5 hours.
- Leakage from pump gland shall be drained to the nearest drain.
- Pump curves for all pumps offered shall be submitted. All curve indicating excessive shut-off head will not be approved.
- Each pump shall be provided with a gate valve at suction and discharge, approved check valve at discharge, approved strainer at suction, flexible connections at pump suction and discharge, eccentric reducer at suction, concentric reducer at discharge, bourdon type glycerin filled pressure gauges at suction and discharge, circulation relief valve and automatic air relief valve.
- Appropriate neoprene vibration isolation mountings shall be provided for each pump sets.
- **Vertical Multi-Stage Pumps:** Multi-stage pumps shall be of centrifugal type and arranged with shafts vertically installed. The impellers shall be of stainless steel mechanically balanced and keyed to shaft. Renewable guide rings are to be provided in the casting, keyed to prevent rotation.
- Pumps shall be driven by elevated in-line TEFC squirrel cage motors via extended vertical shafted complete with universal couplings.
- The shafts shall be stainless steel. Stainless steel sleeves shall be provided to protect the shaft in the water space and through the sealing glands. The sleeves shall be keyed to prevent rotation and secured against axial movement.
- The bearings shall be of ball or roller type protected against ingress of water, dirt and other matter. Pump bearing bracket shall have oil lubricated bronze journal and thrust bearings.

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- Vertical multistage pumps shall have universal flanges. Intermediate bearing, support bearing shall be provided in the pump.
- The shaft seal shall be easily serviceable and shall allow for correct adjustment and loading of the seal. Pump motors above 7.5 kW shall be equipped with a spacer coupling which allows changing of shaft seals without removing the motor. The pump motors shall be of Class "F" insulation and IP55 rating and shall be provided with built-in thermistors for protection against overheating.
- The basic requirements of the pumps are detailed on drawings or specified in schedules of quantities. The flow characteristics of each pump or combination of pump should match the design requirement of the system to ensure stability throughout the operating range.
- Pumps shall be suitable for horizontal/vertical mounting.
- Mechanically seal pump liquid cavity at motor shaft with ceramic seal seat and carbon seal ring suitable for continuous operation at 225_F. The seal shall be able to withstand leakage at the maximum working pressure of the system.
- Bracket shaft shall be alloy steel having ground and hardened thrust bearing faces.
- A flexible coupling shall be incorporated to dampen starting torque and torsional vibrations. Provide casing wear rings, drains and vents.
- Pump shall be factory painted with at least one coat of high grade machinery enamel. Paint shall not contain ozone depleting substances.

2. Hydro-pneumatic Pumps (MR-5, 6, 7,8,9,10 and11)

- Fixed speed Hydro pneumatic pumping units shall be provided for supply of domestic water, flushing water supply for the project. The units shall be selected so as to provide at minimum of 1 bar pressure at the highest/farthest end at the OHT/ESR level. The hydro pneumatic pumping units shall have the following features;

System Description

- The system shall be supplied as complete sets including suction and discharge common manifolds, non-return valves, isolating valves, pressure transmitter on the discharge side and electrode at the suction tank.
- The system operation will be such that the initial small water demand shall be met by the charged diaphragm pressure vessel. Should the water demand continue the system pressure will dip to a preset pump cut-in point when the lead pump starts to operate at reduced speed through the fixed speed drive. When the lead pump is not able to meet the system pressure at full speed, the second pump also starts to operate.
- When the pressure in the system increase due to closing of the motorized valve at the ESR level, auto cutoff of pumps would occur and pump operation would stop.
- The closed diaphragm pressure vessel shall be of polyethylene material with a pressure gauge and isolating valve. The interior shall be of non-toxic lining suitable for use with potable water. The vessel shall be manufactured to conform to ASME pressure vessel code/standards.
- The system shall be under the control of an electronic microprocessor unit (EMU).
- A pressure transmitter shall detect the pressure at the delivery manifold and feedback to the microprocessor control panel via control circuit.

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- The system shall incorporate a frequency converter or frequency converter motors on the pumps and the pressure transmitter shall register the actual pressure on the discharge side.
- The pumping system shall maintain a constant pressure regardless of the system demand. If there is a drop in pressure outside the preset point, the fixed Speed Drive (FSD) pump shall start to run until the pressure increases to the preset limit, or it will continue to increase the pump speeds to the upper limit of the frequency. If the water system demand still cannot be met, the second pump shall be called in to run, the FSD will then work the pump to meet the preset pressure point. If the set point is still unable to be met, the third pump is then activated to run (in case of 3 pumps units).

Local Motor Control Panel

The motor control panel shall be equipped with all the necessary electrical components including a microprocessor control unit and a frequency drive. The control panel and the microprocessor shall cover the followings functions:

- Flexibility and simplicity in allowing the necessary re-adjustment of the pumping system pre-set delivery pressure to operate the pumps within the specified maximum and minimum delivery ranges.
- Built-in frictional loss compensation factor which will automatically increase the delivery pressure setting, in collaboration with the increase in flow demand. This shall be able to minimise the system pressure differences and provide a more constant pressure along the supply line and also to save the energy consumption of the motor when running at low speed.
- Automatic changeover of the pumps to be controlled by the microprocessor which dictates the duty and standby pumps to run at variable speed.
- Built-in clock functions with weekly programming and with switch on system.
- When the system has not been operated for more than 24 hours, it shall automatically start the pumps for a few seconds/day to ensure the pumps readiness at all times. The standby pumps shall be activated upon failure of duty pump(s). In event of control failure, the pumps shall be able to be start/stopped manually at the local panel by means of pressure switches.
- The microprocessor control panel shall be able to cut-off the pumping system when excess pressure is registered in the discharge common manifold.
- The system shall have the capability of receiving input signal concerning reduced water level in suction tanks and shall have control mechanisms to prevent the pumps from running dry.
- Automatically starting the pumps when the water level is back to normal.
- In case of pump failure due to motor overload, the standby pump is switched on automatically. Alarm signal is displayed on the LCD Display unit and alarm lights are activated.
- Functions to limit the no. of start/stop of pumps per hour.

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- The system control panel shall incorporate at least the following components :
 - a. LCD Display
 - b. Pumps selections for up to 4 pumps so that system controller can control up to 6 pumps
 - c. Pump status button to display duty pump speed and system capacity
 - d. Zone status button to display operating parameters for different pumping units
 - e. Setting button to input preset pressure, system start/stop time etc.
 - f. ± 1 button to key in numeric data such as pressure set point, etc.
 - g. Enter button for confirmation of input into the system
 - h. Alarm button to show location of fault - self diagnostic function display
 - i. Hour Run measurement for each supplied pumpset
 - j. Buttons for scrolling to select the actual display reading for system configuration, i.e. up and down scroll concept.
 - k. Necessary devices for programming, supervising and monitoring operation data/system, status shall be incorporating into the control panel.

Operations

Local control panel shall perform as follows :

Auto mode

The desired delivery pressure within the range specified, shall be set at the duty local control panel. The pressure transmitter shall detect the delivery pressure continuously within 1 second and feedback to the microprocessor which will control the drive for speed control of the duty pump. When demand increases, the subsequent pumps in the system will be activated to boost up the pressure. Ultimately the duty pumpset shall be operated fully automatically to maintain the delivery pressure constantly at the desired set value.

Manual Mode

The on/off function of the pumps shall be manually adjusted at the microprocessor located at the local control panel.

Frequency Control By-pass Mode

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All the pumpsets shall be started/stopped automatically with the pump output at fixed maximum rotational speed. All the control and protection functions shall remain active. The cut in/cut out pressure shall be internally calculated by the microprocessor for each pump.

System Features

The required performance features of each Hydropneumatic pumping unit shall be as follows :

System Configuration

Fixed speed pumps with pressure vessels.

Control panel consisting of the following components :

- Pump Functional Unit (PFU) - control unit c/w pre-programmed microprocessor chip. This unit shall control all pumping unit operations through electronic controller.
- Pumping Monitoring Unit (PMU) - monitor the operation of the pumpsets. This unit shall allow for monitoring and setting of all control parameter.
- Fixed Speed Drive
- Circuit Breakers
- Fuses
- Pressure Transmitter

Set Point

Ten separate pressure “set points” shall be able to be programmed into the PMU, and switching between set points is timed by a real time clock when a lower pressure is acceptable during certain periods, for instance after hours or weekends, the set point shall be lowered to minimise power consumption.

An external input shall also be used to switch between set points, or manually adjust a set point at any time.

Friction Loss Compensation

It shall be possible to allow for the friction loss component of the system, calculated at full flow and set as a percentage of the set point which will reduce the working pressure of the pump set depending on the actual no. of pumps in operation. A linear approximation of system resistance curve can therefore be allowed for, and pressure will automatically increase as system flow and subsequent frictional losses

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increase. As such power consumption shall reduce which is required for the pumping system.

Displays

Through the PMU keypad all variable parameters shall be adjustable, current status of settings and measured values shall be able to display on the 2 line x 24 character liquid crystal display.

Individual menus shall be available for monitoring individual pumps, zones, settings, alarms and ON/OFF functions.

Pump Status

Running hours of each pump

Actual pump status (running, not available, standby, allocated to zone, fault)

Maximum head of pump at zero flow.

Zone Status

This menu shall be the main operating menu where at the setting and operating parameters can be viewed,

- Current operating set point
- Measured values in the system
- Operating capacity in terms of total output
- Mode of operation for the zone
- Clock programs (relating to set point pressures)
- Standby pumps
- Pump change over time
- Zone configuration
- Pressure transducer scaling
- Friction loss compensation
- Pump priority
- Inlet pressure measuring (if required)
- System response times
- Allowable number of starts per hour for the pumps
- Minimum limit (loss of water, burst mains protection)

Setting Menu (Set)

In this menu all parameters for the operation of the pump set shall be able to be adjusted as required.

- a Set points (up to 10)
- b. On/Off function (used to prevent unnecessary cycling at low demands)

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- c. Displayed pressure units (Bar, PSI, mBar, kPa)
- d. Real time clock programming for any time of the day, week, or weekend
- e. Zone configuration
- f. Friction loss compensation

Alarm

The alarm menu shall display all faults that occur during operation, logging the time and date of when the fault occurred and when it was corrected, or whether it is still an actual fault, up to 10 faults can be maintained as history in the controller. The following type of faults shall be diagnosed by the controller.

- a. Mains failure
- b. Frequency converter fault
- c. Analogue input (pressure transducer) fault
- d. High discharge pressure fault
- e. Low discharge pressure fault
- f. Motor thermal overload fault

Fixed Frequency Drive

Fixed frequency drive shall be of a reputable make acceptable to Project Manager and shall be complete with RFI filter and harmonic dampers.

Enclosure

An IP 55 powder coated steel enclosure shall house all the electrical components.

The enclosure can be supplied loose for remote mounting, or mounted on a common base with the pumps, it shall be adequately ventilated for use in conditions up to a maximum ambient temperature of 45 degrees Celsius.

Electrical Component

All circuit breakers, thermal overloads and contactors shall be of reputable make acceptable to the architect. Electrical supply to the pump controller shall be protected using an isolating circuit breaker.

Method of Starting

The panel shall be built to start the pumps in suitable starting modes, i.e. D.O.L., Star/Delta, or using Soft Starters.

Quality and Testing

Manufacture of the pumps, plus design and assembly of the complete packaged Hydropneumatic pumping system shall be factory assembled and the pump station shall be fully tested hydraulically and electrically prior to dispatch to site. Test reports etc. shall be submitted for review before dispatch.

Pump Pressure Vessel

Diaphragm type pressure vessels shall be provided as shown on the drawings. They shall be incorporated into the system so that during normal operation the pump shall not need to be start within 30 seconds of it switching off in order to prevent the pump hunting.

The pressure vessel shall be of adequate capacity to accommodate a considerable fluctuation in water demand by the system with minimum start/ stop cycles of the pumps. The vessel shall be constructed of steel plate built to ASME Standards for Unfired Pressure Vessel. A rubber diaphragm shall be provided in the vessel for separating the water and pre-charge nitrogen. The pre-charge pressure shall be adjustable and charging port with non-return device shall be provided. The adjustable cut-in and cut-off pressure unit for the pumps shall be built-in at the vessel to suit the system.

3. Submersible Pumps (MR-12,13, 119,120 and 121)

- These shall be fully submersible with a fully submersible motor. The pumps shall be provided with an automatic level controller and all interconnecting power and control cabling which shall cause the pumps to operate when the water level in the sump rises to a preset level and stop when the preset low level is reached.
- Pumps for drainage shall be single stage, single entry.
- Pump shall be with SS AISI 304/316 vortex impellor, SS AISI 304/316 volute and cover, SS AISI 304/316 stator, SS Shaft, 3 phase motor with all necessary protection and mechanical seal etc. The MOC of the sump shall be strictly in accordance to schedule of quantity.
- Stuffing box shall be provided with mechanical seals.
- Each pump shall be provided with a suitably rated induction motor suitable for 415 volts, 3 phase, 50 Hz A.C. power supply.
- Each pump shall be provided with in built liquid level controller for operating the pump between predetermined levels.
- The pumping set shall be for stationary application and shall be provided with pump connector unit. The delivery pipe shall be joined to the pump through a rubber diaphragm, and bend and guide pipe for easy installation.
- Pump shall be provided with all accessories and devices necessary and required for the pump to make it a complete working system.
- Pump shall be complete with level controllers, power and control switch gear, Auto/off/Manual switches, pumps priority selections and control and power cabling upto motor and controller/probes etc. (Including earthing). Level control shall be such that one pump starts on required level, 2nd pump cuts in at high level and alarms is given at extra high level. All level controllers shall be provided with remote level indications.

Motor Design

- The pump motor shall be a squirrel cage induction, housed in air filled water-tight enclosure. Oil filled motors are not acceptable. The stator windings shall be Class "F" insulation (155 degree C or 311 degree F) for general usage and class 'H' insulation (180 degree C or 317-8 grade 2) for submersible type.
- The stator shall be heat shrunk fitted into the enclosure and shall not use bolts, pins or other fasteners that penetrate through the stator enclosure. The starter shall be equipped with a thermal switch embedded in series in the coils of the stator windings to protect the stator from wheel.
- The motors shall be designed for continuous running duty type at 415 volts, 3 phase, 50 Hz power supply and capable of sustaining a minimum of 20 starts/stops per hour.
- Between stator housing and pump, a tandem seal arrangement will be provided with an oil barrier. Both seals run in oil, allowing dry running without seal damage. Both seals shall be of the rubber bellows or metallic bellow type with positive drive between shaft and rotating seal face.

4. Multigrade filter (MR-14,15, 16 and 17)

- Pressure Filter will be vertical cylindrical Mild Steel body Multi grade Filter with dished ends at top and bottom. The minimum thickness of shell and dish will be 8/10 mm as specified in BOQ.
- Filters will be provided with initial charge of graded filter sand, pebbles, anthracite, and media under bed material. Filter to have complete internal distribution and collection systems of connecting with multiport valve (for controlling all operations for rinsing, backwashing, service etc under automated system linked with differential pressure transmitter and differential guage), pipes and valves of adequate size i.e. inlet, outlet, drain, overflow, backwash lines and associated valves, pressure gauges.
- The Filter media will consists of pebbles, gravel, anthracite and sand. The Filter will be epoxy coated from inside and painted with two coats of enamel paint of approved shade over a coat of red oxide primer. Filter will be supplied with supporting lugs (for embedding in concrete foundation) and fixing on floor complete as required.
- The capacity of filter will be as specified in schedule of quantities. The minimum working pressure of filter will be 2.0 kg/cm² and maximum will be 3.5 kg/cm².The filter test pressure will be 6kg/cm².
- The water quality report is to be assessed and examined at site and filter media to be designed accordingly by WTP vendor. The quality of water from the filter outlet must comply the water quality as per IS 10500/ International standards.
- All interconnecting piping in the filter to be SS 304 as per the schedule of quantities.

5. Activated Carbon filter (MR-18,19, 20 and 21)

- Activated Carbon Filter will be vertical cylindrical Mild Steel body Filter with dished ends at top and bottom. The minimum thickness of shell and dish will be 8/10 mm as specified in BOQ.
- Filters will be provided with initial charge of carbon filter bed and under bed material. Filter to have complete internal distribution and collection systems of connecting with multiport valve (for controlling all operations for rinsing, backwashing, service etc under automated system linked with differential pressure transmitter and differential gauge), pipes and valves of adequate size i.e. inlet, outlet, drain, overflow, backwash lines and associated valves, pressure gauges.
- The Filter media will consists of carbon filter bed and under bed material. The Filter will be epoxy coated from inside and painted with two coats of enamel paint of approved shade over a coat of red oxide primer. Filter will be supplied with supporting lugs (for embedding in concrete foundation) and fixing on floor complete as required.
- The capacity of filter will be as specified in schedule of quantities. The minimum working pressure of filter will be 2.0 kg/cm² and maximum will be 3.5 kg/cm².The filter test pressure will be 6kg/cm².
- The water quality report is to be assessed and examined at site and carbon filter media to be designed accordingly by WTP vendor. The quality of water from the filter outlet must comply the water quality as per IS 10500/ International standards.

6. Differential pressure transmitter (MR-22)

- Pressure transmitters shall be field mounted and shall transmit an isolated 20 mA Supply, 24 V DC / others, signal indicative of process variable to the pump logic controller via standard two wire 24 DC system. Unit shall have stainless steel wetted parts and it should be installed at the discharge header. It should have watertight, electrical enclosure capable of withstanding minimum 10 bar static pressure.
- Differential pressure transmitter to be interlinked with the multiport solenoid valve at filters for auto operation of filter features like rinsing, backwashing, service etc.
- Pressure range to be not less than 0-10 bar.
- Temperature range to be minimum 0-85 degree Celsius.
- Turn down ratio: 1:100 / others.

7. Multiport Solenoid valve (MR-23)

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- Solenoid valve shall be of proven quality and approved sample. Valve shall be electrical operated.
- Solenoid valve will have a valve before and after it and a bypass to it with a valve. The Solenoid valve must keep the entire operations on automatic mode.
- Solenoid valve shall be with a display panel showing the time duration and status of the valve opening and closing.
- Test Pressure range to be not less than 15 bar.
- Temperature range to be minimum 0-85 degree Celsius.

8. Differential pressure Gauge (MR-24)

- Differential pressure gauge to be installed across y strainer for the indication of the strainer cleaning schedule. As soon the differential pressure increases along the inlet and outlet of strainer, an alarm to be generated to indicate the cleaning of strainer. Unit shall have stainless steel wetted parts. It should have watertight, electrical enclosure capable of withstanding minimum 10 bar static pressure.
- Pressure range to be not less than 0-10 bar.
- Temperature range to be minimum 0-85 degree Celsius.

9. Chlorine dosing System (MR-25 and 26)

- Dosing system will have one FRP/ HDPE tank of 200 liters capacity with a positive displacement diaphragm Dosing pump with a variable flow rate as mentioned in the schedule of quantities. The motor shall be suitable for operation at 240 V /single phase/ 50 Hertz supply.
- The pump shall be supplied complete with necessary agitator, poly propylene piping, valves, strainers & injection fittings for system to dose solution to the feed line, as per specification and as mentioned in the schedule of quantities.
- Low level switch to be with a range of 0-600 mm and should indicate in the control panel if the level of solution drops down at a certain level.
- The unit to be linked with the active and free chlorine monitoring system in order to avoid residual chlorine in the system.

10. Ph correction dosing System (MR-27)

- Dosing system will have one FRP/ HDPE tank of 200 liters capacity with a positive displacement diaphragm Dosing pump with a variable flow rate as mentioned in the schedule of quantities. The motor shall be suitable for operation at 240 V /single phase/ 50 Hertz supply.

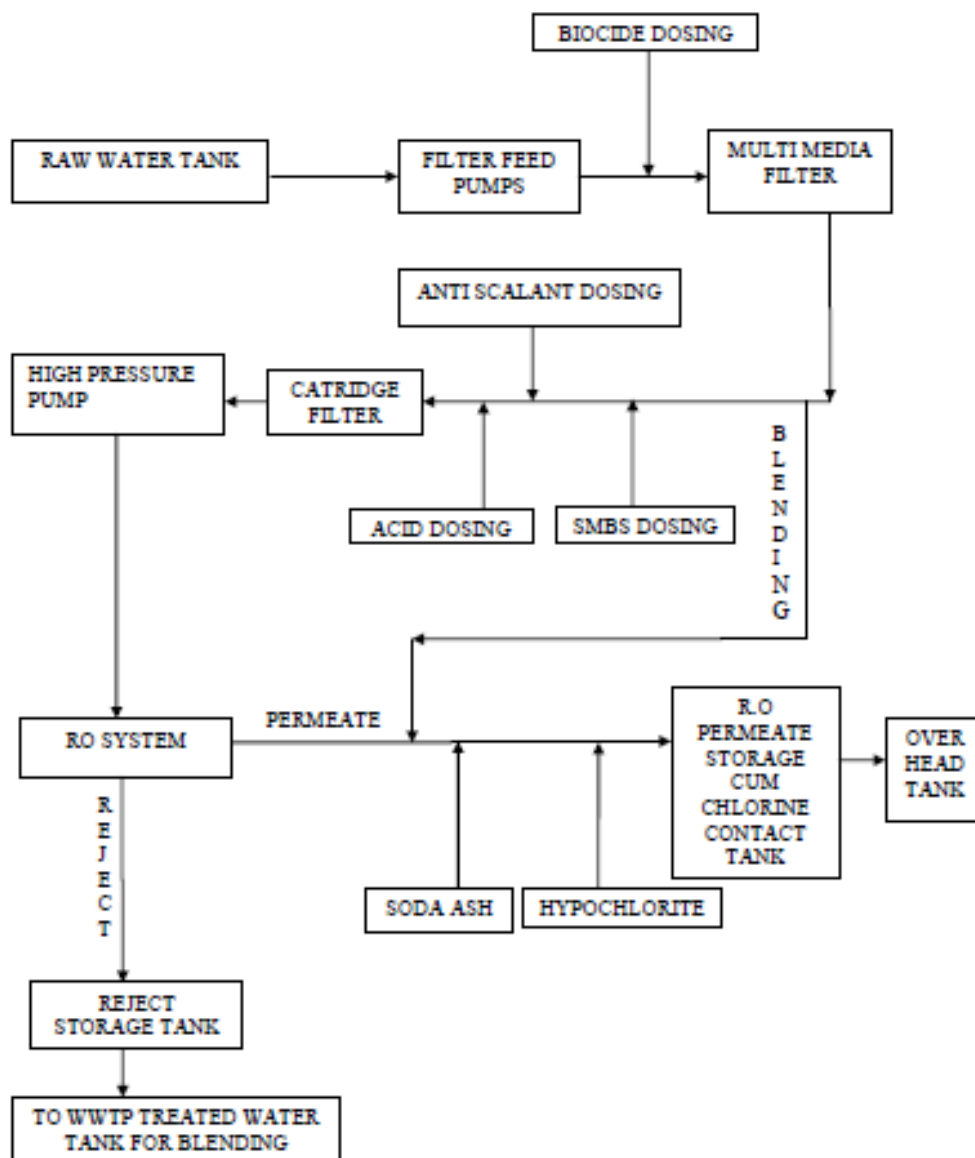
DEVELOPMENT OF PERMANENT CAMPUS (PHASE-I) FOR NALANDA UNIVERSITY

- The pump shall be supplied complete with necessary agitator, poly propylene piping, valves, strainers & injection fittings for system to dose solution to the feed line, as per specification and as mentioned in the schedule of quantities.
- Low level switch to be with a range of 0-600 mm and should indicate in the control panel if the level of solution drops down at a certain level.
- The unit to be linked with the ph meter in order to maintain the ph level between 6.5-8 levels in the system.

11. Reverse Osmosis System (MR-29 and 30)

- The proposed treatment scheme is Reverse Osmosis (RO) system which is well established system for reduction of TDS. Pre treatment units consist with multimedia filter, cartridge filter and chemical dosing system. Hypochlorite dosing will be done before filter to protect the filter against bio fouling. This will be done only during backwashing of filter every 60 days interval. However, backwash of filter will be done every day. SMBS (Sodium Meta-bi Sulphate), Anti-Scalant, Acid will be dosed before RO high pressure pump to reduce the residual chlorine, protect the membrane from scaling and maintain the pH (range 6-7) respectively and hence to increase the design life of membranes. Post treatment like pH adjustment and disinfection are proposed to make the water potable and fit for storage use. Provision is also made to blend part of the filtered raw water with the permeate water to achieve stable and relatively noncorrosive water. The schematic treatment scheme is given below:

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Process Description

The treatment process proposed broadly consists of (i) Pre-Treatment (ii) Reverse Osmosis System and (iii) Post-Treatment.

Pre Treatment:

Pre and Post treatment Dosing System (each consisting of one HDPE tank of 200 litres capacity with a positive displacement diaphragm dosing speed & stroke control pump (1W + 1S) having variable flow rate of 0-6 lph. The motor shall be suitable for operation at 240 V/Single phase/50 Hz. Supply. The pump shall be supplied complete with necessary agitator, polypropylene piping, valves, strainers, low level switch (Range 0-600mm) and injection fittings.):

- Biocide dosing system for pre and Hypochlorite and soda ash post dosing and dosage rate 2-3 mg/l.

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- Anti scalant dosing system for dosing downstream of MGF and ACF and dosage rate 5 mg/l.
- Acid dosing system in inlet of RO membrane and dosage rate 2 mg/l.
- SMBS dosing system for dechlorination at the inlet of RO membrane and dosage rate 5-10 mg/l.
- PH Correction Dosing system (NaOH) for maintaining the ph to drinking water standard. Dosage required will be 2 mg/l.
- All equipment and chemical feed systems will be pre-engineered and skid mounted and will be seamlessly integrated with the main RO process control systems.

Reverse Osmosis System:

- High Pressure Pump: Vertical centrifugal Pump with low pressure switch for smooth operation, dry run protection of adequate capacity and head with SS AISI 316 stage casing, AISI SS 316 impellers, SS Suction chamber, SS 316 Pump shaft, steel base plate, carbon mechanical shaft seal and suction and discharge casing as per IEC standards, connected to TEFC Ventilated induction motor of 2 pole, 2900 RPM, suitable for 400/440 Volts, 3 phase, 50 Hz A.C. supply with glycerin filled pressure gauge, vibration elimination pads, dry run protection etc. complete with base and frame, nuts and bolts. The pump should be rated at the premium efficiency rating of IE. The pump inclosure to be minimum IP 54 rated and insulation class to be F.
- Reverse Osmosis Block comprising of micron filter and membrane encased inside pressure vessels. the membrane to be thin film composite in spiral wound construction. Membrane material to be TFC Polyamide. RO Housing to FRP material with pressure rating of 250 psi.
- A signal to the system PLC indicating operation of the raw water feed pump (pump that feeds to the RO unit) shall start the de-chlorination feed (SMBS dosing unit) pump. If neither raw water feed pump is operating, then the PLC shall not start the dechlorination feed pump(s). An ORP meter signal will be used in the PLC to trim the dechlorination pump speed so that a correlation can be developed between de-chlorination pump feed and the ORP signal, to achieve neutralization of residual chlorine. The PLC shall allow operator adjustment from the HMI of the correlation between ORP signal and the de-chlorination pump speed (frequency).

Micron cartridge Filter

One number micron cartridge filter of size 5 micron is proposed for each train to prevent passage of particulates to the high pressure pump and membrane. The micron cartridge will be of polypropylene material with SS housing. The cartridge filters will be provided with isolation valves and pressure gauges on both sides.

Chemical Dosing system

- **Biocide dosing system:** Without pre-chlorination, the media filters will promote biological activity that can potentially foul the downstream RO membranes. A biocide (hypochlorite) will be periodically circulated through the pre-filters during back-wash of the filter, to prevent biological activity in the filters and avoid fouling of RO membranes. The dosage required will be 2-3 mg/l. With 10-12 % concentration solution the dosage rate is 4 litres per hour. Considering the above Biocide dosing tank of 200 litres capacity has been proposed. Two numbers of dosing pumps of capacity 0 to 6 litres per hour one for each train will be provided.
- **Anti-scalant dosing** is proposed to prevent scaling in the RO membrane. The antiscalant will be dosed downstream of pressure multimedia filter. The dosage required will be 5 mg/l. With 18 % concentration solution the dosage rate is 4.5 litres per hour. Considering the above antiscalant dosing tank of 200 litres capacity has been proposed. Two numbers of dosing pumps of capacity 0 to 6 litres per hour one for each train will be provided.
- **Acid dosing system:** For optimum function of the RO membrane the feed water pH should be in the range of 6 to 7. To maintain this pH, HCl acid will be dosed in the inlet of RO system. The dosage required will be 2 mg/l. With 10 % concentration solution the dosage rate is 4 - 4.5 liters per hour. Considering the above acid dosing tank of 200 litres capacity has been proposed. Two numbers of dosing pumps of capacity 0 to 6 litres per hour one for each train will be provided.
- **SMBS dosing system:** De-chlorination to protect the RO membranes from chlorine exposure shall be accomplished using sodium bisulfite (NaHSO_3). The dosage required will be 5-10 mg/l. With 8-10 % concentration solution the dosage rate is 3-4 liters per hour. Considering the above SMBS tank of 200litres capacity has been proposed. Two numbers of dosing pumps of capacity 0 to 6 litres per hour one for each train will be provided.

Reverse Osmosis Block

The RO Block comprises of membranes encased inside the pressure vessels. The membranes considered are thin film composite in spiral wound construction. The feed water at high pressure enters the RO block and gets separated in to permeate (product) and reject (waste) streams.

Post Treatment:

- **Chlorination Feed System** – chlorination shall be accomplished using an industrial/commercial concentration (10-12%) of sodium hypochlorite. The sodium hypochlorite will be dosed following RO and upstream of permeate

(CT) tank for primary disinfection and to maintain. The dosage required will be 2 mg/l. With 10-12 % concentration solution the dosage rate is 4 litres per hour. Considering the above hypochlorite dosing tank of 200 litres capacity has been proposed. Two numbers of dosing pumps of capacity 0 to 6 litres per hour one for each train will be provided.

- **Ph correction dosing system:** The RO permeate water will be slightly acidic in nature and require suitable dosing to maintain the pH to drinking water standard. Soda ash will be dosed to increase the pH to the required level. The dosage required will be 2 mg/l. With 20 % concentration solution the dosage rate will be 1-2 litres per hour. Considering the above soda ash dosing tank of 200litres capacity has been proposed. Two numbers of dosing pumps of capacity 0 to 6 litres per hour one for each train will be provided. This system is common for pH adjustment and membrane flushing.

RO Membrane cleaning

RO membranes will inevitably require periodic cleaning, anywhere from 1 to 3 times a year depending on the feed water quality. As a general rule, if the normalized permeate flow has decreased by 15% then it is time to clean the RO membranes. There are several different membrane cleaning methods, such as forward flush, backward flush and air flush. Chemicals may also be added in order to aid flushing.

Forward Flush

When forward flush is applied, membranes are flushed with feed water in forward direction. The feed water or permeate flows through the system more rapidly than during the production phase. Because of the more rapid flow and the resulting turbulence, particles that are absorbed to the membrane are released and discharged. The particles that are absorbed to membrane pores are however not released. These particles can only be removed through backward flushing.

Backward Flush

Backward Flush is a reversed filtration process. Permeate is flushed through the feed water side of the system under pressure. When backward flush is applied the pores of a membrane are flushed inside out. The pressure on the permeate side of the membrane is higher than the pressure within the membranes, causing the pores to be cleaned.

Air Flush or Air and water Flush

A newer cleaning method is the so-called air flush or air/ water flush. This is a forward flush during which air is injected in the supplier pipe. Because air is used, causing air bubbles to form, which cause a higher turbulence. Because of this turbulence the fouling is removed from the membrane surface.

Chemical cleaning

During a chemical cleaning process, membranes are soaked with a solution of chlorine bleach, hydrochloric acid or hydrogen peroxide. First the solution soaks into the membranes for few minutes and after that a forward flush or backward flush is applied, causing the contaminants to be rinsed out. RO membrane cleaning involves low and high pH cleaners to remove contaminants from the membrane. Scaling is addressed with low pH cleaners and organics, colloidal and bio-fouling are treated with a high pH cleaner. Cleaning RO membranes is not only about using the appropriate chemicals. There are many other factors involved such as flows, water temperature and quality. Hence properly designed cleaning skids and an experienced service group must be ensured for proper cleaning of RO membranes.

Instrumentation and automation

- The water treatment plant is PLC based fully automated system. Provision will be made to communicate via BACKNET protocol. WTP building is central control station for WTP & WWTP operations The filter feed pumps will be operated through the level switches for on & off operation depending on high & low raw water level inside the raw water tank . The level of the tanks will be transmitted to PLC via level switch. The flow transmitter will be provided in the filter feed pump delivery line to monitor the flow in HMI & to trip the pumps during reduced flow condition through PLC based MCC panel.
- PLC shall be provided with self backup (by its dedicated UPS) for 15 min.
- The inlet & out let of Pressure multimedia filter will be equipped with the pressure transmitter for service flow & Backwash operation. The differential pressure between inlet and outlet of PMF is high than the DPT. will trip the filter feed pump through pressure transmitter & simultaneously the backwash process to be required after reset the PMF valve. After back wash the service flow will be resumed. The opening & closing of actuator valves will be controlled from PLC based MCC panel.
- After PMF, the treated water will enter into the high pressure pump of RO unit through a micron cartridge filter .The inlet & out let of RO high pressure pump will be equipped with pressure transmitter. The inlet pressure transmitter will indicate the status of cartridge filter, whether it has been choked or in running condition. Low inlet pressure of high pressure pump

indicates choked/blockage in micron cartridge filter & normal pressure indicates service mode of micron cartridge filter. Low pressure in the inlet of RO high pressure pump will initiate tripping of RO high pressure pump & initiates cleaning process of micron cartridge.

- From the inlet of micron cartridge filter provision for a blending line will be made to have the desired output quantity of water & TDS level in the permeate line. The flow in the blending line will be controlled by control valve operation through PLC.
- In service mode with the onset of high pressure pump the SMBS & anti-scalant dosing will be started to neutralize the residual chlorine level inside the RO membrane & to resist any form of scaling inside RO membrane. A residual chlorine meter (ORP) signal will be used in PLC to trim the SMBS dosing pump speed so that a correlation can be developed between SMBS dosing pump and the ORP signal to achieve neutralization. The provision not only for SMBS dosing pump but also for other dosing pump will be made to allow the operator to make adjustment from the HMI to change the pump speed accordingly with the residual chlorine meter & pH meter signal. The same is applicable for the PH correction system also. However, the high level in the conductivity meter (TDS more than 500 mg/l in the permeate) will trip the high pressure pump & initiates the chemical cleaning process of RO membrane through PLC.
- During chemical cleaning of RO membrane the RO high pressure pump will be in OFF mode & the chemical solution (Citric acid) from the Acid dosing system will be dosed through a separate micron cartridge filter into the RO membrane. The chemical cleaning is basically the circulation of Citric acid solution through the RO membrane for a certain period. In this condition the Citric acid solution coming out through permeate & the reject water line will be re-circulated. After chemical cleaning the acid solution will be drained out & RO water from the permeate tank will be used for flushing.
- After completion of chemical cleaning & flushing of RO membrane the RO unit is now ready for operation in service mode. The RO permeate from the chlorine contact tank shall be transferred to the overhead water tank through RO permeate transfer pumps. The pumps shall be controlled by signals from the ultrasonic level sensor located in the overhead water tank and the signals for low level and high level switches in RO permeate tanks.
- All the dosing tanks will be equipped with level switch to alarm during low liquid level which will be displayed on HMI to allow the operator for refilling of dosing tanks & onset of dosing pumps.
- In the permeate line the flow transmitter will be provided to monitor the flow in HMI & also to trip the RO high pressure pump & filter feed pumps during reduced flow condition through the PLC.
- The parameters to be monitored in the treated water consists of:

- Flow rate
- Pressure
- Conductivity
- pH
- Turbidity.
- chlorine residual
- Necessary instruments with sensors will be provided for monitoring and recording the above parameters in the treated water. Alarms will be generated when the parameters fall outside the design parameters.
- Other instrumentation and automation considered are:
 - All chemical feed system will be provided with low level alarm
 - Remote speed (frequency) control for chemical feed pumps (Only SMBS and pH correction dosing system)
 - Hand-Auto-Off switched for chemical feed pumps
 - Running status and failure alarm contact wired to the RO/EDI systems PLC
 - PLC controlled de-chlorination system with ORP meter.
 - Auto flush on system shutdown
- Alarms for low inlet pressure, motor starter overload, high temperature, high permeate conductivity, High-low pH. The RO skid assembly shall include a corrosion resistant IP56 electrical junction box with pneumatic arrangement for each automatic valve and terminals for all external wiring connections. All wiring between skid instruments and the electrical junction box will be completed prior to shipment. All actuators proposed in the system will be pneumatic actuators. For pneumatic actuator, an Air compressor will be provided.

12. Electronic Ozonator (MR-31)

- The material of construction of the ozonator to be complete stainless steel enclosure and all components to be high grade material. The system to be with SS 316 electro polished ozone cell, SS 316 electro polished ozone injector(ejector) with SS 316 Non return valve, silicon / teflon tubing 1/4" x 5 meter. All contact parts to be either in SS 316 electro polished or teflon.
- 100-120 gram per hour discharge capacity with electronic power supply inverter with latest ozone technology to generate high capacity ozone with minimum power consumption and minimum break down.

- All relevant technical data submittals of the relevant product to be approved with sample before procuring at site.

13. Ultraviolet unit (MR-32)

- The UV disinfection to have over 30000 UV dosages (30mJ/cm²) and UV intensity monitor and Stainless steel -316 treatment mat, electric cabinet, lamp out alarm circuit with all necessary connections and testing certificates to make it fully functional. The inlet water will be filtered water and outlet water post UV must be completely disinfected and supported with biological water testing as per IS 10500. UV purifier must necessarily be in-built equipped with UV intensity monitor and all necessary provisions suitable to be integrated and monitored on BMS.
- The unit should consist of reactor, cabinet housing, cabinet cooling, treatment chamber, electrical panel, temperature safety control, lampout alert, UV radiometer along with UV monitoring system and UV monitoring readout panel (Intensity monitor required which shows the life cycle remaining since commissioning, Lamp replacement indicator, lamp failure indicator etc.).
- The unit shall be complete with temperature safety control, lamp out alert circuit & UV radiometer with 4 – 20 mA output and auto cleaning feature. The treatment chamber shall be SS 316.

14. Electronic flow meter (MR-38,39,40,41 and 42)

- The flow meter to be preamplifier & microprocessor based electronic type interlinked with the control panel to give the following features:
 - Monitoring the total flow
 - Flow rate
 - high low alarm batching
 - blending
- The signal from read out shall be 4-20 m.amps to be received on BAS.
- Flow Rate Range : upto 2000 LPM or as specified in the schedule of quantities.
- Temperature Range : upto 85 degree celcius.
- Pressure Range : upto 50 bar
- Material of construction: Stainless steel

- IP Rating: IP 67 for transmitter and IP 68 for sensor.
- Accuracy : 1 % on positive and negative side.

15. Water level indicators (MR-43)

- Water level indicators cum controllers working on hydrostatic pressure Measurement principle made of Stainless Steel for installation on storage tanks, and capable of providing 4 to 20 mA analog signal compatible with PLC signal inputs and complete as per working requirements for details of equipment below. All control outputs to MCC panel shall be included as per requirements.
- **Material:**
 - Input voltage – 24 V DC
 - Power Consumption - Less than 5W
 - Size of the unit- Width (W):195 x Height (H): 185 x Depth (D): 85
 - Approximate Weight - 1 kg
- **Special:**
 - Type of sensor – Probe type
 - Number of sensors - 1 in each tank
 - Sensing material – SS 316
 - Transducer enclosure – SS, IP 68
 - Temperature range – 15 to 30oC
 - Accuracy - +/- 0.25 % F.S.
 - Measuring Range – 5 to 10 meters.
 - Cable – length upto plumbing localized panel
 - Sensor Signal output – 4 to 20mA, 2 wire
 - MCC Panel – Digital display to be fixed in plumbing panel

16. TDS Meter (MR-44 and 45)

- TDS meter installed as shown in the tender drawing for the measurement of total dissolved solids in the system. Monitoring to be at inlet of treatment unit and at the outlet of the treatment system. The meter should be capable of providing the signal to the control panel and BMS so that the parameters can be displayed and monitored at all times.
- The TDS meter should be with Built-in non-volatile memory, local display, Automatic Temperature, Compensation, Password Protected, IP - 67 rating, measuring range as specified in the schedule of quantities.

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- The meter shall be with BMS compatible feature and shall provide its signal to the localized control panel and from it the control of the unit along with the meter can be controlled from the main operating station.

17. PH Meter (MR-46)

- PH meter installed as shown in the tender drawing for the measurement of Ph level in the system. Monitoring to be at inlet of treatment unit and at the outlet of the treatment system. The meter should be capable of providing the signal to the control panel and BMS so that the parameters can be displayed and monitored at all times.
- The ph meter should be with Built-in non-volatile memory, local display, Automatic Temperature, Compensation, Password Protected, IP - 67 rating, measuring range as specified in the schedule of quantities.
- The meter to be set at a range of 6.5 to 8 ph level with automatic linkage with the ph correction dosing system to control ph level. The device to be capable of raising an alarm when ph reduces below 6.5 and increases beyond 8.5.

18. Active and free chlorine Meter (MR-47)

- Active and free chlorine meter to be linked with SMBS dosing system for analysis of active chlorine(HOCL) or total free chlorine(HOCl + ClO⁻).
- The system should be comprising of transmitter, cable (10 mtr. Or upto the localized panel, whichever is greater), probe and flow through cell, PE Tubing drain etc complete in all respect.
- The unit should be capable to work at 240 V AC, 50/60 Hz.
- measuring range 0.5 mg/l free chlorine
- Detection range < 10 ppb HOCl and 20 ppb free chlorine
- Response time < 90 seconds
- Temperature range 0-45 oC
- 20 mA isolated analog output
- 4 dry contacts NO/NC(250VAC, 3A / 30VDC, 0.5A ohmic load max.) for high/low limits(programmable delay and hysteresis)
- system alarm with manual or automatic acknowledgement
- timer programmable frequency and sequence).

- The transmitter to IP 65 rated.
- The electrodes to be silver anode and measuring cell to be PVC.

19. Electronic water Meter (MR-48, 49 and 50)

- Water meters of approved make and design shall be supplied for installation at locations as shown. The water meters shall meet with the approval of local supply authorities. Suitable valves and chambers or wall meter box to house the meters shall also be provided along with the meters.
- The meters shall conform to Indian Standard IS:779 and IS:2373. Calibration certificate shall be obtained and submitted for each water meter.
- Provision shall also be made to lock the water meter. The provision shall be such that the lock is conveniently operated from the top. Where the provision is designed for use in conjunction with padlocks, the hole provided for padlocks shall be a diameter not less than 4mm.

Installation Of Water Meter And Stop Cock

- The lines shall be cut to the required lengths at the position where the meter and stop cock are required to be fixed. Suitable fittings shall be attached to the pipes. The meter and stop cock shall be fixed in a position by means of connecting pipes, jam nut and socket etc. The stop cock shall be fixed near the inlet of the water meter. The paper disc inserted in the ripples of the meter shall be removed. And the meter installed exactly horizontal or vertical in the flow line in the direction shown by the arrow cast on the body of the meter. Care shall be taken that the factory seal of the meter is not disturbed. Wherever the meter shall be fixed to a newly fitted pipe line, the pipe line shall have to be completely washed before fitting the meter.

20. Tanker Inlet Connection (MR- 51)

- The inlet connection to be in Galvanized iron heavy duty class C of 150 mm diameter pipe. The end to be fitted with a inlet hose connection via a neck welded flange.
- The tanker inlet connection to be enclosed in a MS Cabinet enclosure, which shall be epoxy painted after fabrication.
- pad locking arrangement to be provided in the connection.
- The item as mentioned in the schedule of quantities shall be including all that are necessary to complete the job.

21. Mosquito Proof Grating (MR- 52)

- Stainless steel grating at the tanks to prevent mosquito from entering the tanks.
- The item as mentioned in the schedule of quantities shall be including all that are necessary to complete the job.

22. Insect vermin- Proof coupling (MR- 53)

- Stainless steel coupling at the tanks to prevent insect from entering the tanks.
- The item as mentioned in the schedule of quantities shall be including all that are necessary to complete the job.

23. Rubber expansion joints (MR- 54, 55, 56, 57 and 58)

- Rubber expansion joints to be single arch with integral rubber flanges with SRR drilled as per BS-10, Table-D, complete.
- Pipe expansion joints are necessary in systems to absorb movement and vibration generated due to pump operation. A typical joint is a bellows of metal (Cast iron), rubber. A bellows is made up of a series of convolutions, with the shape of the convolution designed to withstand the internal pressures of the pipe, but flexible enough to accept axial, lateral, and angular deflections. Expansion joints are also designed for other criteria, such as noise absorption, anti-vibration, earthquake movement, and building settlement.
- Metal expansion joints have to be designed according to rules laid out by EJMA, for fabric expansion joints there are guidelines and a state-of-the-art description by the Quality Association for Fabric Expansion Joints.
- Rubber expansion joint shall be able to absorb vibration, shock and axial compression of 10mm, axial elongation of 10mm and lateral movement of 10mm.
- Rubber expansion joint PN rating shall be 16 kg/cm².

24. PVC Pipes (MR- 59, 60, 61, 62, 63, 64, 65, 66, 67 and 68)

- The pipes shall be PVC (Poly Vinyl Chloride) material for cold water supply piping system with pipes SCH 40/80 PVC pipe conforming to ASTM D -1785 and fittings as per ASTM D-2466/2467 as at a working pressure of 320 PSI at 23 deg C and 80 PSI at 82 deg.C, using solvent welded PVC fittings i.e. Tees,

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Elbows, Couples, Unions, Reducers, Brushing etc. including transition fittings wherever applicable (connection between CPVC & Metal pipes / GI) i.e. Brass adapters (both Male & Female threaded and all conforming to ASTM D-2846 with only CPVC solvent cement conforming to ASTM F-493, with clamps / structural metal supports as required /directed at site including cutting chases & fitting the same with cement concrete / cement mortar as required, including painting of the exposed pipes with one coat of desired shade of enamel paint.

Outside Diameters and Wall Thickness for PVC SCHEDULE 40								
Part No.	Nom (in.)	Size (mm)	Average OD (inch)	Average OD (mm)	Min. Wall Thick	Min. Wall Thick	Max. work Pre. At 23°C PSI	Max. work Pre. At 23°C (kg/cm²)
FP40-212	2 ½"	65	2.875	73.02	0.203	5.16	300	21.09
FP40-003	3"	80	3.500	88.90	0.216	5.49	260	18.28
FP40-004	4"	100	4.500	114.30	0.237	6.02	220	15.47
FP40-006	6"	150	6.625	168.28	0.280	7.11	180	12.66
FP40-008	8"	200	8.625	219.08	0.322	8.18	160	11.25
FP40-100	10"	250	10.750	273.05	0.365	9.27	140	9.84
FP40-120	12"	300	12.750	323.55	0.406	10.31	130	9.14

Outside Diameters and Wall Thickness for PVC SCHEDULE80								
Part No. in	Nom (in.)	Size (mm)	Average OD (inch)	Average OD (mm)	Min. Wall Thick	Min. Wall Thick	Max. work Pre. At 23°C PSI	Max. work Pre. At 23°C (kg/cm ²)
FP40-212	2 ½"	65	2.875	73.02	0.276	7.01	420	29.53
FP40-003	3"	80	3.500	88.90	0.300	7.062	370	26.01
FP40-004	4"	100	4.500	114.30	0.337	8.56	320	22.50
FP40-006	6"	150	6.625	168.28	0.432	10.97	280	19.69
FP40-008	8"	200	8.625	219.08	0.500	12.70	250	17.57
FP40-00	10"	250	10.750	273.05	0.593	15.06	230	16.17

25. Ball Valve (MR- 69, 70, 71, 72 and 73)

- Ball valves shall be full bore, heavy type, quarter turn, chrome/nickel plated bronze / brass body , screwed type, lever operated with Stainless Steel ball and Stainless Steel (AISI 410) stem with Teflon seating and gland packing including coupling and brass handle (to BS: 5351) with screwed female ends tested to minimum hydraulic pressure of 1.5 times the PN rating. All ball valves shall have locking handles to allow servicing and removal of equipment.
- Provide lever handle with plastic sleeve on all ball valves unless otherwise noted. Provide extension stem for all ball valves to be installed on insulated piping. Ball valves should be able to withstand minimum 150% of the operating working pressure.

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- Each valve should be tested for body integrity and seat tightness from manufacturers. The body test pressure shall be 1.5 x PN ratings. The seat test pressure for metal seated valves is 1.1 x PN ratings.
- All valves shall be approved by engineer in charge before they are used on works and shall be of PN ratings as specified.

26. Butterfly Valve (MR- 74, 75, 76, 77, 126,127, 128 and 129)

- Butterfly valves 80mm dia. and above shall be Cast Iron/Ductile iron butterfly valve to be used for isolation. The valves shall be bubble tight, resilient seated suitable for flow in either direction and seal in both direction with accompanying flanges and steel handle.
- Butterfly valves shall be of best quality conforming to IS: 13095/API 609/BS 5155 of PN16 class (tested to 24 kg/cm²) or PN 20 class (tested to 30 kg/cm²) or as specified.
- Provide wafer type slim seal C.I. /DI double flanged butterfly valves of required sizes and of rating as mentioned in schedule of quantity.
- Butterfly valves shall be high performance valves manufactured of cast iron/ductile iron body, epoxy coated, 316 stainless steel disc and stainless steel stem with EN-8/SS-410 shaft.
- Joints for double flanged butterfly valves shall be made with suitable tail/socket pieces on the pipeline and flanges joints made with appropriate number of bolts, nuts and washers with 3 mm thick insertion rubber gasket.
- Provide the following butterfly valve accessories:
 - Valves 150 mm and smaller shall have nine position levers.
 - Valves 200 mm or larger shall have gear operator with crank handle or hand wheel.
 - Provide a position indicator on all butterfly valves.
 - For valves without full access provide enclosed extension stems to allow operation. Provide a padlock for closed and open positions.
 - Where valves are located 2 m above floor level in equipment rooms provide chain wheel operators and chains.
 - All valves shall be approved by engineer in charge before they are used on works.

27. Dual Plate check Valve (MR- 78, 79, 80, 81 and 82)

- Check valves of size 50mm or less shall be as per BS 5154/5352 and of size 50mm or more shall be as per API 594/BS 5153.
- All check valves 50mm and smaller shall be of bronze/brass body and disc, threaded ends tested to minimum hydraulic pressure of 1.5 times the PN rating or as required by the piping system in which they are installed.

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- All non return valves 65mm and larger shall be dual plate non return valve of cast iron body, epoxy coated, stainless steel disc, stainless steel pin and hinges, nitrite/neoprene seal and shall be of flanged end as required by the piping system in which they are installed.
- All check/non return valves shall be spring loaded. Check valves should be able to withstand minimum 150% of the operating working pressure.
- All valves shall be approved by engineer in charge before they are used on works.

28. Y-Strainer (MR- 83, 84 and 85)

- Strainers shall be Y type strainers with gunmetal/bronze body up to 50mm dia. and CI body above 50mm dia. It shall have screwed female ends to BSPT, flanged ends to BS: 10, Table F and shall have perforated S/S (AISI-304) sheet with large screen area.
- It shall be of compact shape and size as per approval and should be easy to install and repair.

29. Stainless steel tank (MR- 86, 88, 89, 90, 91 and 92)

- Double Wall Mirror polished stainless steel tanks are made of best Grade SS 316 L / 304 L in 2B / BA finish with PUF insulated of minimum 50mm thickness to withstand harsh Indian Sun.
- Tank to be provided with all necessary inlet and outlet and vent and overflow connections in bronze or stainless steel material.
- The tank to be provided with a 450 mm diameter opening for accessing the tank.
- The tank cost to be provided by the contractor should include all the cartage, support frame, angle stiffner, stand leg, flanges etc and all that is necessary to complete the system.
- The thickness of the inner layer to be 0.8mm and outer layer 0.6mm minimum.
- All support frame to be in mild steel construction, duly painted by non corrosive paint and ultimately by enamel paint.

30. Modular drinking water fountain (MR- 87)

- Drinking water fountain shall be well mounting type made of vitreous china, stainless steel or any other material as given in the Schedule of Quantities.
- The drinking water fountain shall be with anti-squirt bubble less, self closing valve type with automatic volume regulator.

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- The drinking water fountain shall be provided with an anti-splash back and integral strainer with 32mm or 40mm cast brass trap.
- Water flow to the bottle filler is by means of an electrically activated solenoid push button.
- Unit to include inbuilt filtration for odour, taste and chlorine reduction.
- Key parts to be with a silver based anti microbial compound that reduces the growth of micro organisms and mildew to prevent the surface from discoloration, odor and degradation.
- Cooling system shall use R-134a refrigerant.
- Shall comply with ANSI A117.1 and ADA.
- Shall be listed by Underwriters' Laboratories to U.S. and Canadian standards
- Shall comply with ANSI/NSF 61.
- The model to satisfy CABO/ANSI A117.1.
- All material of construction to be with lead free material.

31. Solenoid valve (MR-93)

- For auto cleaning and auto opening of the drain valve of the flushing water tank at the overhead level.
- Valve to open the drain route to the nearest waste/soil stack when the flow switch installed at the suction line does not detect any flow for a period of 24 hours. The solenoid valve to be provided with a by pass for manual closing of the drain whenever required by the maintenance personal.
- Solenoid valve shall be of proven quality and approved sample. Valve shall be electrical operated.
- Solenoid valve will have a valve before and after it and a bypass to it with a valve. The Solenoid valve must keep the entire operations on automatic mode.
- Solenoid valve shall be with a display panel showing the time duration and status of the valve opening and closing.
- Test Pressure range to be not less than 15 bar.
- Temperature range to be minimum 0-85 degree Celsius.

32. Electrical control Panel (MR-94, 95, 96, 97, 98 and 99)

Definitions

The definitions shall be as per IEC-61439 and other relevant IEC standards.

Codes & Standards

The contractor is required to follow all relevant IS and IEC codes as per latest amendments, however in particular following codes may be applied in addition.

1. IEC-61439 - Standard for low voltage switchgear and assemblies.

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2. IEC-60044 - Standard for instrument transformer.
3. IEC-60099- Standard for surge arrester.
4. IEC: 60255- Measuring relays and protection equipment.
5. IEC -60947 - Low voltage switchgear and controlgear.
- 6.IS 2147 - Degrees of protection provided and enclosures for low voltage switchgear and control gear
7. IS 375 - Marking and arrangement of bus bars.
8. IS 13703-1993- HRC Fuse Links
9. IS 2705- Current Transformer
- 10.IS 3231- Relay
- 11.IS 1248- Indicating Instruments
- 12.IS 722- Integrating Instruments
- 13.IS 6875- Control Switches & Push Buttons.
14. NEC- 2008 - National electrical code.
15. NBC-2016 - National building code.
16. IER-1956 : Indian electricity rules.
17. IEA-2007 : Indian electricity act 2007
18. Any other local bye-law or supply company norm as applicable.

Service conditions

System particulars

- a. Nominal system voltage - $415V \pm 6\%$
- b. Rated system voltage - 1.1kV
- c. Frequency - $50Hz \pm 3\%$
- d. No. of phases - 3
- e. System neutral - Solidly earthed
- f. Short circuit rating - 25kA for 1 sec
- g. Automation compatibility : SCADA compatible
- h. Control supply : 230V tapped from panel incoming.

Tropical conditions

- a. Ambient temperature : 50 degree celsius

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b. Relative humidity (avg.) : 60

c. Isokeraunic level : 33

d. Seismic Zone : Zone-4

e. Climate type : hot and humid

The climatic conditions are prone to wide variations in ambient conditions and hence the equipment shall be of suitable design to work satisfactorily under these conditions.

Tolerances and creepage distance

Tolerances (on all the dimensions) and creepage distances shall be in accordance with provisions made in the relevant Indian/IEC/BIS standards and in these specifications. Otherwise the same will be governed by good engineering practice in conformity with required quality of the product.

Specifications

Panel Cubical Construction

- The complete panel assembly shall be a design verified assembly with design verification done as per IEC-61439.
- Panel fabricated out of 2mm CRCA sheet steel throughout and shall have undergone 7 tank process or better.
- Undrilled gland plates shall be 3mm thick. The gland plates shall have knock able type holes of suitable diameter of cable glands. Minimum 30% extra knock able holes shall be provided on each gland plate. Non-magnetic gland plates shall be used where single core cables are used for three-phase supply.
- The panel shall be self-supporting, free standing or wall mounted.
- The enclosure shall conform to IP55 protection for outdoor panels and IP42 for indoor panels.
- The Panel shall be dust, vermin, corrosion proof and shall be mechanically stable to take the mechanical load of complete assembly with all fixed and moving components.
- The panel shall have appropriate protection against mechanical impact.
- The panel shall be extendable from both sides.
- The terminal blocks shall be provided at convenient location for cable termination. The distance between the terminal strip and gland plate shall be kept in such a way that the cables can be properly dressed & no cable tension is transferred on the terminal strip/or equipment.
- Proper grouting arrangement shall be made in panel for installation of panel in accordance with seismic requirement.
- Complete panel assembly shall be fixed on ISMC-100.
- The design shall ensure generous availability of space for ease of installation and maintenance of cabling, and adequate safety for working in one vertical section without coming into accidental contact with live parts.
- Front and rear doors should be fitted with synthetic rubber or neoprene gaskets with fasteners designed to ensure proper compression of gaskets.
- All sheet steel work forming the exterior of switch boards shall be smoothly finished, leveled and free from flaws. The corners should be rounded. The apparatus and circuits in the panels shall be so arranged as to facilitate their

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operation and maintenance and at the same time to ensure the necessary degree of safety.

- Panel shall be constructed in form-3b methodology.
- All sheet steel work used in construction of panels shall be given for proper shot blasting/surface finish to make it free from all rusts/impurities/deposits.
- It shall be then provided with two primer coat and then/powder coated (electrostatically) with final paint shade RAL7032 as per IS – 5.
- It shall be the process of Powder Coating with suitable primer and having total coating thickness of 85-100 micron. The M.S Sheet Steel shall be given for proper shot blasting / surface finish to make it free from all impurities.
- All sheet steel work used in construction of panels should have undergone a rigorous metal treatment 7 tank process or better as mentioned below.
 - a. All sheet steel work shall be phosphate in accordance with the procedure in accordance with relevant standards for phosphatizing iron and steel. Oil, grease and dirt shall be thoroughly removed by emulsion cleaning.
 - b. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.
 - c. A recognized phosphate process to facilitate durable coating of the paint on the metal surface and also to prevent the spread of rusting in the event of the paint film being mechanically damaged. This again, shall be followed by hot water rinsing to remove traces of phosphate solution.
 - d. After phosphatizing through rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying.
 - e. Passivation in deoxalate solution to retain and augment the effects of phosphatizing.

Busbars and internal connections

- The selection, design and construction of bus bars shall conform to IS/IEC specifications and the latest amendments.
- Busbars shall be designed to carry rated currents during both steady state and transient conditions.
- The bus bars shall be air insulated and made of high conductivity, high strength electrolytic grade aluminium.
- Bus bars shall be located in air-insulated enclosures and segregated from all other compartments of the cubicle.
- Direct access or accidental contact with bus bars and primary connections shall not be possible.
- Bus bars shall be rated in accordance with service conditions and the rated for continuous and short time current ratings specified in SLD / data sheets.
- Busbars shall be design for a temperature rise of 50 degree celsius above the ambient temperature, while for all bolted connections of bus it shall be 55 degree celsius.
- The busbar shall be designed for a temperature of 190 degree during transient conditions.
- Bus bars shall be adequately supported on SMC/DMC insulator supports to with stand electro dynamic stresses due to short circuit currents.

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- Bus bar support insulators shall be of non-hygroscopic material and shall conform to relevant IS standards.
- The current density of the bus bars shall not be less than 0.8 Amp / sq mm.
- Bus bars should be color coded for easy identification of individual phases and neutral.
- All the bus bars should be provided with color coded heat shrink sleeves.
- A main horizontal aluminum grounding bus, rated to carry maximum fault current, extending along the entire of the panel shall be provided.
- The ground bus shall be provided with two-bolt drilling with GI bolts and nuts at each end to receive the main Earthing grid.
- The size of the earth bus shall be as mentioned in drawings and schedules
- Important parameters for complete panel assembly shall be as follows :
 - a. Voltage - 415V \pm 6%
 - b. Frequency - 50hz \pm 3%
 - c. No. of Phases - 3 + 100% Neutral + Earth bus
 - d. Peak Impulse Voltage - 12KV
 - e. Power frequency withstand capability - 2KV
 - f. Short circuit withstand capacity - 25kA for 1 second
 - g. Type of discrimination required among switchgears - Total discrimination
 - h. Min clearance and creepage distance - As per IEC-61439
 - i. Dimensions : As per approved type tested design.
- Control wiring for all control circuit shall be done as follows :
 - a. Each control circuit shall be protected with the help of fuse in the phase and neutral shall be provided with suitable neutral links.
 - b. Control wiring shall be done with 1.1kV grade FRLS type control cables tested for power frequency withstand of 2kV.
 - c. All voltage circuits shall be wired with 1.5sqmm cu control cables.
 - d. All current circuits shall be wired with 2.5sqmm cu control cables.
 - e. Control wiring shall be done neatly with proper dressing and ferruling done.
 - f. Control wiring shall be color coded appropriately.
 - g. Terminal links used for control wiring shall be of good quality and shall withstand the temperature.
 - h. All connections must be be tight.
- Power wiring for main circuit shall be done as follows :
 - a. Switchgears of 100A rating and above shall be connected by the means of suitable busbars only.
 - b. Cable terminal blocks used for power cable termination shall be suitable to withstand the temperature rise due to steady state and transient currents.
 - c. All connections must be be tight.

Safety features and Interlocks

- The safety shutter shall be provided in breaker panels, which shall prevent in advertent contact with isolating contacts when breaker is withdrawn from the Cradle.
- Door interlocking shall be provided in each switchgear compartment with a provision of defeat interlock .

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- All panel doors shall have provision of padlocking.
- Insulating barriers shall be provided in all live sections of the panel.
- There shall be provision of positive earth connection between fixed and moving portion of the ACB either through connector plug or sliding solid earth mechanism.
- Earthing bolts shall be provided on the cradle or body of fixed ACB.
- Arc chute covers shall be provided wherever necessary.
- In case of drawout type switchgears safety shutters shall be provided to fully cover the live section automatically once the switchgear is being draw out
- It shall be possible to bolt the draw-out frame not only in connected position but also in TEST and DISCONNECTED position to prevent dislocation due to vibration.
- There shall be provision for locking the breaker in all three positions.
- The breaker shall be provided with interlock to prevent the breaker from being withdrawn or replaced except in the fully isolated position.
- Interlock shall also be provided to prevent the breaker from closing without in service position.
- Space heaters triggered by thermostat shall be provided in cable compartments to avoid moisture.
- Lamp operated with a door limit switch and a toggle switch shall also be provided in panel compartments along with 6/16A witch socket for ease of maintenance

Moulded Case Circuit Breaker (MCCB)

- MCCB shall be mechanically rugged and shall be designed to carry steady state current and also transient current up to the time arc gets quenched.
- MCCB shall be provided with door operating mechanism having interlock, defeat and padlocking facility.
- MCCB should trip free, quick make and quick break type and should be equipped with a current limiting feature.
- MCCB shall have spreader links and terminal shroud as a feature for safety and proper heat dissipation.
- MCCBs shall have double break mechanism.
- MCCB shall have following parameters / features :
 - a. Rated voltage - 690V
 - b. Rated frequency - 50Hz
 - c. P.I.V - 12kV
 - d. Rated short circuit capacity - 25kA (minimum)
 - e. Poles - Four pole
 - f. Temperature deration : No deration upto 50 degree celsius (In case deration is applicable, higher rating switchgear shall be provided)
 - g. Self watt loss : As per IEC-60947
 - h. Total breaking time : less than 40ms
 - i. Shunt coil : suitable for 230V AC
 - j. Drawout type : Non withdrawable (fixed type)
 - k. $I_{cs} = I_{cu} = 100\%$
 - o. Spare contacts required : 2NO + 2NC
 - p. Indications : On, Off, Trip
 - q. Undervoltage coil : As per design requirement

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- Release of MCCB shall have following parameters / features :
 - a. Overload setting (L) $0.4-1 \times I_n$
 - b. Short circuit setting (with time delay)(S) $2 -10 \times I_r$
 - c. Time delay (td) 0-400 m sec
 - d. Short circuit setting (Instantaneous) (I) $11 \times I_n$
(Where I_n = nominal current of MCCB & I_r = rated current to which it is set.)
 - e. Ground Fault Setting with time delay (0-300ms) (G) : $0.1-1 \times I_n$
 - f. Neutral setting (N) (where ever required): $0.5-1 \times I_n$
 - g. Release type : microprocessor based
 - h. Communication : Fully communicable and shall be equipped with RS-485 port.
 - i. Memory : Inbuilt thermal memory.
 - g. Alarm and indications : Visual indications for L,S,I,G fault
 - h. Release shall be capable to generate remote alarm in case of any internal fault and Spare contacts shall be provided with release to do so.

Contactors

- All contactors and bi-metal relays should conform to IS - 13947 - 4/IEC - 947-4 standards.
- Contactors should be suitable for requisite duty and the contactor shall be designed to operate even in severe operating conditions.
- The Contactors shall be suitable for switching and controlling squirrel cage and slipping motors as well as other AC loads such as solenoids, capacitors, lighting loads, heating loads and transformer loads.
- The contactors shall be suitable for operation in service temperature up to 50 degree C without derating.
- The contactors and bimetal relays shall have been tested for type-2 co-ordination at 50 KA, 415 V 50 Hz as per IS 13947 for both fuse protected as well as fuse-less motor feeders.
- The contactor shall have coil of 220/240 V AC or as may be specifically asked for.
- The design of the current carrying parts, contact system and the magnet system should be such that it should increase reliability of electrical and mechanical endurance.
- Auxiliary contact should have double break parallel bridge contact mechanism. For operator safety the contactors above 45 Amp should have arc-chamber. The construction of the arc chamber should be such that there is no emission of arc by-products on the surrounding equipment.
- The contactor shall have funnel shaped cable entries, cable end stops and predetermined insertion depths.
- Contactor below 63 Amp shall have captive screws preventing the screws from falling.
- Main contacts should be of silver alloy to have long contact life; it should withstand to keep the contact bounce to minimum and should be shrouded with an arc chute.
- Both moving and fix contacts should be accessible for inspection or replacement without disturbing terminal wiring.
- The magnet system should have laminated, construction to minimize the losses.
- Coils should withstand high temperature and ensure low power consumption. Coil should be resin cast/encapsulated. It should have inter layer insulation.

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- Contactor should have facility to mount add-on auxiliary contact block. Mechanical interlocks should be provided for sequential operations if required.
- Contactor should be comfortably mounted in any position on a vertical plane. Contactor should be capable of handling high transient currents.
- It's Insulation voltage level should be – 1000 v. Contactor shall be designed to have mechanical endurance of the order of minimum 15 million operations or better.
- Contactor should operate without deration from - 30° C to +50°C

Current Transformer

- Current transformers shall comply with the requirements of IS. 2705.
- The current transformers shall be core type with cast resin/encapsulated secondary winding.
- CTs shall withstand stresses originated from short circuit for 1 sec. These shall be mounted on the switchboard stationary part.
- The secondary CT leads from all panels should be terminated on the front of the board on easily accessible shorting type terminal connectors so that operation and maintenance can be carried out when the panels are in service.
- CT's shall be given heat run test.
- CT shall have following parameters / features :
 - a. Rated voltage - 415V
 - b. Rated frequency - 50Hz
 - c. Class : 0.5 (for metering) / 5P10 for protection / PS for unit protection
 - d. Rated short circuit capacity - As per fault level
 - e. Construction - Ring / wound type
 - f. Burden - As per SLD
 - g. Rated secondary current : 5A

Control switches

- Control Switches shall be of the heavy-duty rotary type with escutcheon plates clearly marked to show the operating position.
- They shall be semi-flush mounting with only the front plate and operating handle projecting.
- Circuit breaker control switches shall be of the spring return to neutral type, while instrument selector switches shall be of the stay-put type.

Push Buttons

- Push buttons should be of the momentary contact, push to actuate type.
- Push Buttons should be panel mounted, flush type having 22.5 mm \varnothing .
- Push Buttons should be spring returns type.
- Lock and key head with Push turn facility.
- Modular blocks should contain NO-NC contact.
- It should be snap-fit type for easy assembly.
- Double break self-cleaning contacts for prolong life.
- NO-NC contact block should be colour coded for easy identification.
- Push Buttons should have transparent shroud and rubber shroud to enhance protection against ingress as per IP- 67.
- It should withstand operating voltage as well as frequent operation.

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- It should have finger proof shrouded terminals.

Terminal Blocks

- Insulating barriers shall be provided between adjacent terminals. CT Terminal blocks shall be shorting type.
- Terminal blocks shall have a minimum current rating of 10 Amps & 650 volt grade rating complete with insulated barriers. Provisions shall be made for label inscriptions.
- It should have snap fit action.
- It should have captive-screws and self-lifting washers.
- Withstand temp range from -30° C to 100° C.
- Terminal Connectors should have flame retardant property confirming to UL-94, V-2.
- Terminal Block should be suitable for commonly used DIN Rail – 35 X7.5 mm and mounting channel 'C' shaped Std.32 mm.
- Terminal Block should be suitable for commonly used DIN Rail – 35 X7.5 mm and mounting channel 'C' shaped Std.32 mm.
- The construction material should be of high quality like polyamide 6/6 and contacts of Nickel plated brass. Labels shall be of anodized aluminum, with white engraving on black background.
- They shall be properly secured with fasteners.

Digital Energy Meter

- The load manager shall be micro-controller based unit capable to measure a host of electrical parameters and display them on a 128 x 64 backlit LCD.
- It shall have load management feature and shall have six numbers of output relay contacts apart from CT/PT contacts.
- These outputs shall be individually field programmable for both the parameter on which to generate alarm as well as the values on which to activate alarm and deactivate it.
- In addition to this flexibility in terms of load management, the load manager shall also have RS485 port. RS485 supports MODBUS RTU protocol for connections to EMS/SCADA.
- The unit shall be made for three phase four wire system. The installation type, CT ratios and PT ratios shall be site selectable.
- The Load Manager with its six relay contacts shall be capable to be used as a Demand Controller. The method of Demand calculation i.e. sliding window, fixed window shall be selected at site. The device shall have all the features needed to implement a robust electrical load management system.

- It shall be programmable / configurable to suit most control and communication needs. The load manager shall be capable to measure following parameters:
 1. Voltage (Volts L-N & L-L) VL-N Accuracy: 0.5% of Reading VL-L Accuracy: 1.0% of Reading.
 2. Current (Amps IR, IY, IB) Accuracy: 0.25% of Reading.
 3. Line Frequency 45 to 55 Hz, Accuracy: 0.3% of Reading.
 4. Active Power (P) Accuracy: 0.5% of Reading (For IPFI>0.5).

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5. Reactive Power (Q) Accuracy: 1.5% of Reading (Between 0.5 Lag to 0.8 Lead).
 6. Apparent Power (S) Accuracy: 0.5% of Reading.
 7. Power Factor For Individual phases and System. Accuracy: 0.5% of Reading (IPFI \geq 0.5) Range of Reading: 0.05 to 1.000 Lag/Lead.
 8. Total Active Energy (KWh) Range of Reading: 0 to 9999999.9 KWh Accuracy: Class 0.5 as per IS14697.
 9. Total Apparent Energy (KVAh) Range of Reading: 0 to 9999999.9 KVAh Accuracy: Class 0.5 as per IS14697.
 10. Total Reactive Energy (KVARh) Range of Reading: 0 to 9999999.9 KVARh Accuracy: Class 0.5
 11. 3 rd to 15 th Harmonics(Odd) for all Voltages with THD.
 12. 3 rd to 15 th Harmonics(Odd) for all Currents with THD.
 13. Active Power (KW) Demand - Sliding & Fixed, Selectable.
 14. Apparent Power (KVA) Demand - Sliding & Fixed, Selectable
- The device shall also have following features:
 1. Display 128 X 64 Graphical LCD with Operating temp 10°C to 50°C.
 2. Data Logging Buffer 2 MB, Non-volatile memory, capable of holding 19691 records Logging Duration Site selectable.
 3. RS485 Modbus-RTU protocol
 4. Communication USB 8.0 Pen-drive For downloading logged data

D.13.6 Installation, Testing and Commissioning

- The complete Panel assembly shall be installed in accordance with the manufacturer's installation drawing duly approved by "The consultant "
- The panels needs to be grouted considering the seismic zone requirement.
- Panels shall be properly aligned and the leveled within tolerance of +/- 2mm and shall be ensured with a water level indicator or a laser gun whichever available. No shim shall be allowed to make a panel level suitably.
- All live sections and compartments shall be covered with insulation barriers.
- All the components of the panel shall be easily accessible.
- The location of installation shall be cleaned and co-ordination shall be made with other disciplines.
- Grouting holes shall be provided from inside and the panel shall be suitably and tightly bolted. No tuck welding with base channel is allowed.
- Panels shall have peel-able poly layer on the cover for protection from cement, plaster, paints etc. during the construction period.
- The holes made in enclosure for cable termination or anything else shall be made only through drill machine or approved cutting tool with marking of dia done prior to cutting or drilling. Extra left out holes shall be filled neatly with fire retardant sealant.
- The Panel shall be tightly grouted. No spare nuts-bolts shall be left out un-tightened / open inside the DB enclosure in any case.
- Gland plates where ever used for cable termination shall be tightly fixed and shall be earthed.
- Size of Horizontal and vertical bus bars shall be equal.
- Switchgears above 63A shall be mounted on bus bars tightly and accurately.
- Termination lugs shall be tightly fixed and connected and there shall not be any bare wire strand jetting out of the lugs. Suitable crimping tool shall be used and

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terminal wires shall be covered with heat shrinkable sleeves whose color coding has to match with the color of the wire used.

- Color coding shall be followed for internal wiring also in a similar pattern as described. Bus bar shall be tagged for phase indication.
- Panel compartments shall be provided with space heaters and lights operated by door limit switches.
- The door of panel shall be aligned properly and there shall be no air gap left after closing the DB door. Gaskets shall be used to make DB free from moisture.
- Panel shall have Padlocking arrangement and shall be pad locked after complete installation.
- Panel board shall be fully tested (both type and routine test) for its components as per the specification laid under Indian standards. In particular following test shall be done :
 - (a) Continuity test (both earth continuity and loop continuity)
 - (b) Insulation resistance test.
 - (c) Contact resistance test.
 - (d) Primary injection test.
 - (e) Trip test and trip unit reset test with Test knob of breaker.
 - (f) CT testing (Polarity, Knee voltage)
 - (g) Phase rotation test.
 - (h) HV test on bus bar
 - (i) Space heater Testing
 - (j) Control wiring checks

33. Electrical cables (MR-100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117 and 118)

LT CABLE AND TERMINATION (AC and DC cables Heavy duty)

The definitions shall be as per IS 7098-Part 1, IEC 60050-461 and IEC 60502-2

Abbreviation used to define the following are stated in front of the entity

Aluminum Conductor - A

XLPE Insulation - 2X

Steel round wire armor - W

Steel strip armor - F

Steel Double round wire armor - WW

Steel Double strip armor - FF

Non-magnetic (A1.) round wire armor - Wa

Non-magnetic (A1.) strip armor - Fa

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PVC outer sheath - Y

Codes & Standards

The contractor is required to follow all relevant IS and IEC codes as per latest amendments, however in particular following codes may be applied in addition.

1. IS 7098-Part 1- Specifications for XLPE insulated thermoplastic sheathed cables, for working voltage up to 1.1kV (including 1.1kV)
2. IS-1255 - Code of practice for installation and maintenance of power cable up to 33KV rating
3. IEC 60502-1- Standard for cables for rated voltage from 1KV up to 6kV ($U_m=1.2kV$)
4. IEC-60050-461- Definitions for cables.
5. IEC-60811 - Common test methods for cable insulation.
6. IS : 3961- Part 2: Recommended current ratings for cables.
7. IS : 8130 Conductors for insulated cables.
8. IS : 583 XLPE Insulation and outer sheath of electric cables.
9. IS : 10418 Specification for drums for electric cables.
10. NEC- 2008 - National electrical code.
11. NBC-2016 - National building code.
12. IER-1956: Indian electricity rules.
13. IEA-2007: Indian electricity act 2007
14. Any other local bye-law or supply company norm as applicable.

Service conditions

System particulars

- a. System voltage - 415/230 V for AC cables
- b. Frequency - 50Hz \pm 3% for AC cables
- c. No. of phases - 3 for AC / 2 (poles) for DC
- d. System neutral - Solidly earthed
- e. Short circuit rating - As per system fault level

Tropical conditions

- a. Ambient temperature: 50 degree celsius
- b. Relative humidity (avg.) : 60
- c. Isokeraunic level: 33

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d. Seismic Zone: Zone-4

e. Climate type : hot and humid

The climatic conditions are prone to wide variations in ambient conditions and hence the equipment shall be of suitable design to work satisfactorily under these conditions.

Tolerances and creepage distance

Tolerances (on all the dimensions) and creepage distances shall be in accordance with provisions made in the relevant Indian/IEC/BIS standards and in these specifications. Otherwise the same will be governed by good engineering practice in conformity with required quality of the product.

Specifications

LT Cables (AC & DC):

- Cables shall be XLPE insulated PVC sheathed, Al or Copper conductor as specified.
- Stranded Aluminum/Copper conductor shall be used.
- All Aluminum/Copper XLPE cables insulation shall be of high grade Cross- linked Polyethylene for insulation for extrusion process. Cores laid up.
- The inner sheath shall be bonded over with thermoplastic material for protection against mechanical and electrical damage.
- Armoring should be provided over the inner sheath to guard against mechanical damage.
- Armoring should be Galvanized steel wires or galvanized steel strips as specified.
- In single core cables used in A.C. wires/strips, round steel wires should be used; where diameter over the inner sheath does not exceed 13 mm, flat steel armor should be used.
- Insulation shall be of XLPE type as per latest IS general-purpose insulation for maximum rated conductor temp 90 degree C.
- The Conductor shall be stranded Aluminum/Copper circular/sector shaped and compacted.
- In multi core cables the core shall be identified by red, yellow, blue and black coloring of insulation.
- Conductor shall be of electrolytic Aluminum/Copper conforming to IS: 8130 and are compact circular or compact shaped. I
- In Inner sheath laid up cores shall be bonded over with thermo-plastic material for protection against mechanical and electrical damage.
- Insulation, inner sheath and outer sheath shall be applied by extrusion and lapping up process only. The outer sheath shall have FRLS properties.
- Repaired cables or cables made up of re-used copper / aluminium shall not be used.
- The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground buried installations with uncontrolled back fill and chances of flooding by water.
- Progressive automatic in line sequential marking of the length of cables in meters at every one meter shall be provided on the outer sheath of all cables.
- Both ends of the cables shall be properly sealed with PVC/Rubber caps so as to eliminate ingress of water during transportation, storage and erection.

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- Embossing of outer sheet: the following details on the other sheet of cable at a regular interval of 1(one) meter:
 - a. Name of customer : Nalanda University
 - b. Conductor size, type of insulation and voltage grade.
 - c. Manufacturer's name along with ISI mark

- Typical parameters for AC cables shall be as follows :
 - a. Rated Maximum Voltage: 1.1 kV (rms)
 - b. Rated Frequency: 50 Hz
 - c. Rated Power Frequency Withstand Voltage (1 min): 2 kV (rms)
 - d. Rated short time withstand current for 1 sec: as per fault level
 - e. Conductor material: Aluminium / Cu. as per cable schedule.

- Typical parameters for DC cables shall be as follows :
 - a. Rated Maximum Voltage: 1.5 kV
 - b. Maximum permissible DC voltage : 1.8 kV
 - c. Voltage withstand for 5 minutes : 6.5kV
 - d. Rated short time withstand current for 1 sec: as per fault level
 - e. Conductor material: Aluminium / Cu. as per cable schedule.

LT cable termination:

- All cable glands shall be made out of brass and of good quality as approved.
- All cable glands shall be of double compressions type.
- Termination/ Joining of power and control cables shall be done by means of compression methods using solder less tinned copper or Aluminum terminal lugs.
- For control cables terminations, ring tongue or reducer pin type lugs shall be used to suit the purpose.
- Proper crimping tools with crimping paste shall be used to maintain proper conductivity and avoid any air gap.

Cable Tags:

- Cable tag shall be made out of stainless steel minimum 1.2 mm thick and 25 mm x 100 mm size with holes provided to tag the cable.
- Following information shall be engraved in the cable with good quality material and the lettering height shall be 4.5mm
 - a. Source of the Cable from where it is supplied power.
 - b. Destination where the cable is terminated.
 - c. No of cores of cables.
 - d. Cross sectional area of the cable
 - e. Complete notation as described under definition part of cable specification.

Installation, Testing & Commissioning

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- Cables shall be stored in a dry covered place to prevent exposure to climate conditions and wear and tear of wooden drums and it should be preferably concrete surface.
- All drums should be stored in such a manner as to leave sufficient space between them for air circulation. It is desirable for drums to stand on battens directly placed under the flange.
- In no case should the drums be stored “on the flat” i.e. flange horizontal.
- Both ends of the cables shall be properly sealed with PVC/Rubber caps so as to prevent ingress of water, miniaturization of cores and armors during transportation, storage and erection.
- On receipt of cable drums visual inspection of drums should be carried out for any damages to these cables.
- While unloading the cables certain precautions are to be taken to ensure the safety of cables. The cable end to be opened on one side and tested for its insulation and continuity.
- The cable drums should not be dropped or thrown from the trucks/railway wagons etc. during unloading operations as shock may cause serious damage to cable layers.
- A crane may be used for unloading cable drums. While lifting the cable drums with crane, it is recommended that the lagging should be left in place to prevent the flanges from crushing on the cables.
- If crane is not available a ramp should be prepared with approximate inclination of 1: 3 or 1: 4.
- The cable drums should be rolled over the ramp by means of ropes and winches. Additionally a sand bed at the foot of the ramp may be prepared to brake the rolling of the cable drum.
- Cable should not be dragged along the earth surface. Drums should be rolled in the direction of arrow only.
- For laying of cables special care is to be taken to prevent sharp bending, kinking, twisting.
- Cable should be unwound from drum by proper mounting the cable drum on a cable wheel making sure the spindle is strong enough to carry the weight without bending and that it is lying horizontally in the bearings, so as to prevent the drum creeping to one side or the other, while it is rotating.
- The maximum safe pulling force (when pulled by pulling eye) proper and safe method of pulling of cable should be used depending upon the site conditions to avoid any kind of damage to the cables. Following pulling forces to be noted.
 - a. Aluminum Conductor cables: 3.0 Kg/mm²
 - b. Copper conductor cables: 5 Kg/mm²
- Special care is to be taken while laying cable at bends. Following are the recommended bending radius for power and control cables.

Sr. No.	Voltage rating (kV)	PVC / XLPE cables	
		Multi core	Single core
1	Up to 1.1 kV	12D	15D
2	Above 1.1 kV to 33 kV	15D	15D

D = D is over all diameter of cable.

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- Armored cables are to be laid on cable trays/ underground as per relevant design drawing and specifications.
- All flexible cables shall be laid inside exposed / canceled conduits (rigid / flexible)/ raceways or as per relevant design drawing and specifications.
- After the cable trench has been properly excavated and straightened, it shall be covered with 100 mm thick layer of sand, the cable shall then be lifted and placed over the sand cushion.
- It may be planned to lay down the cables in stacks under the trench and under such circumstances, cables shall be laid with the help of angular supports or cable trays suitable to take the load of the cable.
- In case the cable is laid with the help of angular supports inside the trench, such supports shall be provided at a regular intervals so that the cable does not sag due to its weight.
- After laying the cable the complete trench shall be filled with sand / earth up to 200 mm depth from the ground level.
- A layer of silver sand along with a good quality caution tape with warning written in Hindi and regional language shall be laid throughout along the length of the trench at this level to indicate that electrical cables are running below and the area shall not be further excavated without suitable precautions and permissions.
- The complete trench may then be backfilled with earth up to ground level.
- Riggers shall ensure that while laying, the cable should not be subjected to any form of damage. Cables shall be laid by skilled and experienced workmen using adequate rollers to minimize stretching of the cable.
- The cables shall not be laid in such a fashion that one cable crosses over the other. Proper spacing shall be left between two cables as mentioned in the GFC or as specified or directed by engineer-in-charge.
- Drain points shall be ensured inside these trenches so that in case of water logging, the water ejects out through these drain points as a result of natural gradient provided.
- Man-holes shall be provided at strategic locations so as to ease the pulling of cables and maintenance. The manhole shall be covered with suitable covers of mentioned material and dimensions as per GFC.
- When laid in cable trays above ground, power cables to be placed at the bottom most layer and control cables at the top most layer. In case of multi core power cables, cables shall be laid side by side with spacing not less than half the diameter of larger cable.
- Multi-core cables shall be clamped by means of mild steel galvanized saddles. All cables below 1.1 KV single core cables if any should be clamped by means of non-magnetic saddles.
- The saddles / clamps shall not be placed at the intervals more than 1500 mm for horizontal and 1200 mm for vertical runs.
- Multi core control cables can be laid touching each other in cable racks and wherever required may be taken in two layers. These cables should be clamped by means of PVC straps for horizontal and vertical runs. Fabricated aluminum clamps may be used at regular intervals.
- All the cable shall be properly identified at regular intervals and care shall be exercised in laying cables to avoid forming kinks.
- The relative position of the cables, laid on the cable tray shall be preserved and the cables shall not cross each other.

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- At all changes in direction in horizontal and vertical planes, the cable shall be bent smooth with a radius as recommended by the manufacturers.
- All cables shall be laid with minimum half diameter gap and shall be clamped at every meter to the cable tray and shall be tagged for identification with cable tag and clamped properly.
- Tags shall be provided at both ends and all changes in directions both sides of wall and floor crossings.
- All cable shall be identified by embossing on the tag the information as laid down under this specification.
- If there is a need to joint the cable due to finishing of cable in cable drum such joints shall be made through the approved straight through joints and jointing kits as directed by and approved by engineer-in-charge at site.
- Cables shall be fully tested (both type and routine test) as per the specification laid under Indian standards. In particular following test shall be done at site.
 - a. Insulation resistance test.
 - b. Continuity test.

34. Cable Tray

Scope

The scope of work shall include:

1. Supplying, laying, testing and commissioning of cable trays, raceways and its allied accessories.
2. Handling, loading, unloading and storage of cable trays and raceways
3. Civil works associated with the said job.

Definitions

The definitions shall be as per NEMA-VE-2

Accessory: Components used to supplement the function of a straight section or fitting. Examples include, but are not limited to, dropout, cover, conduit adapter, hold-down device, and divider cable tray support.

Span: The distance between the centerlines of supports.

Cable tray system: A section or assembly of sections, and associated fittings, forming a mechanical system used to support cables and raceways.

Channel cable tray: A fabricated structure consisting of a one-piece ventilated- or solid-bottom channel section.

Connector: A component that joins any combination of cable tray straight sections and fittings.

Codes & Standards

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The contractor is required to follow all relevant IS and IEC codes as per latest amendments, however in particular following codes may be applied in addition.

1. NEMA VE-2 -2013
2. IS 1079, 2029, 2639 - Cable trays and their accessories
3. NEC- 2008 - National electrical code.
4. NBC-2016 - National building code.
5. IER-1956: Indian electricity rules.
6. IEA-2007: Indian electricity act 2007
8. Any other local bye-law or supply company norm as applicable.

Service conditions

System particulars

- a. System voltage - 415/230 V for AC
- b. Frequency - 50Hz \pm 3% for AC cables
- c. No. of phases - 3 for AC
- d. System neutral - Solidly earthed
- e. Short circuit rating - As per system fault level

Tropical conditions

- a. Ambient temperature: 50 degree celsius
- b. Relative humidity (avg.) : 60
- c. Isokeraunic level: 33
- d. Seismic Zone: Zone-4
- e. Climate type : hot and humid

The climatic conditions are prone to wide variations in ambient conditions and hence the equipment shall be of suitable design to work satisfactorily under these conditions.

Tolerances and creepage distance

Tolerances (on all the dimensions) and creepage distances shall be in accordance with provisions made in the relevant Indian/IEC/BIS standards and in these specifications. Otherwise the same will be governed by good engineering practice in conformity with required quality of the product.

Specifications

Perforated cable tray:

- Cable tray system shall comprise of hot dip galvanized G.I cable trays, with

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galvanizing thickness of 65 micron and standard length of 2.5 meters made out of 2 mm thick perforated sheet metal for cable trays which are 600mm wide and above and 1.6mm thick for cable trays whose width is below 600mm.

- The construction of the cable trays shall be as per the approved GA drawing from Vendor.
- The construction of cable tray shall follow NEMA standards.
- The cable trays shall be hot dip galvanized with perforations not more than 17.5% and factory fabricated out of G.I., angle iron, tee, bends, sections, flats and perforated sheet for different loads.
- All accessories shall follow NEMA VE-2 standards

Ladder type cable tray:

- Hot dip-galvanized factory fabricated GI ladder type cable trays shall be made up of 2mm thick GI sheet steel with radial bends, elbows, reducers, tee's, coupler plates & supports for cable trays.
- The runners shall be placed at a regular interval of 200mm along the length and dimensions of rungs shall be as mentioned below .
- Rungs shall be bolted type and complete assembly shall follow NEMA VE-2 Standards. factory fabricated 14 Gauge GI ladder type cable trays, with radial bends, elbows, reducers, tee's, coupler plates & supports for cable trays of the following:

a. 1000 mm wide

Runners 25 x 75 x 25 x 3 mm

Rungs 20 x 40 x 20 x 3 mm 250 mm CC

b. 750 mm wide

Runners 20 x 50 x 20 x 3 mm

Rungs 20 x 40 x 20 x 3 mm 250 mm CC

c. 600 mm wide

Runners 20 x 50 x 20 x 3 mm

Rungs 20 x 25 x 20 x 3 mm 250 mm CC

d. 450 mm wide

Runners 20 x 50 x 20 x 3 mm

Rungs 20 x 25 x 20 x 3 mm 250 mm CC

e. 300 mm wide

Runners 20 x 50 x 20 x 3 mm

Rungs 20 x 25 x 20 x 3 mm 250 mm CC

f. 200 mm wide

Runners 20 x 50 x 20 x 3 mm

Rungs 20 x 25 x 20 x 3 mm 250 mm CC

g. 150 mm wide

Runners 20 x 50 x 20 x 3 mm

Rungs 20 x 25 x 20 x 3 mm 250 mm CC

Installation, testing and commissioning

- The Complete installation of cable trays shall be in accordance with NEMA VE-2 standards.
- Before installing cable in the cable tray, examine cable paths to ensure all areas are free of debris that may interfere with cable installation.
- Cable tray should never be used as a walkway.
- Most cable installations require the use of cable pulling tools. On horizontal straight runs, cables generally ride on rollers mounted in or on cable trays.
- These rollers should be properly spaced, depending on the size and weight of the cable, to prevent the cable from sagging and dragging in the cable tray during the pull.
- Cable manufacturer shall be contacted for information regarding proper roller spacing. Cables may be fastened to the cable tray by means of cable clamps or cable ties. Generally, cables shall be fastened every 450 mm (18 in) on vertical runs.
- Although not required by the NEC, single conductor cables can be fastened on horizontal runs to maintain spacing and ensure that the cable is confined within the cable fill area.
- When using cable clamps, the clamps should be sized correctly and tightened only enough to secure the cable without indenting the jacket.
- The same precaution should be observed with cable ties, and they should be applied with a pressure limiting device.
- Extremely long vertical drops introduce a new set of issues requiring special consideration.
- The weight per meter (foot) of the cable multiplied by the number of meters (feet) in the vertical drop, in many cases, exceeds the load carrying capacity of the cable tray component. The one or two rungs supporting this weight are likely to be damaged, and the vertical load could exceed the allowable cable tension.
- The cable weight should be supported in such a manner as to prevent damage to the cable tray or cable during this type of installation.
- As the cable is installed, intermediate supports should be installed on the vertical drop to break the cable load into segments supported at multiple places.
- Once the cable is installed in an open cable tray system, care must be taken to protect the exposed cables from falling objects or debris that could cause damage to the cable.
- In areas where the cable tray is to be covered, covers should be installed as soon as possible. Temporary protection for the cables and cable tray can be constructed of available wood or metal materials until the risk of damage has passed.
- Before installing a metallic adaptable raceway system clear marking shall be done at site for the route where the raceway is planned to be laid.
- The location of junction boxes shall then be identified and marked upon the same routing.
- Complete installation shall be in accordance with seismic requirements.

35. HDPE Pipe (MR-134, 135, 136 and 137)

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- High Density Polythethylene Pipe for Potable Water Supply to conform to IS 4984.
- The above standard lays down the requirements for high density polyethylene pipes for potable water supplies, sewage and industrial effluents.
- The outside diameters of pipes and their wall thickness shall be as stated below:
Table 233 Dimension for High Density polyethylene pipes (all dimensions in mm) (IS-4984)

Outside Diameter mm	Wall thickness mm for Working pressure							
	2.5 Kg/Cm ²		4 Kg/Cm ²		6 Kg/Cm ²		10 Kg/Cm ²	
	Max.	Min	Max.	Min	Max.	Min	Max.	Min
10	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	2.3	2.8
25	-	-	-	-	-	-	2.8	3.3
32	-	-	-	-	2.3	2.8	3.6	4.3
40	-	-	2.0	2.4	2.9	3.4	4.5	5.2
50	-	-	2.4	2.9	3.6	4.2	5.6	6.4
63	2.0	2.4	3.0	3.5	4.5	5.2	7.1	8.1
75	2.3	2.8	3.6	4.3	5.3	6.1	8.4	9.5
90	2.8	3.3	4.4	5.1	6.4	7.3	10.1	11.4
110	3.4	4.0	5.3	6.0	7.8	8.8	12.4	13.9
125	3.9	4.5	6.0	6.8	8.9	10.0	14.1	15.8
140	4.3	5.0	6.8	7.7	9.9	11.1	15.8	17.6
160	4.9	5.6	7.8	8.8	11.3	12.7	18.0	20.0
180	5.6	6.4	8.7	9.8	12.7	14.1	20.3	22.6
200	6.2	7.1	9.7	10.9	14.2	15.9	22.5	25.0

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225	6.9	7.8	10.9	12.2	15.9	17.7	25.3	28.2
250	7.7	8.8	12.1	13.6	17.7	19.7	28.2	31.1
280	8.6	9.7	13.5	15.1	19.8	22.0	31.5	34.9
315	9.1	10.8	15.2	17.0	22.3	24.8	35.4	39.2
355	10.9	12.2	17.1	19.1	25.1	27.9	39.9	44.1

Note: The wall thickness of pipes are based on safe working stress of 39.5 kg/cm² at 2700C and working pressures get reduced at higher temperatures.

- The pipes shall be classified by pressure ratings (working pressure at 2700C) as class 1 for 0.2 MPa, class 2 for 0.25 MPa, class 3 for 0.4 MPa, class 4 for 0.6 MPa and class 5 for 1 MPa.
- The above pipes shall be used for temperature ranging from -400 to 450 C. The recommended maximum working stress for the material at 200 C in a pipe is 50 Kg/cm² for 50 years of life.
- Maximum Admissible Working Pressure for Water Temperature Upto 450 C for High Density Polyethylene Pipes (IS-4984)

	Water Temperature between					
	100	200	250	300	350	400 to 450c
Max. admissible working pressure equal to the nominal pressure (multiplication factor for corresponding Working Pressure given in table)	1.58	1.26	1.00	0.79	0.6.	0.50

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- **Surface Condition:** The pipe shall possess smooth internal and external surfaces. Slight shallow longitudinal grooves or irregularities in the wall thickness shall be permissible provided that the wall thickness remain within permissible limits.
- **Test Pressure at Works :** The pressure in the pipe shall be increased to test pressure (P) within 10 to 15 seconds in the baths whose temperature has been adjusted. The pressure with a permissible deviation of + I 2.5% shall be maintained for the test period laid down in table 235. The test pressure P shall be calculated from the normal dimensions and the values given in the table as follows:

$$P = 2Sa$$

$$d - S$$

Where P = Test pressure in Kg/cm²

S = Wall thickness in mm (min).

a = Induced stresses in Kg/cm² as 'a' in table 235

d = Outside dia in mm

- Stability Requirements of pipes for Internal Pressure Creep Rupture Test (IS-4984)

Stabilities	Test classification	Test duration Maximum temperature CO time-h	Test load holding @ kg/cm ²
A	80	48	41
	80	95	35
	80	170	30
B	27+1	1	130

The sample shall not rupture during the prescribed test period.

- The pipes shall be supplied either as a coil or in straight lengths of 5 to 20 meters. The ends shall be plugged or covered. Pipe lengths greater than 5 m shall be supplied with ends covered.
- **Marking:** Each pipe shall be marked indelibly at intervals of not more than 5 m, showing the manufacturer's name and trade mark and may also be marked with ISI certification mark. The marking shall be in colour shown in the table for different classes of pipes.

Class of Pipe and Colour Codification

Class of Pipe	Colour
2.0 kg/cm ² (class 1,0.2 MPa)	Orange
2.5 kg/cm ² (class 2,0.25 MPa)	Red
4.0 kg/cm ² (class 3,0.4 MPa)	Blue
6.0 kg/cm ² (class 4,0.6 MPa)	Green
10.0 kg/cm ² (class 5,1.0 MPa)	Yellow

36. Hoisting Accessories (MR-138)

- The Hand-Operated CPBs/travelling type manual hoist shall conform to various safety codes as applicable. All parts requiring replacement / inspection/lubrication shall be easily accessible.
- All consumable materials like lubricants, grease etc as required for initial filling, testing & commissioning at site shall be supplied by successful Tenderer without extra cost.
- All commissioning spares shall be included in the offer & shall be supplied along with the equipment. List of such commissioning spares shall be furnished along with the tender.
- Recommended list of spare parts required for two (2) years normal operation of the equipment shall be furnished along with the tender with item wise price.
- All necessary tools and tackles required for the normal maintenance of the equipment shall be provided. A list tools and tackles shall be furnished along with the tender.
- **PAINTING:** All parts of the CPBs shall be thoroughly cleaned of loose mill scales, rust or foreign matters. The surface cleaning shall conform to Indian Standard/ Swedish Standard/ DIN Standard All parts except gears, bearings etc. shall be painted with primer coat of red lead and two finished coat of approved colour. All parts except gears and bearings etc. shall be painted with one primer coat of red lead as per IS:5-1978 and two finished coat of approved colour.
- All parts inaccessible after assembly shall be painted and assembled while the paint is wet.
- After erection, the damaged portion of the painted surface shall be retouched and an intermediate coat/final coat shall be applied.
- The standards, latest on date of issue of LOI shall be followed.

Design standards & general details.

- Supply of Chain Pulley Block shall be as per specific requirement of various electro mechanical equipment of central treatment, drinking treatment and STP Tertiary plant room.
- The CPBs shall be of reputed make.
- Ball and roller anti frictional bearing only shall be used.
- Swivelling type standard shank hook mounted on grease lubricated anti-friction thrust bearing shall be used.
- The Chain Pulley Block shall conform to class-II duty as per IS: 3832-1986.
- Load chain & operating chain shall be of calibrated type.
- Pulley used for the operating mechanism shall have suitable guards to prevent the operating chain from coming out.
- All the open gearing shall have suitable cover.
- No-load testing shall be done at works after full assembly in presence of purchaser. The Chain Pulley Block shall be load tested at site after erection.
- No wooden parts shall be used in the Chain Pulley Block.
- Travelling speeds, reactive effort & bill of materials shall be indicated by the party during approval of drawing & shall be subject to purchaser's approval.
- The contractor to fill the below questionnaire and have to get this verified from the engineer in charge/ Architect consultant.

Questionnaire (to be furnish for each equipment)

1. Equipment No. :

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2. Capacity :

3. Quantity :

4. Height of Lift :

5. Class of Duty :

6. Min^m . Radius of Curvature &
Track beam size: :

7. Max. Tractive effort (Kgs) :
 - Hoist :
 - Travel :

8. Movement in 'm'
corresponding to operating
chain movement of 30m. :
 - Hoist :
 - Travel :

8. Delivery Schedule :

MATERIAL HANDLING EQUIPMENT SPECIFICATION

General :

This part of specification covers the design, engineering, manufacture, assembly, shop testing, painting at manufacturer's shop as well as at site after erection, supply FOR site, storage and re-conservation at site, erection, testing and commissioning of hoisting and handling equipment complete with their electrical equipment and standard accessories with attachments covered under this part of specification.

Scope of work:

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The scope of work of the Tenderer shall include the following:

- a. Supply of commissioning spares and spares for two (2) years normal operation & maintenance of each crane.
- b. Supply of required quantity of initial fill of lubricants, hydraulic fluid, cleaning/ flushing fluid including replenishment during commissioning and other consumables necessary for erection, testing and commissioning of the cranes.
- c. Supply of maintenance tools and tackles required for maintenance or testing/inspection of crane. A list of such tools shall be furnished with the quotation.
- d. Supply of required quantity of paints for intermediate, final coat and retouching.
- e. Supply of drawings and documents.

Technical Specification:

The hoist Electric hoist shall be designed in accordance with the latest edition of IS-3938-1983 and other relevant code wherever applicable. The Technical parameters of the Electric Hoist shall be as follow:

Technical Data Sheet for the Electric Hoist (To be furnished and submit along with the offer)

GENERAL	Sl. No	DESCRIPTION	UNIT	VALUE
	1	DESIGNATION		
	2	NUMBERS OFFER	Qty	
	3	TAG NO.		
	4	CAPACITY	t	
	5.	DUTY CLASSIFICATION		

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HOIST	6.	TOTAL WEIGHT OF HOIST BLOCK INCLUDING ELECTRICAL EQUIPMENT	t	
	7.	MAKE OF HOIST BLOCK		
	1	SPEED WITH SAFE WORKING LOAD	m/min	
	2	LIFTING HEIGHT a) ABOVE FLOOR b) BELOW FLOOR	m m	
	3.	WIRE ROPE <ul style="list-style-type: none"> ▪ TYPE OF CONSTRUCTION ▪ SIZE ▪ MINIMUM BREAKING STRENGTH ▪ TENSILE DESIGNATION ▪ CORE TYPE ▪ NUMBER OF FALLS ▪ FACTOR OF SAFETY ▪ MAKE 	mm KN F/S 2/4 5/6	
	4.	ROPE DRUM <ul style="list-style-type: none"> ▪ MATERIAL ▪ DIAMETER 	mm	
	5.	DRIVES TYPE & MATERIAL OF <ul style="list-style-type: none"> ▪ GAEAR BOX ▪ GEAR & PINION ▪ GEAR RATIO 		

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	6	<p>MOTORS</p> <ul style="list-style-type: none"> ▪ TYPE & NUMBER ▪ Kw RATINGS ▪ SYNCHRONOUS SPEED ▪ CLASS OF INSULATION ▪ ENCLOSURE CLASS ▪ NO. OF POLES ▪ PULL OUT TORQUE ▪ %CDF ▪ FRAME SIZE ▪ MAKE 		
	7	<p>BRAKES</p> <ul style="list-style-type: none"> ▪ TYPE ▪ SIZE ▪ TORQUE RATING ▪ QTY ▪ MAKE 	Kg-m	
	8	<p>LIMIT SWITCH</p> <ul style="list-style-type: none"> ▪ TYPE & DETAILS OF LIMIT SWITCH ▪ QTY ▪ MAKE 		
	9.	<p>LIFTING HOOK</p> <ul style="list-style-type: none"> ▪ TYPE ▪ CODE OF PRACTICE FOR SELECTION ▪ MATERIAL ▪ MAKE 		
	10	<p>OTHER ITEMS</p> <ul style="list-style-type: none"> ▪ SHEAVE DIA , MATERIAL & QTY ▪ TYPE OF COUPLING & THEIR MAKE ▪ TYPE OF BEARINGS & THEIR MAKE ▪ TYPE & DETAIL OF CONTROL 		
TROLLEY	1	MANUFACTURER		
	2	MAKE		
	3	MODEL NO		

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4	SPEED WITH SAFE WORKING LOAD		
5	<p>WHEELS</p> <ul style="list-style-type: none"> ▪ NUMBERS ▪ DIAMETER ▪ MATERIAL & HARDNES ▪ MAX. WHEEL LOAD ▪ WHEEL BASE 	Mm t mm	
6	<p>DRIVES</p> <ul style="list-style-type: none"> ▪ TYPES & MATERIAL OF GEAR BOX ▪ GEAR& PINION MATERIAL & HARDNESS ▪ GEAR RATIO 		
7.	<p>MOTOR</p> <ul style="list-style-type: none"> ▪ TYPE & NUMBER ▪ Kw RATINGS ▪ SYNCHRONUS SPEED ▪ CLASS OF INSULATION ▪ ENCLOSURE CLASS ▪ NO. OF POLES ▪ PULL OUT TORQUE ▪ %CDF ▪ FRAME SIZE ▪ MAKE 		
8	<p>BRAKES</p> <ul style="list-style-type: none"> ▪ TYPE ▪ SIZE ▪ TORQUE RATING ▪ QTY ▪ MAKE 		
9	<p>LIMIT SWITCH</p> <ul style="list-style-type: none"> ▪ TYPE & DETAILS OF LIMIT SWITCH ▪ QTY ▪ MAKE 		

DEVELOPMENT OF PERMANENT CAMPUS (PHASE-I) FOR NALANDA UNIVERSITY

	10	OTHER DETAILS <ul style="list-style-type: none"> ▪ TYPE OF COUPLING & THEIR MAKE ▪ TYPE OF BEARINGS & THEIR MAKE ▪ TYPE & DETAIL OF CONTROL 		
MISCELLANIOUS	1	POWER SUPPLY ARRANGEMENT:		
	2.	POWER SUPPLY & CONTROL VOLTAGE		
	3	LENGTH OF TRAVEL		
	4	RADIUS OF CURVATURE	m	
	5	REQUIRED BEAM SIZE	ISMB	
	6	IF CURVED MONORAIL, NUMBER OF CABLE TROLLEYS PROVIDED AND WIDTH OF EACH TROLLEY		
	7.	DISTANCE BETWEEN HIGHEST HOOK POSITION TO BOTTOM OF MONORAIL (HEADROOM)	mm	
	8	INDICATE BEAM SIZE MINIMUM/MAXIMUM SUITABLE FOR TROLLEY MOVEMENT	ISMB	
	9	PRELIMINARY DIMENSIONED GENERAL ARRANGEMENT DRAWING OF ELECTRICALLY OPERATED HOIST ALONG WITH WHEEL STOP DETAILS TO BE FURNISHED	Whether furnished Yes/No	