

SECTION 11312

END SUCTION CENTRIFUGAL PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope

1. Furnish and install three (3) single-stage vertical end suction centrifugal pumps for pumping of return activated sludge (RAS)
2. Furnish and install three (3) single-stage vertical end suction centrifugal pumps for pumping of waste activated sludge (WAS)
3. Furnish and install one (1) single-stage vertical end suction centrifugal pump for pumping digester supernatant (decant)
4. Pumping units to be
 - a. Bearing-frame design
 - b. Suitable for variable speed operation with electronic variable frequency drive equipment
 - 1) Digester decant pump does not require variable speed operation
5. Each pumping unit to be furnished complete with electric motor, flexible coupling and coupling guard, mechanical seals, base, anchor bolts, suction and discharge fittings, and all appurtenances as specified herein and as required for proper installation and operation
6. Provide manufacturer's field services
7. Furnish and deliver spare parts
8. Prepare and deliver preliminary and final operation and maintenance manuals

B. Additional Requirements Specified Elsewhere

1. Section 01340: Shop Drawings, Product Data, and Samples
2. Section 01400: Quality Control
3. Section 01600: Materials and Equipment
4. Section 01730: Operating and Maintenance Data

C. Related Requirements Specified Elsewhere

1. Section 02615: Ductile Iron Pipe
2. Section 02641: Valves and Accessories
3. Section 03600: Grout
4. Section 05501: Anchor Bolts and Drilled-In Anchors
5. Section 09900: Painting
6. Section 13300: Utility Control Systems
7. Division 16: Electrical

D. Definitions: Definitions of terms and other hydraulic considerations as set forth in the Hydraulic Institute Standards

1.2 QUALITY ASSURANCE

A. Design Basis

1. Fairbanks Morse Pump Corporation, 5410 Series
2. PACO Pumps, 4000 NCF Series
3. Or equivalent
4. Equivalent products of other manufacturers may be accepted subject to compliance with design, function, materials and performance of the specified items

B. Reference Standards

1. Hydraulic Institute Standards

1.3 SUBMITTALS

A. In accordance with Section 01340

B. Shop Drawings and Product Data

1. Submit sufficient data to verify compliance with these specifications and to illustrate construction and assembly of the products
2. Submit complete fabrication, assembly, foundation, and installation drawings and installation instructions
3. Submit detailed specifications and data describing materials, parts, devices, and accessories utilized in the complete pumping assembly
4. Pumps
 - a. Name of manufacturer
 - b. Type and model
 - c. Rotative speed, minimum and maximum
 - d. Size of suction nozzle
 - e. Size of discharge nozzle
 - f. Type of bearings and lubrication
 - g. Type of coupling and assembly details
 - h. Accessories
 - i. Dimensions
 - j. Net weight of pump only
 - k. Net weight of pump assembly with frame and pedestal
 - l. Complete performance curves showing capacity versus head, NPSH required, pump and overall efficiency, and brake horsepower
 - 1) Provide variable speed performance curves with a minimum of 5 speeds plotted from the minimum to maximum recommended rotative speed, except for digester decant pump
 - m. Details to permit impeller adjustment
5. Mechanical seals
 - a. Name of manufacturer
 - b. Type and model
 - c. Materials of construction
 - d. Seal water quality and quantity requirements

6. Motors
 - a. Name of manufacturer
 - b. Type and model
 - c. Rated size of motor (hp)
 - d. Motor service factor
 - e. Type of bearings and lubrication
 - f. Temperature rating
 - g. Full load rotative speed
 - h. Net weight
 - i. Efficiency at full load and rated pumping conditions
 - j. Full load current
 - k. Locked rotor current
 - l. Suitability for operation with variable frequency drive; confirm induction rating/suitability, except for digester decant pump
7. Data on shop coatings and painting
8. List of spare parts to be furnished

C. Test Reports

1. Submit copies of field test reports
2. Field test reports to include
 - a. Test log
 - b. Description of test procedure, equipment, and setup
 - c. Performance curves, plotted against capacity
 - 1) Head
 - 2) Brake horsepower
 - 3) Efficiency
 - 4) Actual speed
 - 5) Net positive suction head available
 - d. Plot curves to be easily read at scales consistent with the performance requirements
 - e. Vibration and balance testing and analysis

D. Certification of Compliance

1. Manufacturer's affidavit of compliance certifying
 - a. All equipment and materials comply with these specifications with any exceptions noted
 - b. Pumps have been properly installed and are operating within specification tolerances
 - c. All tests have been performed with satisfactory results

E. Operating and Maintenance Manuals in accordance with Section 01730

1.4 JOB CONDITIONS

A. Return Activated Sludge Pumps

1. Pumped liquid: Return activated sludge from final clarifiers
2. Altitude: 5385 feet above sea level

3. Temperature range: 12°C to 23°C
4. Solids concentration: 0.15 to 1.50 percent
5. Mechanical seal water supply from plant nonpotable water system

B. Waste Activated Sludge Pumps

1. Pumped liquid: Waste activated sludge from final clarifiers
2. Altitude: 5385 feet above sea level
3. Temperature range: 12°C to 23°C
4. Solids concentration: 0.15 to 1.50 percent
5. Mechanical seal water supply from plant nonpotable water system

C. Digester Decant Pumps

1. Pumped liquid: Aerobic digester supernatant
2. Altitude: 5385 feet above sea level
3. Temperature range: 12°C to 23°C
4. Solids concentration: 0.10 to 1.00 percent
5. Mechanical seal water supply from plant nonpotable water system

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS

A. General

1. Stable and free from cavitation and noise throughout the specified operating head range
2. Design based on a wearing ring diametrical clearance which is not less than the greater of 0.012" or 1 mil/inch of wearing ring diameter
3. Minimum hydrostatic test pressure: 1.5 x shutoff head plus suction pressure
4. Design based on a running clearance between the impeller and the suction cover of at least 0.015"
5. Performance requirements based on previously reported liquid characteristics and elevation

B. Return Activated Sludge (RAS) Pumps Design Operating Conditions

1. Number of units: 3
2. Maximum pump operating speed at 60 Hz (design full speed): 1,800 rpm
 - a. Rated capacity (gpm): 868
 - b. Total head at rated capacity (feet): 38.3
 - c. Minimum shutoff head (feet): 58
 - d. Maximum shutoff head (feet): 80
 - e. Normal operating head range (feet): 37.0 – 52.0
 - f. Maximum capacity at low end of normal operating head range (gpm): 950
 - g. Minimum capacity at high end of normal operating head range (gpm): 200
 - h. Minimum efficiency at rated point (%): 60
 - i. Maximum bhp required at input shaft of pump for any point in normal operating head range: 20

- j. Maximum motor nameplate horsepower: 30
 - k. Minimum sphere size (in): 3
 - l. Maximum required NPSH at any point in normal operating range (feet): 27.6
3. Reduced pump operating speed condition
 - a. Minimum pump operating speed at reduced speed: 60% of full speed
 - b. Capacity at reduced speed (gpm): 217
 - c. Maximum total head at reduced speed (feet): 20.0
 4. Initial Operating Requirements
 - a. Initial operating requirements to be achieved by change in pump impeller size only
 - 1) Pumps to be furnished with impellers sized to meet initial operating conditions
 - 2) Impellers sized to meet design operating conditions to be furnished as spare parts
 - b. Number of units: 3
 - c. Maximum pump operating speed at 60 Hz (design full speed): 1,800 rpm
 - 1) Maximum pump operating speed: 100% of full speed
 - 2) Rated capacity (gpm): 600 gpm
 - 3) Minimum total head at rated capacity (feet): 24.0
 - d. Reduced pump operating speed condition
 - 1) Minimum pump operating speed at reduced speed: 60% of full speed
 - 2) Capacity at reduced speed (gpm): 130 gpm
 - 3) Maximum total head at reduced speed (feet): 13.5

C. Waste Activated Sludge (WAS) Pumps

1. Number of units: 3
2. Maximum pump operating speed at 60 Hz (design full speed): 1,800 rpm
3. Rated capacity (gpm): 174
4. Total head at rated capacity (feet): 31.5
5. Minimum shutoff head (feet): 47
6. Maximum shutoff head (feet): 55
7. Normal operating head range (feet): 26 to 36
8. Maximum capacity at low end of normal operating head range (gpm): 215
9. Minimum capacity at high end of normal operating head range (gpm): 120
10. Minimum efficiency at rated point (%): 50
11. Maximum bhp required at input shaft of pump for any point in normal operating head range: 3.5
12. Maximum motor nameplate horsepower: 5
13. Minimum sphere size (in): 1½
14. Maximum required NPSH at any point in normal operating range (feet): 25.5

D. Digester Decant Pumps

1. Number of units: 1
2. Maximum pump operating speed at 60 Hz (design full speed): 3,600 rpm
3. Rated capacity (gpm): 225
4. Total head at rated capacity (feet): 25.5
5. Minimum shutoff head (feet): 35

6. Maximum shutoff head (feet): 60
7. Normal operating head range (feet): 20 to 30
8. Maximum capacity at low end of normal operating head range (gpm): 365
9. Minimum capacity at high end of normal operating head range (gpm): 155
10. Minimum efficiency at rated point (%): 60
11. Maximum bhp required at input shaft of pump for any point in normal operating head range: 3.3
12. Maximum motor nameplate horsepower: 5
13. Minimum sphere size (in): 1½
14. Maximum required NPSH at any point in normal operating range (feet): 27.5

2.2 MATERIALS

A. Pumping Units

1. Casing and frame: Cast iron, ASTM A48
2. Casing and impeller wear rings: Cast iron or stainless steel
3. Impeller: Cast iron, ASTM A48
4. Shaft: Carbon steel, AISI 1045 or ASTM A311 Class B Grade 1141 or 1144
5. Shaft sleeve: Stainless steel
6. Stuffing box hardware: Non-corrosive metal
7. Mechanical seal
 - a. Metal components: 316 stainless steel
 - b. Stationary face: Carbon
 - c. Rotary face: Silicon carbide
8. Bearings: Anti-friction, heavy-duty
9. Pedestal: Cast iron or fabricated steel

B. Anchor Bolts, Nuts, and Washers

1. Furnished with the equipment supplied
2. Provide in accordance with Section 05501
3. All anchor bolts, nuts and washers to be galvanized (ASTM A153) or electroplated (ASTM A164, Type GS)

2.3 FABRICATION AND MANUFACTURE

A. Casing

1. Permits removal of the rotating element without disconnecting the piping
2. Flanged cleanout handholes on discharge and suction nozzles with interior surfaces flush with the casing water passages
3. Parts to have registered fit for alignment
4. Nozzles
 - a. Flanged
 - b. Flat faced
 - c. ANSI B16.1, Class 125 diameter and drilling
5. Pipe tapped openings with gauge cocks for draining, priming, and venting the casing
6. Water passages smooth to permit maximum efficiency

7. Pipe tapped opening for draining stuffing box leakage

B. Impeller

1. One-piece casting completely machined on all exterior surfaces
2. Statically and dynamically balanced
3. Non-clog type with at least two ports
4. Keyed and locked to shaft with self-locking or pinned non-clog type fastener
5. Uniform sections and smooth surfaces free from obstructions, cracks, and porosity on interior water passages

C. Shaft and Shaft Sleeves

1. Shaft completely machined
2. Shaft deflection at stuffing box not more than 0.002" at any head in operating range
3. Replaceable sleeve extending from the impeller through the stuffing box
4. Sleeve positively locked against rotation and axial movement
5. Sleeves sealed to prevent leakage between shaft and sleeve
6. Total shaft runout less than 0.002" after assembly
7. Shaft sleeves to extend beyond the mechanical seal flanges
8. Suitable splash deflector mounted on shaft adjacent to frame bearing housing

D. Wearing Rings

1. Provide renewable casing and impeller wearing rings
2. Design clearance at least 1 mil/inch of ring diameter
3. Wearing rings positively locked in place

E. Stuffing Box with Mechanical Seal

1. Replaceable bushing at the inboard end
2. Split glands at the outboard end
3. Gland halves interlocked and held in position at all pressures by at least two bolts or studs
4. Mechanical seal
 - a. Double mechanical seal
 - b. Cartridge seal system design with sleeve, gland and seal all in one unit
 - c. Balanced O-ring seal design
 - d. Flushing connection built into seal gland
 - e. Field replaceable stationary and rotary face elements
 - f. Design basis
 - 1) Chesterton Style 255
 - 2) John Crane Type 5620
5. Lubrication: External water supply from plant nonpotable water system

F. Bearings

1. Antifriction type
2. Grease lubricated

3. AFBMA B-10 rating of 100,000 hours at specified operating conditions
4. Rated for maximum shaft speed

G. Flexible Coupling

1. Minimum life rating at continuous full load, maximum rpm and maximum misalignment: 40,000 hours
2. Pin and rubber bushed type

H. Frame and Pedestal Assembly

1. Rigidly support the motor and all rotating elements with two sets of bearings
 - a. Outboard bearing to carry both radial and axial loads
2. Fabricated steel or cast iron drip rim base
3. Permit axial adjustment of impeller without dismantling pump
4. Bearing enclosures to keep out contaminants and retain lubricant
5. Provisions for adding and flushing lubricant
6. Rigidly support motor and shall not be smaller than motor base
7. Adapter between the pump frame and motor to have registered fit
8. Frame, pedestal and casing to be capable of transmitting motor load to support structure
9. Suitable openings and ample clearance for maintenance and access to mechanical seal and flexible coupling
10. Pedestal to extend from pump case to elevation below bottom of suction elbow inlet flange
11. All seams and contact edges continuously welded and ground smooth

I. Balance

1. Accurately machine all rotating parts
2. Place pump in as near perfect rotational balance as practicable
3. Pumps and motors to operate at any point within their operating range without undue noise or vibration
 - a. Equipment which vibrates excessively will be rejected
4. The mass of the unit and its distribution shall be such that resonance at any operating speed is avoided
5. Limits
 - a. Vibration at any point within the pump's operating range to be less than the vibration limits allowed by the Hydraulic Institute
 - b. Ratio of rotative speed to critical speed of unit or components: Less than 0.8 or more than 1.3

J. Motor

1. RAS and WAS pumps: Induction type, inverter duty rated, suitable for use with adjustable frequency drive system
2. Digester decant pumps: Induction type, premium efficiency
3. Open drip proof or TEFC
4. 480 V, 3-phase, 60 Hz
5. Service factor: 1.15, minimum

6. Insulation: Class B or better
7. Motors to be sized for the altitude at location where equipment is to be installed
 - a. Sized so that under maximum continuous design load imposed by driven equipment the motor nameplate horsepower will not be exceeded
 - b. Motor service factor not to be used in determining a non-overload condition
8. Motors to be rated for continuous duty
9. Conform with additional requirements of Section 01600

K. Accessories

1. Each unit
 - a. Lifting eye bolts or lugs
 - b. Provide plugged gauge cock connections at suction and discharge nozzles
 - c. Tapped and plugged openings for casing and bearing housing vents and drains
 - d. Fittings for properly adding bearing lubricant and seal water

- L. Shop Painting: Shop prime exterior surfaces in accordance with Section 01600 and Section 09900

2.4 SPARE PARTS

- A. Furnish all spare parts recommended by the manufacturer

- B. The following spare parts to be furnished as a minimum

1. Return activated sludge pumps
 - a. Three each pump impellers sized to meet design operating conditions, including all parts, accessories and devices required to complete a change of impellers in the field
 - b. Two each spare mechanical seal kit to include mechanical seal and all parts, accessories and devices required to replace the mechanical seal
 - c. Two each set of wearing rings
 - d. Two each complete set of bearings
2. Waste activated sludge pumps
 - a. Two each spare mechanical seal kit to include mechanical seal and all parts, accessories and devices required to replace the mechanical seal
 - b. Two each set of wearing rings
 - c. Two each complete set of bearings
3. Digester decant pumps
 - a. One each spare mechanical seal kit to include mechanical seal and all parts, accessories and devices required to replace the mechanical seal
 - b. One each set of wearing rings
 - c. One each complete set of bearings

PART 3 - EXECUTION

3.1 INSTALLATION

- A. In accordance with procedures recommended by pump manufacturer, the Hydraulics Institute Standards and as specified herein
- B. Accurately locate anchor bolts
 - 1. Refer to Section 05501 for additional requirements
- C. Level, plumb, align, and wedge unit into position to fit connecting piping
- D. Grout pump base after initial fitting and alignment but before final bolting of connecting piping
- E. Take special care to maintain alignment of components
 - 1. Correct any misalignment, noisy operation or other indication of improper setting
- F. No strain to be transmitted to the pump connections
- G. Test pump connections for piping stresses after final adjustment
 - 1. Loosen connections
 - 2. If any movement or opening of joints is observed, adjust piping to fit
 - 3. Eliminate any stress between pump assembly and connecting piping
- H. Do not shim between machined surfaces
- I. Field paint in accordance with Section 09900
- J. Remove all grease, dirt, excess paint, etc., from equipment surfaces prior to final acceptance
- K. Take precautions, as necessary, to properly protect all equipment from damage
 - 1. Installed equipment to be protected for further construction operations

3.2 FIELD QUALITY CONTROL

- A. Provide Manufacturer's Field Services
 - 1. Qualifications of manufacturer's representative
 - a. Authorized representative of the manufacturer
 - b. Experienced in the application, installation, operation and maintenance of the subject work, materials and equipment
 - 2. Services provided by representative
 - a. Provide guidance regarding proper installation

- b. Inspect, check, adjust and test equipment installed, as required, and approve final installation
 - c. Be present when equipment is placed in operation by General Contractor and Owner's personnel
 - d. Revisit site as often as required to correct all problems and until equipment installation and operation are acceptable to Engineer and Owner
3. Manufacturer's representative to instruct Owner's personnel in the operation and maintenance of the equipment furnished, including classroom and field training
- B. Furnish three (3) copies of written report to Engineer certifying that
1. Equipment is properly installed and lubricated
 2. Equipment is in accurate alignment and balance
 3. Equipment is free from any undue stress imposed by connecting piping, anchor bolts, etc.
 4. Equipment has operated satisfactorily under full load conditions and as specified through full operating range

3.3 INSTALLATION, OPERATION AND MAINTENANCE DATA

- A. Refer to requirements of Section 01730
- B. Preliminary and Final Manuals Required
 1. Printed and electronic media

END OF SECTION