

SECTION 43 21 39

PUMPS: WATER, VERTICAL TURBINE
04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9 (1990; R 2000) Load Ratings and Fatigue Life for Ball Bearings

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA E103 (2007) Horizontal and Vertical/Line-Shaft Pumps

ASME INTERNATIONAL (ASME)

ASME B1.1 (2003; R 2008) Unified Inch Screw Threads (UN and UNR Thread Form)

ASME B16.1 (2009) Standard for Gray Iron Pipe Flanges and Flanged Fittings; Classes 25, 125 and 250

ASME B16.5 (2009) Standard for Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24

ASTM INTERNATIONAL (ASTM)

ASTM A 182/A 182M (2009) Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature

ASTM A 240/A 240M (2008) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

ASTM A 276 (2008) Standard Specification for Stainless Steel Bars and Shapes

ASTM A 923 (2008) Standard Test Methods for Detecting Detrimental Intermetallic Phase in Duplex Austenitic/Ferritic Stainless Steels.

ASTM A 790 (2009) Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Pipe

ASTM A 995/A 995M

(2009) Standard Specification for Castings, Austenitic-Ferritic (Duplex) Stainless Steel, for Pressure-Containing Parts

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1

(2007) Standard for Motors and Generators

1.2 GENERAL REQUIREMENTS

1.2.1 Materials and Equipment

Provide materials and equipment which are as specified below, as shown, and are suitable for the service intended. Provide materials and equipment which are new and unused, except for tests. Where two or more pieces of equipment performing the same function are required, they shall be duplicate products of the same manufacturer.

1.2.2 Standard Products

Provide material and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate equipment that has been in satisfactory waterworks operation at least 5 years prior. Equipment shall be supported by a service organization that is reasonably convenient to the jobsite. Pumps and motors of the same types shall each be the product of one manufacturer.

1.2.3 Description

The pumps shall be vertical turbine water pumps of the types indicated and specified. The single driving units for the pumps shall be electric motors as indicated and specified.

1.2.4 Nameplates

Pumps and motors shall have a standard nameplate securely affixed in a conspicuous place showing the manufacturer's name, address, type or style, model, serial number, and catalog number. In addition, the nameplate for each pump shall show the capacity in gpm at rated speed in rpm and head in feet of water. Nameplate for each electric motor shall show at least the minimum information required by 10.38 NEMA MG 1. Such other information as the manufacturer may consider necessary to complete identification shall be shown on the nameplate.

1.2.5 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the fields and shall advise the Contracting Officer of any discrepancy before performing the work.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation; G

Detail drawings consisting of a complete list of equipment and materials. Detail drawings containing complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances in accordance with Note 4 on Drawing S-2, and equipment relationship to other parts of the work including clearances for maintenance and operation.

SD-03 Product Data

Vertical Turbine Pumping Units; G

Manufacturer's descriptive data and technical literature including make, model, weight, and horsepower of each equipment assembly. Complete catalog information, descriptive literature, specifications, and identification of materials of construction. Performance data curves showing head, capacity, horsepower demand, NPSH required, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the design flow conditions. Include seismic analysis for discharge head, equipment support and anchors, and column pipe bowl assembly. Provide pump maximum downthrust or upthrust in pounds, detailed structural, mechanical, and electrical drawings showing locations of connections and weights of components. Assembly and installation drawings including shaft size, seal, coupling, bearings, anchor bolt plan, parts nomenclature, and materials of construction lists. Baseplate drawings with leveling jackscrew details, anchor bolt and sleeve details, and minimum foundation installation and leveling requirements. Power and control wiring diagrams, including terminals and numbers. Complete motor nameplate data, per NEMA MG 1, including motor modifications. Factory finish system for the equipment. Provide special shipping, storage and protection, and handling instructions.

Spare Parts; G

Spare parts data for each different item of material and equipment specified.

Posted Instructions; G

Manufacturer's printed installation instructions including proposed diagrams, instructions, and other sheets.

SD-06 Test Reports

Testing; G

Test reports in booklet form showing all factory performance testing and field tests performed to demonstrate compliance with the specified performance criteria.

SD-10 Operation and Maintenance Data

Vertical Turbine Pumping Units

Six complete copies of operating manual outlining the step-by-step procedures required for system startup, operation and shutdown. The manual shall include the manufacturer's name, model number, service manual, parts list and complete product data, including description of all equipment and their basic operating features. Six complete copies of maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals shall include wiring, layout, and control diagrams of the system as installed.

1.4 QUALITY ASSURANCE

Provide the services of a manufacturer's representative experienced in the installation, adjustment, and operation of the equipment specified. The representative shall supervise the installation, adjustment, and testing of the equipment.

1.5 DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

1.6 SPARE PARTS

The Contractor shall submit spare parts data for each different item of material and equipment specified, after approval of the detail drawings and not later than 6 months prior to the date of beneficial occupancy. Data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after 1 and 3 year(s) of service.

PART 2 PRODUCTS

2.1 PUMP AND DRIVER REQUIREMENTS

2.1.1 Type of Installation

The work shall include furnishing, installing, and testing line shaft [vertical turbine pumping units](#) and their appurtenances as indicated.

The Finished Water Pumps (P-70010, P-70020 and P-70030) and the Concentrate Pumps (P-80010, P-80020, and P-80030) shall be installed in a wet pit as indicated on the Drawings. The RO Feed Pumps (P-10210 and P-10220) shall be of the can mounted installation as indicated on the Drawings.

2.1.2 Pump Drivers

Pumps shall have adjustable speed drive units as indicated. Furnish coordinated operating system complete with pump, drive, and speed controller. Coordinate pump and motor requirements with adjustable speed drive manufacturer and be responsible for torsional vibration of the rotating assembly and related stresses, motor thermal rating, structural design of the pump and motor assembly, drive capacity for actual motor's

nameplate current rating being supplied, minimum motor speed rating for required corresponding torque.

2.1.3 Lateral and Torsional Vibration

Pump and motor assemblies shall have no natural frequencies within 20 percent of the operating speed range. Fundamental critical speed of rotating assembly shall be no less than 50 percent above the rated speed. Pump manufacturer shall conduct an analysis of lateral and torsional vibration of pump and motor assembly. Excitation frequency range of the analysis shall include, but not be limited to, number of motor poles and number of impeller vanes. Perform detailed stress analysis for pump, coupling, motor system at each critical speed, and steady-state operating condition. Stress analysis shall demonstrate that in no case shall maximum stress on pump, coupling and motor components exceed endurance limits of pump, coupling and motor assembly components materials of construction.

2.2 PUMP PERFORMANCE

Pumps shall be capable of discharging quantities of water at maximum pump speed and total pump head with the minimum efficiency indicated.

Pumps shall operate at optimum efficiencies at the performance conditions specified. Pumps shall furnish not less than 150 percent of the rated capacity at a total discharge head of not more than 65 percent of rated total head. The shutoff total head shall not be less than 120 percent of the total head and not more than 130 percent of the total head at the rated condition specified for each pump. In no case shall the required horsepower at any point on the performance curve exceed the specified rated horsepower of the motor or encroach on the motor service factor.

2.2.1 RO Feed Pumps (P-10210 and P-10220)

Capacity (US gpm): Rated: 1450
Total Dynamic Head (Ft): Rated: 401
Min. Bowl Efficiency (%): 80
Max. Speed at Design Point (rpm): 1800
Constant: No
Adjustable: Yes
Horsepower: 200

2.2.2 Finished Water Pumps (P-70010, P-70020 and P-70030)

Capacity (US gpm): Rated: 1250
Total Dynamic Head (Ft): Rated: 245
Min. Bowl Efficiency (%): 80
Max. Speed at Design Point (rpm): 1800
Constant: No

Adjustable: Yes

Horsepower: 125

2.2.3 Concentrate Pumps (P-80010, P-80020 and P-80030)

Capacity (US gpm): Rated: 1000

Total Dynamic Head (Ft): Rated: 240

Min. Bowl Efficiency (%): 80

Max. Speed at Design Point (rpm): 1800

Constant: No

Adjustable: Yes

Horsepower: 125

2.3 LINE SHAFT VERTICAL TURBINE PUMPS

Line shaft vertical turbine pumps shall be constructed in accordance with [AWWA E103](#) except as modified. Pumps shall be designed for flanged discharge and the pump setting or location of the pump suction shall be as indicated on the Drawings.

2.3.1 Pump Head Assembly

Pump head assembly shall consist of the pump baseplate, the discharge head, and the driver. Head assemblies shall be rigid construction arranged for bolting to concrete foundations and shall be provided with at least two eyebolts, or other means of securing slings to facilitate setting and lifting. Pump discharge head and baseplate 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.

Pump head assembly for Finished Water Pumps (P-70010, P-70020 and P-70030) shall be fabricated from Type 316 stainless steel. Pump head assemblies for RO Feed Pumps (P-10210 and P-10220) and Concentrate Pumps (P-80010, P-80020, and P-80030) shall be fabricated from [ASTM A 276](#), S31803 (Alloy 2205) Duplex Stainless Steel. Fabrication practices involving heating and welding of duplex stainless steel shall be carefully controlled to avoid adverse effects on mechanical properties or corrosion resistance. Heat treatment shall be required after fabrication to ensure proper metallurgical conditions are maintained. Conduct testing to verify the absence of unfavorable intermetallic phases as required in accordance with [ASTM A 923](#).

2.3.1.1 Pump Baseplate

Pump head baseplate shall match the pump head assembly materials of construction and shall serve as a sole plate for mounting the discharge head assembly.

2.3.1.2 Discharge Head

Discharge head flanges shall be designed for standard pipe connections conforming to [ASME B16.1](#) and [ASME B16.5](#). Surface-type discharge heads

shall be designed for mounting on the baseplate. Discharge head shall be provided with a mechanical seal with carbon face and primary ring, fluorocarbon o-ring and type 316 stainless steel for all other components or other materials of construction determined to be suitable for the pumped liquid as determined by the pump manufacturer. A lip to collect leakage shall be provided with drilled and tapped connection for drainage pipe. Drainage piping materials of construction shall match the column piping materials of construction. Discharge head shall be designed to prevent contamination of the well/can from the surface, and shall accommodate the required driver assembly. Space shall be provided for access to the coupling between the pump shaft and drive shaft. Pipe taps shall be provided on the discharge head as required for prelubrication and discharge gauge connections.

2.3.1.3 Pump Driver

Vertical solid shaft electric motor drivers shall be provided with ball or roller bearings of adequate strength to carry the hydraulic thrust of the pump impellers and the weight of all rotating parts. Bearings shall have a minimum calculated L-10 rating life of 40,000 hours in accordance with [ABMA 9](#). If there is potential for pump upthrust during any operation of the pump, the drive shall be designed to withstand this upthrust. Motor shall be connected to the pump shaft through a solid coupling that incorporates provisions for vertical adjustment of the impellers. Vertical solid shaft motor drivers shall be sized to transmit the maximum horsepower required by the pump over the entire operating range of the pump. A nonreversible ratchet device shall be incorporated to prevent reverse rotation of the pump and line shafts of pumps with settings of 50 feet or more. Motors powered by VFO's shall be inverter duty per [NEMA MG 1](#).

2.3.2 Water-Lubricated Column and Shaft Assembly

Each section of the discharge column shall consist of a column pipe, line shaft, bearing spiders with bearings spaced not more than 10 feet on centers, and line shaft and discharge column pipe couplings. Line shaft bearings shall be fluted rubber and shall be held in place by bearing retainers. Materials of construction of the bearing retainers shall match the column pipe. Column pipe for Finished Water Pumps (P-70010, P-70020 and P-70030) shall be Type 316L stainless steel meeting the requirements of [ASTM A 182/A 182M](#) Rev C Grade F316L flanges. Column pipe for RO Feed Pumps (P-10210 and P-10220) and Concentrate Pumps (P-80010, P-80020, and P-80030) shall be duplex stainless steel meeting the requirements of [ASTM A 790](#), Grade S31803 (Alloy 2205) with forged duplex stainless steel, [ASTM A 182/A 182M](#), Grade (S31803) flanges.

2.3.2.1 Lubrication

Lubrication of line shaft pumps shall be furnished by the water being pumped.

2.3.4 Pump Bowl Assembly

Pump bowl assembly shall include the pump bowl, pump impeller, and the pump shaft and bearings and may be of single stage or multistage configuration.

2.3.3 Pump Bowls

Bowls for the RO Feed Pumps and the Concentrate Pumps shall be Type CD4MCu stainless steel in accordance with [ASTM A 995/A 995M](#), Grade 1B, including

heat treatment. The bowl bearings and bowl wear rings shall be babbitted carbon.

Bowls for the Finished Water Pumps shall be Type 316 stainless steel. The bowl bearing shall be carbon and the bowl war rings shall be babbitted carbon. Bolts for joining bowls shall be [ASTM A 276](#), S31803 stainless steel.

2.3.4 Impellers

Impellers shall be carefully finished with smooth water passageways and shall not load the prime mover beyond the nameplate rating over the entire performance range of the pump. Impellers shall be statically and dynamically balanced.

Impellers for the RO Feed Pumps and the Concentrate Pumps shall be Type CD4MCu stainless steel in accordance with [ASTM A 995/A 995M](#), Grade 1B, including heat treatment. The impeller wear rings shall be A276, S31803 stainless steel.

Impellers for the Finished Water Pumps shall be Type 316 stainless steel. The impeller wear rings shall be Type 316 stainless steel.

2.3.5 Pump Shafts

Shafts shall be capable of transmitting the required thrust in either direction and the total torque of the unit.

Shafts and shaft sleeves for the RO Feed Pumps and the Concentrate Pumps shall be [ASTM A 276](#), S31803

Shafts and shaft sleeves for the Finished Water Pumps shall be Type 316 stainless steel.

2.3.6 Pump Cans

The RO Feed Pump Manufacturer shall be responsible for sizing and furnishing the RO Feed Pumps and cans as a complete system. Dimensions of the RO Feed Pump cans shall be in accordance with Section 9.8 of the Hydraulic Institute Standards. Materials of Construction for the RO Feed Pump cans shall be [ASTM A 276](#), S31803 (Alloy 2205) Duplex Stainless Steel. Wall thickness of the can including discharge head flanged connection shall be determined by the RO Feed Pump Manufacturer based on the specified operating conditions and maximum test pressure requirements indicated in the Piping Schedule.

2.4 PUMP ACCESSORIES

2.5 ELECTRICAL EQUIPMENT

2.5.1 General

Electrical motor-driven equipment specified shall be provided complete with motors as specified in Section [26 60 13](#), LOW VOLTAGE MOTORS. Motor controls, equipment and wiring shall be as specified in Section [26 20 00](#) INTERIOR DISTRIBUTION SYSTEM.

2.5.2 Line shaft Vertical Turbine Pumps

2.5.2.1 Electric Motors

Each electric motor-driven pump shall be driven by a weather-protected, Type I for the RO Feed Pumps and the Finished Water Pumps) and totally-enclosed fan cooled (for the concentrate pumps) vertical continuous-duty, inverter duty, electric motor conforming to NEMA MG 1. Motors shall have a 1.0 service factor. Motors shall be squirrel-cage induction motors having normal-starting-torque and low-starting-current characteristics, and shall be of sufficient size so that the nameplate horsepower rating will not be exceeded throughout the entire published pump characteristic curve. Motor bearings shall provide smooth operations under the conditions encountered for the life of the motor. Adequate thrust bearing shall be provided in the motor to carry the weight of all rotating parts plus the hydraulic thrust and shall be capable of withstanding upthrust imposed during pump starting and under variable pumping head conditions specified. Motors shall be rated 460 volts, 3 phase, 60 Hz and such rating stamped on the nameplate. Motors located exposed to atmospheric conditions shall be suitable for operation in 50 degrees C ambient temperature.

2.6 EQUIPMENT APPURTENANCES

2.6.1 Attachments

All necessary bolts, nuts, washers, bolt sleeves, and other types of attachments for the assembly and installation of the RO Feed Pumps (P-10210 and P-10220) and Concentrate Pumps (P-80010, P-80020, and P-80030) shall conform to the requirements of ASTM A 276, alloy S31803 for bolts, nuts and sleeves, and ASTM A 240/A 240M, alloy S31803 for washers. Threads shall be clean-cut and shall conform to ASME B1.1. Bolts, nuts, washers, bolt sleeves, and other types of attachments for the assembly and installation of the Finished Water Pumps (P-70010, P-70020 and P-70030) shall be Type 316 stainless steel.

2.6.2 Equipment Guards

Equipment driven by open shafts, belts, chains, or gears shall be provided with all-metal guards enclosing the drive mechanism. Guards shall be constructed of galvanized sheet steel or galvanized woven wire or expanded metal set in a frame of galvanized steel members. Guards shall be secured in position by steel braces or straps which will permit easy removal for servicing the equipment. The guards shall conform in all respects to all applicable safety codes and regulations.

2.6.3 Special Tools

A complete set of all special tools which may be necessary for the adjustment, operation, maintenance, and disassembly of all equipment shall be furnished. Special tools are considered to be those tools which because of their limited use are not normally available, but which are necessary for the particular equipment. Tools shall be high-grade, smooth, forged, alloy, tool steel. Special tools shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such special tools until completion of the work, at which time they shall be delivered to the Contracting Officer.

2.6.4 Shop Painting

All motors, pump casings, and similar parts of equipment shall be in accordance with Specification Section 09 90 00.00 40, PAINTING AND COATING. Ferrous surfaces obviously not to be painted shall be given a shop coat of grease or other suitable rust-resistant coating.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 General

Each pump and electric motor shall be installed in accordance with the written instruction of the manufacturer and under the direct supervision of the manufacturer's representative. The impellers shall be set by the manufacturer's representative. Adjust pump assemblies such that driving units are properly aligned, plumb, and level with driven units and interconnecting shafts and couplings. Do not compensate for misalignment by use of flexible couplings. After pump and driver have been set in position, aligned, and shimmed to proper elevation, grout space between bottom of baseplate and concrete foundation with poured, nonshrinking grout of proper category. Remove all wedges after grout is set and pack void with grout. Connect suction and discharge piping without imposing strain to pump flanges.

3.1.2 Foundations

Foundations shall be as specified in Section 03 31 00.00 10 CAST-IN PLACE STRUCTURAL CONCRETE and as indicated in the Drawings. Anchor bolts and expansion bolts shall be set accurately. Anchor bolts shall be sized and furnished by the pump manufacturer.

3.2 PAINTING AND FINISHING

Unless otherwise specified all exposed ferrous metal not factory finished shall be painted as specified in Section 09 90 00.00 40 PAINTING AND COATING. No factory finished equipment or appurtenances shall be painted except that damaged factory finishes shall be retouched in an acceptable manner with paint obtained from the manufacturer. Nameplates shall not be covered with paint but shall be cleaned and legible at completion of the work.

3.3 TESTING

3.3.1 Factory Pump Test

Factory pump performance testing shall be made in conformance with AWWA E103 and the Hydraulic Institute Standards. Conduct on each pump at maximum rated speed and at reduced speeds. Perform testing of each pump for continuous 3-hour period without malfunction. Testing shall include hydrostatic testing of the bowl, column and discharge head assemblies of each pump. Hydrostatic test pressure shall be at 150 percent of shutoff head with test pressure maintained for not less than 5 minutes. A minimum of five performance test points shall be conducted on each pump which shall include shut-off, rated, and runout performance conditions at each speed tested. For adjustable speed pumps perform testing at a minimum of three reduced speed conditions. For each of the performance test points provide test records shall include the following:

- a. Total Head
- b. Capacity
- c. Horsepower
- d. Flow measured by factory instruments and storage volumes
- e. Recorded distance from suction water surface to pump discharge centerline for duration of test
- f. Pump discharge pressure converted to feet of liquid pumped and corrected to pump discharge centerline
- g. Calculated velocity head at the discharge flange
- h. Bowl head
- i. Driving motor voltage and amperage measured for each phase
- j. Correct all data in accordance with Hydraulics Institute Level A acceptance criteria.

3.3.2 Field Equipment Test

After installation of the pumping units and appurtenances is complete, operating tests shall be carried out to assure that the pumping installation operates properly. The Contractor shall make arrangements to have the manufacturer's representatives present when field equipment tests are made. Each pumping unit shall be given a running field test in the presence of the Contracting Officer for a minimum of 3 hours. Each pumping unit shall be operated at its rated capacity including other capacities at reduced speed operation. The Contractor shall provide an accurate and acceptable method of measuring the discharge flow and head. The pumping unit shall not develop vibration exceeding the limits specified in HIS 9.6.4.

3.3.2.1 Correct Installation of Appurtenances

Tests shall assure that the units and appurtenances have been installed correctly, that there is no objectionable heating, vibration, or noise from any parts, and that all manual and automatic controls function properly.

3.3.2.2 Deficiencies

If any deficiencies are revealed during any tests, such deficiencies shall be corrected and the tests shall be reconducted.

3.4 MANUFACTURER'S FIELD SERVICES

The Contractor shall obtain the services of a manufacturer's representative experienced in the installation, adjustment, and operation of the equipment specified. The representative shall supervise the installing, adjusting, and testing of the equipment.

3.5 FIELD TRAINING

Contractor shall conduct a training course for the maintenance and

operating staff. The training period of 8 hours normal working time shall start after the system is functionally complete but before the final acceptance tests. The training shall include all of the items contained in the operating and maintenance instructions as well as demonstrations of routine maintenance operations. Contracting Officer shall be given at least two weeks advance notice of such training.

3.6 POSTED INSTRUCTIONS

Framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, shall be posted where directed. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed as specified above for the wiring and control diagrams, and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the systems.

-- End of Section --