SECTION 11205 - SUPPLEMENTAL

VERTICAL MIXED FLOW PUMPS

PART I – GENERAL

1.1 SCOPE. Contractor shall furnish all labor, materials, tools, equipment, and supervision required to install vertical, variable speed mixed flow pumps with vertical hollow-shaft type motors direct-connected to the pumps with bolted motor couplings. Each pumping unit shall be provided with an electric motor. The pumps shall be utilized for pumping returned activated sludge (RAS) having 0.5% to 1.5% solids.

A. Work Included: Twenty-five vertical mixed flow pumps to be installed in the Secondary Clarifiers.

B. System Description. The existing pumps (various types) shall be replaced with new vertical mixed flow pumps. The new pumps shall be installed at the same location as the existing pumps. All new pumps shall be completely interchangeable between clarifier wet well locations.

C. Performance Assurance. Contractor and Pump Manufacturer shall coordinate the hydraulic model study and field performance tests to assure that each pump operates on the pump curve.

1.2 UNIT RESPONSIBILITY. The Pump Manufacturer shall be responsible for coordination of the necessary components to provide a complete pumping system. These components include the pump, pump motor, sole plate, variable frequency drive, instrumentation, RAS wet well baffles, clarifier center sludge well baffles, and seal water assembly.

1.3 RELATED WORK. These specifications must be used together with Specification Sections 11100, Pump Application General Requirements and 11050, Equipment General Provisions. Errors due to failure to reference these sections will be borne by Contractor. Related equipment sections include:

A. Section 05500 - Metal Fabrications (RAS wet well and clarifier sludge well baffles).

B. Section 15130 - Indicating Devices.

C. Section 16151 - Low Voltage Variable Frequency Drives.

D. Section 16220 - Motors.

1.4 QUALITY ASSURANCE.

A. All products shall comply with all applicable regulating codes and requirements of:

1. City of Detroit Building and Safety Departments.

2. Occupational Safety and Health Act (OSHA)-Federal and State.

3. Michigan Department of Environmental Quality (MDEQ).

4. Federal, State and Local Codes.

5. National Electrical Code (NEC).

B. The manufacturer shall ascertain that all work required under this Contract is executed in strict accordance with but not limited to the following reference standards:

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

2. American Society of Testing and Materials (ASTM).

3. American Water Works Association (AWWA).

4. American National Standards Institute (ANSI).

5. Federal Specification issued by the Federal Supply Service, General Services Administration, U.S. Government (Fed. Spec.).

6. Institute of Electrical and Electronic Engineers (IEEE).

7. National Electrical Manufacturer's Association (NEMA).

8. National Fire Protection Association (NFPA).

9. Hydraulic Institute Standards (HIS).

10. Underwriters Laboratories (UL).

C. These standards shall include all applicable latest amendments and errata. In case of conflict, the standards with the more stringent requirement shall apply. The RAS pumps, motors, and VFDs shall be from the same supplier.

D. The manufacturers for the pump, motor and VFD shall be responsible to ensure that the pump, motor, VFD and pump discharge column with all accessories are packaged and coordinated to make the entire pumping system compatible. Shop and field testing of pumps are as specified herein.

E. Provide services of factory-trained service engineer, specifically trained on type of equipment. Services to include:

1. Installation support, start-up, testing, and calibration.

2. Operation and maintenance instruction.

1.5 SUBMITTALS. Detailed, dimensioned shop drawings and data shall be submitted to the Engineer and approved before fabrication, shipment or specified work begins. Shop drawings to be submitted shall include outline and assembly drawings of the equipment, showing location of service connections. Drawings shall include bill of materials. Provide all required submittals such as O&M manuals, drawings, wiring diagrams, installation instruction, etc.

Submit certified shop and erection drawings and data regarding the vertical mixed flow pump and motor characteristics and performance including:

A. Suction Intake Physical Hydraulic Model Study [Cash Allowance Item]:

1. Model Testing Laboratory Credentials.

2. Detailed Test Procedures and Schedule

3. Model Testing Summary Report.

B. Certified pump curves based on actual shop test of pumping units that meet the specified requirements for head capacity, power and efficiency, using at least six (6) test points. Indicate the safe operating range on the certified pump curves. Submit pump curves for each unit on 8-1/2" by 11" sheets.

C. Pump drawings including materials and dimensions for the motor, sole plate, and all pump components.

D. Shop drawings for accessory equipment.

E. Operating and maintenance instructions and parts' lists.

F. O&M manuals.

G. Pump manufacturer shall provide written certification that the pumping unit is operating at least 35 percent above or below the critical frequency throughout the operating range and speed. Critical frequency analysis shall be performed by the pump manufacturer to assure smooth operation without excessive distortion or vibration.

H. Shop Performance Testing Procedures

I. Field Performance Testing Procedures and Final Report

1.6 WARRANTY. Each complete pumping unit shall be warranted for a period extending from Owner's acceptance through two (2) years after the date of acceptance.

1.7 FAILURE TO COMPLY. If the manufacturer fails to promptly rectify the defects/or replace any defects in the material, or performance on the VFD/pump equipment and appurtenances, or when a delay may result in serious loss or damage, the DWSD may choose to obtain the services of an independent contractor for repairs. All cost associated with this repair (including but not limited to fees and charges of engineers, hydraulic modeling consultants, architects, attorneys, etc., as well as all material and labor, etc.) shall be paid by the manufacturer. Manufacturer shall assume the responsibility of warranty for repair work. If modifications or repairs are unsuccessful, Contractor is responsible for removal of all equipment, as directed by Owner, at no additional cost.

1.8 PURCHASE OF PUMPING EQUIPMENT. The pump manufacturer shall furnish the pump; discharge column including the discharge elbow with provision for Victaulic coupling; and motor as a complete package to ensure proper coordination, compatibility of equipment and operability with the VFD.

1.9 PAINTING AND COATING. Surfaces in contact with sludge shall be surface prepared to SSPC-SP-10 and coated with two (2) coats of coal-tar epoxy paint. The internal surface of the motor shall be coated with the manufacturer's standard system, and surfaces in air shall be surface prepared to SSPC-SP-10 and coated with two (2) coats of epoxy paint. The motors and pumps shall be painted safety orange.

1.10 SUCTION INTAKE STRUCTURE PHYSICAL HYDRAULIC MODEL STUDY

A. The Contractor shall be responsible for coordination of a model study to be conducted by Northwest Hydraulics Consultants (NHC; ph: (604) 980-6011 Nancy Sims/Brian Hughes) using personnel that have experience in modeling pump intakes. The objective of the model study is to ensure that the final wet well and baffle configuration generates favorable flow conditions at the inlet to the pump and to provide recommendations for optimizing baffle configuration. The model study shall be conducted to indentify adverse hydraulic conditions that can affect pump performance, including:

1. Free and sub-surface vortices.
2. Swirl approaching the pump impeller.
3. Flow separation at the pump bell.
4. Non-uniform axial velocity distribution.
5. Flow splitter plate orientation.
6. Baffle port size and orientation.
7. Model will indicate any non-ideal suction intake flow condition.

B. The designed contract documents wet well and baffles shall be modeled using the design pump size and location in the wet well to evaluate the potential adverse hydraulic conditions, in accordance with the Hydraulic Institute, American National Standard for Pump

Intake Design. After collecting data for the proposed configuration, baffle design modifications shall be made to remediate any adverse conditions, and conduct further evaluations using the model to optimize intake conditions over the range of design pumping conditions. Upon completion of the model tests, and prior to executing any submittals for full scale modifications, the model test results and summary shall be submitted to the Engineer for review.

1. Physical Model Description. With only one RAS pump per wet well and assuming that all wet wells are similar in design and pumping capacity, only one wet well will be modeled. A 1:4 scale physical model will be developed based on the drawings provided by the Engineer. The model will include approximately 30 feet (prototype) of the RAS pipeline (equivalent to 10 diameters), the RAS wet well and the RAS pump suction bell and pump column. The model wet well and pump will be fabricated using clear acrylic plastic to permit visualization of the flow patterns within the wet well and entering the pump suction bell. The model will allow for evaluation of impact of swirl and entrained air in the RAS influent pipeline on the wet well configuration. The impact of return activated sludge solids content will be considered as part of the study.

During design and construction of the model, care will be taken to ensure the features of the model can be modified during the test program to facilitate design modifications as necessary. Specific allowances will be made for the installation of baffles as described in the Contract Documents provided by the Engineer.

Flow will be circulated through the model using a centrifugal laboratory pump. Total model discharge will be controlled with a butterfly valve downstream from the laboratory pump and measured with an orifice plate.

2. Tasks. The study will be executed using the following tasks:

a. Task 1: Model Design and Construction – NHC will prepare physical model design drawings and submit them to the Engineer for review and approval, prior to the onset of model construction.

b. Task 2: Model Testing – Model testing will be separated into the following phases:

1) Existing Design Tests – This model will be used to evaluate the performance of the existing wet well design to identify the causes of the current pump performance problems. Testing will be limited to two (2) operating conditions (maximum flow rate at maximum and minimum water levels).

2) Initial Design Tests – Evaluation of the proposed design for the replacement RAS pumps, including evaluation of the preferred baffle configuration developed by the Engineer (or a refined baffle configuration developed on the basis of the existing design tests). Again, testing will be limited to two (2) operating conditions (maximum flow rate at maximum and minimum water levels).

3) Design Development Testing – Development and evaluation of modifications to the proposed design. It is anticipated that refinements to the baffle configurations could be implemented that would either improve performance or reduce construction costs. One and one-half (1.5) weeks of design development testing have been included in this scope of work. No more then five (5) tests should be allowed to evaluate baffle configurations in the model.

4) Final Design Documentation Testing – Following the development of a preferred design, the physical model will be run to document the selected geometry under a variety of operating conditions. Two (2) operating scenarios will be run for this final evaluation.

c. Task 3: Witness Test and Reporting:

1) A model witness test will be held at NHC's laboratory to present the findings of the study and demonstrate the performance of the proposed final design.

2) A model study report will be prepared and submitted to the Engineer within 2 weeks of completing the model tests. The report will contain a description of the model; a summary of modeling procedures; and a description of the simulation results, including video recordings, observations, tabular and graphical data; conclusions; and recommendations. Five bound hard copies of the final report will be provided.

PART 2 – PRODUCTS

2.1 MANUFACTURERS.

A. KSB, Inc.

B. Cascade Pump Company.

C. Fairbanks-Morse

The manufacturers shall be limited as indicated without exception.

2.2 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. The vertical mixed flow pumps shall be designed for pumping returned activated sludge (RAS) having 0.5% - 1.5% solids and shall be interchangeable.

A. Each pump shall be designed for the following flow conditions:

1. Fluid Pumped: Activated sludge
2. Unit Weight: 62.43 lb / ft3
3. Max Capacity: 12 mgd

4. General Head of Pump: 30 feet
5. Power Absorbed: 100 HP (safety factor included)
6. Speed: 880 rpm / 1180 RPM

B. Return Activated Sludge pumps shall be single-stage vertical mixed flow type, driven by inverter-duty vertical hollow shaft motors equipped with variable frequency drives. The pumping unit shall be designed to withstand all static loads, dynamic load, thrust, head and vibrations developed by the pumping system throughout the operating range for 24 hours a day, 365 days per year, without excessive noise or damage to the pump system, piping or structure (based on HI Standards). All rotating parts shall be static and dynamic balanced. The pump design shall result in theoretical hydraulic balance. The manufacturer shall provide certificates of static and dynamic balance/specifying the residual unbalance in accordance with the International Organization for Standardization requirements. The pump capacities and characteristics are:

CAPACITY / CHARACTERISTIC	MAXIMUM DESIGN	NORMAL OPERATION	MINIMUM OPERATION
MGD	12.0	7.0	5.2
GPM	8,330	4,860	3,610
Rated Total Head (ft)	30.0	22.5	20.5
Guaranteed Efficiency (min.)	77%	76%	67%
RPM	880 / 1180	655 / 850	592 / 750
BHP	76 / 82	35 / 35	27 / 24

C. The pumps, at maximum total head, shall not load the motors in excess of their rated horsepower under conditions of normal voltage, frequency, temperature, and clean water.

D. Based upon the specific pump selected, the pumps shall be capable of passing 2-inch diameter solids.

E. Noise level of pump/motor shall not exceed 80 dB at a distance of five (5) feet.

2.3 PUMP CONSTRUCTION.

A. Pump Discharge Column. The pump discharge column shall be made of steel pipe and shall have discharge flange of 18” diameter in accordance with the requirements of ASTM 134-90, ANSI/ASME B-36, 10M-1985 having a minimum wall thickness of 5/16”.

1. The top portion of the discharge column shall be welded around the periphery of the discharge column to a 1-1/2” thick base plate. The base plate shall be in accordance with the requirement of ASTM A-36.

2. The pump base plate shall have hole pattern matched to the sole plate. The sole plate shall have hole pattern coordinated with the concrete slab and curb as required at each pump location. The manufacturer shall field-verify the hole pattern and size of the bolts for the pump base plate and the sole plate.

3. Suitable lifting lugs shall be provided to lift the column.

B. Discharge Nozzle. The discharge column shall have a discharge nozzle of 18" outside diameter, with saddle fitting on the discharge column and Victaulic end fitting at the discharge end or a suitable adapter to convert from a flanged connection to a Victaulic end fitting compatible with the existing 18" Victaulic couplings, where these have been provided on previous contracts. The piping material shall meet the requirements of ASTM 134-90, ANSI/ASME B-36 10M-1985 and shall have a wall thickness of 3/8".

C. Impeller. The impeller shall be multi-vane axial flow type; shall have fixed pitch vanes, made of A351 CF8M or 410 stainless steel; and shall be dynamically balanced. The impeller shall fit on the bowl shaft and be fastened to the shaft by thrust collar and key arrangement.

D. Pump Shaft. The pump shaft and impeller shall be supported by bearings. The pump, shaft, and motor shall be furnished as an integral unit. Each shaft shall be made of A276 420 PSQ or 416 PSQ stainless steel material adequately designed to meet the maximum torque required at any startup condition or operation point in the system.

E. Seals. The shaft sealing assembly shall consist of a cast iron tension box, bronze packing gland, bronze packing box bushing, stainless steel gland nuts and bolts, and packing-type seal.

F. Bearing. Each pump shall rotate on permanently water-lubricated, fluted rubber bearings or reinforced ceramic bearings. The bearings shall be suitably sized and properly spaced to transfer all radial and axial loads to the pump housing and minimize deflection.

G. Fasteners. All external screws, bolts, and fasteners shall be made of 304 or 316 stainless steel.

H. Nameplate. A stainless steel nameplate, having embossed raised letters and numbers, shall be attached to each pump casing. The name plate shall include design data pertaining to the respective pump on which it is mounted, located in an accessible location, which includes:

1. Manufacturer.

2. Product name.

3. Model number.

4. Serial number.

5. Date of manufacture.

6. Pump size.

7. Capacity and head.

8. Pump speed.

9. Impeller diameter.

10. Labels of tested compliance.

11. Similar essential data.

I. Integral Suction Bell Baffle. Each pump shall include an integral suction bell anti-swirl baffle fabricated from steel plate and attached to the pump suction bell with stainless steel hardware. Provide provisions to install the suction bell baffle in line with the pump discharge, perpendicular to the discharge, or at positions oriented 45 degrees from each of these positions.

2.4 SPARE PARTS.

A. The following spare parts shall be provided:

1. Three (3) Suction Bowl Bushings.

2. Three (3) Thrust Collars and Keys.

3. Three (3) Impellers.

4. Three (3) Discharge Bowl Bushings.

5. Nine (9) Sets of Line Shaft Bearings.

6. Three (3) Bowl Shafts w/ Chrome Journals.

7. Six (6) Line Shaft Couplings

8. Not Used

9. Three (3) Line Shafts w/ Chrome Journal

10. Not Used

11. Three (3) Tension Nut Bushings.

12. Three (3) Tension Nut Bodies.

13. Three (3) Tension Nuts.

14. Three (3) Lock Rings and Washers.

15. Three (3) Gland Plates.

16. Three (3) Head Shafts.

17. Three (3) Adjusting Nuts

18. One (1) Suction Bowl.

19. Three (3) Sets of Pumping Unit Indicating Devices.

2.5 SPARE PUMPS

In addition to the spare parts described above, provide the following:

A. Two (2) spare pumps (new).

2.6 SPARE PUMP MOTORS

In addition to the spare parts described above one of the following two options for spare pump motors shall be provided.

A. Two (2) new spare motors, including enough motor spare parts to rebuild three (3) motors.

2.7 SPARE PUMP VFDS

In addition to the spare parts described above one of the following spare variable frequency drives (VFDs) shall be provided.

A. Four (4) new spare VFDs, including recommended spare parts.

PART 3 – EXECUTION

3.1 GENERAL.

A. Execution Procedure.

1. Physical Hydraulic Model Study. Upon Notice-To-Proceed, the Contractor shall initiate the hydraulic model study as described in Section 1.10.

2. Shop Performance Test. Shop performance tests shall be performed on the first two pumping units to be used as part of the Pilot Field Performance Test. Only upon

successful completion of the Pilot Field Performance Test, shall the Contractor perform shop performance tests on additional pumping units.

3. Pilot Field Performance Test. Initially install and test first two pumps to verify performance prior to fabricating and installing remaining pumps.

4. Field Performance Test.

B. Delivery, Storage, and Handling.

1. Ship equipment, materials and spare parts assembled complete except where partial disassembly is required by transportation regulations or for protection for which it is intended.

2. Pumps shall be prepared for shipment after test. Preservative to be applied to machined surfaces and journals to prevent corrosion during transit. Each rotor to be blocked, as required, to prevent bearing damage by impact loading, such as humping.

3. All equipment shall be wrapped to guard against corrosive elements during storage.

4. Pack spare parts in containers bearing labels clearly designating project name, location, contract number, contents and pieces of equipment for which intended.

5. The Engineer and Installation Contractor shall be given two (2) week's notice of the date and time of delivery of all equipment. The delivery shall be made on Monday through Friday from 8:30 AM to 3:30 PM to the Wastewater Treatment Plant (WWTP), 9300 W. Jefferson, Detroit, MI 48209. The equipment shall be unloaded by the company undertaking the transportation as directed by the Engineer or the manufacturer.

6. Deliver spare parts at same time as pertaining equipment.

3.2 SUCTION INTAKE STRUCTURE PHYSICAL HYDRAULIC MODEL STUDY.

A. The physical hydraulic model study shall be performed as described in Section 1.10. The Contractor shall coordinate with the physical hydraulic model study laboratory to ensure accuracy and effectiveness to meet the design requirements.

3.3 SHOP PERFORMANCE TEST.

A. The Engineer shall be given (4) week's notice of all shop tests in order that arrangement may be made for his representatives to be present. The shop tests for the first two pumps shall be witnessed by the Owner and/or Owner's representative.
B. The Contractor shall test all pumps with one job VFD and one job motor.

C. Each pump has to be run for a minimum of 1 hour at each test point. Before testing, the pump should run 24 hours with full load with VFD. Initial readings at the start and also the end of the 24 hour run shall be recorded. The full load test readings should include readings with VFD before and after the test.

D. All pump bowl assemblies shall be given a shop performance test using a job motor job transfer switch, job bypass motor starter and job variable frequency drive shipped to the testing location. Test programs are to be conducted and be witnessed by the Owner's representative. The test program shall be conducted in accordance with the latest standards of the Hydraulic Institute for Vertical Pump Tests. Test reports shall be certified and submitted for review and approval prior to shipment from the factory.

1. The first part of the test program will be to determine the performance at the rated full speed that includes determination of bowl efficiency and brake horsepower using the job motor, job transfer switch, and job bypass motor starter. The head range for the test will be from approximately 50 feet to 25 feet.

2. The second part of the test program is to include operation of the job variable frequency drive. Tests shall be conducted to determine the speed at which the specified reduced speed performance requirements are satisfied. The test results shall indicate the head and capacity and establish a performance curve at each speed.

E. The Guaranteed Bowl efficiencies shall be expressed as a percentage to the nearest one tenth of one percent.

F. Pumps having efficiencies less than the ratings as specified in Article 2.2.B shall not be considered. The manufacturer shall make all necessary remedies to the equipment, if any, at no extra cost to the DWSD.

G. All pump casing and discharge column shall be tested at the factory under a hydrostatic test pressure of 1.5 times the rated head or 1.25 times the pump shutoff head at the rated speed.

1. Casings which show imperfections such as sweating, porosity, cracks or other defects shall be rejected. Plugging or patching of defects will not be permitted unless specifically authorized by the Engineer.

2. The manufacturer shall furnish certified copies of the hydrostatic test reports to the Engineer.

H. The shop tests shall verify the efficiency of the VFD unit, the vertical pumping unit and other equipment in this package.

I. The manufacturer shall furnish drawings for approval showing the proposed test arrangement and description of the test procedure. These drawings shall be submitted at least 30 days in advance of the date scheduled for the tests. The drawings shall include data on the equipment to be used and the various measuring devices.

J. Tests runs shall be made for at least six points on the head capacity curve as directed by the Engineer. There shall be zero signs of cavitation such as break-off from the normal head capacity characteristic or any unusual sounds or vibrations when operating at these conditions. The length of time of each test shall be sufficient to obtain stable and dependable results and shall be subject to the approval of the Engineer.

K. Operate the pump for not less than 1 hour and take readings at the start of testing and at each operating point to determine that the pump will operate satisfactorily without vibration at the specified minimum head condition, without more than the specified NPSH available in the installed field operating condition.

L. The pump shall not be shipped until hydrostatic and performance test submittals are approved.

M. If the performance of the pumps does not meet the requirements of the Contract Documents, similar tests shall be conducted on revised pumps and proof shall be furnished to the Engineer that the requirements are met.

N. The manufacturer shall submit for approval certified copies of the reports of the performance tests for each pump. These reports shall be complete and shall show all observed data, formulas, corrections, and constants used to arrive at the head, capacity, horsepower and efficiency of each test run. A sample calculation shall also be included to show how the results were obtained from the return data.

O. Shop test must use projects VFD drive and motor when testing pump.

P. All non witnessed pump test curves shall be certified by a third party.

3.4 PILOT FIELD PERFORMANCE TEST AND FIELD PERFORMANCE TESTS.

A. Each Pilot Performance Field Test shall include:

1. Each pump motor shall be tested separately and as a unit with the job VFD and its controls at the installation site at Detroit Wastewater Treatment Plant, and shall be conducted in conformity with the latest edition of the standards of Hydraulic Institute.
2. Each pump shall be run for a minimum of 48 hours before testing; 24 hours at full capacity with the VFD and 24 hours at full capacity without VFD (bypass). Record the pumping rate and motor load at the start and completion of each phase.
3. Pump shall be tested over its complete capacity range.
4. Test run shall be made for at least six (6) points on the head capacity curve asdirected by the Engineer, and as practical based on field conditions. It is anticipated that the existing pump discharge knife gate valve will be used to throttle the pump discharge to achieve the required head conditions.
5. Prior to the test, the Contractor and Pump Manufacturer shall coordinate or perform calibration of existing RAS discharge magnetic flow meter. Contractor and Pump Manufacturer shall provide all other instrumentation/equipment required for field

testing. Contractor and Pump Manufacturer are responsible for verifying the accuracy of instrumentation/equipment.

6. Pump shall be tested to determine its performance against the manufacturer supplied pump curves. The results should not deviate from the certified manufacturer's curve for efficiency, flow, head and horsepower by no more than 3.0% for normal operation and 5.0% for maximum design within 24 hours. There shall be zero signs of cavitation such as break-off from the normal head capacity characteristic (drift) or any unusual noise levels or vibrations when operating at these conditions. Results shall be subject to the approval of the Engineer.
7. Pump shall be tested to determine that the pump will operate satisfactorily without vibration or cavitation within the available range of field testing head conditions.
8. Pump shall be tested to determine that the pumping unit is operating at least 35 percent above or below the critical frequency throughout the operating range. The pump shall be tested for 10 starts per hour before putting into normal operation.

B. If the Pilot Field Test does not meet the performance criteria outlined above, as determined by the Contracting Officer, the Contractor is responsible for all modifications and retesting at no cost to DWSD. If modification is not successful, refer to Section 1.7 FAILURE TO COMPLY.

3.5 ADJUSTING, TESTING AND ADDITIONAL SERVICES.

A. The manufacturer shall make such field tests as he may deem necessary to determine the performance of the equipment is in conformity with the guaranteed performance data as submitted by him in the shop drawing submittal. He will be permitted to make minor changes and adjustments in the equipment before any field acceptance tests are made.

B. After the equipment has been started and prior to make field acceptance tests, the City will operate the VFD equipment and pump motor for a reasonable running-in-period during which the Contractor will be allowed to make adjustments and minor alternatives subject to the approval of the Engineer and to make preliminary performance tests.

C. The manufacturer shall perform a pump/motor vibration field test with the VFD equipment in the line and bypass modes, per Hydraulic Institute for vertical pumps.

1. Location of Points:
   a. Motor.
   b. Pump.

D. The manufacturer shall perform noise level monitoring according to IEEE 85 and shall not exceed 80 decibels at distance of five (5) feet away from any motor surface.

E. Qualified technical representatives of the equipment suppliers shall be provided by the manufacturer to secure proper installation, adjustment and testing. The number of visits required shall be coordinated by the Contractor for each of the components as follows:

1. Technicians representing the pump/motor and VFD manufacturers shall be provided for sufficient time to test, adjust and complete a proper installation for each pump and VFD to function as a complete system including any ancillary sensors and accessories.

End of Supplemental Section

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