

SECTION 11313

SUBMERSIBLE SEWAGE PUMPS

PART 1 GENERAL

1.1 Summary

- A.** This Section covers the supply and installation of submersible pumps as indicated and specified.
- B.** Submersible pumps shall be furnished at the site complete with pump casings, shafts, bearings, seals, lubrication, piping assemblies, guide rails, anchor bolts, motors, controls, power cable, and all other parts and accessories indicated, specified, or required for proper installation, operation, and maintenance.
- C.** Pumps shall be capable of pumping Raw unscreened sewage.
- D. Related Work Specified Elsewhere**

Protective Coatings.....Section 9900
Motors, Instruments and Control SystemsSection 16010
through Section 16950

1.2 Quality Assurance

A. Reference Standards and Specifications

1. American National Standards Institute (ANSI)

ANSI B16.1 - Cast-Iron Pipe Flanges and Flanged Fittings.

2. American Society for Testing and Materials (ASTM)

ASTM A48.

3. Anti-Friction Bearing Manufacturer's Association (AFBMA)

4. Hydraulic Institute Standards (HIS)

1.1-1.2 – Centrifugal Pumps – Nomenclature, Definitions, Application and Operation.

11.6 – Submersible Pump Tests.

9.1-9.5 – Pumps – General Guidelines for Types, Definitions, Application and Sound Measurement.

5. National Electrical Manufacturer's Association (NEMA)

6. Institute of Electrical and Electronics Engineers (IEEE)

7. National Fire Protection Association (NFPA)

70 - National Electrical Code (NEC).

B. Certified Witnessed Factory Tests and Reports

- 1.** Perform tests on each pump in accordance with Hydraulic Institute Standards except as otherwise specified.
- 2.** Statically balance pump impellers and dynamically balance all pump/motor units such that equipment vibration velocity is less than 0.12-inch per second.
- 3.** Submit results of factory tests in accordance with Section 16950.
- 4.** Perform standard tests on all motors in accordance with IEEE.

1.3 Submittals

- A.** Submit complete Operation and Maintenance Manuals as specified in Section 1330.
- B.** Submittals shall include, but not be limited to, the following:
 - 1.** Letters of Certification of Compliance on materials, equipment, etc.
 - 2.** Final Certified Drawings showing outline dimensions, foundation layout, or mounting information, and other pertinent dimensions.
 - 3.** Field erection instructions, assembly drawings and/or diagrams, detailed reference lists and lists of erection details.

- 4.** Shop Detail Drawings showing individual sub-assemblies and fabricated pieces with material specifications and other applicable data.
- 5.** Installation instructions, operating and/or service manuals, and all other data pertinent to operating or servicing the complete apparatus. Preventative maintenance instructions and recommended frequency.
- 6.** Schematic and wiring diagrams of power, control and piping systems. A detailed description of operation shall be included for each diagram to describe all modes of operation of the system indicated. Where the integrated system requires interlocking and control of other components in normal operation, these components shall be included in the description of operation.
- 7.** General bulletins and product literature describing complete apparatus including operating principles and fundamentals.
- 8.** Service data sheets showing design performance, utility requirements, etc., as applicable to the specific duty for which the equipment is supplied.
- 9.** Materials of construction of all components.
- 10.** Renewal parts list with diagrammatic or cross-section drawings showing part identification. Material analysis or trades designation for each significant part is to be noted on parts lists or on a separate sheet.
- 11.** Mechanical seal details, specifications, etc.
- 12.** Bearing manufacturer's standard identification and/or interchangeable number for all anti-friction bearings in the equipment proper and its accessory items.
- 13.** Standard performance curves, indicating the impeller size and the maximum size available. Curves shall cover range from shutoff to 120% of design flow rate at the conditions specified, and shall be submitted for the following parameters as a function of pump capacity and speed at design temperature:

- a. Total developed head.
- b. Required brake horsepower.
- c. Pump efficiency.
- d. Required NPSH.
- e. Minimum recommended submergence.
- f. Variable frequency curves.

14. Lubrication specification.

C. Control System

- 1. Instrumentation components.
- 2. Control panel layout and dimensions.
- 3. Wiring diagrams.
- 4. Narrative description of operation.

D. Submersible Motors

- 1. Nameplate information consisting of the following:
 - a. Manufacturer's name and serial number.
 - b. Horsepower output.
 - c. Temperature rise and method indicated.
 - d. Maximum ambient temperature.
 - e. Insulation class.
 - f. Rpm at rated load.
 - g. Frequency.
 - h. Number of phases.

1.5 Delivery, Storage, and Handling

- A.** Materials are to be marked or tagged with part number and order number for field assembly requirements.
- B.** Touch-up paint with instructions for applications is to be supplied by the manufacturer for application by erection personnel.
- C.** All supports, members, and miscellaneous parts shall be packaged for shipment in such manner to prevent abrasion or scratching.
- D.** Deliver materials to the site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time not to delay that Work.
- E.** Store materials to permit easy access for inspection and identification. Keep steel members off the ground, using pallets, platforms, and other supports. Protect steel members and packaged materials from corrosion and deterioration.
- F.** Store mechanical equipment in covered storage off the ground to prevent condensation.

PART 2 PRODUCTS

2.1 Manufacturers

- A.** Manufacturers regularly engaged in the manufacture of the submersible pump equipment as specified herein and who can demonstrate equipment of this specified design, in actual service for not less than five years will be considered as acceptable manufacturers. All like items shall be furnished by one manufacturer to ensure uniformity and interchangeability of parts. Manufacturer shall guarantee all equipment furnished; however, this shall not relieve the CONTRACTOR from his responsibility for the proper installation and functioning of the work.
- B.** Manufacturer shall have five installation of same size equipment in same application within the last five years. Manufacturer to submit installation information, including size, location, and a total of three operator contact names, and operator phone numbers with the submittals.

C. Acceptable Manufacturers

1. Flygt (ITT Fluid Technology Corporation).
2. Fairbanks-Morse Pump Corporation.
3. KSB Inc.
4. Approved equal.

D. The naming of a manufacturer in this Specification is not an indication that the manufacturer's standard equipment is acceptable in lieu of the specified component features. Naming is only an indication that the manufacturer may have the capability of engineering and supplying a system as specified.

2.2 General Requirements

- A.** Provide totally sealed, explosion proof rated submersible electrically operated centrifugal pumps capable of pumping raw, unscreened sewage up to 4% Total Suspended Solids.
- B.** Provide pumps capable of operating continuously for extended periods of time without damage.
- C.** Pump controls shall be specified and as follows:
1. Furnish three pumping units as specified and indicated.
 2. Provide constant speed service pumps suitable for operation on a variable frequency drive (VFD). VFD will be supplied by the CONTRACTOR.
 3. Speed of pumps to be governed by liquid level depth in wet well. The higher the level in the wet well, the faster the motor operates, the more volume is pumped. Level transmitter to be part of pump control system.
- D.** Pump head-capacity curve shall be continuously falling from shutoff head.
- E.** Pump discharge connection elbow and discharge piping shall be installed such that pump will automatically connect and seal to discharge connection elbow when lowered into place.

- F.** Pump shall be easily removable for inspection or service.
- G.** Provide guide rail system and pump rail guide bracket to raise or lower pump unit by chain.
- H.** Guide entire weight of pump unit with a minimum of two guide bars or cables.
- I.** Seal interface of the pump and discharge elbow by metal-to-metal contact equipped with water cooled jacket. The pump shall be automatically connected to the discharge connection elbow when lowered into place and shall be easily removed for inspection or service. There shall be no need for personnel to enter the pump wet well to connect the pump to the discharge connection elbow. A simple linear downward motion of the pump shall accomplish sealing of the pumping unit to the discharge connection elbow.
- J.** No portion of the pump shall bear directly on the floor of the sump.
- K.** The pumps, with their appurtenances and guide bar systems, shall be capable of continuous submergence under water without loss of watertight integrity to a depth of 60 ft.
- L.** Pumps shall be able to pass 3-inch diameter solids.
- M.** Pump motors shall be inverter duty (VFD) rated in accordance with NEMA MGI standards.
- N.** Only two pumps shall be permitted to run at any one time while power is supplied from emergency generator (with future capacity available for a third operating pump).
- O.** Contractor shall supply sufficient amount of electrical cable to make all necessary connections between pumps and electrical control panel.
- P.** Provide enlargers/reducers as necessary to ensure pump locations, pipe locations, and pipe sizes are as shown on the Drawings. If enlargers/reducers affect pump locations, pipe locations, or pipe sizes, the CONTRACTOR shall notify the ENGINEER before construction of the pump station proceeds.
- Q.** Each Pump will be equipped with a mix-flush valve to assist in the suspension of solids.

2.3 Design Requirements: pump(s) shall be designed for the following pump station conditions.

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| A. | Single Pump Immediate Peak Flow: | As indicated in Special Provisions. |
| | Ultimate Design Flow: | As indicated in Special Provisions. |

The immediate peak flow will be achieved with 1 pump operating. The ultimate design peak flow will be achieved with 2 pumps operating in parallel.

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| B. | Shutoff head (minimum): | As indicated in Special Provisions. |
| C. | Maximum Motor Speed: | As indicated in Special Provisions. |
| D. | Minimum Overall Efficiency: | As indicated in Special Provisions. |
| E. | Maximum Motor Horsepower: | As indicated in Special Provisions. |
| F. | Pump Setting: | As indicated on drawings |
| G. | Maximum Depth of Water in Wet Well: | As indicated on drawings |
| H. | Minimum Depth of Water in Wet Well: | As indicated on drawings. |

2.4 Materials and Construction

- A.** Construct motor housing, pump casing, and major pump components of cast iron conforming to ASTM A48 with smooth surfaces devoid of blow holes or other irregularities.
- B.** Provide bolts, nuts, and washers of ANSI Type 316 stainless steel.
- C.** All mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton rubber O-rings. Fittings shall be such that sealing is accomplished by metal-to-metal contact between machined surfaces. This will result in controlled compression of rubber O-rings without the requirement of a specific torque limit.

Rectangular cross-sectioned gaskets requiring specific torque limits to achieve compression shall not be considered as adequate or approved equal.

D. Submersible Motors

- 1.** Vertical squirrel-cage induction type housed in an air-filled, watertight chamber.
- 2.** NEMA Design B, Class F insulation.
- 3.** Rated 460 volts, 3 phase, 60 hertz, U.L. listed and suitable for Class I, Division I, Group D, hazardous locations
- 4.** Constant speed operation, suitable for operation on VFD's.
- 5.** Totally enclosed construction suitable for submerged service.
- 6.** Rating:
 - a.** Ambient temperature: 120 degrees F.
 - b.** Service factor: 1.15.
 - c.** Speed as specified or indicated for each piece of equipment driven.
 - d.** Adequate to drive equipment without using service factor except in emergency conditions.
 - e.** Rated for continuous duty, capable of withstanding a maximum of 15 starts per hour.
- 7.** Provide water seal leak detector between first and second mechanical seals with wiring included in power cable.
- 8.** Motor data nameplate with all lubrication and electrical data located at each motor.
- 9.** The instrument and power cables shall be submersible to the same water depth as the motor casing, Type SPC with Chloroprene jacket, insulated for 90 C, non-wicking fillers, and at a length to suit surface junction box as indicated on the Drawings (minimum 50 feet).

- 10.** Size cable in accordance with applicable NEC requirements. Cable shall be listed by a recognizable testing agency or laboratory.
- 11.** Cable shall be coated with Hypalon.
- 12.** The cable entry water seal design shall preclude specific torque requirements to insure a watertight submersible seal. The cable entry shall be comprised of a single cylindrical elastomer grommet, flanked by stainless steel washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter. The cable entry junction chamber and motor shall be separated by a stator lead sealing gland or terminal board, which shall isolate the motor interior from foreign material gaining access through the pump top. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.
- 13.** The junction chamber, containing the terminal board, shall be sealed from the motor by elastomer compression seal (O-ring) and be field replaceable. Connection between the cable conductors and stator leads shall be made with threaded compressed type binding post permanently affixed to a terminal board and thus perfectly leak proof.
- 14.** A minimum of three thermal switches shall be embedded in the stator end coils, one per phase winding, to monitor the stator temperature. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the motor control panel.
- 15.** Provide a leakage, bearing temperature, and over temperature protection system which shall consist of leakage, bearing temperature, and over temperature sensors at the motor, control module, and necessary control power transformer which shall be remotely located.

E. Impeller

- 1.** Cast iron, ASTM A-48 Class 35B, or Class 30.
- 2.** Double shrouded, non-clog design having a long thrulet without acute turns.

3. Secured to shaft with key and self-locking device to prevent slipping in either direction.
4. Balanced statically and dynamically to eliminate vibration and minimize hydraulic end thrust.
5. Castings shall not have been repaired by plugging, welding, or other means.
6. Provide renewable stainless-steel casing wearing ring for efficient sealing between volute and impeller. The wear ring system shall consist of a stationary ring made of Type 420 stainless steel with a minimum Brinell hardness number of 450 when tested in accordance with ASTM E10. The wear ring system shall be fitted to the volute inlet. The pump shall also have a stainless steel impeller wear ring heat-shrink fitted onto the suction inlet of the impeller.
7. The impeller shall be capable of handling solids, fibrous materials, and heavy sludge.

F. Shaft

1. Ample diameter to assure first critical speed will occur at not less than 150 percent of rated pump speed.
2. Pump and motor shaft shall be the same unit. The pump shaft is an extension of the motor shaft. Couplings shall not be acceptable. The shaft shall be ASTM A572, Grade 50 carbon steel or Type 420 stainless steel and shall be completely isolated from the pumped liquid.

G. Bearings

1. Minimum B-10 life of 100,000 hours.
2. Pump shaft to rotate on two (upper and lower) permanently lubricated bearings without end movement.
3. The upper bearing shall be a single roller bearing. The lower bearing shall be a two row angular contact bearing to compensate for axial thrust and radial forces.

4. The lower and upper bearing housings shall include an independent thermal sensor to monitor the bearing temperatures. If a high temperature occurs, the sensor shall activate an alarm and shut the pump down.

H. Shaft Seal

1. Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The seals shall operate in a lubricant reservoir that hydrodynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary and one positively driven rotating tungsten-carbide ring. The upper, secondary seal unit, located between the lubricant chamber and the motor housing, shall contain either one stationary tungsten-carbide seal ring and one positively driven rotating tungsten-carbide seal ring, or one stationary Ni-resist seal ring and one positively driven rotating carbon seal ring.
2. Moisture detector shall be installed in oil seal chamber and connected to pump controls.
3. Seal faces shall be made of tungsten carbide.
4. Each interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment, but shall be easily inspected and replaceable.
5. Each pump shall be provided with an oil chamber for the shaft sealing system. The seal oil shall be FDA approved non-toxic. Seal lubrication shall require an oil chamber capacity no greater than 16 pints. The drain and inspection plug, with positive anti-leak seal, shall be easily accessible from the outside.

2.5 Accessories

A. Pump Discharge Connection

1. Connected to discharge piping and anchored to sump floor with stainless-steel anchor bolts.

2. Designed to receive pump discharge connection without bolts.
3. Integral with guide rail.
4. Cast or ductile iron.
5. Flanges shall conform to ANSI B16.1.

B. Guide Rails

1. Fasten stainless-steel guide supports to pump so that no lifting loads are applied to pump or motor housing.
2. Stainless-steel pipe.
3. All 316 stainless steel, including rails, brackets, and anchor bolts.
4. Size as recommended by pump manufacturer.
5. Shall not support any portion of the pump weight.
6. Provide a minimum of two guide rails per pump.
7. The guide rail supports shall be placed at 8 foot maximum intervals, less as required to provide support.

C. Lifting Chain

1. Supply 316 stainless steel, lifting chain or cables attached to a lifting eye on the pump casing.
2. The length of the chain shall be able to lower the pump from the top of the wet well to operating position as indicated on the Drawings, plus five additional feet of length.
3. Provide 316 stainless steel locking hook or clasp at top of wet well to securely retain the upper end of the lifting chain during pump operation.

D. Cable Holder

1. Provide grip holders for pump and control cables.

2. Cables shall be easily adjusted to pumping level without splices.
3. Provide continuous power and control cables from control panel to pumps and level controls with an intermediate waterproof junction box for removing submersible pump for maintenance.

2.6 Electrical Equipment

- A. Conform to NEC, NEMA, IEEE and Section 16950 on all electrical equipment and controls.
- B. Provide level transducers and watertight electric float switches, complete with accessories, in accordance with Section 16010 through Section 16950.
- C. Provide electrical control panel, motor starters, and pump controls in accordance with Section 16010 through Section 16950.
- D. Motors shall be equipped with thermal sensors attached to or imbedded in the motor windings and connected to pump controls.

2.7 Control Panel

- A. A control system, specifically designed for pumping stations, should be used in order to provide monitoring and transfer to an alternate pump when required, to ensure a maximum degree of protection and assurance of continuity of service.
- B. Conform with Section 16010 through Section 16950.
- C. Hand-Off-Auto switch for each pump. Controls for all pumps shall be provided.
- D. Variable frequency drive (VFD) motor starters as specified in DIVISION 16.
- E. Elapsed runtime meter for each pump.
- F. Enclosure shall be NEMA 3R.
- G. Furnish phenolic name plates for each pump and panel mounted device.

- H. Ambient temperature: 120 degrees F. outdoors
- I. Control panel to allow three pumps to run at a time on emergency power.
- J. Pump operation to provide equal run time on motors.
- K. Provide wet well level control, pump failure, and alarm conditions.
- L. Provide wet well level control for speed control input for VFD drive units.

2.8 Factory Coating

- A. All surfaces coming into contact with water, other than stainless steel, shall be coated by an approved high quality epoxy coating.

2.9 Spare Parts

- A. The following spare parts shall be provided:
 - 1. One set of wear rings.
 - 2. One set of gaskets.
 - 3. One set of bearings.
 - 4. One set of mechanical seals.

PART 3 EXECUTION

3.1 Installation, Start-Up, and Testing

- A. All Work shall conform to manufacturer's recommendations and the requirements of Section 16010 through Section 16950.

3.2 Manufacturer's Field Service

- A. A factory trained representative of the manufacturer shall visit the site and provide installation, start-up and training services as specified in Section 16010 through Section 16950.

- B.** Length of service shall be a minimum of one 8-hour day for start-up excluding training.
- C.** Provide a minimum of four hours for training of Owner's operating personnel.

3.3 Installation

- A.** Make all electrical and control connections.
- B.** Provide all necessary lubrication for initial start-up, testing and as required for final acceptance.
- C.** Provide a complete unit with all materials, components and adjustments as required for successful operation.
- D.** Installation, start-up and testing of all equipment and associated construction shall conform to manufacturer's recommendations.
- E.** Install pipe and pipe appurtenance supports to minimize stresses being placed on pump and connections.

3.4 Performance Tests

- A.** As specified in DIVISION 1.
- B.** Performance tests shall be conducted by an authorized manufacturer's representative.
- C.** Conduct in the presence of General Contractor, Owner, and/or Engineer.
- D. Equipment Tests**
 - 1.** Check performance of all components as a functioning unit.
 - 2.** Check alignment of each unit.
- E. Operational Tests**
 - 1.** Conduct such operational tests as necessary to determine that the performance of equipment and controls is as specified.

2. Tests will generally consist of placing equipment in operation under varying conditions and observing performance.
 3. Use pump station magnetic flow meter to verify flow rates. Pumps shall be tested under all normal operating conditions.
 4. Provide pressure gauges as necessary to determine operating heads.
 5. Test all control sequences and functions.
- F.** Make all necessary equipment adjustments and corrective work indicated by tests.
- G.** Submit a written test report to General Contractor (with one copy to Engineer) in a letter form stating operations performed and results obtained for each unit.

3.5 Warranty Provisions

- A.** Contractor shall provide a written warranty from the manufacturer covering all equipment and materials furnished directly or indirectly by the pump supplier. Warranty shall cover parts and labor for any adjustments or repairs required for a period of five years from the date of final acceptance by Owner or 10,000 hours under normal use, operation and service. The warranty shall cover parts and labor and shall be in printed form.
- B. End of Warranty Inspection**
1. Perform on equipment unit by manufacturer's representative.
 2. Perform within 60 days prior to date of warranty expiration.
 3. Ascertain or appraise the following:
 - a. Status of equipment and installation after normal usage.
 - b. Adherence to manufacturer's recommended maintenance and operation of equipment.
 4. Include alignment checks.

- C. Make adjustments necessary to restore equipment within original tolerances.
- D. Submit a written letter report to Owner (with copy to Engineer) covering the inspection items and including recommendations where applicable.

3.6 Painting

- A. Prepare surfaces of damaged and uncoated areas and touch-up as required for complete protection.

PART 4 MEASUREMENT AND PAYMENT

4.1 Measurement

- A. No measurement will be made for this item, Submersible Sewage Pumps.

4.2 Payment

- A. Payment will be made at the contract lump sum price bid and shall be considered full payment for providing labor and materials to perform this work.

**** END OF SECTION 11313 ****