SPECIFICATIONS FOR VERTICAL SHAFT DRIVEN DOUBLE SUCTION CENTRIFUGAL PUMPING SETS AND ACCESSORIES

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1.0 PART 1 - GENERAL

1.1 SCOPE

Each pumping unit shall consist of a vertical centrifugal pump, vertical drive shafts, 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 tenderer 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, dry pit volute casing enclosed impeller centrifugal type, designed so that impeller shaft and bearings can be removed without disturbing the connection piping or casing. The pump shall be pedestal mounted on a fabricated steel base with sufficiently large openings to permit access to pump suction line.

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.

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. In case of pumps running parallel, rating of each motor should be higher than the maximum capacity required by each pump.

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

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

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 motors higher 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 ENVIRONMENTAL CONDITIONS

The equipment to be provided under this contract shall be suitable for installation and operation at elevations of about ……. M. above sea level inside weather protected structures. Outside ambient temperatures range between …… and ……^{0}C and water temperature varies between …… and …… ^{0}C.

Relative Humidity is expected to range between …….. and 100%. Atmosphere is dusty.

1.8 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

Pumps shall be vertical shaft driven, volute casing, double suction vertically split casing centrifugal type.

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 below.

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	[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 $NPSH_A$ at the pump shaft center line level shall ascertained by the Bidder, by considering the distance between the sump water level and the first stage impeller eye line 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 at the ***clear water reservoir*** 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 and considering the water levels of the distribution reservoir which is nearly xxxx m away from the ***high lift house (high lift pump will be manually operated according to the water level at this reservoir).*** These water levels of the ***distribution reservoir*** shall be displayed at the ***high lift pump house panels*** via ***wireless transmission***. The levels which should be ***displayed at the high lift pump house panel*** are mentioned in ***the page no…….***

The system should allow the operator to switch on the pump when water level at ***distribution reservoir*** is at predetermined level (this level will be decided by the engineer at the time of installation) and switch off the pump when water level at ***distribution reservoir*** is maximum. But these levels should not be interlocked with motor starters of the …… pumps so the operator can switch ON and OFF the pumps as he wished.

A reset able audio visual buffer arrangement should be activated when water levels of ***distribution reservoir*** are at predetermined level (to switch on the pump) and maximum level to switch off the pump.

Any error occurring in the ***wireless level transmission system*** (level monitoring system) should be displayed at the ***high lift pump house panel*** in proper manner with a reset able audio visual buffer arrangement.

Any error or malfunctioning shall be indicated with an alarm in respective panel until the fault is correct.

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

A resetable audio visual buffer 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 EFFICIENCY

Minimum pump efficiency 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>

<u>Followings Table can be used as a guideline.</u>

Impeller Materials

	Material	Code	Application	Peripheral Speed m/s	Use
1	Bronze	ASTM B584 / ASTM B505	Anti-corrosion	50	Treated water
2	Stainless steel	ASTM CF 8 JIS-SCS 13	Anti-corrosion Anti-erosion	65	Treated water Borehole pump
3	i) High Cr. Iron (Hard Iron) ii) Stainless Steel (With a suitable coating)	i) ASTM A532 TYPE III ii) ASTM CF8M/ JIS-SCS13	Anti-erosion Anti-corrosion	35 70	Raw water & Waste water with sand, silt.
4	i) Grey cast iron	i) EN-GJL250 JIS-FC250	Low total head	35	Raw water intake with no abrasive particle. & Treated waste water

	Material	Code	Application	Peripheral Speed m/s	Use
5	i) Phosp. Bronze ii) Ductile Iron Casting	i) ASTM B505 ii) ASTM 80-40/ JIS-FCD 400	Anti-corrosion Anti-erosion	45 45	Raw water
6	i)Stainless steel ii)Phosp. Bronze	i)JIS-SCS13/ ASTM CF8 ii) ASTM B 505	Anti-erosion Anti-corrosion	70 40	Saline water, Waste water
7	Stainless steel	SCS14/ASTM-CF8m AISI316	Anti-corrosion Anti-erosion	70	Saline water and Sea water

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

<u>Followings Table can be used as a guideline.</u>

<u>Materials of casing and other parts of pump</u>

	Material	code	Application	Use
1	Gray Cast Iron	EN 1561-EN GSL 250 JIS FC 250	Casing Common material up to 10 bar	i) Treated water ii) Raw water without abrasive material iii) Sewage
2	Ductile Iron Casting	ASTM 80-40 JIS FCD 400	Casing High strength	i) Treated water ii) Raw water without abrasive material
3	Carbon steel casting	JIS SC 450 EN 10213-2	Casing High strength	i) Treated water ii) Raw water with abrasive material
4	Ni-Resist casting		Casing	Sewage & Raw water with abrasive material

	Material	code	Application	Use
5	i)Carbon steel ii)Stainless steel/ Chrome Nickel Steel	i)EN 1.0503 ii)EN 1.4021/ EN 1.4301/ EN 1.4401	Pump shaft	Common material High strength (Treated/ Raw/ Sewage Saline/ Seawater)
6	Stainless Steel	316 SS	Bolting	For all
7	i) Stainless Steel ii) Bronze	i) EN4021/ EN 4301 ii) BC6	Shaft sleeve	Select the depending on application & type of pump

Other pump related parts shall be selected according to the design and site condition.

2.1.5 PRESSURE GAUGES

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

a). Suction compound gauge of 100 mm. diameter, calibrated in meters of water and Kg/cm2 reading from vacuum to 10 m. head at the suction side.

b) 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.

2.1.6 CONSTRUCTION

Pumps shall be vertical shaft driven centrifugal volute casing, double suction, split casing type with suction and delivery flanges positioned in the fixed half of the housing.

The motor shall be mounted on a rigid cast or fabricated steel motor stool suitably designed for accurate alignment of the motor, drive shaft assembly and the pump.

Suction and delivery flanges shall be drilled in conformity with NP ….of BS 4504 table 10/11 and incorporate two tappings in each flange for mounting suction and delivery pressure gauges, the spare tapping being plugged. Flanges shall be machined on face and edge and spot faced at seating surfaces of the bolt heads and nuts.

Casing shall be of close grained cast iron in conformity with BS 1452, Grade 220 free from cracks, impurities and any other casting defect and shall incorporate replaceable wear rings. The surfaces of all water passages shall be smooth and free from all pits and projections which might cause undesirable turbulence.

Two halves of the casing shall be properly secured with each other with fine threaded screws with washers seated on properly milled seats. Dowels and guide rods shall be provided for alignment of the two halves of the hosing in subsequent dismantling.

Lifting lugs or eye blots shall be provided at well balanced positions and also tappings shall be available for priming, gland lubrication and drainage connections and air releasing cocks shall be provided on pump casings to permit air release during priming.

Pump shaft shall be of a diameter sufficient to prevent distortion from stresses imposed on them and shall be machined all over, out of stainless steel to conforming to Grade 431S29 of BS 970. the areas in contact with water and also over the full length of stuffing box, protected with shaft sleeves keyed to properly shrunk fitted onto the shaft. Fine ground finished surfaces shall be made for bearing seats.

Pump shaft shall be mounted on ball or roller thrust bearings at the bottom and ball or roller bearings at top, with static grease lubricated in rigid and robust plummer blocks properly seated to prevent ingress of moisture and designed for a continuous (24 hrs/day) duty life of not less than 50,000 hrs. Provision shall be available for external grease lubrication of the bearings.

The shaft sealing shall be arranged with gland packing with lantern and adjustable gland lubricated by water lines, tapped out from top and bottom of the pump housing. These lubricating piping and connection nuts shall be stainless steel with a anti leakage copper washers at the seating surfaces.

Impeller shall be double suction type, cast out of Leaded Gunmetal LG2/LG4 conforming to BS 1400 and shall be dynamically balanced including coupling, shaft and wear rings prior to final assembly up to 150% of the operating speed. The flow passage shall be smooth and free from hollows, cracks, pinholes and projections which might incite or encourage cavitation. All exterior surfaces shall be accurately machined.

Vertical drive shafts of tubular form shall be provided for each pump for connection to the motor driver. Shafting shall be complete with flexible couplings sized to carry the loads of intended service. The bearings shall be heavy duty, self aligning continuous (24 hrs/day) duty life of not less than 50,000 hrs with 1 ½ degrees misalignments. Shafts shall be joined by universal type flexible couplings and shall have greased lubricated needle bearing universal joints and splined slip joints.

Pressure gauges shall be fitted to each pump with operating cocks as indicated below :

a). A compound gauge of 100 mm. diameter, calibrated in meters of water or kg/cm2, reading from ……. M Vacuum …….. m. head at the suction side.

b) A pressure gauge of 100 mm, diameter calibrated in meters of water or kg/cm2 where the reading at nominal duty shall be two thirds the maximum reading.

2.1.7 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. Tome 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 NEMA 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 SUPPORT PEDESTAL

Each motor shall be mounted on a support pedestal designed to carry the motor weight of

the vertical shafting plus all dynamic loads associated with the operating of the unit. The pedestal shall be designed with adequately sized openings to permit access to the upper universal joint of the drive shaft.

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 b e 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 tappings 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/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.	Impeller	01 set
2.	Shaft sleeves	02 sets
3.	Pump bearings	02 sets
4.	Impeller neck rings	01 set
5.	Lantern rings	01 set
5.	Casing wear rings	01 set
6.	Coupling bushes	01 set
7.	For pumps with motor power 30 kW and above complete rotor assembly (dynamically balanced) shall be provided in place of item nos. 1 to 5.	
8.	Gland packing	01 set
9.	All gaskets, seals and packings	02 sets
10.	Stuffing box gland with nuts & bolts	01 set
11.	Motor contactors	01 set
12.	All relays and timers	01 set
13.	Indicator lamp covers	01 set
14.	Indicator lamps	01 set
15.	Fuses	03 set
16.	Supply voltage monitoring relay	01 no.
17.	Thermal overload	01 no.
18.	Auto transformer	01 no. (if applicable)
19.	Motor bearings	01 set
20.	Lightning surge diverters	01 set

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.