

SECTION 43 21 39

SUBMERSIBLE END SUCTION PUMP

PART 1 GENERAL

1.1 DESCRIPTION

- A. Scope:
1. Provide all labor, materials, equipment, and incidentals required to furnish and install solids handling submersible, end suction centrifugal pumps complete and operational with motors, control equipment, and accessories as shown and specified. Anchorage devices are included in the scope of this Section.
- B. Coordination:
1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before submersible end suction pump Work.
- C. Related Sections:
1. Section 05 05 33 - Anchor Systems.
 2. Section 09 91 00 - Painting and Protective Coatings.
 3. Section 33 31 23 - Sanitary Sewer Force Mains, Valves, and Appurtenances.
 4. Section 33 32 15 - Wastewater Pump Station Startup.
- D. Related Materials:
1. CFPUA Design Guidance Manual.
 2. CFPUA Pump Station Turnover Document.
 3. CFPUA Material Specification Manual.

1.2 REFERENCES

- A. Standards referenced in this Section are:
1. ANSI/HI 1.3, Standard for Centrifugal Pumps for Design and Application.
 2. ANSI/HI 1.4, Standard for Centrifugal Pumps for Installation, Operation, and Maintenance.
 3. ANSI/HI 1.6, Centrifugal Pump Tests.
 4. ANSI/HI 9.1-9.5, Standard for Pumps – General Guidelines for Types, Definitions, Application, Sound Measurement, and Decontamination.
 5. ANSI/HI 9.6.2, Standard for Centrifugal and Vertical Pumps for Allowable Nozzle Loads.
 6. ANSI/HI 9.6.3, Standard for Centrifugal and Vertical Pumps for Allowable Operating Region.
 7. ANSI/HI 9.6.5, Centrifugal and Vertical Pumps for Condition Monitoring
 8. ANSI/HI 9.8, Pump Intake Design.
 9. ANSI/HI 11.6, Submersible Pump Tests.
 10. IEEE 85, Airborne Sound Measurements- Rotating Electrical Machinery.
 11. NEMA MG-1, Motors and Generators.

1.3 DESIGN REQUIREMENTS

- A. Submersible Pumps: Follow requirements of the CFPUA Design Guidance Manual.

1.4 QUALITY ASSURANCE

- A. Supplier’s Qualifications:
 - 1. Supplier shall have a minimum of five years’ experience producing substantially similar equipment to that required for the Project and shall be able to provide documentation of at least five installations in satisfactory operation for at least five years each.

- B. Component Supply and Compatibility:
 - 1. Obtain all products included in this Section, regardless of component Supplier, from one submersible end suction pump manufacturer.
 - 2. Submersible end suction pump Supplier shall review and approve or prepare all Shop Drawings and submittals for all components provided under this Section.
 - 3. All components shall be suitable for specified service conditions and shall be integrated into overall assembly by the submersible end suction pump Supplier.

- C. Certification
 - 1. Certification of Compliance:
 - a. Obtain certification of compliance with the Contract Documents from the submersible end suction pump manufacturer on manufacturer letterhead; certification by manufacturer’s representatives is not acceptable.
 - b. Certification shall be worded as follows:

“*[Insert manufacturer’s name]* proposes to supply equipment included in Section 43 21 39, Submersible End Suction Pump, for the Cape Fear Public Utility Authority, Wilmington, NC, *[INSERT THE PROJECT NAME AND SITE NAME]*. We have examined the Contract Documents and understand the Project requirements insofar as they affect the proposed products. We certify that the products will operate satisfactorily under the conditions described in the Contract Documents and that the products meet the requirements of the Contract Documents:

[List exceptions, deviations or changes necessary or recommended to accommodate the proposed products.]

We further certify that the products to be furnished shall conform to the Standards referenced in Section 43 21 39 - Submersible End Suction Pump, of the Contract Documents.

[List exceptions, deviations or changes necessary to accommodate the proposed products.]

Authorized Signature & Title

Date”

- c. Provide justification for exceptions, variations, deviations, or changes. ENGINEER will determine whether exceptions, deviations, and changes are

acceptable. Exceptions, variations, deviations, and changes may result in rejection of products.

- d. Provide certification before submitting Shop Drawings. Shop Drawings will not be reviewed prior to receipt of certification.
- e. Acceptance of certification shall not relieve CONTRACTOR of responsibility for adequacy of all products.
- f. Submittal of certification shall not relieve CONTRACTOR and Supplier of requirement to comply with submittal procedures in the Contract Documents.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings of:
 - a. Pump controls specified in this Section, including panel layout and wiring diagrams. Drawings shall be:
 - 1) adequate for control panel fabrication, installation and maintenance.
 - 2) approved prior to manufacture.
 - b. Include:
 - 1) an elementary control (ladder) diagram.
 - 2) interconnection wiring (schematic) diagram.
 - 3) interior and exterior panel component layout drawings.
 - 4) Component catalog cuts.
 - 5) Contractor's installation drawings. This is Covered in Section 01 33 00 - Submittals.
2. Product Data:
 - a. Manufacturer's literature, illustrations, specifications, paint certification (if required) and engineering data including; dimensions, materials, size, weight, and part lists for all components in sufficient detail to allow an item-by-item comparison with the Contract Documents.
 - b. Pump performance data and curves, range from minimum flow to shut-off head at full speed and all speed curves specified showing:
 - 1) Overall pump efficiencies.
 - 2) Required net positive suction head (NPSH).
 - 3) Flow rate.
 - 4) Head.
 - 5) Brake horsepower.
 - 6) Speed.
 - 7) Shut-off head.
 - 8) Curves shall indicate Preferred Operating Region (POR) and Allowable Operating Region (AOR), as defined in ANSI/HI 9.6.3.
 - 9) Specify recommended ratio of available NPSH divided by required NPSH for water service.
 - 10) For variable speed units, curves shall have at least five speeds plotted between maximum and minimum rpm.
 - c. Motor Data: Furnish certified motor data sheet for previously tested, electrically duplicate motor to that specified, including the following:
 - 1) Speed-torque relationship.
 - 2) Efficiency at $\frac{1}{2}$, $\frac{3}{4}$, and full load.
 - 3) Power factor at $\frac{1}{2}$, $\frac{3}{4}$, and full load.
 - 4) Slip at full load.

- 5) Run Amps, Start (or locked rotor) Amps, Run kW, Run kVA, start kVA, NEC Code Letter.
 - 6) Temperature rises and results of dielectric tests.
 - 7) Bearing type and lubrication medium
 - 8) Insulation class and temperature ratings.
3. Testing Plans, Procedures, and Testing Limitations:
 - a. Provide pump Supplier's proposed shop testing plan, including complete list of testing facility limitations.
 - b. Provide proposed field-testing plan.
- B. Informational Submittals:
1. Certificates: Provide certificate of compliance as specified in this Section.
 2. Manufacturer Instructions:
 - a. Provide Supplier's instructions for handling and installing products.
 - b. Setting drawings, templates, and directions for installing anchor bolts and other anchorages.
 3. Source Quality Control Submittals:
 - a. Results of shop testing for complete pump and motor unit.
 - b. Location of nearest permanent service headquarters of pump manufacturer to the Site.
 4. Field Quality Control Submittals:
 - a. Results of field testing.
 - b. Submit a written report of the results of each visit to Site by pump manufacturer's service representative, including purpose and time of visit, tasks performed, and results obtained.
 5. Qualifications Statements:
 - a. Provide documentation of Supplier's qualifications as specified in Quality Assurance article of this specification.
 6. Warranty Documentation:
 - a. Manufacturer's Standard Warranty.
 - b. Special Warranty, if specified.
- C. Closeout Submittals: Submit the following:
1. Operation and Maintenance Manuals:
 - a. Submit complete operation and maintenance manuals, including shop and field test reports, maintenance data and schedules, description of operation, and spare parts information.
 - b. Provide operation and maintenance manuals per Section 01 70 00 – Execution and Closeout Requirements.
 2. Warranty Documentation:
 - a. Manufacturer's Standard Warranty.
 - b. Special Warranty, if specified.
- D. Maintenance Material Submittals: Furnish the following:
1. Spare Parts:
 - a. One spare impeller, trimmed to match installed impeller.
 - b. One spare pump.
 2. Tools:
 - a. Furnish two sets of special tools required for normal operation and maintenance of products furnished.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
1. Prior to shipping, completely inspect products to assure that components are complete and comply with all requirements. Box or crate products as required to prevent damage during shipment. Protect machined surfaces and matching connections to prevent damage.
 2. Deliver products to Site to ensure uninterrupted progress of the Work. Deliver anchorage products that are to be embedded in concrete in ample time to prevent delaying the Work.
 3. Inspect all boxes, crates, and packages upon delivery to Site and notify ENGINEER in writing of loss or damage to products. Promptly remedy loss and damage to new condition per manufacturer's instructions.
 4. Comply with Section 01 60 00 - Product Requirements.
- B. Storage and Protection:
1. Keep all products off ground using pallets, platforms, or other supports. Protect steel, packaged materials, and electronics from corrosion and deterioration.
 2. Comply with Section 01 60 00 - Product Requirements.

1.7 WARRANTY

- A. Special Warranty on Submersible End Suction Pumps:
1. Provide manufacturer's written warranty, running to the benefit of OWNER, agreeing to correct, at OWNER's option, remove, or replace materials or equipment specified in this Section and found to be defective for a period of two years after date of Substantial Completion. Replacement value of items regularly subject to wear in normal use, such as seals, bearings, impellers, rotors, and stator, may be prorated.

PART 2 PRODUCTS

2.1 SUBMERSIBLE END SUCTION PUMPS

- A. Manufacturers:
1. Products and Manufacturers: Provide products of one of the following:
 - a. Xylem/Flygt N Series, Model _____
 - b. F.E. Myers, Division of Pentair Pump, Model _____.
 - c. Sulzer type ABS, Model _____.
- B. System Description:
1. Pumps:
 - a. Comply with ANSI/HI 1.3, ANSI/HI 9.6.3, and ANSI/HI 9.8.
 - b. Type: submersible, non-clog, end suction centrifugal slide-rail-mounted.
 - c. Design:
 - 1) Constructed for operation under complete submersion, partial submersion, and dry conditions.
 - 2) Suitable for raw wastewater service.
 2. Performance Criteria: Each pump shall comply with the following

Pump tag numbers.	PS1, PS 2	
Primary rated head.		ft
Capacity at primary rated head.		gpm
Secondary rated head		ft
Capacity at secondary rated head.		gpm
Operating head range for full speed continuous operation.		ft
Minimum shutoff head.		ft
Static Head		ft
Maximum nominal pump speed.	1750	rpm
Capacity at minimum head at reduced speed.		gpm
Maximum power required at pump input shaft at any point from minimum operating head to shutoff head.		bhp
Efficiency at rated head, wire to water.		%
Motor Volt	230	V
Phase	3	
Wetwell depth (guide-rail mounted).		ft
Minimum liquid depth in wetwell (guide-rail and skid mounted)	See detail drawings	
Minimum NPSHA at rated head.		ft
Minimum pump discharge nozzle/elbow size.	4	in
Minimum test sphere diameter.	3	in

C. Materials:

1. Stator Housing, Oil Chamber Housing, Impeller Casing, and Impeller: Cast iron, ASTM A48, Class 35B.
2. Casing Wear Ring: Bronze, ASTM B62.
3. Impeller Wear Ring: Martensitic stainless steel, Brinell 200-250.
4. Shaft: Alloy steel, hard chrome plated; or martensitic stainless steel, AISI Type 416 or 420.
5. Mechanical Seals: 2 tandem single type, oil lubricated with tungsten carbide or silicon carbide seal rings at all points, except the upper rotating seal, which shall be carbon.
6. Discharge Base: Cast iron
7. Guiderails: Stainless steel pipe (corrosion- resistant 316 or better), ASTM A312, Schedule 40S.
8. Upper guiderail bracket, cable hooks, and chain hooks: AISI Type 316 stainless steel.

D. Pump Construction:

1. Impeller Casing: The impeller casing shall have well-rounded water passages and smooth interior surfaces free from cracks, porosity, blowholes, or other irregularities.

The discharge nozzle shall be flanged and sufficiently rigid to support the pumping unit under all operating conditions.

2. Impeller: The impeller shall be dynamically balanced, semi-open, multi-vane, back swept, screw-shaped, non-clog design. The impeller leading edges shall be mechanically self-cleaned automatically upon each rotation as they pass across a spiral groove located on the volute suction. The leading edges of the impeller shall be hardened to Rc 60 and shall be capable of handling solids, fibrous materials, heavy sludge, and other matter normally found in wastewater. The impeller shall be locked to the shaft, held by an impeller bolt and shall be coated with alkyd resin primer as needed.
3. Wear Ring: Renewable wearing rings shall be provided in the casing and on the impeller unless the pump is capable of impeller to volute adjustment.
4. Oil Chamber Housing: The oil chamber shall contain a drain plug.
5. Mechanical Seals: The seal located between the seal chamber and the seal inspection chamber shall be a leakage-free seal. The upper seal shall contain one stationary and one positively driven rotating corrosion and abrasion resistant tungsten-carbide seal ring. The rotating seal ring shall have small back-swept grooves laser inscribed upon its face to act as a pump as it rotates, returning any fluid that should enter the dry motor chamber back into the lubricant chamber. All seal rings shall be individual solid sintered rings. Each seal interface shall be held in place by its own spring system. The seals shall not depend upon direction of rotation for sealing. Shaft seals without positively driven rotating members or conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces are not acceptable. The seal springs shall be isolated from the pumped media to prevent materials from packing around them, limiting their performance. The seals shall require neither maintenance nor adjustment and shall be readily accessible for inspection and replacement.

Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and shall provide capacity for lubricant expansion. The seal lubricant chamber shall have one drain that is accessible from the exterior of the motor unit. The seal system shall not rely upon the pumped media for lubrication.

The area about the exterior of the lower mechanical seal in the cast iron housing shall have cast in an integral concentric spiral groove. This groove shall protect the seals by causing abrasive particulate entering the seal cavity to be forced out away from the seal due to centrifugal action.

Seal leakage shall not contaminate the motor lower bearing. The leakage chamber shall be equipped with a float or probe type switch that will signal if the chamber should reach 50% capacity.

Seal lubricant shall be non-hazardous.

Shaft seals lacking positively driven rotating members or conventional double mechanical seals which utilize a common single or double spring acting between the upper and lower units and requiring a pressure differential to offset external pressure and effect sealing, will not be acceptable. The seals shall not rely upon the

pumped media for lubrication and shall not be damaged if the pumps are run unsubmerged for extended periods while pumping under load.

E. Pump Removal System:

1. Pumps shall automatically and positively mate with associated discharge piping when pump is lowered into place. Pumps shall be removable for inspection or service without requiring removal of bolts, nuts, or other fastenings.
2. Provide for each pump guide rails of Schedule 40 Type 316 stainless steel.
3. Provide each pump with chain of high-tensile strength, proof-tested, stainless steel chain. Provide sufficient length of chain for removing pump from wet well without requiring supplementary cords, cables, or chains. Connect chain to lifting eye or bail on pump with stainless steel, adjustable closure D-ring or similar hardware acceptable to ENGINEER. On opposite end of chain from pump, provide stainless steel, adjustable closure D-ring or similar hardware acceptable to ENGINEER. Chain and hardware shall be sized to sustain all tensile stresses during lifting of pump. For each pump, provide one suitable hook or bracket on wall just below operating floor to which chain will be hooked when not used for hoisting.
4. Pump manufacturer shall provide guide rail brackets, self-sealing ANSI flange, stainless steel chain (as applicable) holder with support grip, and other items necessary for complete guide-in, pump removal system.
5. Access Frames and Covers: Provide with each pump rectangular 6061 T6 aluminum alloy access frame and cover complete with heavy-duty stainless-steel hinges and locking hasp. Cover shall be capable of 300 psf live loading and have safety checked or abrasive, non-slip surface. Opening sizes shall be as shown on the Drawings. Access frames and covers shall conform to Material Specification Manual Section I12.

F. Motors:

1. Motor shall be stainless steel solid shaft, ball bearing type. Motor casing shall be air-filled or oil-filled and watertight with moisture resistant Class H, 180 degrees C insulation. Voltage, phase, and frequency shall be as specified in "Design and Performance Criteria" in this Section.
 - a. Motor shall be NEMA Design B, normal starting torque, normal slip, squirrel cage induction type, continuous duty.
 - b. Isolate cable entry with internal terminal board.
 - c. Motor shall be capable of continuous operation in a non-submerged condition without damage. Pump and motor shall be capable of intermittent operation up to 15 starts per hour in non-submerged condition, without damage.
 - d. Motor shall be non-overloading for entire pump operating curve, shall have a minimum of 1.15 service factor, and provide full rated horsepower with a voltage unbalance of three percent. Motors for use with variable frequency drives shall have insulation system constructed in compliance with or exceeding NEMA MG-1 Part 31.
 - e. Motor cable shall be suitable for submersible duty and be so indicated by code or legend permanently applied to cable.
 - f. Motor thrust bearings shall be capable of continuous thrust loads under all conditions of pump operation from zero head to shut-off. Anti-friction bearings shall be rated for B-10 life of 50,000 hours.

- g. Motor Sensors:
 - 1) For supplemental motor protection, each pump motor shall be equipped with at least three thermal sensors embedded in stator windings and wired to the associated control panel.
 - 2) Provide leakage sensor in lower part of stator housing, wired to leads in motor's watertight terminal chamber.
- h. Motors shall have over-temperature sensors in motor windings.
- i. Motor: list for National Electric Code Class 1, Division 1, Group D Hazardous location.
- j. VFD applications: provide motors with inverter duty windings.

G. Control Panel: Follow Section 26 29 15 - Pump Control Panels.

2.2 ANCHOR BOLTS AND ANCHORS

A. Anchors: Follow Section 05 05 00 - Anchor Systems.

2.3 FINISHING

- A. Shop Finishing:
 - 1. Epoxy Coating - Primer & Finish Coat: Pump is protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer and a polyester resin finish paint on the exterior of the pump.
 - 2. Coat machined, polished, and non-ferrous surfaces with corrosion prevention compound.
- B. Field painting shall conform to Section 09 91 00 - Painting and Protective Coatings. Touch-up of factory-applied finishes shall be compatible with factory-applied finish and specified service conditions.

2.4 ACCESSORIES

- A. Provide the following for each pump unless otherwise specified.
 - 1. Discharge Elbow.
 - 2.

2.5 SOURCE QUALITY CONTROL

- A. Pump Shop Tests: Shop Test all pumps provided under this Section.
 - 1. Hydrostatically test pump bodies per ANSI/HI 1.6, to the greater of: twice specified pump discharge head at Design Point No. 1, or 1.5 times pump's shutoff head.

PART 3 EXECUTION

3.1 Inspection:

- A. Examine conditions under which products are to be installed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 Installation:

- A. Install products in conformance with manufacturer's instructions and recommendations, and the Contract Documents.
- B. Anchorages:
 - 1. Install pumps on concrete bases. Provide anchorages in new or existing concrete, as applicable, per equipment manufacturer's recommendations and the Contract Documents.
- C. General:
 - 1. Conform to ANSI/HI 1.4.
 - 2. Perform all fitting required for installation. Set products accurately in location, alignment, and elevation, plumb and true.
 - 3. Provide utility connections per the Contract Documents. Support piping and valves independent of pump. Verify that utilities and valves are tested and operational before placing equipment into operation. When pumps are connected to piping with rigid hardware, connection of discharge nozzle to piping shall conform to ANSI/HI 9.6.2.
 - 4. Align and adjust products and piping in presence of Engineer.
 - 5. Provide for initial operation lubricants recommended by equipment manufacturer.
 - 6. Prior to energizing motor driven equipment, rotate drive motor by an external source to demonstrate free operation of mechanical parts. Do not energize equipment until safety devices are installed, connected, and functional.
- D. Field painting shall conform to Section 09 91 00 – Painting and Protective Coatings.
- E. Field Quality Control:
 - 1. Site Tests:
 - a. Following installation, Contractor and qualified field service representative of equipment manufacturer shall conduct operating tests of all equipment, functions, and controls at Site, in presence of Engineer and CFPUA. Should tests result in malfunction, make necessary repairs, revisions, and adjustments and restart test from beginning. Repeat tests and repairs, revisions, and adjustments until, in opinion of Engineer, installation is complete, and equipment is functioning properly and accurately, and is ready for permanent operation.
 - b. Field Operating Test; follow Section 33 32 15 - Pump Station Startup, and:
 - 1) Field test equipment and its controls in local mode, followed by demonstrating proper operation and controls in automatic mode. Demonstrate that each part and component of system individually and all parts and components together function properly in manner intended. Total duration of testing shall be determined by CFPUA and shall be related to local conditions. All testing equipment and manpower shall be by Contractor.
 - 2) Conform to applicable provisions of ANSI/HI 9.6.5.

2. Manufacturer's Services: Provide qualified, factory-trained serviceman to perform the following:
 - a. Instruct Contractor in installing equipment.
 - b. Inspect and adjust equipment after installation and ensure proper operation.
 - c. Test-operate the products in presence of Engineer and verify that equipment conforms to Contract Documents.
 - d. Instruct Owner's personnel in operating and maintaining the products.
 - e. Manufacturer's representative shall make a minimum of 3 visits, with a minimum of 4 hours onsite for each visit. First visit shall be for assistance in installing equipment; second visit shall be for checking completed installation and start-up of system; third visit shall be to instruct operations and maintenance personnel. Representative shall revisit the Site as often as necessary until installation is acceptable.
 - f. Training: Furnish services of qualified factory trained specialists from manufacturer to instruct Owner's operations and maintenance personnel in recommended operation and maintenance of products.

3.3 ANCHORS AND ANCHOR BOLTS

- A. Use expansion anchors in precast and cast-in-place concrete.

3.4 FIELD QUALITY CONTROL

- A. Operational Test: Demonstrate that all pumping station equipment is electrically, mechanically, structurally, and otherwise acceptable, and that it is safe, in optimum working condition, and conforms to the specified operating conditions by supplying sufficient clear water and operating station through several pumping cycles. During operation 1) observe and record operation of pumps, discharge gage readings, amperage draw, pump controls and liquid level controls, 2) check calibration of instrumentation equipment, test manual control devices, and automatic control systems, and 3) be alert to any undue noise, vibration, or other operational problems.
- B. Manufacturer's Start-Up Services: Provide for a minimum of two 8-hour days including O&M instructions to the operating personnel. Representative shall schedule at least two separate trips for these services. The Owner shall be notified when Manufacturer's representative is to be at the work site one week in advance to be present during start-up of equipment.

END OF SECTION