SPECIFICATIONS FOR MOTOR DRIVEN SELF LUBRICATED VERTICAL TURBINE PUMPING SETS AND ACCESSORIES

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1.0 PART 1 - GENERAL

1.1 SCOPE

Each pumping unit shall consist of vertical turbine centrifugal pump, column pipes, line shafts, level indicators, couplings, squirrel cage induction motor and all necessary appurtenances to provide a complete pumping system. The contractor shall require that the pumping units specified herein to be supplied by a single manufacturer. The contractor shall supply install, commission and hand over all equipment to the satisfaction of the Engineer.

The Bidder must visit the site and inspect the space requirement and other installation requirements before making the bid.

1.2 TYPE

Each pump shall be of the vertical turbine centrifugal type comprising stages which accommodate rotating impellers and stationary bowls possessing guide vanes. The pump shall be vertical line shaft driven, above/below ground delivery as shown in the diagram.

1.3 UNIT RESPONSIBILITY

The contractor shall cause all equipment specified under this contract to be furnished by the pump manufacturer who shall be responsible for the adequacy and compatibility of all pumping unit components. Any component of each pumping unit not provided by the pump manufacturer shall be designed, fabricated, tested and installed by factory authorized representatives experienced in design and manufacture of such components. This requirement, however, shall not be construed as relieving the contractor of the overall responsibility for this portion of work.

1.4 DESIGN REQUIREMENTS

The arrangements shown on the drawings are based upon the best information available to the Engineer at the time of design and is not intended to show exact dimensions peculiar to any specific equipment unless otherwise shown or specified. Therefore, it may be anticipated that the structural supports, foundations, connecting piping and valves shown in part or whole, may have to be changed in order to accommodate the pumping equipment furnished. No additional payment will be made for such changes. Any such changes shall be submitted to the Engineer for his approval.

Pumping units shall be designed to operate without over loading cavitations or damaging vibration at the specified speed, flow and head conditions. The shut off head of the proposed pumps shall be at least 10% more than the specified head at the specified capacity.

The motor shall be supported independently on the motor room floor above and shall be connected to the pump with intermediate shafts a shown in the drawing nos. ……..

Motor rating shall be at least 10 % more than the power required by the pump at the specified

duty point in case of pump running solo.

The motor base shall be designed for anchor bolting to a concrete foundation, assuming that the pump, without restraint at the suction and discharge connections, is subjected to a displacing force equal to that developed by an internal pressure equal to three times shut-off head at the operating speed.

The motor shall be coupled to the pump through vertical drive shafts as specified under 2.1.7.

The complete pumping unit shall be designed to operate without overload on any component at any point along the pump curve at the specified speed.

1.5 CRITICAL SPEEDS

Each complete system, including pump, motor and all appurtenances, shall have no dangerous critical or resonance frequencies or multiples of resonance frequencies within 20% above and 35% below the operating speed of the pump.

For the purposes of design, a dangerous vibratory critical speed shall be defined as one, which produces a torsion stress exceeding 2.4×10^7 Nm^{-2}.The contractor shall be responsible for the analysis of critical speeds, which shall be analyzed and certified by a professional engineer regularly engaged in this type of work.

1.6 FACTORY TESTING

1.6.1 Materials

Melt and strength tests of the cast iron used in the manufacture of the pumps' major components shall be performed in accordance with the applicable BS standards as indicated in the specification. The contractor shall furnish the Engineer with certified copies of the results of all tests.

1.6.2 Performance Tests

Pump shall be factory tested for performance in accordance with ISO 9906 by a testing agent approved by the Engineer and shall be to accuracy class C. The supplier shall submit these test curves prior to shipment of the equipment. These test curves shall include Head, Efficiency, Power absorbed and NPSH required against Capacity. The Engineer shall witness these tests.

Pump to be supplied under this contract with more than 30 kW shall be tested with its distinctive contract motor.

1.6.3 Hydrostatic Tests

Each pump shall be hydrostatically tested. Test pressure shall not be less than twice the shut-off head as shown on the approved head-capacity curve.

The test procedure shall be as follows:

	Condition	Time (Minutes)
1	Test Pressure	180
2	Atmospheric	05
3	Test Pressure	15
4	Atmospheric	05
5	Test Pressure	30

At no time during this test shall the casing show undue deflection or signs of weakness at any point, nor shall the external surfaces of the casing show sweating through porous metal or leaking through gasket or cracks or other defects.

The contractor shall furnish the Engineer with certified results of the tests.

1.6.4 Vibration Tests

Vibration tests shall be carried out in accordance with ISO 2372 – 1974.

1.6.5 Motor Tests

Motor shall be tested in accordance with NEMA and IEEE Procedures. The tests shall include,

a. Routine Tests
   i. No load current
   ii. Locked Rotor Current
   iii. Winding Resistance
   iv. High Potential Test.

b. Complete Tests
   i. Rated Load Temperature Rise.
   ii. Slip.
   iii. Locked Rotor Torque.
   iv. Breakdown Torque.
   v. Efficiencies at 100, 75 and 50 percent of Full Load.
   vi. Power factor at 100, 75 and 50 percent of Full Load.

The contractor shall furnish the all certified test results before shipment.

1.7 WARRANTY

The contractor shall provide manufacturer's warranty to the employer that the Goods and Services Supplied under the contract will comply strictly with the Contract and shall be first class in every case and shall be free from defects. The supplier further warrants to the Purchaser that all materials, equipment and supplies furnished by the supplier for the purpose of the goods will be new, merchantable of the most suitable grade, and fit for their intended purposes. The supplier shall warrant that the services to be carried out under this contract will conform to generally accepted professional standards and engineering principals.

This warranty shall remain valid for the period mentioned in the Data Sheet. After the final acceptance, any part of the equipment which fails or does not give satisfactory performance during this period of warranty, shall be replaced within the number of days as mentioned in the **Data Sheet** from the date the Contractor has been notified to do so.

All expenses involved in this connection shall be borne by the contractor who should take this into consideration when bidding.

2.0 PART 2 – PRODUCTS

2.1 PUMPS

These specifications are for the supply and installation of ____Nos. motor driven self lubricated deep well vertical turbine pumping sets complete with all accessories , pipe work, valves, fittings and electrical control panels as shown in drawing Nos.---- for the ---- - Water Supply scheme.

2.1.1 OPERATING CONDITIONS

Pump is required to deliver clear water with specific gravity 1.0, at a maximum temperature of 38.5°C. Water will contain 3.0 ppm of chlorine and the pH value will be between 6.5 and 7.5.

The performance of the pumps shall be complying with the requirements indicated in the table given in Data Sheet.

Description	Unit	Pumps
Number of installed pumps	Nos.	
Number of pumps in simultaneously operation	Nos.	
Capacity of a pump (at the total head of …. m)	m^3/hr (l/s)	
Operation at normal duty conditions	[mWC]	
NPSH available/Submergence levl	[m]	
Expected overall efficiency	%	
Expected nominal speed	rpm	
Method of starting	-	
Number of starts per hour	No/hr	6 or as desired
Connection to pipes	-	Flange
Media	-	Treated water
Total Annual Operational hours	Hours	8000

Actual $NPSH_A$/Minimum Submergence level at the pump inlet level shall ascertained by the tenderer, by considering the distance between the sump water level and the pump inlet level at the installed position.

Note : <u>NWSDB Designer must change and customize the following section to suit the particular case.</u>

Here …… pumps will be provided with ……starters. Pump units shall be provided with an arrangement for dry running protection. All necessary for installation of such arrangement, including cabling, relays etc shall be included in the contract.

The ……. pumps are expected to operate one on duty and one standby.

The …… pumps will be operated ***manually and no auto mode is required***

(change as required) for pump operation. The ……. pumps will start only when following initial conditions are satisfied (these initial conditions should be interlocked with motor starters of the …… pumps)

The system power supply shall be normal.

The water level in the sump shall be above dry running protection level.

Once the above requirements are met, an operator can switch on the pump while keeping the common delivery valve in closed position.

On failure of the duty pump, operator shall be able to select stand by pump through the duty selector and operate.

Power supply status of ***pump house incoming panel***, Status of the ***pumps*** (run, stop and malfunctioning), any error occurring in the ***level transmission system*** between ***Clear water reservoir and low lift pump house*** should be displayed with ***audible buzzer*** at the ***low lift pump house panels***.

A resetable audio visual buzzer arrangement should be activated at high lift pump panel house when duty low lift pump tripped/other malfunction.

2.1.2 SPEED

Nominal operating speed of the pump shall not exceed …….. RPM. However, the pumps with higher speed may be considered if no suitable offer is received for the specified pump.

2.1.3 FFICIENCY

Minimum pump efficiency (wire to water) expected at the duty point is …..%. The efficiency at the duty point will be a consideration in the evaluation of the offer of the as both capital and the operational costs will be taken into consideration in evaluating the bids. An alternative offer for pumps with lower efficiency will be considered if a suitable offer for pumps with the required efficiency is not received.

2.1.4 CONSTRUCTION MATERIALS

Note : <u>NWSDB Designer must change and customize depending on the particular case.</u>

MATERIALS

Component	Material
Pump shaft	Stainless Steel conforming to BS 970 Grade 43IS29.
Impellers	Leaded Gunmetal LG2/LG4 conforming to BS 1400.
Bowls	Cast Iron conforming to BS 1452 Grade 220.
Column pipes	Low Carbon Steel conforming to BS 970
Impeller Neck Rings/Casing wear rings	Leaded Bronze LB2 conforming to BS 1400.
Gland	Leaded Gunmetal LG2/LG4 conforming to BS 1400.
Line shaft	Carbon steel BS 970 Grade 080M40
Bolts, studs & nuts	Stainless steel conforming to BS 970

2.1.5 COUPLING

Motor shall be coupled to the shafting by semi flexible coupling. The coupling shall be statically and dynamically balanced over a speed range up to 150% of the operating speed.

2.1.6 PRESSURE GAUGES

Following gauges shall be installed with each pump, with operating and vent cocks.

a) A pressure gauge of 100 mm. diameter calibrated in meters of water and Kg./cm2 with a maximum reading approximately twice the total head of the pump, on the delivery side.

2.1.7 CONSTRUCTION

A pump head of high grade cast iron conforming to BS 1452 Grade 220 or fabricated steel shall be provided for mounting the motor. It shall be designed to carry the weights of motor , pump column assembly and bowl assembly plus dynamic loads associated with the operating of the unit. The discharge outlet shall be flanged as shown in the drawing no. …….. and provided with a flanged taper to match the delivery line.

The pump/motor thrust bearing shall have ample capacity to carry the weight of all the rotating parts and the hydraulic thrust of the pump impellers, and have a n ample safety factor. This factor should be based on an average life expectancy of five years operation at 24 hours per day.

The column pipes shall be of low carbon steel and protected by a bitumen or similar anti-corrosive coating. The total length of discharge column shall be …….. meters. The column pipe shall be furnished in interchangeable sections not over ……. Meters in length, and connected with threaded sleeve type couplings/flanged couplings. The joints are to be butted to ensure perfect alignment after assembly.

The line shaft shall be turned, ground and polished precision carbon steel conforming to BS 970 Grade 080M40 shafting of ample size to operate the pump without distortion or vibration. The shafts shall be furnished in interchangeable sections not over ……. Meters in length and shall be coupled with strong steel couplings machined from solid steel bar.

A non corrosive stainless journal shall be placed on each shaft at the bearing point.

The outer diameter of this stainless steel journal shall be substantially flush with the outer diameter of the shaft.

The column assembly shall have Leaded Bronze bearing retainers conforming to BS 1400, threaded into column pipes. Each bearing retainer shall contain a water lubricated natural or synthetic rubber bearing having high resistance to abrasive wear and designed for vertical turbine pump service. The pump shall be capable of handling 50 ppm of sand particles during its normal operation.

The pump bowls shall be of close – grained cast iron conforming to BS 1452 Grade 220, free from blow holes, and other faults; accurately machined and fitted to close dimensional tolerances. Bowls shall be capable of withstanding a hydraulic pressure equal to 2 times the shut off head as specified in 1.7.2.

The bowls shall be coated inside with a smooth vitreous enamel, which reduces friction losses in the water passage.

The impeller shaft shall be of stainless steel conforming to BS 970 Grade 43S29. The impeller shaft shall be supported by a combination of water lubricated fluted natural or synthetic rubber and Leaded Bronze bearings.

The impeller(s) shall be of Leaded Gunmetal LG2/LG4 conforming to BS 1400, accurately machined and furnished, and statically and dynamically balanced up to 150% of the speed.

They shall be securely fastened to the impeller shaft with tapered bushing.

Each bowl shall have an impeller seal ring to prevent slippage of water between bowl and impeller.

The impellers shall be adjustable by means of a top shaft nut at the top of the discharge head or top of the motor.

A suction pipe of adequate length and proper diameter and same material as pump column shall be provided. A galvanized steel suction strainer with total surface area of not less than four times the area of the suction pipe/suction bell mouth of adequate cross sectional area shall be provided.

A pressure gauge of 100 mm. diameter calibrated in meters of water or kg/cm2 with a maximum reading of approximately twice the operating head of the pump shall be provided on the delivery side.

2.1.8 CALIBRATION OF INSTRUMENTS & METERS

All instruments & meters shall be calibrated in the metric units as follows.

1. Pressure shall be indicated in metric water meter.
2. Flow shall be indicated in cubic meters/hour or litres/second
3. Quantities shall be indicated in cubic meters
4. Time shall be indicated hours.
5. Amperage shall be indicated in Amperes
6. Voltage shall be indicated in Volts.

2.2 ELECTRIC MOTORS AND LT EQUIPMENT

2.2.1 MOTORS

All motors shall be of Energy Efficient Continuous …….. phase, squirrel cage , induction type designed for …….. V. 50 Hz and maximum kVA inrush current shall be NEMA Code F. design of the motors shall be such that they can operate within ± 6% of the normal voltage continuously without damage. Synchronous speed shall be …… rpm.. Each motor shall be provided with a lifting eye bolt and shall have a service factor.

Motor enclosures shall be protected to IP 55.

2.2.2 INSULATION

Motors shall be of class ……. Insulation of specify standards but the operating temperature rise shall be restricted to that of class ……

2.2.3 THERMAL PROTECTION

Thermal protector sensing elements shall be of the same manufacture and shall be coordinated with the thermal protection relay. The sensing elements shall be embedded and sealed in the end winding of each stator phase. The sensing elements of all three phase shall be connected in series and, the end leads brought out to a conduit fitting,. The thermal protector relay contacts shall be of ample capacity to operate the motor starter control units.

2.2.4 SPACE HEATERS

All motors over 30 kW shall be provided with a space heater. Heater shall be installed adjacent to the core iron and shall be rated 230 V single phase supply. Space heater terminals shall be separately wired to a terminal box. Space heater rating in Watts and Volts shall be noted on the Motor Nameplate.

2.2.5 BEARINGS

Motor bearings shall be of high – precision manufacture, anti friction type designed for an continuous (24 hrs/day) duty life of 70,000 hrs.

2.2.6 MOTOR MOUNTING

Each motor shall be mounted on pump head as specified under 2.1.5..

2.2.7 BALANCE

Each rotating assembly including coupling half, shaft and rotor shall be dynamically balanced up to 150% of the operating speed prior to final assembly.

2.2.8 PROTECTION OF ENCLOSURE

Motor enclosures shall be protected to IP 55.

2.2.9 MOTOR – PUMP COUPLING

The motors shall be coupled to the pump through vertical drive shafts as specified under 2.1.5.

2.2.10 MOTOR RATING

Motors shall be continuous duty type (duty designation – S1) with minimum 6 starts per hour and the ratings of the motors shall be at least more than the power required at the point of 115% of the capacity at the specified duty point.

2.2.11 MOTOR CONTROL CENTRE

All electrical equipment shall be rated to operate on …….. V., …… phase 50 Hz. Supply.

They shall basically consist of ;

a) Panel enclosures
b) Busbars with MCCB's (Distribution section)
c) Supply incoming section
d) Small power distribution section
e) Motor starting sections
f) Automatic controllers & indicators
g) Cabling

2.2.12 PANEL ENCLOSURE CONSTRUCTION

Enclosures shall be of sheet metal construction using 1.5 mm. thick steel sheets with corrosion resistant coat. Fabrication shall be done using seam or spot welding and finish shall be elegant and workmanship of high quality. The interiors of cubicles shall be finished with gloss white paint. The cubicle exterior shall be finished to cream colour. All cut- outs and holes to be drilled in the panel shall be carried out before rust proofing.

All cubicles shall be adequately earthed independent of the earth connection via the cable glands, and cubicle sections shall be electrically bonded to each other.

Enclosure shall be ……../ …….. mounted.

Enclosure shall be protected to IP 55.

Doors shall be suitably hinged to ensure uniform pressure right along the rubber beading. The rubber beading shall be flat type that provides protection against dust and drops of water. Doors shall be lockable with special type operated locks. Hinges shall be zinc die – castings or stainless steel.

2.2.13 DIMENSIONS

Enclosure dimensions shall be carefully selected so that ample working space is available or easy replacement of components.

Access to the cubicles or cubicle compartments for all normal routine maintenance shall be from the front.

2.2.14 ARRANGEMENT OF COMPONENTS WITHIN ENCLOSURES

Arrangement of components shall be logical,. Cable entry shall be from the bottom where knock out flanges shall be fixed. All cables shall terminate at independent terminals installed at the bottom part of the enclosures. Where busbars are used they shall occupy the top portion of the enclosure. Contactors and protective devices shall be in the middle portion of the enclosure. All meters shall be conveniently located for easy reading and MCCB's located at convenient heights. Maximum operating height of the enclosure shall not exceed 2000 mm.

2.2.15 WIRIG WITHIN THE ENCLOSURES

Wiring within the enclosure shall be done in neatly arranged PVC cable trays with detachable lids. All wires shall be numbered lugged and connected properly. The control wiring diagram printed on paper (properly laminated) shall be fixed on to an interior wall of the enclosure. Phases of the each end of the cable shall be marked using Red, Yellow and Blue tapes and the neutrals shall be marked using Black tapes.

2.2.16 SUPPLY INCOMING SECTION

Incoming section shall consist of the following basic elements.

a) One 4 pole moulded case circuit breaker of adequate capacity with thermal magnetic overload and earth fault trip.

b) One ammeter with selector switch for monitoring phase currents

c) One power factor meter.

d) One voltmeter with selector switch for monitoring phase to neutral and phase to phase voltages.

e) One supply voltage monitor with the following features and interlocked with all motor starters.

- Phase failure protection
- Supply voltage imbalance (adjustable)
- Under and over voltage (adjustable)
- Phase reversal

f). Lamp indicator to indicate operating condition of supply voltage monitor.

g). Incoming terminals.

h) Surge suppression device (surge arrestors)

i) Duty selector switch with interlocking arrangements.

j) One no. Three phase 04 pole MCCB of …. A capacity shall be incorporated in the panel board for an auxiliary power supply.

2.2.17 BUSBARS

All bus bars (TP&N running over the entire length of panel) shall be copper and of adequate thermal and short circuit capacity to withstand extreme short circuit conditions without permanent damage. An earth bus bar shall be provided at the bottom portion of the enclosure. Current density in busbars shall not exceed 3A per sq mm.

2.2.18 MOTOR STARTING SECTION

Motor starting panel shall be an integral part of the incoming panel with separate cubicles and doors for each section. Method of starting shall be …… / …… type. All starter should be wired to check the control circuit with the supply but without running the Motor.

Motor starters shall comply with BS 587 or equivalent. Starter shall be adequately rated for the required number of starts per hour and in any case not less than 6 starts per hour. Contactors incorporated in motor starter shall conform to BS 775 and BS 5424 or equivalent. If the method of starting is Auto Transformer, Then over heating protection for the Auto Transformer coils shall be provided.

Motor starter panel to be provided shall consist of the following basic elements.

a). One 3 pole MCCB with adequate rated capacity and thermal magnetic overload trip to serve as the feeder for the starter.

b). Contactors wired for …… starting.

c). One three phase adjustable thermal overload.

d). Three ammeters to rated phase currents and ammeters shall be marked according to the phase designations, R – phase …… etc.

e). Indicator lamps to indicate following :

* Pump running
* Pump tripped (overload)

* Pump stopped
* Pump tripped (low water level)

f). Hours run meter

g). set of control relays, timers etc. necessary for operation.

h). 2 pole – MCB for control supply.

i). Thermal protector relay connected to thermal sensors, mounted in the Motor windings.

j). Power factor correction capacitors to correct the power factor to 0.95 lagging for motors of 25 kW and above.

k). Auto transformers (if applicable).

l). Outgoing terminals.

2.2.19 AUTOMATIC CONTROLLERS & INTERLOCKS

The following shall be provided.

a). Automatic cut –off of the pumps when the well level in the sump is below the minimum level.

b). Control relays, transducers, cables etc. necessary for realizing above shall be provided.

2.2.20 ELECTRICAL PANEL BASIC ELEMENTS

This section specifies the requirements for the basic elements to be used for the construction of Multi Motor starting panels.

2.2.21 MOULDED CASE CIRCUIT BREAKER (MCCB)

MCCB's shall be manually operated type manufactured to IEC 157 – 1 standard or equivalent.

Insulated phase barriers shall shield each pole of the circuit breaker, and circuit breaker contacts shall have adequate arc suppression.

MCCB's shall be fitted with thermal and magnetic overload trips and thermal trip shall be adjustable for all capacities. For capacities exceeding 100 A., the magnetic trip too shall be adjustable.

Breaking capacity according to IEC 157 at 400 V shall be above 20 kA for all MCCB's used.

Each incoming circuit breaker shall in addition be provided with instantaneous earth faults protection.

2.2.22 CONTACTORS

Contactors shall conform to IEC standards or equivalent for motor starting contactors.

Capacities of the contactors shall be carefully selected leaving sufficient extra capacity, according to the AC – 3 rating.

2.2.23 AUTO TRANSFORMERS (IF APPLICABLE)

Autotransformers shall be 3 – phase type with tapings at 50%, 65% and 80%. Protection against overheating shall be provided by installing thermal sensors on all links and those shall be connected to the protection relay etc.

2.2.24 AMMETERS AND VOLTMETERS

- Instruments shall comply with BS 89.
- Instruments shall be of sealed type and shall be flush mounted on the cubicles.
- Ammeters fitted to motor circuit shall have a suppressed overload scale and shall operate with current transformers.
- Voltmeters with selector switches to read phase and line voltages shall be provided to read the voltages on all bus bars.

2.2.25 CONTROLS – INDICATORS AND ALARMS

Indication lamps and push buttons shall be colored as follows;

Lamp Marking	**Colour**
ON	Red
FAULT	Amber
OFF	Green
Button Marking	**Colour**
START	Green
STOP	Red
RESET	Black

2.2.26 EARTHING TERMINALS

Earthing bar mounted in the lower part of the enclosure (earth bus) shall be marked main earth terminal and shall be completed with screw connections, for earthing conductors.

2.2.27 POWER CABLES

All power cables shall be PVC/insulated, 4 core with copper conductors. Cable sizes shall be determined in accordance with latest IEE wiring regulations.

All underground cables shall be PVC/SWA/PVC 4 core with copper conductors.

2.2.28 CONTROL CABLES

All control cables shall have copper conductors with minimum cross section of 1.5 mm2.

2.2.29 CABLE INSTALLATION

Method of installation for cables shall be selected in accordance with IEE wiring regulations to suit the specific application. However, the following requirements are to met.

a). Cables which are to be run on walls, ceilings or other building structures shall be secured on cable trays, ladders or enclosed in conduits or trunking.

b). Where building structure incorporates covered trench system cable shall be laid on horizontal trays against the sides(s) of the trench

c). Every cable shall be permanently identified at each end by cable markers with semi rigid black PVC carrier strip which shall be fixed axially by means of 2 PVC straps.

d). All power cables and control cables to be run external to the buildings shall be in type 400 PVC pipes so that the cable can be pulled out for inspection and easy replacement. Manhole openings shall be provided every 30 m. or after bend and top side of the cable path shall be covered by suitable concrete slabs.

2.2.30. EARTH ELECTRODES

The earth electrode shall be minimum of 50 mm in diameter and be driven in to the ground at least 2 meters below the ground level. Where multiple rods are installed they shall be separated by a distance not less than their driven length. Earth electrodes shall be provided with a non – ferrous clamp and the connections shall be made in a concrete inspection chamber set flush with the finished ground level. The inspection chamber shall be permanently marked “ELECTRICAL EARTH”.

Where said conditions make the use of rod type electrode impractical or uneconomical a grid configuration may be used. The grid shall comprise horizontally buried bare copper tape or multi stranded cables.

Earth resistance of the earth shall not exceed 5 ohms.

2.2.31 EARTH CONDUCTORS

Earth conductors shall be sized in accordance with IEE regulations. PVC cable insulation shall be green. Cable armouring and screens shall not be used as sole earth protective conductor, and earthing shall be arranged in accordance with BS 7430 of 1991.

2.2.32 ITEMS TO BE EARTHED

The following equipment shall be connected to the main earth terminal by means of earthing conductor with cross sectional area as per requirement of IEE wiring regulations;

a) Panel enclosures

b) All motor cases

c) Metal cable trays, supports etc.

d) Any other metal object which may become under faulty conditions.

2.3 SPARES

Bidder shall quote for the following spares for **each pumping set.**

1.	Impellers	01 set
2.	Bowls wear rings	01 sets
3.	Impeller neck rings	01 sets
4.	Bowl bearings	02 sets
5.	Rubber spider bushes	01 set
6.	Line shaft couplings	01 set
7.	Impeller taper locks	01 set
8.	Coupling bushes	01 set
9.	Thrust bearing	02 sets
10.	Gland packing	01 set
11.	'O' rings	01 set
12.	Motor bearings	01 set
13.	Set of gauges	01 set

The Bidder shall quote for the following spare parts for the control panel also.

1. A set of all contactors
2. A set of all relays and timers
3. A set of all meters
4. A set of water level electrodes
5. A set of all indictor lamp covers
6. Two sets of all indicator lamps
7. Three sets of fuses

3.0 PART 3 – EXECUTION

3.1 INSTALLATION

The contractor shall provide the complete pumping system and factory – trained personnel to supervise installation and initial operation of all components. The pumps shall be aligned, connected and installed at the locations shown and in accordance with the manufacturer's recommendations. Contractor shall certify that the equipment is installed in a manner to ensure proper operation.

3.2 CERTIFICATION

Manufacturer shall supply certified pump performance curves demonstrating compliance with the performance specified herein.

3.3 TESTING

After the completion of installation each pumping unit shall be field tested to ensure compliance with the performance requirements a specified.

Any additional costs that may have to be incurred due to non – performance of the equipment shall be recovered from the contractor as per the clause 1.11 of this specification.