Section 15150 – Non-Clog Submersible Centrifugal Pumps and Drives

1. General.

1.1 Summary

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing wet-pit and dry-pit non-clog, submersible centrifugal pumps and drives.

B. Related Sections

01000 Special Provisions
01600 Materials and Equipment
01650 Starting of System
09900 Painting
13329 Sequence of Operation
15163 Variable Frequency Drives
16010 Electrical General Requirements
16050 Basic Electrical Materials and Methods
16260 Motor Controllers
16310 Motor Control Panel

1.2 Submittals

A. Submit shop drawings and manufacturers data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

1) Certified performance curves in accordance with Hydraulic Institute Standards signed and sealed by the manufacturer’s licensed professional engineer.

2) Certified copies of results of hydrostatic test.

3) Setting plans which shall include:

   (a) Anchor bolt layout and bolt dimensions.

   (b) Outline dimensions and weights of pumps and guiderail system.

4) Pumps: Submittal data and drawings shall include:

   (a) Manufacturer, type, and model number.

   (b) Assembly drawing, nomenclature and material list, O&M manual, and parts list.

   (c) Impeller type, diameter, sphere size passing, number of vanes and identification number.

   (d) Complete motor performance data including: HP rating, full load current, efficiency; voltage/phase/ frequency;
(c) Complete performance curve(s) showing full range (shutoff to run-out) head vs. capacity, NPSHR, hydraulic efficiency, motor active (KW) input power, and shaft power (BHP).

(f) The manufacturer shall indicate, by arrows to points on the flow versus head in feet of water curves, the limits recommended for stable operation, between which the pumps are to be operated to prevent surging, cavitation and vibration. The stable operating range shall meet the hydraulic performance requirements of the proposed system.

(g) A copy of the system head curves and recommend pump performance curves are included in Section 01000 - Special Provisions. The system head curves include high and low head conditions with appropriate friction factors. The system head curves shall be plotted on the CONTRACTOR’S proposed pump curve and submitted for review.

5) Location and description of Service Centers and spare parts stock.

6) Bearing life projection and warranty at the specified operating condition.

7) Operations and Maintenance Manual in accordance with Section 01600.

1.3 References

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. The referenced publications shall be the current effective edition.

B. Hydraulic Institute Standards (HI)

C. American Society for Testing Materials (ASTM)


2) ASTM A470 Standard Specification for Vacuum-Treated Carbon and Alloy Steel Forgings for Turbine Rotors and Shafts

D. American Iron and Steel Institute (AISI)

E. Insulated Cable Engineers Association (ICEA)

F. American Society of Mechanical Engineers (ASME)/American National Standards Institute (ANSI)

1) B16.1 Gray Iron Pipe Flanges and Flanged Fittings

G. National Electrical Manufacturers Association (NEMA)

H. Institute of Electrical and Electronics Engineers (IEEE)
2. Products

2.1 Products

A. Acceptable manufacturers and products must be on the Approved Product List on the City of Virginia Beach Department of Public Utilities web site or be determined by the OWNER to be an approved equal.

2.2 Pump Performance

A. The pumps shall be suitable for pumping raw sewage and shall be designed and fully guaranteed for this use. The fluid temperature range shall be from 40 degrees to 104 degrees F.

B. Sewage pumps shall be submersible centrifugal sewage pumps as shown on drawings with operating parameters as follows (see section 01000 - Special Provisions for details):

<table>
<thead>
<tr>
<th></th>
<th>Primary Condition</th>
<th>Secondary Condition</th>
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<tr>
<td>Capacity (gpm)</td>
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<tr>
<td>Total Dynamic Head (Feet)</td>
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<tr>
<td>Maximum Horsepower at Design Condition (bhp)</td>
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<tr>
<td>Speed at Design Condition (rpm)</td>
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<tr>
<td>Shutoff head (Feet)</td>
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<tr>
<td>Motor Horsepower</td>
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<tr>
<td>Speed</td>
<td></td>
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<tr>
<td>Impeller Size (In.)</td>
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C. Manufacturer shall confirm that NPSHR will be less than NPSHA at any point on the pump curve.

D. Secondary conditions will vary, based on manufacturers standard performance curves.

E. Pump seals shall be cooled without an external coolant source.
2.3 Pump Construction

A. Major pump components shall be of gray cast iron, ASTM A48, Class 30, with smooth surfaces devoid of blow holes or other casting irregularities. All exposed nuts or bolts shall be AISI type 316 stainless steel. All metal surfaces coming into contact with the pumped media, other than stainless steel, shall be protected by a factory applied spray coating of epoxy primer with an epoxy paint finish. The exterior coating of the pump as specified in Section 09900.

B. Sealing design shall incorporate metal to metal contact between machined surfaces. Pump/Motor unit mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton rubber O-rings. Joint sealing will be the result of controlled compression of rubber O-rings in two planes, and O-ring contact of four sides without the requirement of a specific bolt torque limit.

2.4 Cooling System

A. Wet-pit: Motors shall be externally cooled by submergence in the pumped media.

B. Dry-Pit: Motors shall be internally cooled by the pumped liquid and externally cooled by surrounding atmosphere. Closed cooling systems utilizing secondary cooling liquids such as potable water or glycol shall not be used.

2.5 Cables

A. The cable entry seal design shall insure a watertight and submersible seal. Each motor shall be fitted with sufficient cable so that no splices are required between the pump and the pump starters. The CONTRACTOR shall supply two separate cables for each pump and coordinate the required cable length for the installation as shown on the drawing. Control wiring or sensor cables shall be run in separate conduit than power cable or wiring. Cable restraints and supports shall be suitable to support cable without damage to the cable and be 316 stainless steel.

B. The power cable shall be Type ATC, SOW, or W and sized according to the NEC and ICEA standards and shall be of sufficient length to reach the control panel without the need of any splices. The outer jacket of the cable shall be oil resistant rubber.

2.6 Motors

A. Motor shall be furnished with nameplate indicating voltage, phase, current, design type; service factor; insulation class; rotation; speed; current, power factor, and start (max. inrush) current; locked rotor current; NEC code letter; and motor torque as a continuous function through the motor start cycle from no rotation to synchronous speed.

B. The pump motor shall be induction type with a squirrel cage rotor, shell type design, housed in an air or oil filled, watertight chamber, NEMA B type. Motor shall be UL listed for use in Class I, Division 1, Group C and D hazardous locations. The stator windings and stator leads shall be insulated with moisture resistant Class F installation rated for 311 degrees F. The stator shall be dipped and baked three times.
in Class F varnish, and shall be heat-shrink fitted into the stator housing. The use of bolts, pins, or other fastening devices requiring penetration of the stator housing is not acceptable.

C. The motor shall be specifically designed for submersible pump usage and designed for continuous duty pumping media of up to 104 degrees F and capable of up to 10 evenly spaced starts per hour. The motor and cable shall be capable of continuous submersion underwater to a depth of 65 feet without loss of watertight integrity.

D. Thermal switches shall be imbedded in the stator lead coils to monitor the temperature of each phase winding. These thermal switches shall be set to open at 125 degrees C, and shall be used in conjunction with and supplemental to external motor overload protection; and shall be connected to the control panel.

E. Dual moisture detection probes shall detect the entrance of moisture and provide an alarm. The moisture detection probes shall detect the entrance of moisture in the stator and lower seal cavity and send an alarm to the control panel. Single probe or float switch sensors shall not be allowed.

F. Motors shall be suitable for operation with controllers as indicated on the Contract Drawings. Motors for Variable Frequency Drive applications shall be rated for induction inverter duty.

G. The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.15 at an operating temperature of 104 degrees F ambient and with a temperature rise not to exceed 190 degrees F. A performance chart shall be provided showing curves for torque, current, power factor, input/output kW and efficiency. This chart shall also include data on starting and no-load characteristics.

H. The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve.

2.7 Bearings

A. The pump shaft shall rotate on bearings with a minimum L10 bearing life of 50,000 hours at any point along the usable portion of the pump curve.

B. For Inverter Duty Motors

  1) Insulate the ODE bearing and provide a shaft grounding strap. Insulate bearing probes to prevent shorting out bearing insulation.

2.8 Mechanical Seal

A. Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The lower seal shall be independent of the impeller hub. The seals shall operate in an oil reservoir that hydro-dynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump and the oil chamber, shall contain one stationary and one positively driven rotating tungsten carbide or silicon carbide ring. The upper,
secondary seal unit, located between the oil chamber and the motor housing, shall contain one stationary tungsten carbide seal ring and one positively driven rotating silicon carbide seal ring. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment and shall be capable of operating in either clockwise or counter clockwise direction rotation without damage or loss of seal. For special applications, other seal face materials shall be available.

B. Each pump shall be provided with an oil chamber for the shaft sealing system. The oil chamber shall be design to prevent overfilling and to provide oil expansion capacity. The drain and inspection plug, with position anti-leak seal shall be easily accessible from the outside. The seal system shall not rely upon the pumped media for lubrication.

2.9 Pump Shaft

A. Pump and motor shaft shall be a solid continuous shaft. The pump shaft is an extension of the motor shaft. Couplings shall not be acceptable. The pump shaft shall be of AISI Type 416 stainless steel, and shall be completely isolated from the pumped liquid.

2.10 Impeller

A. Impellers shall be non-clog type, manufactured of close-grained cast iron conforming to ASTM A48, Class 30.

B. Impellers shall be of one piece, single suction, enclosed radial flow design with well-rounded leading vane edges and a thick hydrofoil shape with large openings to prevent the accumulation of solids and stringy material.

C. The clearance between the impeller outside diameter and cutwater shall be capable of passing a 3-inch sphere. Impellers shall be statically and dynamically balanced and secured to a straight or tapered fit on the pump shaft by means of a bolt, washer and key. The arrangement shall be such that the impeller cannot be loosened by operating torque in either forward or reverse rotation.

2.11 Volute

A. Volutes shall be made of close-grained cast iron conforming to ASTM A48, Class 30 and of one piece design with smooth fluid passages large enough to pass any size solid that can pass through the impeller.

B. Volutes shall be flanged with discharge as shown on the Contract Drawings. Diffusion vanes are not permitted.

C. Volute discharge shall be a minimum of 4" diameter.

D. Volutes shall be furnished with large cleanout openings located at the impeller centerline, to allow access to the impeller.

E. Flanges shall be ASME/ANSI B16.1 class 125 raised or flat faced flanges.
F. Casing shall be hydrostatically tested to 1.5 times the design head or 1.25 times the shutoff head, whichever is greater.

G. Dry pit pump volute shall be furnished with a ¾ inch diameter tap for an air vent and a ½ inch diameter tap for a gauge connection. Both taps shall be located on top of the volute.

2.12 Wear Rings

A. Pumps shall be equipped with replaceable stationary and mobile wear rings.

B. The stationary wear ring shall be stainless steel with a Brinell hardness of 425-475.

C. The mobile wear ring shall be stainless steel with a Brinell hardness of 325-350.

2.13 Pump/Motor Protection Relay

A. All stators shall incorporate thermal switches in series to monitor the temperature of each phase winding. Should high temperature occur, the thermal switches shall open, stop the motor and activate an alarm.

B. A leakage sensor shall be provided to detect water in the stator chamber. When activated, the leakage sensor will activate an alarm.

C. Each pump shall be provided with its own self-contained control and status module, which will be mounted within the pump control panel. This module shall provide a single point within the control system for pump sensor output processing. The module shall have a manual reset.

D. All alarms connected to the control and status module shall be integrated with the RTU/PLC panel.

2.14 Guide Rail Bracket and Discharge Base for Wet-Pit Pumps

A. The sliding bracket assembly shall be a part of the pumping unit and constructed such that, when the pumping unit is lowered onto the discharge base elbow, the knifing action of the vertical metal to metal seal will provide a self-cleaning, non-clogging, non-sparking assembly.

B. Two 316 stainless steel rails shall be provided to guide the pump when it is being raised or lowered in the wet well. They shall mount on the discharge base/elbow provided by the pump manufacturer and be secured at the top to the top slab. The rails shall guide the pump into position on the discharge elbow as it is lowered into place. The rail guide system shall be secured to the wall discharge piping with intermediate 316 stainless steel brackets at no more than 8-foot intervals.

C. The discharge base shall be rigid, set and secured to the concrete floor of the wet well and shall be capable of supporting the total weight of the pumping unit and discharge piping. The base shall be bolted directly to the wet well bottom slab using 316 SS adhesive anchors or cast in place SS anchor bolts. The discharge base shall include a
90 degree elbow with a 125 pound ANSI flange discharging vertically, be suitable for the pump and be of manufactured of either cast or ductile iron.

2.15 Pump Lifting Bail for Wet-Pit Pumps

A. Wet-pit pumps shall be supplied with a factory installed fixed stainless-steel lifting bail. If the pump vendor does not offer a lifting bail, one shall be fabricated and provided by the CONTRACTOR.

2.16 Spare Parts

A. One spare full diameter impeller and one spare set of mechanical seals.

2.17 Sump Pump

A. The sump pump shall be a submersible unit capable of pumping 20 gpm at 20 feet of head. The unit shall have a 115/230-volt single-phase 1/2 HP (min.) motor. The unit shall be equipped with a vertical slide float. The unit shall be equipped with a 1-1/2-inch NPT discharge. The unit shall be hard wired to the L.P. panel on a dedicated circuit. No other components will be permitted on the sump pump circuit. If a junction box is required between the pump and the panel, the junction box shall be waterproof.

3. Execution.

3.1 Installation

A. Pumping equipment shall be installed in accordance with recommendations of the manufacturer, and the details shown on the contract drawings. A copy of the installation instructions shall be made available to the ENGINEER and the OWNER prior to equipment installation.

B. In the event any equipment fails to meet the specifications, it shall be modified and retested in accordance with these specifications.

3.2 Pump Testing

A. After installation, the pumping system shall be field tested using potable water. The CONTRACTOR shall be responsible for providing water and for conveying the water to the site and providing required meter and back-flow prevention check valve assembly. Each pump shall be cycled through the sequence of operation “pump on” as the level rises in the wet well and then “pump off” during draw down. Once each pump has been tested separately, the pumps will be operated in parallel.

B. Each pump shall operate over its intended operating range without undue noise, vibration, or cavitation. The CONTRACTOR shall monitor and record vibration at three symmetrically located points on each pump at maximum and minimum speed and supply data to the OWNER. Each pump shall operate within the tolerances established in the Hydraulics Institute (HI) standards and within an acceptable range on the certified pump curve provided by the manufacturer.
C. Upon completion of the installation, on-site testing, and before acceptance by the OWNER, the Pump Manufacturer or the authorized Pump Manufacturer’s Representative shall submit a written statement that the pump installation has been completed in accordance with the manufacturer’s recommendations.

3.3 Manufacturer’s Representative

A. Provide manufacturer’s representative in accordance with Section 01650 – Starting of System.

B. Prior to Operational Testing, the CONTRACTOR shall have the manufacturer do the following:

1) Megger test the stator and power cables.

2) Check proper rotation.

3) Check power supply voltage.

4) Measure motor operating load and no load current.

5) Check level control operation and sequence.

C. During Final Acceptance Testing, the manufacturer's service representative shall review recommended operation and maintenance procedures with the OWNER’S personnel.

END OF SECTION