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VERTICAL TURBINE LINESHAFT WELL PUMP & MOTOR
(OIL LUBRICATED)

1202.0100 GENERAL

1202.0101 Description of Work. The work under this section shall consist of furnishing all labor, materials, equipment, and appurtenances required for the installation and testing of vertical turbine well pump and motor, in accordance with the details shown on the plans, special specifications, and the requirements of these specifications. The vertical turbine well pump and motor includes pump bowl assembly, suction pipe with intake screen, column pipe assembly, inner column assembly, pump discharge head, lineshaft lubrication system, vertical hollow shaft electric motor, and all associated components.

It is the intent of these Specification to obtain a high efficiency, durable, vertical turbine well pump and motor of heavy duty construction for continuous service or for intermittent service, whichever imposes the most severe conditions on the pump. Pumps that have mechanical defects or do not meet the range or head-capacity characteristics, horsepower, efficiency requirements will be rejected after testing and shall be replaced without additional cost to the Owner for furnishing, removal, reinstallation, and retesting. Mechanical defects shall include the following:

- Excessive vibration
- Improper balancing of any rotating parts
- Improper tolerances
- Binding
- Excessive bearing heating
- Defective materials, including materials that do not conform to the specifications
- Improper fitting of parts
- Any other defect which will in time damage the pump or unreasonably impair the efficiency of the pump

1202.0102 Related Specifications.

Section 0106 – Control of Material of the standard contract conditions.

1202.0103 Submittals. Five sets of shop drawings and literature shall be submitted for each vertical turbine well pump and motor. All submittals and copies thereof shall be clean, legible prints that are easily reproduced and shall reference the project name and plan number. Shop drawings and literature together with an assembly drawing showing the entire pump and motor assemblies shall include detailed specifications and drawings indicating:

(A) Pump

- Pump curves and literature (See list below)
- Manufacturer
- Model and number of stages
- Design full-load speed
- Nominal size
- Design speed
- Size and type of suction intake screen
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- Component materials
- Coating types and manufacturers
- Unit weights of components
- Any other noteworthy design features

The pump performance curve and literature, for the specific impeller diameter and number of stages, for the entire operating range of the pump including shut-off head, shall include:
  a) A head-capacity curve with design point indicated
  b) A horsepower requirement curve
  c) An efficiency curve
  d) A thrust factor (K) curve
  e) A NPSHR curve
  f) Standard lateral
  g) Pump shaft diameter
  h) Impeller type and diameter
  i) Dimensioned assembly drawing detailing the entire vertical turbine well pump, including column pipe, inner column assembly and discharge head
  j) Calculations indicating net lineshaft stretch
  k) Calculations indicating expected “wire to water” efficiency

See sample pump curve at end of section for proper plotting of data and information required. Failure to comply with these requirements will result in rejection of the submittal.

(B) Motor
- Manufacturer
- Model
- Horsepower
- Thrust bearing rating
- Dimensioned assembly drawing
- Certified performance data as follows:

The motor shall have short commercial tests performed which include: no load current, locked rotor current, winding resistance, high potential, and vibration and bearing inspection. Certified copies of test reports on the short commercial test performed on a compatible motor shall be submitted for review as part of the shop drawing submittal. Certified performance data, in the form of a computer analysis, or a complete initial test on a motor comparable to the one being provided, shall be submitted for review as part of the shop drawing submittals. The complete initial test data for a comparable motor shall include, but not be limited to: full load heat rise, percent slip, breakdown torque, and locked rotor torque, efficiency, and power factor at full, 3/4 and 1/2 load.

1202.0104 Delivery, Storage, and Handling. Vertical turbine well pump and motor components shall be delivered to the site, stored and handled in accordance with the manufacturer's instructions, except as may be modified by the plans, special specifications, or as directed by the Engineer. The equipment shall be packaged, shipped, and handled in such a manner that no damage will result to any component. The vertical turbine pump bowl assembly shall be assembled and shipped as a single unit. A 22" to 24" long column pipe nipple shall be installed in the pump discharge case to prevent any damage or strain to the pump shaft. Precaution shall be exercised in handling so as to avoid imposing strain on any part of the pump and bowl assembly.
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**1202.0200 PRODUCTS**

Vertical turbine well pumps and the materials used in their manufacture shall comply with the most recent revision of the following standards:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Standard Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical Turbine Pumps - Line Shaft and Submersible Types</td>
<td>ANSI/AWWA E101</td>
</tr>
<tr>
<td>Discharge Head</td>
<td>Cast Iron ASTM A 48 Class 30 or Fabricated Steel ASTM A 53 Grade B</td>
</tr>
<tr>
<td>Suction and Discharge Cases *</td>
<td>Cast Iron ASTM A48 Class 30</td>
</tr>
<tr>
<td>Bowls</td>
<td>Cast Iron ASTM A48 Class 30</td>
</tr>
<tr>
<td>Impellers</td>
<td>Bronze ASTM B584-836</td>
</tr>
<tr>
<td>Pump Shaft</td>
<td>ASTM A-582 Grade 416 Stainless Steel PSQ</td>
</tr>
<tr>
<td>Discharge Case Bearing</td>
<td>ASTM B-584-836 or ASTM B-505-932</td>
</tr>
<tr>
<td>Suction Case Bearing</td>
<td></td>
</tr>
<tr>
<td>Intermediate Bowl Bearing(s)</td>
<td>ASTM B-584-836 or ASTM B-505-932 and/or fluted neoprene*</td>
</tr>
<tr>
<td>Bowl Assembly Bolts, Studs, Nuts</td>
<td>ANSI 300 Series SS</td>
</tr>
<tr>
<td>Column Pipe</td>
<td>ASTM steel A53</td>
</tr>
<tr>
<td></td>
<td>Grade A Schedule 40</td>
</tr>
<tr>
<td>Oil Tube</td>
<td>ASTM steel A53</td>
</tr>
<tr>
<td></td>
<td>Grade A Schedule 80</td>
</tr>
<tr>
<td>Lineshaft</td>
<td>ASTM A-108 Grade 1045 PSQ Carbon Steel</td>
</tr>
<tr>
<td>Lineshaft Bearing</td>
<td>ASTM A145 Bronze</td>
</tr>
<tr>
<td>Lineshaft Coupling</td>
<td>ASTM steel A-108 Grade 1018</td>
</tr>
</tbody>
</table>

* If fluted neoprene intermediate bowl bearings are provided, every fourth bearing shall be bronze, or, each intermediate bowl bearing shall be ½ bronze and ½ neoprene.

**NOTE:** All vertical turbine well pump components shall conform to the latest revision of National Sanitation Foundation (NFS) Standard 61 in force for the State of Arizona.

**1202.0201 Pump Bowls Construction, Materials, and Design**

**(A) Pump Design.** The vertical turbine well pump shall be a vertical single or multi-stage unit, as required, with enclosed impellers. The vertical turbine well pump shall be furnished as a complete, ready-to-install unit by a single supplier.
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Vertical turbine well pumps shall be capable of operating at 150% of design head or shutoff head, whichever is less, for not less than two minutes without excessive vibration, binding, rubbing of rotating parts, or damage to the pump.

The pump shall be designed and constructed so that the lateral impeller adjustment shall exceed the calculated net lineshaft stretch by 0.125" minimum for the specified installation conditions.

The pump curve for the vertical turbine pump shall be as steep as practicable within the constraints of this section, and shall exhibit a continuously rising characteristic to shutoff head, with no points of zero slope or slope reversal. The bowls efficiency shall be as specified by the Special Specifications.

(B) Pump Construction. The vertical turbine well pump shall be constructed for operation with an enclosed line shaft. The lineshaft tubing adapter shall be provided with deflector seals about the shaft to prevent the entry of water into the oil tube. The pump shall be constructed with a 10" tube adapter stickup and a 20" pump shaft stickup. The tube adapter and pump shaft shall be machined to either Johnston new style or Peerless standard dimensions and threading.

Pump bowls shall be precision close grained cast iron and free of blow holes, sand holes and other defects, and shall be accurately machined and fitted. Bowls shall be coated internally with vitrified porcelain enamel or fusion bonded epoxy. Exterior coating shall be in compliance with AWWA Standard D102, for two-component catalyzed epoxy paint.

The suction case shall have anti-vortex vanes to suppress vortex formation. The bottom bearing housing in the suction case shall be cast as an integral part of the suction case. The bottom bearing shall be a long bearing filled with nonsoluble grease or lubricant that will not break down or dissolve. The housing shall be equipped with a cap or plug to prevent the escape of grease or lubricant. An opening large enough to enable easy removal of the suction case bearing is desirable.

The impellers shall be of the enclosed type and shall be accurately machined to fit the matching faces of the bowls. The impellers shall be balanced both statically and dynamically and shall have non-overloading characteristics. The castings shall be accurately machined with vanes carefully finished to ensure smooth passageways. Impellers shall be free of any casting imperfections. Each impeller shall be fixed to the pump shaft with a tapered carbon steel lock collet.

(C) Suction Pipe and Strainer. The pump shall be installed with a 10' long suction pipe of the same size as the pump column, threaded 8TPI RH tapered. The lower end of the suction pipe shall be fitted with a galvanized cone type strainer having a total open area at least three times the cross-sectional area of the suction pipe.

1202.0202 Column Pipe Assembly

(A) Column Pipe. The column pipe size shall be such that the friction loss shall be less than 5 feet of head per 100' of column at design operation. The column pipe shall be furnished in interchangeable sections of a nominal length of 10 feet with a maximum deviation of 0.25 inches, except the top section shall not exceed 5 feet in length. Designs and weights of column pipe and
couplings shall conform to the provisions of AWWA Standard E101-88 Table 3. The column pipe shall be connected with 8 TPI RH straight-threaded sleeve couplings. The ends of each section of the column pipe shall be faced parallel and machined with straight threads to permit ends to butt in the couplings.

(B) Innercolumn Assembly. All innercolumn (oil tube, lineshaft, couplings and bearings) shall be machined to either Johnston new style type or Peerless type dimensions and threading. Innercolumn assembly shall be shipped assembled in 10' nominal lengths.

The oil tube shall be of sufficient diameter to provide adequate lubrication under any operating conditions. Both ends of each oil tube length shall be bored, faced, and threaded inside to accommodate butt connection by the line shaft bearings, which also act as oil tube couplings. Each oil tube length shall be interchangeable and shall be 60" in length with a maximum deviation of 0.125", except the top length, which shall be sized appropriately for the length of the column pipe assembly.

The line shaft shall be of ample size to operate without distortion or vibration, and shall meet the torque requirements and all other requirements of AWWA E101-88 Table 5 and Section A5.5. Line shaft sections shall be uniformly 10’ in length and interchangeable.

Line shaft couplings shall be threaded from solid bar stock and provided with a relief hole. Couplings supplied shall provide a safety factor of 1½ times that of the line shaft.

Enclosing tube stabilizers or spiders of steel-reinforced rubber or neoprene shall be installed to center and stabilize the oil tube within the pump column. The bottom stabilizer shall be installed within 20' of the top of the pump bowl assembly. The top stabilizer shall be installed within 20' of the discharge. Intermediate stabilizers shall be installed so that no more than 30' shall separate any two stabilizers.

(C) Tension Tube, Top Shaft, and Adjusting Nut. The top length of oil tube or the tension tube shall be designed for application of proper tension to the oil tube. Only tension tubes with externally threaded tops are acceptable. A lineshaft coupling shall be provided above the stuffing box, within the discharge head, for easy removal of the motor shaft. Tubing tension nuts and packing assemblies shall be of Johnston, Peerless or a similar type. The motor shaft shall be of such length and top threading and keyway length to provide easy adjustment through the entire impeller adjustment range. Adjustment threading shall be 10 TPI. Adjusting nuts shall be large bronze hex nuts and shall be drilled and tapped for lock screws on three alternate sides. Pumps with shafts exceeding 1-11/16" in diameter or exceeding 500' of column length shall have a sandwich type thrust bearing installed between the drive block and the adjusting nut for ease of adjustment.

1202.0203 Pump Discharge Head And Lubrication System. The discharge head shall be designed for above ground discharge with sufficient strength and rigidity to support the motor mounted on it and carry the weight of the attached column and bowl assemblies. If fabricated steel, a radius or three-piece mitered type elbow shall be used for smooth transition. The discharge flange shall be faced and drilled to match 150 pound ANSI connections. Minimum weights of discharge head assemblies shall be: 6" - 290 lb.; 8" - 390 lb.; 10" - 590 lb.; 12" - 690 lb. The discharge head shall have lugs for hoisting. The top of the discharge head shall have a NEMA flange registered fit for direct mounting the drive motor/right angle gear drive, without use of adapters.
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The discharge size shall be the same size as the column pipe. The discharge design shall have ample room to permit the shaft to be coupled above the packing box and enough open area to allow easy working access to the shaft, packing, and oil line connection. Tubing tension and packing assemblies shall be of Johnston or Peerless style. The discharge shall have a 3/4" tapped and plugged side drain opening for drainage and cleaning as necessary, and a 1" tapped and plugged bottom hole for well casing sounding access or for installation of a sounding tube as specified.

A solenoid activated lineshaft lubricator with manually adjustable sight drip feed and a five quart reservoir shall be provided. The reservoir shall be securely mounted to the discharge so that the bottom of the reservoir is no lower than the top of the discharge head. The copper lubrication tubing shall curve smoothly downward from the reservoir to the lineshaft lubrication inlet with no kinks, dips, or sharp bends.

1202.0204 Motor. The motor shall be a vertical hollow shaft squirrel cage premium efficiency motor or a motor as otherwise indicated in the special specifications. The motor shall comply with NEMA MG-1 standards and shall be NEMA WP-1. The motor shall operate below motor nameplate full load amps for all three phases, over the entire range of the pump curve. The motor shall comply with various other requirements specified in the special specifications. The following motor information shall be stamped on a permanently affixed, engraved stainless steel motor nameplate:

Horsepower
Full load RPM
Voltage
Number of phases
Frequency
Service Factor
Design class
Motor insulation class
Ambient temperature rating
NEMA nominal efficiency
Motor power factor
Motor duty cycle
Frame size
Type
Full Load Current
Temperature rise class

The motor conduit box shall be provided with a grounding terminal. The conduit box shall be sized to handle required conduit and wire.

The motor windings shall be copper with not less than 98% conductivity.

The motor shall be capable of continuous operation at full load and at a voltage 10% above or below the rated voltage provided that the sum of voltage and the frequency variation does not exceed 10% with the frequency variation not exceeding 5%.

Motor bearings to be lubricated with grease shall be equipped with grease nipples and grease relief plugs. The thrust bearing(s) shall be oil-lubricated with accessible drain and fill plugs on the oil
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reservoir. The oil level on the reservoir shall be indicated by a sight gauge. The thrust bearing(s) shall have ample capacity to carry 125 percent of down-thrust at pump design performance. The bearing(s) shall have a life rating of at least 50,000 hours at the operating down-thrust presented by the pump assembly at design performance.

The motor shall be supplied with non-reverse ratchet, ball bearing type. The ratchet can be quickly fitted at any time or removed for servicing without disturbing the coupling or pump setting.

1202.0300 EXECUTION

1202.0301 Installation. The vertical turbine lineshaft well pump and motor shall be installed and adjusted as specified and in accordance with the manufacturer's recommendations. Installation of connecting piping shall not impose any strain on the pump.

Prior to installation, the contractor shall furnish five sets of installation and lubrication instructions for the vertical turbine pump. The instructions shall include detailed information regarding adjustment as well as recommendations for the proper type of lubricant.

1202.0302 Testing. The pump and driver, unless otherwise noted, shall be field tested for compliance with the head-capacity and horsepower requirements specified. The contractor shall furnish all manpower, facilities, power, and equipment required for conducting all tests. Field tests and manufacturers' tests will be conducted in accordance with the latest requirements of the Hydraulic Institute Standards.

The pump shall be field tested for vibration and alignment before the pump test. Testing shall be as specified by the special specifications. Field tests shall be conducted using the fluid that the pump was specified for.

Vibration shall be tested with a Starret vibrometer or a vibrometer acceptable to the Engineer. The vibration limits of the pumping unit shall be as described in the Hydraulic Institute Standards. It shall be the responsibility of the pump manufacturer to dynamically balance the pump and motor to reinforce, stiffen, or support the pump casing, frame, pedestal, or shafting in order to provide vibration levels within the limits described therein.

Each pump shall be operated by the contractor for as long as required to insure proper installation and operation. Following the operation by the contractor, the Agency will operate the pumps to determine if the pump satisfies all of the performance requirements. The contractor shall be responsible for making all adjustments required for proper operation.

The contractor shall provide the service of a fully qualified, factory-trained service representative of the pump manufacturer who shall inspect the installation, initial start up, and testing of the pump, and make adjustments as may be necessary for proper operation. The contractor shall make all provisions for the services of the manufacturer's representative for such periods of time as may be necessary to place the unit in satisfactory operating condition.

1202.0304 Pumping Plant Design Performance. The specified design performance of the well pump shall be measured at the pump discharge, so Contractor shall include all column and discharge losses
in his calculations. The pumping plant wire to water efficiency as measured and calculated during the acceptance test of the pumping plant shall exceed 72% at the specified design point or the pumping plant shall not be accepted.

**SAMPLE PUMP CURVE**

1. Manufacturer __________________  5. Pump Model No. __________________
2. Impeller Diameter ______________  6. Design GPM ______________
3. Design Head ______________      7. RPM ______________
4. H.P. __________________        8. No. of Stages ______________

* Range of capacity (GPM) and Total Pump Head (TPH) shall be of the size to properly demonstrate the pump operational characteristics throughout the entire pumping range of the pump. Failure to do so will result in rejection of the pump curve.