# SECTION 1201

## VERTICAL TURBINE BOOSTER PUMPS

### 1201.0100 GENERAL

**1201.0101 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 pumps, all in accordance with the details shown on the plans and the requirements of these specifications.

**1201.0103 Submittals.** In order to be accepted for incorporation into the work, the manufacturer's make and model of vertical turbine pump and motor shall be submitted by the Contractor for Agency review and approval.

All submittals shall reference the project plan number.

Drawings and literature submitted shall include detailed specifications and drawings indicating dimensions, make, style, speed, size, type, horsepower, full-load amps, head capacity, efficiency, NPSH curves, specific materials used, design features, weights and any other information required.

Certified copies of test reports shall be submitted for review with 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 submittal. Complete initial motor test data shall include but not be limited to: full load heat rise, percent slip, breakdown torque, and locked rotor torque efficiency power factor at full, 3/4 and 1/2 load.

The contractor shall furnish the Engineer five sets of the following information for each pump specified prior to the pump being approved for installation. The information shall be accurate and clear. General statements will not be accepted. The pump curve shall be the actual operating curve for the impeller diameter supplied. A generic catalog curve is not acceptable. Pump curve data shall be presented in the format shown on the sample pump curve information table provided in the special specifications. The information to be submitted for each pump shall include:

- Name of pump manufacturer
- Number of stages in pump
- Impeller material - ASTM specification and diameter
- Thrust load on impellers per foot of head at design point and shutoff
- Information regarding impeller thrust balance
- Impeller shaft material including ASTM specification compliance
- Impeller type - semi-open\enclosed
- Impeller shaft diameter
- Bowl diameter
- Bowl material including ASTM specification compliance
- Pump column outside diameter
- Thickness of steel in pump column
- Column and discharge elbow lining material, make, and type
- Number of spiders and intermediate bearings (does not include upper bowl bearing)
- Spider material including ASTM specification compliance

- Bearing material including ASTM specification compliance
- Line shaft material including ASTM specification compliance
- Outside diameter of line shaft
- Type and Make of shaft seal
- Head, capacity, efficiency, horsepower, and Net Positive Suction Head (NPSH curves)
- Internal coating

**1201.0104 Delivery, Storage, and Handling.** Vertical turbine pumps 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 unit shall be shipped in such a manner that no damage will result to any part. Every precaution shall be exercised in handling so as to avoid imposing any strain on any part of the pump.

**1201.0200 PRODUCTS**

These specifications are intended to serve as a guide to the functional requirements needed to assure a quality product without unnecessary or expensive design features. It is the intent of these specifications to obtain a vertical turbine pump of heavy-duty construction for heavy duty, continuous service or for intermittent service, whichever imposes the most severe service on the pump. Pumps will be installed at the elevation noted on the plans.

**1201.0201 Materials.**

**(A) Standards.** Vertical turbine pumps and the materials used in their manufacture shall comply with ANSI/AWWA E101

**(B) Pump.** The vertical turbine pump shall be a vertical single or multi-stage unit, as required, with semi-enclosed or enclosed impellers. The pump and motor thrust bearings shall be designed to adequately handle momentary up-thrust at start-up.

The vertical turbine pump shall be furnished as a complete, ready-to-install unit by a single supplier. This requirement shall include, but not limited to, pump, motor, discharge head, mountings, and, if so specified and equipped, variable speed drive, engine, and/or drive shaft assembly.

Vertical turbine pumps which are determined to have mechanical defects or which, after testing, do not meet the range of head-capacity characteristics, horsepower, efficiency, or vibration requirements shall be rejected. Rejected pumps shall be replaced without additional cost to the Agency inclusive of, removal, furnishing and installation of replacement pump, and retesting. Mechanical defects shall include excessive vibration, improper balancing of any rotating part, improper tolerances, binding, excessive bearing temperature, defective materials including materials that do not conform to the specifications, improper parts fit, or any other defect which will, over time, damage the pump or unreasonably impair the efficiency of the pump.

Impellers, cases, seals, shafts, bearings and any other item which does not comply with these specifications with regard to metallurgy, material, or hardness shall be replaced without additional cost to the Agency.

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When packing gland drains are required or where water flushing or sealing of packing glands or mechanical seals is specified, the contractor shall furnish and install all required appurtenant piping and valves.

Bronze used in the manufacture of any vertical turbine pump shall not contain more than 2 percent aluminum nor more than 6 percent zinc.

Vertical turbine pumps shall be capable of operating against a closed discharge valve for not less than two minutes without excessive vibration, binding, rubbing of rotating parts, or damage to pump, motor or drive.

The head capacity 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 pumping head shall be the total dynamic head which, in these specifications, shall be the sum of the static head plus the friction head above the pump discharge outlet plus the velocity head at the discharge outlet. The pumping head does not include the losses in the entrance, column, or discharge elbow.

The rated efficiencies shall include the losses in the suction bell, in the pump column, and in the discharge elbow. The efficiency curve plotted on the manufacturer's pump curves, shall comply with this criteria regardless of the manufacturer's normal practice. The vertical turbine pump shall be field tested on this basis.

**(1) Discharge Head.** The discharge head shall be manufactured of fabricated steel with an aboveground discharge flange. The baseplate shall not be less than 1-1/2 inches thick and shall be manufactured to fit the flanged top of the pump barrels as noted on the plans. The base plate shall be circular. Square baseplates will not be approved. The upper flange shall have the same diameter as the electric motor and shall be a minimum thickness of 1-1/2 inches. Windows in the outer shell shall be as small as possible, but of sufficient size to permit working on the seals and couplings. The shell shall be tapped to accommodate a drain pipe. The drain tap shall be located so as to provide drainage of any water that accumulates in the shell. The stuffing box shall contain a Type 316 stainless steel shaft sleeve and Borg-Warner Type U Mechanical Seal, or equal, complete with seal flange. All metal parts of the seal shall be Type 316 stainless steel except that the rotating faces shall be Type 316 stainless steel with a Stellited facing. The seal flange shall be Type 416 stainless steel. The coupling and all of its component parts shall be capable of transmitting 150 percent of the shaft torque and also be capable of carrying all vertical thrust with an appropriate factor of safety. The foregoing arrangement shall permit removal of the seal and sleeve without disturbing the piping or the driver. Pump discharge flanges shall be 125 or 150 pound ANSI standards. The size shall be as indicated on the plans.

**(2) Column Pipe.** The column pipe shall be steel pipe of the diameter and schedule indicated on the plans or special specifications. Spiral weld or lap joint pipe shall not be used for column pipe. Column sections shall be joined by flanged joints with 300 Series stainless steel bolts or National Pipe Thread couplings.

The inside and outside surface of all column pipes and the inside surface of discharge elbows shall be thoroughly sandblasted to near white in accordance with SSPC-SP10. All ferrous surfaces shall be factory coated with three coats of thermosetting or fusion bonded epoxy coating. The epoxy coating shall be appropriate for use in potable water systems in accordance with AWWA C-550. Coatings shall be holiday free and have a minimum dry film thickness of twelve mils. When it is impossible for fusion bonded powder epoxy to be applied, the use of thermosetting liquid epoxy will be permitted.

**(3) Line Shaft.** The line shaft shall be open and shall be turned and precision ground Type 416 or Type 410 heat treated stainless steel shafting, furnished in sections not exceeding six feet in length. Line shaft couplings shall be of Type 416 or Type 410 stainless steel. The shaft diameter shall be as per special specifications excluding undercut. The line shaft shall not be reduced in size through the stuffing boxes.

**(4) Line Shaft Bearing and Retainer.** Line shaft Bearings shall be of the removable type. Line shaft bearings shall be fluted neoprene rubber and easily removed for replacement. Line shaft Bearing retainer shall be bronze per ASTM B-584-C92300. Line shaft bearing spacing shall be limited to a maximum of six feet. The top column assembly shall have an integral line shaft bearing located immediately beneath the discharge head to provide stability for the mechanical seal assembly.

All line shaft bearings and retainers shall be aligned so as to prevent vibration and shaft fatigue.

**(5) Bowl Assembly.** The bowl cases shall be of Meehanite or cast iron conforming to ASTM A 48, Class 30. The bottom case shall have long bearings which shall be filled with nonsoluble grease. The suction bells shall have anti-vortex vanes to suppress vortex formation.

The impellers shall be of the semi-enclosed or enclosed type and shall be accurately machined to fit the matching faces of the cases. The impellers shall be balanced both statically and dynamically and shall have non-overloading characteristics. Impellers shall be either bronze containing not more than six percent zinc or close grained nickel-steel. The castings shall be accurately machined with blades carefully scraped to insure smooth passageways. Impellers shall be keyed to the impeller shaft and retained by either split ring and thrust collar, or fastened with a tapered lock collet. The impeller shaft shall be Type 416 stainless steel. The shaft shall not be smaller in diameter than the line shaft.

The bottom bearing housing shall be cast as an integral part of the bottom case. The housing shall have sufficient vertical depth to allow the pump shaft to move downward as the impeller face, casing, or clearance parts wear.

The bottom bearing shall be packed with a nonsoluble hydraulic grease or lubricant that will not break down or dissolve. The grease or lubricant shall not need replacement for the life of the pump. The bearing housing shall be provided with a cap or plug to prevent the escape of any lubricant used. The bottom bearing shall be bronze conforming to ASTM B 584-C93200.

**(6) Operation.** Operating conditions shall be as indicated in the special specifications for the following:

Type of water pumped
Temperature of water pumped
Elevation of pump structure floor
Elevation of center line of suction pipe
Elevation of center line of discharge pipe

**(7) Pump Performance.** Pump characteristics shall include the following:

Design capacity (gallons per minute)
Design total pumping head (pump lift in feet)
Minimum allowable lab efficiency (%) at Design Point
Minimum operating pumping head (pump lift in feet)
Minimum allowable lab efficiency (%) at minimum operating pump head
Minimum shut-off head (feet)
Revolutions per minute
Minimum NPSH available (feet)
Minimum horsepower.

**(8) Motor.** The motor shall be either a vertical solid shaft motor, 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. The following motor characteristics shall be indicated in the special specifications and shall be stamped on a permanently affixed engraved stainless steel motor nameplate.

Horsepower
Speed - at rated load
Voltage
Phase
Hertz
Service Factor
NEMA design
Minimum insulation
Ambient temperature
Enclosure
Efficiency (minimum at full load)
Part winding
Duty Cycle

The motor conduit box shall be provided with a grounding terminal. The conduit box shall be sized to handle a 2-1/2 inch conduit. The motor start winding configuration shall be as specified on the plans or in the special specifications.

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 the 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 zerk type fittings and grease relief plugs.

The motor thrust upper bearings shall be oil-lubricated with accessible drain and fill plugs on the oil reservoir. The sight gauge assembly on the oil reservoir shall be easily serviceable and removable from the outside without disassembly of any part of the motor. The lower guide bearing shall be grease lubricated. The oil level on the reservoir shall be indicated by a sight gauge. The thrust bearing shall have ample capacity to carry 125 percent of the maximum down-thrust produced at shut-off head and be capable of withstanding any momentary up-thrust produced by the pump. The bearings shall have a life rating of at least 50,000 hours at the operating down-thrust presented by the pump assembly. The motor shall be equipped with a non-reverse ratchet assembly. The non-reverse ratchet shall be designed such that it can be quickly fitted at any time or removed for service without disturbing the drive coupling or pump impeller setting.

The motor(s) supplied 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 the motor(s) provided 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 power factor at full, 3/4 and 1/2 load.

**1201.0300 EXECUTION**

**1201.0301 General.** Vertical turbine pumps shall be furnished as specified by the plans, the special specifications, or as directed by the Engineer.

**1201.0302 Installation.** Pumps shall be installed and adjusted as specified. Installation shall be 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 three sets of installation and lubrication instructions for each type of centrifugal pump. The instructions shall include detailed information regarding adjustment as well as recommendations for the proper type of lubricant.

Each 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.

Each pump shall be field tested for vibration and alignment after installation. 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.

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The vibration limits of pumps shall be as described in the Hydraulic Institute Standards. It shall be the responsibility of the 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 prescribed limits.

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 listed in Subsection 1201.0201. The contractor shall be responsible for making all adjustments required for proper operation.

Test specimens or scrapings of impellers, wear rings, if any, bearings, casings, or other critical parts may be obtained by the Engineer for laboratory analysis. Field hardness tests may be conducted on critical pump components at the Agency's expense if deemed necessary.

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, 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.

The contractor shall provide three complete sets of operating and maintenance instructions for the pump motor unit prior to final acceptance.