SECTION 11210

VERTICAL (DRY-PIT) CENTRIFUGAL SEWAGE PUMPS

PART 1 GENERAL

1.01 REQUIREMENTS

A. Furnish, install, adjust, test, and start a vertical (dry-pit) non-clog centrifugal sewage pump with extended shafts and variable speed electric motors, complete as specified below.

B. It is the intent of these Specifications to obtain complete and operable equipment. All items and accessories appearing in the manufacturer's literature as standard, as modified herein, shall be included. Also, since it is not possible to name every single component, all accessories necessary to accomplish the intent of these Specifications shall be included as if they were specifically mentioned herein.

C. All equipment and accessories shall be of the highest quality available in the industry, and assembly and installation shall show the highest quality of workmanship available in the respective trades.

D. All equipment furnished shall be new, unused, the products of manufacturers having a minimum of five (5) years experience in manufacturing, marketing and servicing units similar to those proposed for this project.

1.02 SUBMITTALS

A. Furnish and submit shop drawings that shall include the following technical information as it may apply to the Project:

1. Pump dimension drawings.
2. Pump performance curves, including other impeller sizes.
3. Materials of construction.
4. Couplings or extended shaft.
5. Motor dimensions.
6. Motor Specifications including efficiency.

B. Pumps over 200 HP: For pumps over 200 HP submit with assembly drawings, three (3) copies of a lateral critical speed analysis and torsional frequency analysis for the assembly prepared by the pump manufacturer. Provide calculations to support bearings and shafts selection and deflection, per latest Hydraulic Institute Standards. All calculations for the proposed pump with impeller are required to meet the future conditions listed in these specifications including the worst case in the performance curve. Calculations shall include structural considerations and shall verify that the design is sufficient to accommodate all dynamic operational forces of the pump equipment, and provide a smooth and quiet performance with minimum vibration.

C. Instruction Manuals: Furnish five (5) bound and indexed sets of Operations and Maintenance manuals, prepared by the pump manufacturer, properly organized for quick reference and shall include the following information:

1. Operating instructions
2. Maintenance instructions
3. Parts lists
4. Dimensional drawings
5. Assembly drawings
6. Installation instructions
7. Equipment performance and test data

1.03 SCOPE OF LATERAL CRITICAL SPEED ANALYSIS AND TORSIONAL FREQUENCY (PUMPS OVER 200 HP)

A. Conduct a lateral critical speed analysis of the pump to determine Lateral Critical speeds which can be excited by the operation of the pump with a focus on the determining if the pump design meets the specified separation margin criteria.

B. Determine all natural frequencies and mode shapes for all pump rotor lateral natural frequencies up to 125% of vane pass frequency.

C. The “wet” critical speed analysis will be iterated to create the “dry” analysis results, (Both wet and dry analysis results are specified).

D. The shaft deflection in the seal area shall be determined.

E. A shaft fatigue analysis will be performed with the shaft -bending stress due to the radial load as the alternating load, and the torsional stress as the mean stress.

F. The mean and alternating stresses with stress concentration factors will be plotted on a Goodman Diagram to determine if a factor of safety of at least 2, is obtained.

G. Create a simplified model of the motor rotor and intermediate shafting using rotor mass, inertia, and center of gravity information provided by the motor and intermediate shafting.

H. Couple the motor, intermediate shaft, and pump rotor models and conduct a torsional analysis to determine torsional critical speeds which can be excited by the operation of the unit with a focus on mode shapes for torsional natural frequencies up to 125% of vane pass frequency, including 1x, and 2x, running speed, vane pass, and 1x, and 2x, line frequency.

I. Model the motor structure as a cylinder with the mounting flange wit properties adjusted based on motor static structure mass, reed frequency, and center of gravity information provided by the motor vendor.

J. Perform a structural (or Reed Frequency) test.

PART 2 PRODUCTS

2.01 GENERAL

A. The pumping unit provided shall consist of pump, coupling, base, electric motor and appurtenances.

B. The pumping unit as described herein, shall include all parts and accessories listed below or as necessary for proper installation of complete units. These shall include:

1. Pump with supports
2. Coupling
3. Extended shaft
4. Electric Motor
5. All parts necessary to connect all components of the pumping units together, except cables between motors.
6. Temperature switch
7. Spare parts

C. Impellers, shafts, and motors shall be dynamically balanced. Submit balance reports to the Engineer and include these reports in the final installation, operation, and maintenance manuals. All motors shall receive the best / precision / special balance available by the manufacturer for their product, to insure that the final composite assembly of the pump and motor shall operate without any natural frequency vibrations at any speed within the motor speed range.

D. To assure unity of responsibility, all components of the pumping unit shall be furnished by the pump manufacturer, who shall be responsible for the proper functioning of all parts manufactured by him or purchased from other manufacturers and included in his package.

2.02 PUMPS

A. The pumps shall be vertical, single stage, single bottom suction, clockwise or counterclockwise rotation (viewed from above), centrifugal, dry pit, non-clog, flexible coupled type, designed specifically for pumping raw sewage with a minimum solid sphere size of three inches.

B. The pumps shall be driven by electric motors. The units shall be automatically controlled according to level in the wet well.

C. Pumping units shall be capable of operating continuously at any head within the above range without damage to any component and without vibration levels exceeding those specified herein below. Pumps shall have a minimum efficiency of 75% at design operating point. Pump systems that operate at 4000 GPM and greater, shall start and stop against closed valves. These will not

open until the pressure on the pump side exceeds the pressure on the force main and the pumps will not stop until the valves are fully seated. Regardless of whether or not the large pumps are operated on variable speed controllers, the pumps shall be equipped with slow opening and slow closing, pump control valves to prevent transmission line surge. Pump flow control valves for this application shall be of the type and manufacturer, and configuration specified under another specification section, either attached or referenced in the pump criteria table.

D. Pump structure shall have a first natural frequency of at least twice the shaft rotative speed. Natural frequency or resonance shall not affect the operation of the pump at any point within the range specified.

E. Pumping units shall be capable of operating continuously at the designed performance range without damage to any component and without vibration levels exceeding those specified herein below. Pumps shall have the best efficiency as possible at the design operating point and throughout the whole range of the pump curve.

F. Vibration shall not exceed velocity limits established by the Standards "Rotodynamic Pumps for Vibration Measurements & Allowable Values," in ANSI 9.6.4, 2009, of the ANSI/Hydraulic Institute, throughout the whole range of the pump curve established by the pump manufacturer for the selected and approved pump.

2.03 PUMP COMPONENTS

A. Casing: Casing shall be ASTM A-48 Class 25-35 cast iron. The design shall be of sufficient strength, weight and metal thickness to insure long life, accurate alignment and reliable operation. Volute shall have smooth fluid passages large enough at all points to pass any size solid which can pass through the impeller and provide smooth unobstructed flow. Casing shall have removable suction cover and stuffing box cover. Casing shall be so arranged that the impeller may be removed without disturbing either suction or discharge piping. Pump Information shall be stamped on stainless steel tags permanently attached to the Pump.

B. Suction Elbow: The pumps shall be provided with a long-radius, increasing size, clean-out type cast iron flanged elbow which is bolted directly to the pump suction flange. The clean-out hand hole shall be provided with a removable cover of the largest possible size. The inner surfaces of each hand hole cover shall generally conform to the curvature and radius of the suction elbow. A 1/4-inch tapped hole for gauge connection shall be provided in the elbow near the suction flange.

C. Piping Connections: Suction and discharge connections shall be ANSI Class 125 flat face flanges, diameters to be at least but not less than as shown in the installation drawings. Each suction and discharge flange shall be drilled and tapped for gauge connections. A ½ inch IPS tap shall be supplied in the suction and discharge nozzle. Gauge connections shall be ½ inch-14 NPT in the suction

and discharge nozzles. Provide 3/4 inch plugged connections for casing vent and drain. Provide a hand hole located as to permit access to the impeller to clear obstructions and to measure the clearance between wear rings. The interior surface of the hand hole shall follow the contour of the casing.

D. Suction Cover Wear Plate: A replaceable AISI Type 400 series stainless steel suction cover wear ring or plate, providing 1/4 inch minimum wear, shall be installed with its wear surface parallel to the end of the impeller. The wear plate shall have a minimum of 375 BHN, and at least, 50 BHN points above the hardness of the impeller wear ring. The case wear ring shall be installed in the case using countersunk, flat-head, socket head, machine screws.

E. Impeller: Impeller shall be a single-suction enclosed type, single or multi-vane type, made of cast gray iron, ductile iron, or duplex stainless steel. Impeller shall be particularly designed with smooth water passages to prevent clogging by large chunks, splinters or fibrous materials, and shall be capable of passing solids having a sphere size of no less than 3 inches in diameter. The capability of the impeller to pass various size spherical solids shall be a function of the pump size, but in no event shall the size be less than 3-inches in diameter. Impeller shall be dynamically and hydraulically balanced, and shall be keyed and held in place and secured to the shaft by a stainless steel nut locked in place by no less than two set screws threaded into the pump shaft, and shall be readily removable without the use of special tools. The proposed pumps shall have impellers available for future acquisition and installation, at least 1-inch diameter above and below the one furnished. Evidence of this shall be offered in the form of published manufacturer's catalog data.

F. Impeller Wear Ring: A replaceable AISI Type 410 stainless steel wear ring allowing 1/4 inch minimum wear, shall be provided. The ring shall be mounted on the impeller to provide a renewable surface opposite the suction cover wear ring. The wear ring shall have a minimum 325 BHN; and at least, 50 BHN points below the hardness of the suction cover wear ring.

G. Impeller Clearance Adjustment: Pump shall have provisions for adjustment of axial clearance. This adjustment shall be made through the use of metal shims placed between the bearing frame and outboard bearing housing, sliding the inboard bearing relative to the bearing frame to assure positive bearing alignment. Clearance between wear rings shall be as necessary to avoid rubbing between wear rings, but not less than the manufacturer’s recommended tolerance.

H. Stuffing Box and Cover:

1. Stuffing box cover shall be made of close-grained cast iron with integral stuffing box. The stuffing box shall be designed to accept five rings of packing and have a water flush connection for the introduction of flushing water if the Department so chooses to install a flush water system. The bottom of the stuffing box shall be machined square for installation of the first packing ring.
2. The stuffing box shall include a 316 series stainless steel packing

follower gland and have 316 series stainless steel gland fasteners and hardware.

3. Provide Waterless Packing manufactured by Slade, no exceptions.
4. Provide spare packing rings for each pump, pre-cut and packaged for long-term storage.
5. The stuffing box cover and frame assembly shall be provided with a 1 inch, NPT threaded / tapped hole for the installation of a PVC male pipe adaptor and drain pipe to remove leakage from the stuffing box.

I. Shaft & Shaft Sleeves:

1. Pump shaft shall be high-strength carbon steel, AISI 1040, or 4140 accurately machined and of sufficient size to transmit full drive output. The shaft shall be tapered at the impeller end and the end shall provide for an impeller stud, nut or bolt, or a lock plate assembly.

2. Maximum shaft deflection at any point in the operating range under original or future performance shall not exceed 0.002 inch. The shaft shall be protected from the pumped liquid by a shaft sleeve in the stuffing box area.

3. Shaft sleeves shall be O-ring sealed to the impeller hub as well as the pump shaft. The shaft shall be O-ring sealed between the shaft and shaft sleeve to prevent leakage of pumped liquid out, or air into the pump.

4. The shaft sleeve shall be secured to the shaft by a socket-head setscrew, located on the shaft sleeve for easy maintenance access.

5. Where packing shall be in the stuffing box, renewable shaft sleeves used with packing shall be of a corrosion-resistant 420 series stainless steel and shall have a 450 or better, Brinnell Hardness. Ceramic-coated sleeves are not acceptable. Provide a spare shaft sleeve for every pump provided.

6. Where mechanical seals are required, renewable shaft sleeves used with the mechanical seals shall be a type 316 stainless steel. The sleeve provided shall extend the full length of the seal housing and under the gland.

7. If mechanical seals are required and provided, the contractor shall provide one complete replacement mechanical seal for each pump and two seal repair kits for each pump as spare parts.

8. If a mechanical seal is used for the pumps, it shall also be provided with a stainless steel, Spiral Track Series D, solids excluding bushing installed in the bottom of each stuffing box.

9. If mechanical seals are selected for use on the pumps, the seal manufacturer shall provide their solids excluding, automatic air venting controls that will provide for control of flush water as well as the removal

of trapped air at the seal faces.

J. Coupling and Protective Guard: Coupling shall be a metal grid type coupling with gear type hubs and totally enclosed coupling cover, as manufactured by Falk, SteelFlex, T-Series, or approved equal. Coupling alignment shall be required by use a register fit for the motor to the pump assembly by a precision machined motor support stand and C-faced vertical motor. The pump shall be provided with a completely-enclosing, 316 series stainless steel expanded metal mesh screen, which shall prevent accidental contact with the rotating coupling and shaft assembly.

K. Bearing frame: Pump bearing frame shall be one piece rigid cast iron construction. Frame shall be provided with a cast iron bearing housing at the outboard end, and a cast iron end cover at the inboard end. Both ends of the frame shall be provided with lip type grease seals and labyrinth type deflectors to prevent the entrance of contaminants. Frame shall be provided with a 1 inch IPS tapped hole, located as low as possible to drain any leakage form the packing gland. Bearing frame shall be designed so that the complete rotating element can be removed from the casing without disconnecting piping.

L. Bearings:

1. Bearings shall be designed for a B-10 life of 40,000 hours minimum at any point of present or future pump operation, and 100,000 hours at the BEP of the pump curve. Radial inboard bearing shall be ball or roller type suitable for all loads encountered in the service conditions. Axial thrust outboard bearings shall be angular contact double row ball type, suitable for thrust loads in two directions. Pre-loaded bearings shall have the pre-load adjusted by the use of pre-cut, precision, stainless steel, shims.

2. The bearings' temperature shall not exceed the manufacturer’s recommended temperature when operating continuously at any point through the recommended operating range of the pump. Provide factory installed, Mico Bearing RTD Temperature sensing instruments for each pump thrust bearing housing, for customer connection of electrical wiring.

M. Bearing Lubrication: Bearings shall be grease lubricated with provisions for the addition and relief of grease. Grease shall be lithium or aluminum complex base, as manufactured by Lubri-Plate, 1200-2 Series (Lithium Base) or 730-2 Series (Aluminum complex base), or approved equal.

N. Vertical Pump Support: Pump shall be supported by cast iron or fabricated steel pedestal base with openings large enough to permit access to the suction elbow and clean-out hand hole. Base shall be designed to support the assembled weight of the pump and shafting. It shall safely withstand all stresses imposed thereon by vibration, shock and all possible direct and eccentric loads. Supports shall be as shown in the drawings or of the pedestal type including the suction elbow. In any case, base shall have adequate horizontal dimensions,

foundation contact area, anchorage facilities and shall be of sufficient height so that the suction elbow will not touch the floor or foundation upon which the pump is mounted.

O. Vertical Pump Support:

1. Each pump shall be provided with a fabricated pump support structure or large steel support plate that will span the opening of two parallel pump support piers as shown on the station design drawings.
2. Each set of pump support piers shall be set at such elevation as to provide for the mounting of the below base, suction elbow for the pump, mounted with space under the elbow which shall not touch the floor.
3. The pump manufacturer shall design this support plate such that it will provide robust structural rigidity and dampen all natural and excited frequencies being grouted to the concrete support piers.
4. The use of fabricated steel support piers shall not be acceptable.
5. Pump support plates shall be wide enough to provide liberal access to all flange bolts in the suction elbow, elbow clean-out cover, and pump / pipe drain connections. Openings shall be large enough to permit access to the suction elbow and clean-out hand hole.
6. Base shall be designed to support the assembled weight of the pump and shaft. It shall safely withstand all stresses imposed thereon by vibration, shock and all possible direct and eccentric loads.
7. Supports shall be rigid enough to keep pump vibration within limits outlined by the Standards “Rotodynamic Pumps for Vibration Measurements & Allowable Values,” in ANSI 9.6.4, 2009, of the ANSI/Hydraulic Institute.
8. The structural support plate shall be a minimum of 1 inch thick steel for pumps with less than 100 HP motors and 1.5 inches thick for pumps with motors 100 HP and less than 200 HP. Pumps with motors 200 HP and above shall be provided with 2 inch thick mounting plates.
9. Mounting plates shall be machined flat on the top and bottom sides, and shall be factory coated on all surfaces except those where the pump mounts and the contact areas of the underside of the plate that are grouted to the top of the mounting piers.
10. Motor support assemblies shall be designed for mechanically rigid and stiff construction and connection to the pump support structures for the elimination of any naturally resonant vibration.
11. The pump support mounting plates which shall be grouted on to the concrete support piers, shall be grouted in place with epoxy grout, and set with a machinist’s level or laser level, flat to .005 inch over the entire span of the plate, to insure a plumb pump and motor shaft.

P. Hardware:

1. All pump fasteners, shims, and accessory hardware, including screen type coupling guards and their fasteners, shall be stainless steel and not have paint applied to any of their surfaces.
2. All pump fasteners shall use stainless steel flat washers and spring type

lock washers as the manufacturer prefers, for the protection of the painted surfaces.

3. All fasteners shall be hand torque tightened to published factory specifications and checked in the field after installation in the presence of the Department's representative.

2.04 MANUFACTURER

A. The vertical (dry-pit) non-clog centrifugal sewage pumps that are approved for use in the Miami-Dade Water and Sewer Department system modified as required to meet the Specifications are as follows:

1. Goulds Pumps NC,
2. Worthington,
3. Yeomans
4. Fairbanks Morse.

B. All pumps used in the Department system shall be compatible for operation and maintenance in the Miami-Dade Water and Sewer Department system and part of a standard pump model of the pump manufacturer. Parts shall be available in the present and for the foreseeable future. The cost and availability of the spare parts shall be acceptable to the Department prior to any pump purchase.

2.05 PUMP MOTORS

A. General:

1. Motors and auxiliaries shall comply with the latest applicable IEEE, ANSI and NEMA Standards, which are hereby made apart of these Specifications.

2. It is not the intent to specify details of design and construction. The motor shall be constructed and equipped with accessories in accordance with the manufacturer's standard practices where they do not conflict with this Specification.

B. Motor Design:

1. The motors shall be of the squirrel cage induction type, vertical solid shaft, 1.15 S.F., NEMA Type II weather protected with stainless steel air filters, of NEMA Design B or TEFC, and suitable for continuous operation in a 40° Centigrade ambient temperature at full horsepower. The motor shall not be overloaded beyond its full load rating by the pump at any operating condition on the pump characteristic curve. Suitable for operating with variable frequency drive controllers between 100% and 50% of full speed. Inrush current shall not exceed 5.6 KVA per rated horsepower, NEC code F. Motors shall be designed for frequent repetitive starting, with a cycle time of 10 minutes.

2. Motors shall be sized so that it is not overloaded at any point of the pump

curve.

3. The motors shall be designed to withstand a 5% overspeed in either direction of rotation. Motor torques shall conform with NEMA MGI-20.41.

4. Motors shall be designed to produce a maximum noise level of 95 dB at a distance of one meter from their surface. Insulation system shall be reated type "F" or better, suitable for a maximum temperature of 155 degrees C.

5. The motor shall be dynamically balanced and fan cooled. The use of solder or similar deposits is not acceptable. Any parent metal removed to achieve dynamic or static balance shall be removed in a manner which will maintain the structural integrity of the rotor.

6. The motors shall be of the "high efficiency type" with a minimum guaranteed efficiency of 93% at full load. Motors shall have a maximum temperature rise at continuous full load of 80 degrees by resistance measurement. Efficiency and temperature rise shall be stamped in the nameplate. Efficiency shall be demonstrated with certified tests in accordance with the Standard 112-a of the IEEE.

C. Bearings:

1. Bearings shall be anti-friction type, ball bearing, double shielded and lubricated of adequate capacity to assure a minimum B-10 life of 100,000 hours. Anti-friction bearings shall be made from vacuum degassed steel.

2. Bearing and corresponding lubricant shall capable of assuring the minimum service as stated above. Where lubricant shall be grease, the bearings shall have readily accessible grease inlet and outlet fittings in the bearing housing to allow regreasing from the exterior. Where lubricant shall be oil, oil bath shall be fitted with suitable sight glass, and arranged to prevent the entry of oil or oil vapor to the motor windings.

3. Bearings shall be supplied with bearings temperature switches for remote alarm on over-temperature.

D. Motor Construction:

1. Frame shall be of fabricated carbon steel and end bells shall be made of heavy duty, impact resistant cast iron. Motor terminal boxes shall be a minimum of 1200 cubic inches, with standard threads. Metric threads will not be accepted. Separate boxes for high and low voltage shall be provided. The high voltage terminal box shall be designed for and include lightning arresters and surge capacitors and provided with insulated terminals of sufficient strength to support all terminated conductors and possible surge or vibration stress and sufficient dielectric strength for the imposed voltage. Capacitors and arresters shall be terminated with flexible leads. Supply conductors shall be physically

supported within the terminal box. The box shall be constructed of nine gauge or heavier aluminum. Access to the terminal box shall be thru a door with lock and key. All keys shall be the same.

2. The motor mechanical design and coil bracing shall be suitable for full voltage starting and also 5 cycle bus transfer as a precaution against possible high-speed reclosing. All winding and rotor bars shall be copper. End coil bracing shall be in place before VPI process. Insulation system shall be rated type "F" or better, suitable for maximum average temperature of 155 degrees C or higher. Individual turns in the starter coils shall be insulated with Class "H" enamel covered with two layers of polyester and glass yarn.

3. Motor shall be sized such that it will deliver full rated power and service factor at its rated temperature rise if the motor is later rewound, by a motor shop approved by the motor manufacturer, using conventional insulation.

4. The enclosure shall provide access to the interior parts of the motor for inspection or minor cleaning without a major disassembly of the motor. End-shields and bearing housings shall be provided to permit bearing and winding inspection without the need for realignment. Motor vent openings shall have removable stainless steel guard screens and inlet air filters with stainless steel media.

5. Lifting lugs shall be furnished, designed in accordance with NEMA MG 2-2.02.

6. All hardware shall be made of 316 stainless steel.

7. Exposed surfaces shall be protected with at least two coats of epoxy type paint after the surface has been cleaned and primed according to the instructions of the epoxy paint manufacturer. Motor vent openings shall have stainless steel guard screens and inlet air filters with stainless steel or aluminum media. Finish color shall be light gray conforming to ANSI 61.

E. Stator:

1. The complete stator shall be a sealed system which receives at least two complete vacuum pressure impregnation process cycles of 100% solids epoxy resin. Windings shall be provided with a polyurethane dispersion to inhibit insulation abrasion by sand, salt, fly ash or other abrasive materials entrained in the cooling air.

2. Stator and rotor core pieces shall be machine stamped from low loss non-aging silicon steel. Laminations shall be insulated by a layer of varnish or enamel.

F. Rotor Shaft:

1. Rotor shafts shall be designed for maximum strength and rigidity and shall be manufactured from carbon steel meeting SAE standard for 1045 steel.

2. For the rotor shaft, the critical speed shall be a minimum of 50% above the rated motor speed.

G. Space Heaters:

1. Motor shall be provided with 120 volt single phase space heaters (not touching the windings) sized to prevent condensation. Maximum temperature of the heaters shall not exceed 200° C.

H. Data Plates:

1. All data plates shall be stainless steel suitable attached to the pump. Data plates shall contain the manufacturer's name, pump size and type, serial number, speed, impeller diameter, capacity and head rating, efficiency, temperature rise and other pertinent data shall be stamped in the nameplate.

2. A special data plate shall be attached to the pump frame which shall contain identification of frame and bearing numbers.

I. Motor Manufacturers:

1. Motor shall be as manufactured by U.S. Motors, Ideal, General Electric, Westinghouse, Louis-Allis or approved equal.

2.06 TOOLS AND SPARE PARTS

A. Special Tools:

1. Furnish, together with the pumping units, one (1) set of any special tools, other than common plant mechanic’s tools, necessary to install, adjust, maintain or repair the pumping units or any of the components.

B. Spare Parts:

1. Spare parts as listed below shall be furnished with the pumping unit. These shall be packaged for long term storage in suitable heavy cardboard or wooden boxes, clearly marked with the contents.

2. Three sets of spare casing wear plates, impeller wear rings shaft sleeves, bearings and impellers shall be provided. In addition each pump shall be provided with a spare impeller trimmed at the maximum diameter available.

PART 3 EXECUTION

3.01 TEST, GENERAL

A. The tests of the pumping units are divided into four parts: Hydrostatic tests of pump component parts at the pump factory, tests of the motors at the motor factory, tests of the assembled pumps at the factory, and final acceptance tests to be conducted after installation.

B. Tests shall be scheduled, only after the factory has pretested the unit and submitted preliminary test data that has been deemed satisfactory by the Engineer.

3.02 HYDROSTATIC TEST OF PUMP COMPONENTS

A. Pump casings, suction covers and stuffing box covers assembled shall be pressure tested at 150 percent of the maximum shut-off pressure at the future conditions. The test pressure shall be held for a minimum of 15 minutes. Test reports certified by a manufacturing company official who is a Registered Professional Engineer in the State where the factory is located and who has personally witnessed the test shall be submitted to the Department.

3.03 MOTOR TEST

A. Routine factory certified tests shall be given to each motor as required by NEMA and ANSI Standards. Tests shall be performed in accordance with IEEE Standard No. 112A "Test Procedures for Polyphase Induction Motors and Generators".

B. In addition to the above, routine factory tests including no load, full load, locked rotor current and high potential tests shall be performed. Winding resistance, sound level, temperature rise and peak-to-peak amplitude of vibration shall be measured. Pull-in and pull-out torque shall be determined. Tests shall be made according to standard NEMA procedures and five (5) certified copies of reports and speed-torque curves shall be furnished to the Department before pump delivery.

C. The motor shall be tested for vibration at no load and at rated voltage and frequency. The maximum allowable peak-to-peak amplitude of vibration on the bearing chambers shall be 2.0 mils.

3.04 PUMP TEST

A. The pump shall be tested to develop the performance curves, for assurance of proper and vibration free operation.

B. Data gathering shall be in accordance with Hydraulic Institute Standards. Curves shall be plotted using the data obtained at the tests. All curves shall extend from shut-off to actual runout points. Curves shall include: head vs. capacity, brake horse power, mechanical efficiency and wire to water efficiency. There should be a minimum of 10 test points spaced at approximately equal

head. Test data and pump curves shall be certified and five (5) copies of each shall be sent to the Department.

C. Vibration shall be continuously monitored during all pump tests, After completing the performance test on the pump, the pump will be operated at variable speed from full speed to 50% of it and back to full speed and from shut-off to run out heads while monitoring the vibration.

D. Included in the performance tests there shall be a period of 5 minutes of pump operation against a closed discharge valve. Pressure, power consumption, and vibration shall be monitored. Immediately after completing this test, the pump shall be disassembled for inspection to determine if there is evidence of excessive shaft bending and/or rubbing of wear rings. If the temperature inside the pump approaches the boiling point the test will be stopped at that moment for the particular unit.

E. Field tests and assistance shall be provided by service technicians experienced in each kind of equipment installed, and for each specific function.

F. For equipment start-up and acceptance tests. The factory representative shall supervise the start-up and acceptance testing of each pumping unit, as described below. The pumping unit will be subjected to operational testing under a variety of conditions including low NPSHA and various discharge heads. Also included shall be vibration measurement tests as described in other paragraphs of this subsection of the Specifications. The factory service technicians shall perform all final adjustments necessary for the best possible operation.

G. At the end of each start-up and acceptance tests, including vibration measurements, the Department Representative and the factory representative shall, jointly, analyze the test data. If all evidences prove that the installation is correct, the factory representative shall issue a certification and upon acceptance of the Department's Representative of the statements in such certification, the unit will be considered accepted.

3.05 FIELD QUALITY CONTROL

A. Pump assemblies shall be furnished along with Manufacturer's Field Service Technicians for startup.

B. For pumps 200 hp and over, provide a minimum of 3 man days for a Manufacturer's Field Service technician and 2 man days for pumps under 200 hp.

3.06 INSTALLATION

A. All of the equipment specified under this section of the specifications shall be installed in strict accordance with these Specifications and the instructions received from the manufacturers. Workmanship and miscellaneous materials shall follow the best standards of quality recognized for the trades involved.

Where there may be conflicts between the Specifications and manufacturer's instructions, this shall be brought to the attention of the Department, who shall issue orders resolving the conflict, and its opinion shall be final and binding for all involved parties.

END OF SECTION