

# **SUBMERSIBLE TURBINE WELL PUMP**

## **1.1 PART 1: GENERAL**

### **1.1.1 SCOPE OF WORK**

- A. This section covers the submersible turbine well pumping unit for Joyous Well Pump. The Contractor shall provide all pumping unit (pump, motor), labor, materials, equipment, and incidentals required to provide, test, warranty, supervise installation, training, and make ready for operation the submersible turbine well pumping unit and identified appurtenances as specified herein.
- B. All necessary and desirable equipment and auxiliaries whether specific all mentioned in this specification or not, shall be furnished as required for an installation incorporating the latest version standard for this type services. Also included shall be supervisory during installation and field testing of each unit and instructing the regular operating personnel in the proper care, operation and maintenance of the equipment.
- C. The Contractor shall submit in his bid all the necessary documents, certificate of origin of equipment, characteristic curves, and any other official papers deemed necessary to confirm that the pump, mechanical seal and the driving motor are new and they are complied with the tender's technical specifications.

### **1.1.2 MAIN WORK TASKS**

- A. Supply of submersible pump, and submersible electrical motor complete.
- B. Supply of pump power cable spliced to the motor leads.
- C. Supply of RTD cable spliced to the motor sensor motor leads, and connecting it with the Motor Control Centre (MCC).
- D. Supply of riser column pipe, 6" \* 260 meters including couplings at one end of each pipe as per the technical specifications.
- E. Supply of Suitable Motor Cooling Shroud.
- F. Supply of S.S Check Valve at the top of Submersible Pump with (25 bar.).
- G. Supply of two line access pipes of PVC 260 meter each line, total 520 meter.
- H. Supply of cable with electrode and specific dry relay for dry level protection installed at the discharge head.
- I. Supply of all other materials to complete the wiring and cable connection with need panel at the discharge well head.

### 1.1.3 **RELATED WORK**

- A. Concrete work and the installation of anchor bolts are included in Division 3.
- B. Field painting is included in related spec.
- C. Instrumentation is included in related spec.
- D. Valves, mechanical piping and appurtenances, except as hereinafter specified, are included in related spec.
- E. Electrical work, except as hereinafter specified, is included in related spec.

### 1.1.4 **SUBMITTALS**

#### **A. Pump Manufacturers Qualifications**

1. The pump unit shall be a submersible pump, protection seal and elect. Motor assembly designed for continuous submerged operation. The Contractor shall approve that the Sub. Electrical motor is used for distilled water filled application or as recommended. The pump, mechanical seal and motor as one unit shall be fabricated by one manufacturer. The manufacturer must be able to certify that similar units of the same model range have been in operation for at least fifteen years.
2. The manufacturer service representative shall maintain an adequate stock of spare parts to facilitate timely repairs in the event of equipment failure. The manufacturer shall provide 7 days/24 hour service and technical support for the product via worldwide network. A statement of response time and extent of experience of the local service organization shall be included with the submittals.

#### **B. Pump Information**

Prior to ordering the fabrication pumping equipment, submit six copies of the manufacturer's literature and Shop Drawings, which are to include all the following items, to the ENGINEER for approval.

Drawings & Data	Complete Assembly
	Materials List
	Foundation
	Installation
	Equipment
	Drawings

Submersible Pump	Name of the Manufacturer
	Type, Model, and Serial Number
	Selective materials
	Adjustable Clearance
	Design Rotative Speed
	Number of Stages
	Weight
	Complete Performance Curves
	operating range
	Regulation range speed at VFD
	NPSHR
	Installation procedure
	Column installation
	Shop Coatings

Submersible Electrical Motor	Name of Manufacturer
	Type and Model
	Type, Size, and Rating of Bearing & Lubrication
	Base motor type and strainer
	Rated Size of Motor in Hp.(KW)
	Temperature Rating
	Sensor temperature type
	Service Factor
	Full Load Relative Speed
	Weight
	Current at Full, $\frac{3}{4}$ , and $\frac{1}{2}$ Load
	Efficiency at Full, $\frac{3}{4}$ , and $\frac{1}{2}$ Load
	Power Factor at Full, $\frac{3}{4}$ m and $\frac{1}{2}$ Load
	Full Load Torque
	Operation and Maintenance Manuals with Connection Diagrams
	Velocity speed Cooling Water
	Speed Range Operation Curves
	Distilled water filling type
	Motor Capabilities Curve
	Starting Current Curve

Columns Pipe Rise, Check Valves, monitoring pipes, shroud	Manufacturer's Technical Data
	Performance Charts
	Catalogue Cuts
	Thread Pattern
	Wall thickness
	Joint Length data
	Installation Instructions
	Shroud Diameter
	Coating
	Weight
	List of Parts with Price and Source
	List of Supplies with Price and Source

Cable Power and RTD Cable	Manufacturer's Technical Data
	Performance Charts
	Insulation Wall thickness
	Catalogue Cuts
	Installation Instructions
	List of Parts with Price and Source
	List of Supplies with Price and Source

Instrumental and Level electrodes for sensing water level	Manufacturer's Technical Data
	Performance Charts
	catalogue Cuts
	Installation Instructions
	List of Parts with Price and Source
	List of Supplies with Price and Source

Product Data Section	Manufacturer's Technical Data
	Performance Charts and Curves
	Catalogue Cuts
	Installation Instructions
	List of Parts with Price and Source
	List of Supplies with Price and Source

Drawings Section	Complete list of Equipment and Materials
	Wiring and Schematic Diagrams
	System Layout
	Anchorage of Equipment and Appurtenances

Instruction Section	Operating Instructions.
	Maintenance Procedures.
	System Checking Methods.
	Staff Training.
Certification	Specify and Describe the Names and Qualifications of the Factory

	Trained Personnel.
Operation and Maintenance Manuals	Specify and Describe the Six Complete Sets of the Manufacturer's Instructions
	System Layout Showing Piping, Valves, and Control, Approved Wiring and Control Diagrams
	Control Sequence Describing Start-up, Operation, and Shutdown
	Operating and Maintenance Instructions

**C. The following shall be submitted in compliance with this Section:**

1. Complete catalogue information, descriptive literature, specifications, and identification of materials of construction. Complete and detailed assembly and installation instructions.
2. A Certificate of Unit Responsibility Assignment signed by officers of both the Contractor and the pump manufacturer corporations, to the assignment of responsibility in accordance with these Contract Documents. No other submittal material related to submersible pump will be reviewed until the certificate has been received and found to be in conformance with these requirements.
3. The manufacturer of the submersible pump shall have ISO 9001.
4. Any variation from this specifications shall be underlined is the submittal and the reason for the changes shall be explained in submittal.
5. The Contractor/ manufacturer shall indicate the operation range limits on the performance curves recommended for satisfactory operation without surge, cavitation's, heating, and overload, under/over flow or vibration. The operating range shall be with three working curves and as wide as possible based on actual hydraulic and mechanical tests.
6. Predicted pump performance curves for each condition point shown head, temperature, power, efficiency and NPSH required on the ordinate plotted against capacity on the abscissa. Pump inlet, bowel, column and discharge head losses for column pipe shall be shown as separate curves.
7. Control diagrams and process and instrumentation diagrams relating to the submitted equipment, show specific necessary for the equipment proposed in the submittal
8. Curves for variable speed pumps shall be provided at 15-20% of rpm intervals between the minimum and maximum speeds required to achieve the specified operating conditions. Manufacturer's recommended operating range for stable operation and prevention of surge, heating, overload, cavitation's and vibration.
9. Performance data curves showing head, capacity, horsepower demand, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity with a minimum of 9 points. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the guarantee point.

10. Under no circumstances shall the manufacturer's recommends operating range be less than that required to meet the pump operating conditions specified. **Proposed pump selections meeting this discharge head requirement by operating the equipment at less than full speed will be rejected.**
11. Motor submittal shall include certified calculations for motor rotor and frame reed frequencies.
12. Complete description and sketch of proposed test setup for factory test, at least 4 weeks in advance of the proposed test date. Submittal material shall include sample calculations and proposed test log format.
13. Drawings show general dimensions and confirming the size of pump, mechanical seal and motor drive, and specified appurtenances; piping connections; construction details of equipment; power and control wiring diagrams. Total weight of pumping unit as well as weight of individual components.
14. Drive unit support calculations and data with analysis should be done at the site during starting and testing the submersible pump.
15. The certified material shall include copies of test logs and resulting performance curves at least four weeks prior to shipping the unit from the factory. Manufacturer's reports on hydrostatic tests, including calibration test results on all instruments used to conduct the factory hydrostatic and performance tests.
16. All parts and material used submersible pump should be suitable for drinking potable water.
17. Finish Coating/Lining system.

#### **D. Quality Control Submittals:**

1. Factory Functional and Performance Test Reports and Log (five copies).
2. Manufacturer's Certification of Compliance that the factory finish system is identical to the requirements specified herein.
3. Special shipping, storage and protection, and handling instructions.
4. Manufacturer's printed installation instructions.
5. Manufacturer's Certificate of Proper Installation.
6. Suggested spare parts. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
7. List special tools, materials, and supplies furnished with equipment for use during installation, prior to and during start up, and for future maintenance.

#### **E. Instructions**

1. Instructions shall be concise, complete, and typewritten.
2. Control & wiring instructions with diagrams shall be comprehensive and include the layout of the entire pump system.
3. Operating instructions with diagrams shall cover preventative maintenance procedures, methods of checking the system for normal operation, and procedures for safely starting and stopping the system.
4. A pump system training course will be provided to the Client by factory trained and certified instructors.

## **F. Operation and Maintenance Manuals**

1. Six complete sets of manuals containing the manufacturer's operating and maintenance instructions shall be required for each piece of equipment.
2. One set is due at the time the test procedure is submitted. The remaining five sets are due prior to the installation completion.
3. The Operation and Maintenance manuals shall be permanently hardcover bound.
4. The operation and maintenance manuals should be approved and completed before 40 days of training.
5. The manuals shall be inscribed with the following information: "OPERATING AND MAINTENANCE INSTRUCTIONS", name and location of the facility, name of the Contractor/ manufacturer, and contract number.
6. Fly sheets shall be placed before instruction sections for each subject.
7. Instruction sheets shall be approximately 8 1/2 by 11 inches with large sheets of drawings folded in.
8. Instructions shall include the following items:
  - a. System layout diagram.
  - b. Wiring and control diagrams.
  - c. Control sequence describing start up, operation, and shutdown.
  - d. Maintenance and troubleshooting.

### **1.1.5 DELIVERY, STORAGE AND HANDLING**

- 1.1.5.1** All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the unit and equipment are ready for operation.
- 1.1.5.2** All equipment and parts must be properly protected against any damage during shipment. Store equipment in accordance with manufacturer's recommendations, and suitable for keeping access for predictive maintenance issues during storing if needed.
- 1.1.5.3** Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Client/Engineer.
- 1.1.5.4** The finished surfaces of all exposed flanges shall be protected by wooden or equivalent blank flanges, strongly built and securely bolted thereto.
- 1.1.5.5** Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.
- 1.1.5.6 No shipment shall be made until all required submittals and shipments have been approved by the Employer in writing.**

### **1.1.6 SUPPLEMENTS**

- A. Some specific requirements are attached to this section as supplements.



### 1.1.7 ACCESSORIES

- A. Equipment Identification Plate: 16-gauge stainless steel with 6 mm die-stamped equipment tag number securely mounted in a readily visible location on the surface plate with manufacturer name, mode number, serial number, m<sup>3</sup>/hr. at rated head in meters, rpm, and date of manufacturer.
- B. Lifting Lugs: Required for all equipment weighing over 50 kg.

### 1.1.8 FACTORY FINISHING

- A. The submersible Pump, shall be supplied with a Potable Water coating, according American Water Work (AWWA), NSF Drinking Water and Occupational Safety and health OSHA, Painting and Protective Coatings.
- B. The interior surfaces of the Bowels shall be painted with **PORCELAIN ENAMELLED** coating, according American Water Work (AWWA), NSF Drinking Water and Occupational Safety and health OSHA, Painting and Protective Coatings.
- C. All coating systems in contact with water shall be NSF approved for potable water contact.

### 1.1.9 SOURCE QUALITY CONTROL

- A. Pump, seal and motor will be factory tested in accordance with the American National Standard for Submersible Pump Tests Hydraulic Institute ANSI/HI 2.6-1994, American National Standard for Pumps – General Guidelines for Types, Definitions, Application, and Sound Measurement Hydraulic Institute ANSI/HI 9.1-9.5-1994, and Institute of Electrical and Electronics Engineers, Inc. Standard Test Procedures for Polyphase Induction Motors and Generators IEEE 112.
- B. Types of Tests:
  - 1. Performance test to demonstrate hydraulic and mechanical integrity.
  - 2. Performance test for mechanical and electrically integrity.
  - 3. Hydrostatic test of pressure-containing components.
  - 4. Vibration test.
  - 5. Motor test per IEEE 112.
- C. The motor manufacturer shall perform and submit the additional data for the following tests on each motor actually furnished, and the results shall be within the associated test requirement:

No-Load Current at rated Voltage ..... ±2% Balance between all Phases Oil Dielectric Resistance.....>14kv.

Winding Resistance to Ground.....>1,000 Meg. Ohms. Phase - to - Phase Ohms ..... Manufacturer's Standard

Motor Coast Time ..... Manufacturer's Standard String Test with Seal and Pump ..... FLA or less at Design Point

- D. Records of all tests performed by the manufacturer shall be made in accordance with the American National Standard for Submersible Pump Tests Hydraulic Institute ANSI/HI 2.6-1994, American National Standard, for Pumps – General Guidelines for Types, Definitions, Application, and Sound Measurement Hydraulic Institute ANSI/HI 9.1-

9.5-1994 and Institute for Polyphase Induction Motors Generators IEEE 112

- E. Factory Witness Test: A Witnessed factory test is required for the pumps. CLIENT may witness shop tests and Inspect and check the testing equipment used.
- F. The Pump shall have a continuously rising curve. Unless indicated otherwise, the required pump shaft horsepower at any point on the performance curve shall not exceed the rated horsepower of the motor or encroach on the service factor.
- G. All test records shall be bound permanently and provided in a report by the manufacturer. Five certified copies of the report shall be provided to the ENGINEER not less than 10 days prior to the shipment of the equipment from the factory.
- H. The required specific test points on each pump actually furnished are as follows:
  - 1. Head at the rated capacity.
  - 2. Two pump curve points at heads greater than the rated capacity.
  - 3. Two pump curve points at heads less than the rated capacity.
  - 4. Shut-off Head.
- I. The factory test data and test curve shall include Capacity in m<sup>3</sup>/hr., Head in meters, and Efficiency in percent, and Load in kW for each test point. The job pump, protection seal and motor shall be string tested together for the pumping unit. All test data and the test curves shall represent actual test data without correction back to a reference RPM.
- J. Pump Test Tolerances: As defined in the Hydraulic Institute Standards.

**1.1.10 EXTRA MATERIALS**

- A. Furnish one complete set of any special tools required to dismantle the submersible pumping unit.
- B. All the spare parts, extra materials and provisional material like the pumping unit shall be complete in every aspect, ready to attach to the column pipe and put into use.
- C. Supply 10 splice joints complete units submerge water type for the power cable.

**1.1.11 REFERENCE STANDARDS**

- A. American National Standard for Submersible Pumps for Nomenclature, Definitions, Application and Operation Hydraulic Institute ANSI/HI 2.1-2.5-1994 or latest standard
- B. For Sub. Pump Tests Hydraulic Institute ANSI/HI 2.6-1994 or latest standard
- C. For Pumps – General Guidelines for Types, Definitions, Application and Sound Measurement Hydraulic Institute ANSI/HI9.1-9.5-1994 or latest standard
- D. American Water Works Association Standard for Pumps- Submersible Types ANSI/AWWA E101-88 or latest standard
- E. American National Standards Institute (ANSI): C50.41, Polyphase Induction Motors for Power Generation Stations or latest standard

- F. Institute of Electrical and Electronics Engineers, Inc. Standard Test Procedures for Polyphase Induction Motors and Generators IEEE 112 or latest standard
- G. National Electrical Manufacturers Association (NEMA) NEMA MG 1 – Motors and Generators or latest standard
- H. American Society for Testing and Materials (ASTM):
  - 1. A48, Standard Specification for Grey Iron Castings.
  - 2. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
  - 3. A276, Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes.
  - 4. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
  - 5. B148, Standard Specification for Aluminium-Bronze Sand Castings.
  - 6. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.
- I. ANSI/HI 9.8 Pump Intake Design Standard
- J. American Gear Manufacturers Association (AGMA)
- K. American Welding Works (AWS)
- L. Anti-Friction Bearing Manufacturers Association (AFBMA)
- M. Occupational Safety and Health Administration (OSHA)
- N. Steel Structure Painting Council (SSPC)
- O. Underwriters Laboratories (UL)
- P. ISO 9001 Quality Systems
- Q. ISO 10816 Mechanical Vibration--Evaluation of Machine Vibration by Measurement on Non-rotating Parts--Part 1: General Guidelines, Annex B, Table B.1. Zone A, Class I, II or III, as applicable. For the purposes of this specification, Annex B of ISO 10816, Part 1 shall form a part of this specification and ISO 10816, Part 1.
- R. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

#### **1.1.12 WARRANTY**

The equipment shall be warranted for a period of 2 year from date of substantial completion to be free from defects in workmanship, design or material. If the equipment should fail during the warranty period due to a defective part(s), it shall be replaced and the unit(s) restored to service at no expense to the Employer. Substantial completion of the well pump incorporates testing and commissioning approved by the Engineer.

### **1.2 PART 2: PRODUCTS**

#### **1.2.1 GENERAL**

- A. The pumping unit shall be supplied by one manufacturer and shall be complete including pump, protection seal, motor, and appurtenances such as, but not limited to, couplings, guards and gauges.

- B. The pump, seal, elect. Motor and controls shall be designed and built for 24-hour continuous service at any and all points within the required range of operation, without overheating, without capitations, and without excessive vibration or strain. All parts shall be so designed and proportioned as to have liberal strength, stability and stiffness and to be especially constructed to meet the Specifications.
- C. The motor and protection seal should be carried the reverse speed at the reverse flow through the pump in case the check valve out of order.
- D. Pump support and surface discharge is to be as described herein.
- E. Each major piece of equipment shall be furnished with a stainless steel nameplate, with embossed data, securely mounted to the body of the equipment. As a minimum, the serial number, rated flow capacity, head, speed and all other pertinent data. As a minimum, nameplates for motors shall include the manufacturer's name and model number, serial number, horsepower, speed, input voltage, amps, number of cycles and power and service factors.
- F. Verification of Dimensions: The Contractor shall become familiar with all details of the work, verify all dimensions in the fields and shall advise the Employer of any discrepancy before performing the work.

### **1.2.2 CONDITIONS OF OPERATION**

- A. The pump shall be designed for the conditions of service described herein and shall operate within the system head curves as appended. The pump shall have a rising head system curve for stable pump operation from the minimum head operating point to the shut-off head.
- B. The specific conditions of service for pump as detailed in the Appendix of this Section.

### **1.2.3 PUMP CONSTRUCTION**

- A. Contractor to furnish of one complete submersible pumping unit, to be set in the deep well, suitable for potable water service. The water quality analysis of the well is presented in the Appendix.
- B. The pump shall be driven by a seal and submersible electric motor, distilled water filled application or as recommended connected to the pump.
- C. The pump, protection seal and the submersible electrical motor shall be constructed by one manufacturer to operate at 3,000 rpm (nominal) and meet the duty points and performance specified. The pump shall be designed to provide a long operating life with minimum required maintenance in the deep set conditions.
- D. The submersible electrical motor shall be heavy duty and should be carried the reverse speed at the reverse flow through the pump in case the check valve out of order.

- E. Pump shall be constructed in accordance with the American National Standard for Submersible Turbine Pumps for Nomenclature, Definitions, Application and Operation Hydraulic Institute ANSI/HI 2.1-2.5-1994.

#### 1.2.4 **COLUMN PIPE**

- A. Column Pipe shall be supplied by the Contractor.
- B. Each column pipe shall have installed at its end.
- C. Length of column pipes shall position the pump intakes 260 meters.( strainer).
- D. Individual Column lengths shall not exceed 6 meters.
- E. The discharge column pipe shall be a threaded and coupled steel pipe conforming to ASTM A120, ASTM A53 Grade B SCHEDULE 40 or equivalent API. Threads shall be of the buttress type. The column pipe shall be 150 mm internal diameter.
- F. Thread pattern: API 8-10 round long
- G. Couplings: to match column pipe threads, API 8-10 round long.
- H. Torque straps to be welded across the lower 50 meters of couplings shall be steel, 40 mm wide, 7 mm thick, and shall overlap to pipe to allow a 50 mm weld length on the column pipe. Two torque straps shall be welded across each coupling that is set in the lower 50 meters of the column pipe.

#### 1.2.5 **CHECK VALVES**

- A. The discharge column pipe shall be equipped with a column silent globe check valve located immediately above the bowl assembly. .
- B. The material of type check valve shall be **stainless steel 316**.

#### 1.2.6 **PUMP CHARACTERISTICS**

- A. The pump shall meet the operating conditions stated below.
- B. Guaranteed Performance for Deep Well
  - 1. Rated Pumping condition
    - a. Pumping Capacity, m<sup>3</sup>/h 120
    - b. Pump Total Head, Meter 290
    - c. Bowl Assembly Efficiency not less than %78
    - d. Shutoff head 380 Meter .

2.

- a. The Submersible Electrical Motor shall be heavy duty type, capable of working with variable frequency drive (VFD) to cover the operating conditions.
- b. Power of submersible Electrical Motor shall be capable of operating the pump at various operation conditions.
- c. The submersible pumping unit shall operate on multi-curve operating ranges through adjusting rotational speed (frequency).
- d. The operating range is defined as (+/- 15 -20 %) from the best efficiency point (BEP) on each curve.

- C. Best efficiency point of pump shall be at a capacity greater than the rated capacity
- D. Pump speed shall be 2960 rpm, nominal.
- E. NPSH required shall not exceed 5 meters at any flow rate or as recommended by manufacturer.
- F. Pump head capacity curve shall be continuously rising to shutoff.
- G. Pump horsepower characteristic shall be non-overloading and shall not exceed the motor rated horsepower at any point over the entire pump curve.
- H. The submersible pumping unit shall be suitable for continuous operation at any condition in the allowable operating range without excessive vibration or accelerated wear.
- I. As the diameter of the well casing is a 12 5/8" inch. Therefore, and depending on the other available information in this section and the other sections, the Contractor shall coordinate with the pump unit manufacturer to furnish the largest and the most appropriate diameter of the pump motor and shroud for this well
- J. The diameter of the pump at least 6" inches with suitable electrical submersible motor.

### 1.2.7 PUMP DESIGN AND CONSTRUCTION

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- A. The pump shall be constructed with enclosed impellers that are dynamically balanced at the full pump speed. Impellers shall be securely fastened to the shaft with taper collets, lock nuts, or keys and constructed such that the impellers do not float down during down thrust.
- B. The pump shaft and coupling strength shall be rated at a minimum of 1.5 times the maximum horsepower requirement of the pump bowl assembly, as well as being capable of transmitting the total torque and thrust of the pump bowl assembly in either direction of rotation.
- C. The impellers and bowls shall be constructed of cast Stainless steel and the interior surfaces of bowls and should be free from sand holes and other detrimental imperfections. All other pump components shall be of equivalent corrosion resistant materials. The pump assemblies shall be capable of withstanding a hydrostatic pressure equal to twice the pump head at rated capacity or 1.5 times the pump shut-off head, whichever is greater. Shafting shall be K-500 Monel or equivalent.
- D. The pump discharge threads shall match the column pipe as specified herein, or an adapter of adequate strength shall be provided.
- E. Contractor to perform all operational, performance, and acceptance testing for pump, motor, controls, instrumentation, and electrical at his expense.
- F. In addition to normal pumping requirements, the pump shall be design reversing from total head water at column pipe rise if the main check valve at the top of pumps not holding the column of water. The well head connections, joints, threaded column connections, piping; pump shall be suitable for sustained well recharge by reverse flow through the pump back at that dynamic total head.
- G. The complete pumping unit shall operate without overload on any component at any point along the pump entire full-speed operating curve. Pump required by virtue of the specified operating conditions to operate against a closed or throttled valve for any period of time exceeding five seconds.
- H. Pump Selection: Pump shall be selected to place all specified continuous duty operating conditions within the manufacturer's Allowable Operating Range as defined in ANSI/HI 9.6.3. And specified operation range in this document for well pump specifications with rated conditions and all other continuous duty full speed operating conditions specified for this pump.

The detailed pump specifications shall fall within the manufacturer's Preferred Operating Range as defined in ANSI/HI 9.6.3.

The variable speed operation to achieve this objective will not be considered.

Pump selection proposing maximum diameter impellers for the proposed pump model and casing size will not be accepted.

- I. The well pump should be suitable for operation at least fifteen years without pulling pump again.

#### **1.2.8 SEAL SECTIONS**

- A. The seal sections shall be designed to operate with the provided pump and submersible motor, to the performance specified for these components.
- B. The seal shall be designed to provide a reservoir for the electric motor and equalize the internal pressure of the motor with respect to the well annulus pressure. It shall be designed to have the required construction for expansion and contraction during normal thermal cycling of the unit.
- C. The seal housing shall be manufactured from a corrosion resistant material such as or equivalent to Chrome Molly steel (ASTM A369, A450) containing 9% chrome, 1% molybdenum or better.
- D. The thrust bearing in the seal section shall carry the up and down thrust created by the pump. The thrust bearing shall be rated to carry a load at least 2 times the generated pump thrust at any allowable operating condition or continuous operation at the pump shut-off head, whichever is higher. The thrust bearing must be capable of operating in reverse rotation and under conditions of several pumping unit starts and stops per day.
- E. The seal section design shall include as a minimum three mechanical face seals to prevent water intrusion into the motor. It shall be capable of transmitting the entire motor torque at the service factor and shall contain a heat exchanger section to circulate the motor fluid in the thrust bearing area. Design shall incorporate an elastomeric barrier to isolate well fluids from the motor fluid. A high capacity labyrinth chamber may be substituted for the elastomeric barrier at the manufacturer's discretion.

#### **1.2.9 ELECTRICAL SUBMERSIBLE MOTOR**

- A. Motor kW delivered and as stated on the stamped nameplate shall be equal to or greater than the maximum pumping load. And the motor should be one unit. Proposed series motors connection to meeting the full load and voltage by operating the equipment will be rejected.
- B. Motor place of manufacturer and place of assembly data shall be provided.
- C. The motor shall have a standard nameplate with operating data, and bearing and lubrication data.
- D. The motor shall have motor winding temperature detectors (RTD's) or other approved means to monitor motor temperature. Cable for the RTD's shall be provided suitable for the installation in continuous lengths adequate for the maximum setting depth listed plus 30 meters.



- E. The minimum class temperature of the motor should not less 150°C. The estimated thermal life of an insulation system at rated temperature equals 15 years.
- F. Motor shall be rated for the specified reduced voltage starting application

**G. Submersible Elect. Motor Performance Specifications:**

- 1. Min. Motor Full Load hp, rated at 45°C at the rated design flow of the pump 120 m<sup>3</sup>/h with capability to increase discharge of 20% by using VFD. (Heavy duty).**
2. Motor Service Factor Required 1.15
3. Motor Voltage 400
4. Motor Frequency 50 Hz/60Hz
5. Phase 3
6. Nominal RPM 2960
7. Minimum Motor Efficiency Required full load 88%

**1.2.10 SUBMERSIBLE MOTOR DESIGN AND CONSTRUCTION**

- A. The submersible motor shall be designed to operate with the provided pump, to the performance specified for these components. The motor shall be constructed using copper winding wire coated with a high dielectric insulation.
- B. The motor windings shall be totally encapsulated in a thermo set epoxy that fills the winding slots and covers the winding end coils in order to prevent winding wire movement due to normal motor vibration. The motor shall be filled with distilled water or as recommended, selected by the manufacturer to provide the lubrication necessary for several starts and stops per day. The motor housing shall be manufactured from a corrosion resistant material such as or equivalent to Chrome Molly steel (ASTM A369, A450) containing 9% chrome, 1% molybdenum.
- C. The motor thrust bearing shall be designed and built to support the weight of the rotor stack , and the dynamic head generated by the pump while operating continuously at the motor rated speed and full load.
- D. The motor lead connector shall be either the potted, plug-in style, or tape-in style, connecting to the motor with a bolted connector, and of sufficient length to allow the splice to the drop cable above the pump. The motor lead shall be encased in stainless steel cable guards starting from the plug and extending up to the splice with the drop cable and strapped to the motor, pump end, and drop pipe with 20 mm wide stainless steel bands spaced a maximum of 1.5 meters apart.

**1.2.11 MOTOR COOLING SHROUD**

- A. A motor cooling or flow inducer shroud shall be supplied for the motor as part of the well pump installation. The motor shroud shall be designed and utilize pipe material whose outside diameter will fit inside the well casing (12" inch,) without binding and the shroud inside diameter shall provide for a motor cooling velocity to keep the motor temperature at 45°C. The shroud shall be of length to extend at least half meter down the length of the motor.

- B. The shroud shall be fabricated out of stainless steel material such as or equivalent to Chrome Molly steel (ASTM A369, A450) containing 9% chrome, 1% molybdenum or better . It shall be furnished with a bolted adapter that will allow its removal from the pump and motor without welding or cutting. This adapter shall be furnished with the strength required to support the entire string weight of drop pipe, water, check valves, and cable. Fasteners shall be 316 Stainless steel.
- C. The motor cable shall be protected with a rubber seal at the penetration where it passes through the shroud adapter plate at the top of the pump. Submittal drawings shall show sizes and materials for this assembly.

#### **1.2.12 SUBMERSIBLE CABLE**

##### **A. Materials**

- 1. Size, as recommended by the motor manufacturer
- 2. Insulation Rating: 5,000 Volts
- 3. Number of Conductors: 3
- 4. Ground: One
- 5. Conductor Material: Copper
- 6. Stranding Class B
- 7. Fillers non hydroscopic material
- 8. Conductor Insulation: Polypropylene
- 9. Cable Configuration: Flat
- 10. Jacket: Nit rile Rubber with overall  
armoured stainless steel
- 11. Temperature Rating: 200°C wet
- 12. Tested ICEA S61-402, IEEE 1019

- B. The pump cable shall be furnished and supplied in one continuous length from the motor leads to the well head with one splice only allowed at the motor leads. Any cable fillers shall be non-hydroscopic, paper or jute fillers are not allowed. Length of cable shall be adequate for the maximum setting depth listed plus 30 meters.
- C. The down whole cable shall be high-potential tested at the factory, and the applied test voltage shall exceed the nameplate voltage rating of the cable to conform to the applicable IEEE and ICEA cable manufacturing standards.

#### **1.2.13 LEVEL ELECTRODES**

- A. The sensing electrodes type of level control supply for used on well water level that have sufficient conductivity to operate one of the controls relays to protect pump from draw down level, the Contractor/ manufacturer should provide wire level, relays and sensors to protect the pump at drain level. The setting sensor level 280 – 320 meter from the discharge head level of the well.
- B. The Contractor should supply deep well level probe one switch. The cable supported strain relief connection PVC shield – stainless, the probe have capacity to take the load from the weight of total drop down length of the probe.

#### **1.2.14 MONITORING PIPES**

- A. Furnish two PVC pipes of 40 mm diameter and 5 mm wall thickness water level monitoring access pipes. The monitor pipe shall Schedule 80 PVC plastic pipe as listed in ASTM D1785 "Standard Specifications for Poly Vinyl Chloride (PVC) Plastic Pipe, Schedules 80, and 3 ml/each, and shall be mechanically joined by square form flush joint threads (2 threads per inch) conforming to ASTM F480, or equal.
  - 1. Each pipe shall have extended into the well to a required depth and be continuous to fitted with slotted PVC pipe to coverage of the total remaining depth of the well to the uppermost bowel of the pump installed in the well.
  - 2. The down end of pipes should have plug and support.

#### **1.2.15 EQUIPMENT APPURTENANCES**

- A. Pumping equipment shall be provided with all necessary equipment appurtenances to make the pumping unit functional.
  - 1. Bolts and nuts shall conform to the requirements of ASTM A307.
  - 2. Threads shall be clean-cut and shall conform to ASME B1.1.
  - 3. Galvanized bolts, nuts, and washers shall be zinc coated after being threaded by the hot-dip process conforming to ASTM A123 as appropriate.
  - 4. Stainless steel bolts, nuts, and washers shall be Type 316.
  - 5. Unspecified bolts, nuts, washers shall be zinc coated after being threaded by the hot-dip process conforming to ASTM A123 as appropriate.

#### **1.2.16 PUMP HEAD ASSEMBLY**

- A. Pump head assembly shall consist of the pump base plate and the discharge head. Head assemblies shall be of low, rigid construction arranged for bolting to concrete foundations and shall be provided with at least two eyebolts, cast lugs or other means of securing slings to facilitate setting and lifting. Pump discharge head and base plate shall be capable of withstanding all end and side thrusts imposed by the pump during operation and have adequate strength to resist vibration at any operating speed.
- B. Pump Base plate: Pump head base plate shall be cast-iron or steel and shall serve as a soleplate for mounting the discharge head assembly.

#### **1.2.17 CONTROL EQUIPMENT**

- A. Automatically controlled pumps shall have three-position MANUAL-OFF-AUTOMATIC selector switch in cover. Additional controls or protective devices shall be as indicated in the division of boosting pump station. A pump low-water cut off shall be installed in the well on the suction pipe and shall shut the pump off when the water level in the well reaches the low level after giving an audible alarm. Pump shall operate via pressure level transducer located in the balancing tank. This transducer is connected to the PLC unit in the main control panel of the pumping station. A high pressure transducer is installed on the main pump discharge to cut off the pump in case of high pressure when the above level controller failure or in case of any emergency (closing the valves of tank inflow while the pump is operating). More over the pump is equipped with dry flow sensor to shut down the pump in case of dry flow condition.

### **1.2.18 SHOP TESTS**

- A. The Engineer shall have the right to inspect any equipment to be furnished under this Section prior to their shipment from place of manufacture.
- B. Each pump shall be factory tested with a Standard Performance Test as described in Hydraulic Institute Standards, for submersible turbine pumps and all test data submitted for approval by the Engineer prior to shipment. Certified copies of the calculated pump performance curves shall be submitted including anticipated head, capacity, efficiency, and total brake horsepower. NPSH and required submergence. Such testing shall be performed in a manner that will insure that each assembled pump and motor shall be tested at the specified design operating conditions to make certain that the unit conforms to the specified requirements. Certified copies of test results shall be submitted to the Engineer for approval.
- C. Each motor shall be factory tested and copies of test results shall be submitted to the Engineer for approval.

## **1.3 PART 3: EXECUTION**

### **1.3.1 PREPARATION**

- A. Coordinate with other trades, equipment and systems to the fullest extent possible.
- B. Take all necessary measurements in the field to determine the exact dimensions for all work and the required sizes of all equipment under this Contract. All pertinent data and dimensions shall be verified.

### **1.3.2 INSTALLATION**

- A. Provide onsite services during installation of the pumping unit. These services shall be provided by a qualified representative of the Manufacturer. The services are expected to include a minimum of 15 days of onsite inspection and training. It is the intent that the training specified for the PWA (WBWD) be done during the actual installation and operation of the pumping unit.
- B. The manufacturer's representative shall be onsite during the complete installation and start-up of the pumping unit. The manufacturer's representative shall inventory and inspect the equipment, provide training and instruction to the PWA during installation and operation of the pumping unit, and certify and provide a certificate that the assembly, setup, and installation meet the manufacturer's recommended installation requirements.
- C. Installation of the pumping unit shall be in accordance with American National Standard for Submersible Pumps for Nomenclature, Definitions, Application, and Operation Hydraulic Institute ANSI/HI 2.1-2.5-1994 and manufacturer's printed instructions.

D. During installation of the pumping unit, obtain, record, and submit to the ENGINEER measurements of; line-to-line ohms all phases, line-to-ground Meg ohms, all phases, every 30 meters of setting depth, beginning with the pumping unit hanging above the well.

E. Field Acceptance Tests

1. After the installation is completed start-up will occur. The Contractor will be given a period of time in which to make adjustments to the pump equipment under the supervision of the pump manufacturer's technical representative.
2. Once the adjustments are made the pumps will be operated for 7 calendar days of 23 hours per day minimum with a minimum of one start and stop per day to verify successful performance and substantial completion – after which the warranty period of the equipment will commence.
3. Initial testing of equipment shall be included in the Contractor's price. The Contractor is responsible for unsatisfactory performance of the equipment and subsequent tests.
4. After the 7 calendar day period the tests will be accepted if successful performance of Field Testing is demonstrated as indicated

### **1.3.3 COMMISSIONING AND TESTING**

A. The pumping unit shall be field tested during the 7 day acceptance period to demonstrate:

- 1.Satisfactory operation without excessive noise and vibration at any operating head, including shutoff.
- 2.Indicated head, flow, and efficiency at the design point and at least two points above and below the design point to satisfactorily demonstrate the range of pump performance.
- 3.No undue attention is required for operation.

B. The following field testing shall be conducted:

- 1.Prior to running the pump and motor obtain no load volts, all phases, and static water level.
- 2.Start up, check, and operate the pumping system.
- 3.Obtain concurrent readings of motor voltage all phases, amperage all phases, well water level, water temperature, pumping rate in m3/hr, and pump discharge head in meters for at least 5 pumping conditions. Check each power lead to the motor for proper current balance.
- 4.Electrical and instrumentation tests shall conform to the requirements of the sections under which that equipment is specified.

C. In the event any pumping unit fails to meet the specified requirements, the pumping unit shall be modified or replaced **and re-tested as above until it satisfies the requirements.**

D. **After each pumping system has satisfied the requirements, the Contractor and Manufacturer's Representative shall certify in writing that it has been satisfactorily tested and that all final adjustments have been made.** Certification

shall include the date of the field tests, a listing of all persons present during these tests, and the test data.

#### **1.3.4 FIELD PAINTING**

A. Factory painted items requiring touch up work shall be cleaned completely, and shall be primed and top coated as specified.

#### **1.3.5 WELL CHLORINATION**

A. Upon completion of the work, the well shall be chlorinated with a solution of chlorine which when mixed with water equal in volume to that contained within the well will result in 100 mg/L concentration. The solution shall be left undisturbed for at least 12 hours and then pumped to waste. The strength of the solution and manner of introduction shall be further discussed with the Engineer and his approval obtained prior to performance to insure compliance with any health requirements. Chlorination of the well, site piping, and the water tank at the site shall be performed simultaneously. Because of this, the chlorination shall be scheduled so that the Engineer may be present during the introduction of the chlorine into the facilities at the site and before the chlorine solution is introduced into the well. The Contractor shall be responsible for sampling and additional disinfecting should sample analysis show the presence of coliform bacteria.

#### **1.3.6 MANUFACTURER'S SERVICES**

- A. A Manufacturer's qualified representative ( Acceptable to the Employer by submitting CV to Employer) with experience in the installation, adjustment, and operation of the specified equipment shall supervise the installation, adjustment, and testing of the equipment
- B. Ten (10) working days of supervisory service shall be provided by the Contractor at no expense to the Employer.

#### **Pump Data**

- Pump rated flow: 120 m<sup>3</sup>/hr.
- Proposed diameter of pump as manufactured.
- Total delivery head (TDH): 290m.
- Best efficiency: not less than 78%.
- Shut of head: 380 m
- Speed 2960rpm.
- Electrical Motor: capable of driving the pump with allowance of increasing the discharge of 20% using the VFD, 3ph, 400v, 2960rpm
- Column rising pipes: Dia. 6" \* 260m (sch-40) API 8.
- Shroud for Pump: as manufacturer recommendations.

- Power flat cable: as manufacturer recommendations.
- RTD Cable: as manufacturer recommendations.
- Check valve: 316 SS and as manufacturer recommendations.
- Access PVC pipe line: 260m of 40mm diameter (Sch-80), threaded with coupling.

**Note: 90 meters of PVC pipes must be perforated.**

Approved manufacturers: Peerless, ITT-Gould's, EMS, National, and Flowserve or equally approved and should have a local agent/distributor in Palestine or Israel

### **General Control Scheme and Operation of the Submersible Pump and the MCC**

1. The submersible pump shall operate on both automatic and manual modes.
2. The control scheme shall utilize high pressure setting and relief valve according to operation of pump
3. The pump shall stop working in a time delay from 1-60 sec when the flow transmitter indicates that there is a drop flow at setting range.
4. The Pump shall stop / start automatically in time delay (1 hour) and according to the level water at balancing tank.
5. The Pump should not be permitted to operate again without manual **RESET** in the following cases:
  - a. The Water Level Sensor in the well indicates that the dynamic water level is below the critical limit.
  - b. In the case of motor overheating from RTD.
  - c. In case of current overload.
  - d. In case of current low load.
  - e. In case of over voltage, drop voltage and unbalance voltage.
  - f. In case over frequency.
  - g. In case sense ground current.
  - h. over / drop flow pumping In case flow.
  - i. The control scheme shall utilize an alarm at annunciation at the Operating Room





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