

**SPECIFICATION FOR END SUCTION VERTICAL  
DELIVERY BACK PULL – OUT CENTRIFUGAL  
PUMPING SETS AND ACCESSORIES**

## TABLE OF CONTENT

	<b>Page No.</b>
<b>1.0 GENERAL</b>	
1.1 Scope	6ab-3
1.2 Type	6ab-3
1.3 Unit Responsibility	6ab-3
1.4 Design Requirements	6ab-3
1.5 Critical Speeds	6ab-4
1.6 Factory Testing	6ab-4
1.6.1 Materials	6ab-4
1.6.2 Performance Tests	6ab-4
1.6.3 Hydrostatic Tests	6ab-4
1.6.4 Vibration Tests	6ab-5
1.6.5 Motor Tests	6ab-5
1.7 Environmental Conditions	6ab-5
1.8 Warranty	6ab-5
<b>2.0 PRODUCTS</b>	
2.1 PUMPS	6ab-6
2.1.1 Operating Conditions	6ab-6
2.1.2 Speed	6ab-6
2.1.3 Efficiency	6ab-6
2.1.4 Construction Materials	6ab-6
2.1.5 Coupling	6ab-6
2.1.6 Pressure Gauges	6ab-6
2.1.7 Construction	6ab-7
2.1.8 Calibration of Instruments & Meters	6ab-8
2.2 Electric Motors And Lt Equipment	6ab-8
2.2.1 Motors	6ab-8
2.2.2 Insulation	6ab-8
2.2.3 Thermal Protection	6ab-8
2.2.4 Space Heaters	6ab-8
2.2.5 Bearings	6ab-8
2.2.6 Motor Mounting	6ab-9
2.2.7 Balance	6ab-9
2.2.8 Protection of Enclosure	6ab-9
2.2.9 Motor- Pump Coupling	6ab-6
2.2.10 Motor Rating	6ab-9
2.2.11 Motor Control Centre	6ab-9

	<b>Page No.</b>
2.2.12 Panel Enclosure Construction	6ab-9
2.2.13 Dimensions	6ab-10
2.2.14 Arrangement of Components within Enclosures	6ab-10
2.2.15 Wiring within the Enclosures	6ab-10
2.2.16 Supply Incoming Section	6ab-10
2.2.17 Busbars	6ab-11
2.2.18 Motor Starting Section	6ab-11
2.2.19 Automatic Controllers & Interlocks	6ab-12
2.2.20 Electrical Panel Basic Elements	6ab-12
2.2.21 Moulded Case Circuit Breaker (MCCB)	6ab-12
2.2.22 Contactors	6ab-13
2.2.23 Auto Transformers (If Applicable)	6ab-13
2.2.24 Ammeters and Voltmeters	6ab-13
2.2.25 Controls – Indicators and Alarms	6ab-13
2.2.26 Earthing Terminals	6ab-14
2.2.27 Power Cables	6ab-14
2.2.28 Control Cables	6ab-14
2.2.29 Cable Installation	6ab-14
2.2.30. Earth Electrodes	6ab-14
2.2.31 Earth Conductors	6ab-15
2.2.32 Items to be Earthed	6ab-15
2.3 Spares	6ab-15
<b>3.0 EXECUTION</b>	
3.1 Installation	6ab-16
3.2 Certification	6ab-16
3.3 Testing	6ab-16
<b>PART II</b>	<b>6ab-17</b>

# **SPECIFICATIONS FOR END SUCTION VERTICAL DELIVERY BACK PULL – OUT CENTRIFUGAL PUMPING SETS AND ACCESSORIES**

## **PART I**

### **1.0 GENERAL**

#### **1.1 SCOPE**

Each pumping unit shall consist of end suction centrifugal pump, coupling, 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 end suction, vertical delivery centrifugal type with back pull - out facility for easy maintenance. The pump and motor shall be mounted on a fabricated common steel base.

#### **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 motor shall be connected to the pump by a semi flexible coupling.

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  $2.4 \times 10^7 \text{ Nm}^{-2}$ . 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 20816-1: 2016.

#### **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 given in Clause 1.7 in Part II of this specification. Outside ambient temperatures variances are given in Clause 1.7 in Part II of this specification.

The expected Relative Humidity range is given in Clause 1.7 in Part II of this specification.

### **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 PRODUCTS**

### **2.1 PUMPS**

Pumps shall be end suction vertical delivery, enclosed impeller centrifugal type with suction and delivery flanges positioned in the fixed half of the housing.

Pumps and Motors shall be coupled through a semi flexible coupling and shall be mounted on a rigid and robust cast or steel fabricated base plate suitable for vibration free operation.

#### **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 1 in Clause 2.1.1 in Part II of this specification.

#### **2.1.2 SPEED**

Nominal operating speed of the pump shall not exceed the value given in Clause 2.1.2 in Part II of this specification. 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 given in Clause 2.1.3 in Part II of this specification. 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**

Construction Material is specified in Clause 2.1.4 in Part II of this specification

#### **2.1.5 COUPLING**

Motor shall be directly coupled to the pump, through a semi flexible coupling, which can take the proper alignment. 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). Suction compound gauge of 100 mm. diameter, calibrated in meters of water and Kg/cm<sup>2</sup> 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./cm<sup>2</sup>

with a maximum reading approximately twice the total head of the pump, on the delivery side.

### 2.1.7 CONSTRUCTION

Pumps shall be end suction single stage vertical delivery centrifugal type with vertical split back pull out casing in order to facilitate easy dismantling without disturbing suction and delivery piping.

Shall be coupled to the motor through a semi flexible coupling and the pump and the motor shall be mounted on a rigid and robust fabricated common base plate, suitable for bolting onto a concrete foundation.

Suction and delivery flanges shall be in the direction of pump axis and vertical directions respectively.

Suction and delivery flanges shall be drilled in conformity with NP 16 of BS 4504 table 10/11 and incorporate two tappings in each flange for mounting suction and delivery compound and pressure gauges respectively, the spare tappings 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 conforming to BS 1452, Grade 220, free from cracks, impurities and any other casting defects and shall incorporate replaceable casing wear rings.

Tappings shall be available for priming, gland lubrication and drainage connections, with integral leakage troughs (splash guards) and air cocks shall be provided on pump casing to permit air release during priming.

Housing shall be able to withstand twice the closed valve pressure.

Pump shaft shall be of a diameter sufficient to prevent distortion from stresses imposed on it and shall be machined all over out of stainless steel to conforming to grade 431S29 of BS 970 and the areas in contact with water and also over the full length through the stuffing box protected with shaft sleeves keyed or properly locked onto the shaft, with fine ground finished surfaces for bearing seats. Shaft sleeves shall be properly secured onto the shaft through shrink fit or key.

Pump shaft shall be mounted on ball or roller bearings adequately sized, properly grease lubricated and suitable for 25,000 hrs. trouble free operation. Adequate floating allowance for possible expansion and misalignment shall be available for the shaft. Provision shall be made for external grease lubrication of the bearings.

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

Pump shaft shall be properly guarded at splash guard area with a window guard and with a properly designed easy detachable rigid coupling guard at coupling guard at coupling ends.

Impeller designed with optimized hydraulics, shall be open or semi-open type, cast out of



leaded Gun Metal LG2/LG4 conforming to BS 1400 and shall be statically and dynamically balanced up to 150% of the operating speed.

## **2.1.8 CALIBRATION OF INSTRUMENTS & METERS**

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

- i. Pressure shall be indicated in metric water meter.
- ii. Flow shall be indicated in cubic meters/hour or litres/second
- iii. Quantities shall be indicated in cubic meters
- iv. Time shall be indicated hours.
- v. Amperage shall be indicated in Amperes
- vi. Voltage shall be indicated in Volts.

## **2.2 ELECTRIC MOTORS AND LT EQUIPMENT**

### **2.2.1 MOTORS**

Specification for motors is given in Clause 2.2.1 in Part II of this specification.

### **2.2.2 INSULATION**

Motors Insulation class is given in Clause 2.3.2 in Part II of this specification

### **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 and pump shall be mounted on a common base plate designed to carry the motor weight and the pump weight plus all dynamic loads associated with the operating of the unit.

## **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 a semi flexible coupling.

## **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 the voltage and frequency specified in Clause 2.2.11 in Part II of this specification. 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 as specified in Clause 2.2.12 in Part II of this specification.

Enclosure shall be protected to IP 55.

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 WIRING 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 30 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 as specified in clause 2.2.18 in Part II in this specification. 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 method is given in Clause 2.2.18 (b) in Part II in this specification.
- c). One three phase adjustable thermal overload.
- d). Three ammeters to rated phase currents and ammeters shall be marked according to the phase designations.
- 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;

<b>Lamp Marking</b>	<b>Colour</b>
ON	Red
FAULT	Amber
OFF	Green
<b>Button Marking</b>	<b>Colour</b>
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 mm<sup>2</sup>.

## **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 : 2011.

### 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.	Casing wear rings	01 set
6.	Coupling bushes	01 set
7.	Gland	01 set
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 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 as 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.