CITY OF TAMPA

Bob Buckhorn, Mayor **CONTRACT ADMINISTRATION DEPARTMENT**

Michael W. Chucran, Director

ADDENDUM NO. 5

DATE: March 8, 2016

Contract 15-C-00037; Howard F. Curren AWTP Diffused Air Reactor Improvements, Phase I

Bidders on the above referenced project are hereby notified that the following addendum is made to the Contract Documents. BIDS TO BE SUBMITTED SHALL CONFORM TO THIS NOTICE.

Item 1: Pier Mounted Vertical Turbine Mixers Clarification: Mixers shall adhere to the requirements of the Contract Documents, including specification Section 11225, paragraph 1.03(E) "The pier mounted vertical turbine mixers shall be as manufactured by Chemineer Model 20 GT, or an approved equal."

Item 2: Section 11376 – Fine Bubble Diffused Aeration System: Replace Section 11376 – Fine Bubble Diffused Aeration System with the attached Section 11376 – Fine Bubble Diffused Aeration System.

Item 3: Section 15050 – Process and Utility Piping, Fittings, Valves, and Accessories:

Replace Paragraph 2.03.A.1 with the following:

> All butterfly valves shall be of the tight closing, peroxide cured, field replaceable EPDM seat design. Valves shall be bubble-tight at rated pressures with flow in either direction, and shall be suitable for applications involving throttling service. Valve disc shall rotate 90º from the full open position to the tight shut position."

DELETE Paragraph 2.03.A.8 in its entirety.

Item 4: Section 16485 – Variable Frequency Drives: Replace Section 16485 – Variable Frequency Drives with the attached Section 16485 – Variable Frequency Drives.

Item 5: Section 13615 Process Instrumentation and Controls-Products; Section 2.01 Field Mounted Instruments Section A. Thermal Mass Flow Sensor: Add the following table:

Tag #	Temp	Flow Rate	Line Size[2]	Pipe Sch.	Length of Straight Pipe[1][3]	Pressure
FE/FIT-111	20-200ºF	0-4680 scfm	12”	SS of 12 ga.	11’-0”	6-10.0 psi
FE/FIT-112	20-200ºF	0-3750 scfm	10”	SS of 12 ga.	11’-0”	6-10.0 psi
FE/FIT-113	20-200ºF	840-2420 scfm	10”	SS of 12 ga.	11’-0”	6-10.0 psi
FE/FIT-114	20-200ºF	280-1010 scfm	10”	SS of 12 ga.	11’-3”	6-10.0 psi
FE/FIT-115	20-200ºF	120-430 scfm	8”	SS of 12 ga.	11’-3”	6-10.0 psi
FE/FIT-116	20-200ºF	140-410 scfm	8”	SS of 12 ga.	11’-3”	6-10.0 psi
Spare	20-200ºF	0-4680 scfm	8”	SS of 12 ga.	Min 11’-0”	6-10.0 psi

(1) Refer to drawings M-102 through M-107 for actual upstream and downstream pipe lengths.
(2) Size may vary by diffuser manufacturer. To be coordinated with equipment supplied.
(3) Length based on line size provided. See note 2.

Item 6: Sheet E-103 Diffused Air Reactor Details; VFD INTERCONNECTIONS: Replace Note 2 with the following Note 2:

“2. Provide and install Yaskawa Model iQ1000 by ICON Technologies, with the following rating: 480V, 6-pulse, 17amp.”

Item 7: Sheet E-103 Diffused Air Reactor Details: VFD INTERCONNECTIONS: ADD ‘Load Reactor’ at output of VFD.

All other provisions of the Contract Documents and Specifications not in conflict with this Addendum shall remain in full force and effect. Questions are to be e-mailed to Contract Administration@tampagov.net.

Jim Greiner

Jim Greiner, P.E., Contract Management Supervisor

SECTION 11376

FINE BUBBLE DIFFUSED AERATION SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work: Furnish all labor, materials, equipment, and incidentals required to install, place in operation, and field test fine bubble diffused aeration systems for all six (6) zones of Train 1 of the Diffused Aeration Reactor as shown in the drawings. These Specifications are intended to give a general description of what is required, but do not cover all details, which will vary in accordance with the requirements of the equipment as offered. It is, however, intended to cover the furnishing, shop testing, delivery, complete installation, and field testing of all materials, equipment, and appurtenances for complete fine bubble diffused aeration systems as herein specified.

1. Equipment components included:

a. Stainless steel droplegs.

b. PVC manifolds.

c. Panel Diffuser assembly with membrane, gaskets, end seals, integral fixed joint couplings.

d. Stainless steel supports, hold downs and anchors.

e. Bolts, nuts and gaskets for aeration system flange connections.

f. Purge systems.

2. The aeration system shall be designed based on the following Actual Oxygen Requirements (AOR) and the following Standard Oxygen Correction Factors Perimeters unless otherwise approved by the Engineer.

3. Where shown in the drawings, diffuser grids installed in aeration zones with pier mounted vertical turbine mixers (Specification 11225), aeration equipment shall be compatible with mixers and designed to withstand any forces resulting from mixer. Coordinate with mixer manufacturer as required.

Parameter	Units	Max. (All Zones Aerated)	Max. (Zones 1 & 2 Anoxic)	Average	Min.
AOR	Lbs O_2/day	36,263	31,604	19,883	12,041
Alpha	-	0.55	0.55	0.55	0.55
Beta	-	0.95	0.95	0.95	0.95
Theta	-	1.024	1.024	1.024	1.024
Dissolved Oxygen	mg/L	2.0	2.0	2.0	2.0
Site Elevation	ft. above sea level	23	23	23	23
Ambient Pressure	psia	14.69	14.69	14.69	14.69
Temperature	°C	30	30	30	30

B. Related Work Described Elsewhere:

1. Project Coordination: Section 01040.
2. Operating and Maintenance Data: Section 01730.
3. Painting: Section 09900.
4. Piping, Valve, and Equipment Identification: Section 09905.
5. Pier Mounted Vertical Turbine Mixers: Section 11225.
6. Instrumentation: Division 13.
7. Mechanical: Division 15.

1.02 QUALITY ASSURANCE

A. Qualifications:

1. The equipment shall be products of manufacturers who are fully experienced, reputable and qualified in the manufacture of the equipment to be furnished. The diffused aeration equipment shall be the integrated product of a single manufacturer who designs and manufactures the entire assembly. The system components shall be designed, constructed, delivered and installed in accordance with the best practices and methods.

2. Each component and ancillary equipment items furnished under this specification shall be new and unused, and the product of a manufacturer

having a successful record of operation, manufacturing and servicing similar duty equipment for a minimum of five (5) years.

3. The diffused aeration equipment shall be furnished by a single supplier who shall be responsible for the coordination of the system design and who shall assume complete responsibility for the proper function of the system.

B. Equipment Manufacturers: The diffused aeration equipment shall be the Gold as manufactured by Sanitaire (Xylem, Inc). or Aerostrip Q Type as manufactured by Ovivo USA, LLC.

1.03 SUBMITTALS

A. Material and Shop Drawings: Copies of all materials required to establish compliance with these Specifications shall be submitted in accordance with Section 01040: Project Coordination. Submittals shall include at least the following:

1. Certified shop and erection drawings showing all important details of construction, physical characteristics, dimensions, connections, and anchor bolt locations. Show plan, elevation and cross sections of the equipment. Show details of droplegs, manifolds, quantity and location of diffuser assemblies, supports, hold downs, anchor bolt locations, threaded union and/or flanged joints, field connections, and purge systems.

2. Descriptive literature, bulletins, and/or catalog cut sheets of each item of equipment. Provide the recommended minimum, design and maximum air flow for the system.

3. The total weight of the equipment including the weight of the single largest item.

4. A complete total bill of materials for all equipment.

5. A list of manufacturer's recommended spare parts to be supplied including those specified in Paragraph 1.06, with the manufacturer's current price for each item.

6. A detail of the intended support members with certification demonstrating their adequacy for the application and anticipated loads.

7. Calculations showing the thermal expansion/contraction of the manifolds and air distribution headers and the resulting thrust forces, full buoyant

uplift load on the air distributers, as well as forces from the movement of the water. Provide calculations for the total loads the pipe supports and anchors must resist. Include forces from the pier mounted vertical turbine mixer and Mixed Liquor Return pumps, where applicable.

8. Performance data including oxygen transfer calculations, headloss calculations and pressure equipment and operating experience for the diffused aeration equipment indicating the equipment proposed for this Project will comply with the specified mixing and oxygen requirements.

9. The equipment suppliers' recommended installation procedures.

10. Submit a reference list of at least 5 different applications in domestic wastewater treatment plants of similar size, with at least 5 years of successful operation, where the manufacturer has supplied equipment substantially the same regarding design, materials of construction, structural elements and other characteristics to that proposed for this project.

11. The aeration equipment supplier shall submit a detailed operational description specifying instrumentation and process safety nets for the process control logic to protect the aeration system during operation.

B. Factory Oxygen Transfer Efficiency Test:

1. Provide factory clean water performance testing data for three (3) different conditions and densities to demonstrate the capacity of equipment to meet the specified oxygen transfer efficiency and mixing requirements. The three (3) test conditions shall be selected by the Engineer. Testing shall have been conducted at an approved facility by an independent testing firm.

2. Tests shall have been performed in accordance with the latest ASCE Clean Water Test Procedure.

3. Testing shall have been conducted in a tank having a surface area greater than 300 square feet to eliminate the potential of wall effects. Testing shall have been conducted at the specified submergence and for a diffuser density equivalent to the actual project tank configuration. Diffuser density is defined as the ratio of the total tank surface area to the total combined diffuser surface area.

4. Submit test data as part of the shop drawings for the diffused aeration equipment. Include a plot of pounds oxygen per day per 1000 cubic feet of tank volume versus air per 1000 cubic feet of tank volume in tap water at 14.7 psia, 20°C and zero dissolved oxygen at the specified submergence. Certify and stamp all tests by a Professional Engineer.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. The aeration system shall be delivered to the site for installation assembled in as large of sections as is practical. The diffused aeration equipment shall be capable of being set in place and field erected by the Contractor with only minimal field assembly.

B. All equipment and parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation.

C. The Contractor shall store and temporarily support equipment prior to installation in strict accordance with the manufacturer's recommendations and instructions. Protect all exposed surfaces. The Contractor shall keep records of the storage parameters and the dates that storage procedures were performed. The Contractor shall be responsible for work, equipment, and materials until inspected, tested and finally accepted.

D. Protect the equipment from being contaminated by dust, dirt, vibration and moisture. The equipment storage area shall be well ventilated to prevent excessive heat buildup.

E. Exposed openings for connection to piping shall be properly plugged or protected by wooden planks, strongly built and securely bolted to flanged surfaces.

F. The Contractor shall handle all components during delivery, storage and installation in a manner to prevent damage of any nature in accordance with the manufacturer's approved written instructions and in accordance with instructions given on-site by the manufacturer's representative.

G. Each box, crate or package shall be properly marked to show its net and tare weight in addition to its contents.

1.05 SPARE PARTS

A. The following spare parts shall be furnished and shall be suitably marked and boxed (protected from UV light) for shipment and storage:

1. Diffuser and Membrane Assemblies (ready for installation on air header)
   Quantity: 5 percent of total diffusers supplied

2. It is understood that the diffusers offered by various manufacturers have slightly different configurations. The intent of this Specification is to ensure

that the plant operational staff can replace membranes in a timely manner, therefore, depending upon the design of the diffuser, spares may include only membranes if the design facilitates simple membrane replacement. Alternatively, the entire diffuser assembly may be necessary if the membrane is not replaceable using standard tools and techniques normally available at a municipal wastewater treatment plant.

1.06 DEFINITIONS

A. SCFM: Standard cubic feet per minute is understood to be air at 68 degrees F, 14.7 psia, and 36 percent relative humidity flowing at a rate of 1 cubic foot per minute.

B. SOTE: Standard oxygen transfer efficiency is understood to be the fraction of oxygen transferred to tap water under standard conditions of 20 degrees C, 0.0 mg/l residual dissolved oxygen concentration, and a barometric pressure of 760 mm Hg (dry air).

C. Sidewater Depth: Sidewater depth is understood to be the interior dimensions from the structure base to the water surface.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. The test data submitted as part of the shop drawing shall indicate an SOTE of at least that required per Paragraph 2.01.D. at a sidewater depth of 17.00 feet over the range of air flows set forth in this Specification. The manufacturer of the aeration system shall design the aeration grids and place the diffusers to ensure that this transfer efficiency can be attained under the operating air flow ranges specified herein. Further, the system shall ensure adequate mixing within the basins to keep solids in suspension over the range of air flows specified.

B. The diffused aeration system will be installed in a concrete basin with six (6) aeration zones. Dimensions of zones are given in the table below:

	Zone 1[(1)]	Zone 2[(1)]	Zone 3	Zone 4	Zone 5	Zone 6[(1)]
Zone Length (ft.)	52’-7”	52’-2”	52’-2”	52’-2”	52’-2”	52’-7”
Zone Width (ft.)	53’-0”	53’-0”	53’-0”	53’-0”	53’-0”	53’-0”
Zone Depth (ft.)	17’-0”	17’-0”	17’-0”	17’-0”	17’-0”	17’-0”
Drop Leg Diameter (inches)	12	10	10		8	8

(1) A portion of the zone is unavailable for diffuser installation. Refer to Drawings for actual floor space available.

C. Design aeration system to transfer the following minimum amount of oxygen per day at standard conditions at the specified submergence, air rate and pressure.

Parameter	Units	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Max Pressure at Top of Drop Leg	PSIG	8.30	8.24	8.05	8.00	8.00	8.30
Minimum Diffuser Submergence	ft	15.86	15.86	15.86	15.86	15.86	15.86

Oxygen Transfer and Performance Requirements – Maximum (All Zones Aerated)								
Parameter	Units	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Total/ Overall
Oxygen Distribution	%	33.3	29.2	20.3	9.5	4.5	3.2	100
Actual Oxygen Transfer Rate (AOR)	Lbs 0_2/day	12,091	10,602	7,344	3,458	1,621	1,147	36,263
Standard Oxygen Transfer Rate (SOR)	Lbs 0_2/day	28,702	25,168	17,434	8,209	3,848	2,723	86,083
Min Delivered SOTE	%	29.4	32.2	34.5	39.1	43.6	40.7	32.8
Design Air Rate	SCFM	3,895	3,118	2,017	838	352	337(1)	10,556

(1) Design air flow rate based on minimum air rate required for mixing (0.12 scfm/ft^2) which exceeds that required for process.

Oxygen Transfer and Performance Requirements – Maximum (Zones 1&2 Anoxic)								
Parameter	Units	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Total/ Overall
Oxygen Distribution	%			31.3	27.6	24.0	17.1	100
Actual Oxygen Transfer Rate (AOR)	Lbs 0_2/day			9,877	8,721	7,596	5,410	31,604
Standard Oxygen Transfer Rate (SOR)	Lbs 0_2/day			23,447	20,703	18,032	12,843	75,024
Min Delivered SOTE	%			32.7	33.4	34.3	32.7	33.3
Design Air Rate	SCFM			2,865	2,472	2,099	1,569	9,005

Oxygen Transfer and Performance Requirements – Average								
Parameter	Units	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Total/ Overall
Oxygen Distribution	%			44.0	29.5	16.9	9.6	100
Actual Oxygen Transfer Rate (AOR)	Lbs 0_2/day			8,749	5,873	3,352	1,910	19,883
Standard Oxygen Transfer Rate (SOR)	Lbs 0_2/day			20,768	13,941	7,957	4,534	47,200
Min Delivered SOTE	%			33.4	35.9	39.3	39.1	35.5
Design Air Rate	SCFM			2,481	1,551	808	463	5,302

Oxygen Transfer and Performance Requirements – Minimum								
Parameter	Units	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Total/ Overall
Oxygen Distribution	%			55.7	23.0	11.5	9.8	100
Actual Oxygen Transfer Rate (AOR)	Lbs 0_2/day			6,702	2,773	1,381	1,185	12,041
Standard Oxygen Transfer Rate (SOR)	Lbs 0_2/day			15,909	6,584	3,279	2,813	29,638
Min Delivered SOTE	%			35.1	40.5	43.9	40.7	37.7
Design Air Rate	SCFM			1,811	650	337(1)	337(1)	3,135

(1) Design air flow rate based on minimum air rate required for mixing (0.12 scfm/ft^2) which exceeds that required for process.

2.02 EQUIPMENT DESCRIPTION

A. General:

1. The diffuser equipment system shall be of the fixed header, fine bubble, membrane strip type. The system shall be suitable for installation in the structures shown on the Drawings.

2. The process train will include multiple aeration zones and each zone will receive air via a single drop pipe. The number of aeration grids per zone are listed in paragraph 2.01. The locations and sizes of the drop pipes to each diffuser zone is provided in paragraph 2.01. The equipment for each grid shall include, but not be limited to, a vertical section of drop pipe, a flexible connection to the drop pipe, an air manifold, air headers, diffusers, supports, expansion joints, air manifold and header joints, gaskets, bolts, nuts, and washers.

3. The design, fabrication, and installation of the diffuser equipment shall be such that, upon completion of installation, all diffusers are leveled to within $\pm$ 1/4 inch of a common horizontal plane.

4. The fine bubble membrane strip diffuser equipment shall be designed for easy installation and shall include provisions for level adjustment, rotational adjustment, and thermal expansion.

5. The entire system shall be designed to allow for expansion and contraction over a temperature range of 60 to 104 degrees F when installed.

6. The system shall be designed to withstand the design air pressures plus a minimum 1.5 psig surge factor.

7. All pipe supports and assemblies shall be shop fabricated from Type 304L stainless steel with a 2D finish conforming to AISI 304L and ASTM A240-78a.

B. Drop Pipe, Air Manifold, and Headers:

1. Drop pipes shall be a minimum of Schedule 10 or 12 gauge Type 304L stainless steel pipe meeting the requirement of Section 15066. The pipes shall extend from approximately 8 feet below the top of the process tank to approximately 3 feet above the air grid manifold. A Van Stone style flanged connection with a 150 pound bolt pattern shall be provided at the top of the pipe and a Type 304L stainless steel band clamp coupling with gasket shall be provided for connection to the manifold.

2. Stainless Steel – Pipe, Fittings and Supports

a. Fabricate all welded parts and assemblies from sheets and plates of 304L stainless steel with a 2D finish conforming to ASTM A240, 554, 784, 778.

b. Fabricate non-welded parts and flanges from sheets, plates or bars of 304 stainless steel conforming to ASTM A240 or ASTM A276.

c. Welds & Welding Procedure

(1) Weld in the factory with ER 304L filler wire using MIG, TIG or plasma-arc inert gas welding processes. Provide a cross section equal to or greater than the parent metal.

(2) Provide full penetration butt welds to the interior surface with gas shielding of interior and exterior of joint.

(3) Continuously weld both sides of face rings and flanges to eliminate potential for crevice corrosion.

d. Corrosion Protection and Finish

Clean all welded stainless steel surfaces and welds after fabrication by using the following procedure:

(1) Pre-clean all outside weld areas to remove weld splatter with stainless steel brushes and/or de-burring and finish grinding wheels.

(2) Finish clean all interior and exterior welds and piping by full immersion pickling and rinse with water to remove all carbon deposits and contaminants to regenerate a uniform corrosion resistant chromium oxide film per ASTM A380 Section 6.2.11, Table A2.1 Annex A2 and Section 8.3.

(3) Corrosion protection techniques not utilizing full immersion methods are unacceptable and will be cause for rejection of the equipment.

3. Manifolds: Provide a PVC manifold for connection to the air distribution headers: Alternative 1.

a. Fabricate manifolds with a maximum length of 30 feet.

b. Provide threaded union or flanged joints to connect manifold sections and to connect to the air distribution headers to prevent rotation and separation.

(1) Design threaded union joints with spigot section connected to one end of the distribution header, a threaded socket section connected to the mating distribution header, an o-ring gasket and a threaded screw on retainer ring. Solvent welding shall be done in the factory.

(2) Fixed joints shall be designed to resist 80 ft-lb torque without joint movement or failure.

(3) All fixed joints shall have interlocking splines and grooves to prevent rotation of the air distributors. All rotational forces shall be transferred through the interlocking splines. Joints that require the o-ring to transfer rotational forces between the splines are not acceptable. If positive locking fixed joints are not used, all distributor connections shall be 125 lb flanges.

(4) Design flanged joints with a 125 lb drilling angle face ring, follower flange and stainless steel hardware.

c. Fabricate 6-inch diameter manifolds and larger of Schedule 40 PVC conforming to ASTM D1784, D1785 and D2466.

d. Design piping, pipe joints and supports to resist expansion/contraction thrust forces of the air distribution headers over a temperature range of 125ºF.

e. PVC components shall be produced from a PVC compound with a minimum tensile strength of 7,000 psi.

f. Design manifolds to withstand 125° F mean wall temperature.

g. PVC components shall have a titanium dioxide resin content of at least 1.5 percent to minimize ultraviolet light degradation.

h. Factory solvent weld all PVC joints and diffuser holders. Field solvent welding shall not be permitted.

4. Distribution Pipe (and Diffuser Holders): Alternative 1

a. Produce all pipe and fittings from PVC compound with a minimum tensile strength of 7000 psi.

b. Fabricate air distribution headers with a maximum length of 24 feet. Provide diffuser holders factory solvent welded to the crown of the pipe for positive air seal and strength.

c. Fabricate minimum 4-inch diameter air distribution headers of SDR 35 conforming to ASTM D3915, D3034, or Schedule 40 conforming to ASTM D1784, 1785 and 2466.

d. Connect air distribution header sections with threaded union or flanged joints to prevent rotation and separation.

e. Fabricate joints with mating halves which are factory solvent welded to the ends of the air distribution header. Field solvent welding shall not be acceptable.

f. Provide threaded union joints with spigot and socket ends joined with a threaded ring and sealed with an O-ring gasket.

g. Flanged joints shall include an angle face ring, follower flange with 150 lb. drilling and stainless steel hardware.

h. Air distribution headers and diffuser holders shall resist a dead load of 200 lbs. applied vertically to the outer edge of the diffuser holder.

i. Provide threaded removable end caps complete with gasket, threaded coupling and end plate at the end of each air distributer.

j. All fixed and expansion joint o-ring gaskets shall be of natural rubber/SBR with a Shore A durometer of 45±5.

5. Distribution Pipe and Manifolds (and Fittings): Alternative 2

a. PVC air header piping and fittings 6 inches and larger shall be Schedule 40, conforming to ASTM D 1784, 1785, and 2466.

b. Pipe and Fittings Extruded from Type 1, Grade 1, Class 12454-B material in accordance with ASTM D 1784.

c. Solvent Cement: In accordance with ASTM D 2564.

d. Polyethylene (PE) piping shall be 1-inch in diameter and meet the requirements of ASTM D 1248, Type III, Class C, Category 5 Grade P34, or ISO S8, 3/SDR 17.6.

e. All polyethylene shall be provided in continuous lengths. No field welding shall be required.

f. Provide compression fittings to connect PE piping to diffuser and air header piping.

g. All feed assemblies shall be fabricated for field installation using standard components and couplings.

h. Feed lines shall be easily connected and disconnected to allow purging of debris after installation but before operation. Each distribution pipe shall be supplied with a removable end cap or plug to allow purging of the air lines.

i. Couplings between segments of the PVC distribution pipe shall be from 304 stainless steel.

6. Pipe Supports: Provide each section of manifold and air distribution header (where applicable) with a minimum of two (2) supports. Additional requirements are set forth below:

a. General:

(1) Support spacing to be limited to a maximum of 8 feet.

(2) Design all supports to allow for thermal expansion and contraction forces over a temperature range of 125°F and to minimize stress build up in the piping system.

(3) Design supports to be adjustable without removing the air distribution header from the support.

(4) Design supports to allow for complete removal from the tank, less the anchor bolt, to facilitate installation of additional headers and in-tank maintenance. Support structures which consist of rods epoxied directly into the tank floor are not acceptable.

(5) All hardware for supports shall be Type 316 stainless steel.

b. Manifold Supports 6-inch Diameter and Larger:

(1) Supports shall include hold down guide straps, support structure and anchor bolts.

(2) Guide straps shall have a 2-inch minimum width to eliminate point load on manifold and minimize binding.

(3) Design supports for a total of ±2-inch vertical adjustment for leveling of manifold within 1/4 inch of a common plane.

(4) Attach supports to tank floor with two (2) Type 316 stainless steel anchor bolts.

c. Diffuser and Manifold Supports 4-inch Diameter:

(1) Provide guide and fixed type supports to allow expansion/contraction.

(2) Supports shall include hold down straps, support structure, and single anchor bolt.

(3) Design supports for a total of 1-1/2-inch vertical adjustment for leveling air distribution headers within ¼ inch of a common plane.

(4) Guide straps shall have 1-1/2-inch wide top and bottom contoured bearing surfaces with chamfered edges to minimize binding and resistance to movement of air distributor under full buoyant uplift load.

(5) Design strap to be self-limiting and so that it cannot be over-tightened.

(6) Fixed straps to have 1-1/2 inch wide top and bottom contoured bearing surface with punched burrs to positively grip the air distributor when tightened.

d. When diffused aeration equipment is installed in swing zones with mixers, additional supports shall be provided in the areas near the mixers to address the turbulence caused by the mixers. The number of supports shall be determined by the manufacturer of the diffused aeration system. Coordinate with mixer supplier to determine forces from the mixers.

e. When diffused aeration equipment is installed in areas near the Internal Recycle pumps, additional supports shall be provided to account for the forces created by the pumps. The number of supports shall be determined by the manufacturer of the diffused aeration system.

7. Membrane Diffuser

a. Incorporate an integral check valve or check valve perforation techniques into the membrane diffuser such that when air is shut off the pores close.

b. Design and test diffusers for a dynamic wet pressure (DWP) of 12 inches ± 20% water column @ 1.0 SCFM/diffuser and 2 inches submergence.

c. Visual Uniformity: Observe diffusers for uniform air distribution across the active surface of the diffuser at 0.5 SCFM/diffuser and 2 inches submergence. Active surface is defined as the perforated horizontal projected area of the diffuser.

d. Quality Control: Test diffuser using primary sampling criteria outlined in Military Standard 105E.

e. Manufacture diffuser membrane from sheets of polyurethane or homogenous thermoplastic material from the polyurethane family.

f. The membrane material shall have an additive for resistance to ultraviolet light.

g. Produce seemless diffusers free of tears, voids, bubbles, creases, or other structural defects.

h. The surface of the membrane shall be smooth to prevent biological growth from attaching.

i. Diffuser material shall provide minimum 5 year life in the wastewater environment. All diffusers shall be tested in the factory for uniformity, bubble distribution and leaks. All individual membranes shall be tested for pressure drop and given a unique serial number. All test results associated with the membrane serial number shall be maintained at the manufacturer's facility for a period of 5 years.

j. Furnish diffuser material to meet the following:

Test	ASTM Test Method	Value
Specific Gravity	D-792	1.13 +/- 0.5
Durometer (Shore A)	D-2240	90 +/- 5
Ultimate Tensile Strength	D-882	9700 PSI Min
Ultimate Elongation	D-882	550% Min
100% Modulus	D-882	1200 PSI Min
300% Modulus	D-882	3200 PSI Min

Min. Softening Point (TMA Onset)	ES2347-04	151 C/304 F
Max. Softening Point (TMA Endpoint)	ES2347-04	171 C/341 F
Tear Resistance (MD/CD Ave.)	D-1004	500 pli
Thickness		0.023" +/- 5%

k. Diffuser Body: Alternative 1

(1) Provide a 4-inch diameter diffuser body with wing assembly to support the polyurethane membrane.

(2) Extrude PVC diffuser body with integral diffuser support wing on the crown of the pipe to support and restrain the membrane.

(3) Diffuser body shall have a minimum 0.125" wall thickness.

(4) Longitudinal wing edges shall have a groove designed to seat a silicone o-ring cord to restrain membrane down the length of the diffuser.

(5) Diffuser support wings shall have end seal assemblies consisting of an EPDM gasket, PVC support holder, and stainless steel strap with locking unit.

(6) Perforations shall be needle-punched. A 3/8-inch wide strip down the longitudinal center of each membrane shall remain unperforated in order to seal over the air flow control orifices in the diffuser support wing.

(7) Design diffuser as one piece extruded part with a minimum thickness of 0.023-inch.

l. Diffuser Body: Alternative 2

(1) The frame shall provide structural support for the diffuser membrane and be structurally self-sufficient. In addition to securing the entire perimeter of the membrane with an airtight sealing mechanism, the frame shall provide the necessary mechanism for even distribution of air. No fasteners shall be allowed to penetrate the membrane.

(2) The base profile shall be made from PVC. The membrane shall be fastened to the base profile using polyamide tubing.

(3) Air shall be supplied to the strip diffuser through a fitting in the end of the diffuser. The air feed fitting shall be made from PVC and shall be bonded to the base profile.

(4) The diffuser shall be anchored by preformed elements (304 SS or PP) and secured by stainless steel bolts, nuts and anchors.

(5) The outside dimensions of the strip diffuser shall be approximately 7 inches wide and 98 or 157 inches long.

8. Anchor Bolts

a. Design a mechanical or adhesive anchor bolt system for embedment in 4,000 psi concrete with a pullout safety factor of 4.0.

b. Provide a mechanical stainless steel expansion type anchor bolt system.

c. Provide a chemical bond adhesive stainless steel anchor bolt system with stainless steel threaded stud bolt.

d. All anchor bolts shall be Type 316 stainless steel.

9. Liquid Purge System: Systems where the diffusers are mounted higher than the piping system shall be provided with a liquid purge system. Provide a liquid purge system for each aeration grid to substantially drain the submerged aeration piping system including air lift purge eductor line and control valve.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All materials and equipment shall be stored, handled and installed in such a manner as not to degrade quality, serviceability or appearance. The equipment shall be stored in a clean, dry location free from construction dust, precipitation and excess moisture as well as extreme temperatures. Diffusers shall be stored to avoid exposure to direct sunlight and heat (not to exceed 104°F).

B. Continuously weld both sides of face rings and flanges. All metal welding on the aeration equipment shall be completed by welders certified by AWS. All stainless steel welding shall be by the shielded arc, inert gas, MIG, or TIG method. Filler wire shall be added to all welds to provide a cross section of weld metal equal to, or greater than, the parent metal. Butt welds shall have full penetration to the interior surface, and gas shielding shall be provided to the interior and exterior of the joint.

C. Interior weld beads shall be smooth, evenly distributed, with an interior projection not exceeding 1/16 inch beyond the inner diameter of the air header or fitting.

D. All outside weld areas shall be wire-brushed to remove weld splatter. Brushes shall be of stainless steel and used only on stainless steel.

E. Solvent welding of PVC joints shall be in strict accordance with the pipe manufacturer's written requirements.

F. Follow equipment manufacturer's recommendations for sequencing of equipment installation. The diffuser system shall be stored, handled and installed in strict accordance with the manufacturer's recommendations to ensure that warranty of diffusers is not voided. The individual diffusers shall not be installed until all other work in the basin has been finished. Care shall be taken to protect the diffusers from physical damages and prolonged exposure to weather without protection. All air piping shall be purged of debris before the aerators are connected and the basins are filled with water. After the system has been installed and the air piping purged, all connections shall be tested for leaks. The basin shall be filled with clean water to a level a few inches above all connections and run at the design air flow rate without any visible leaks. Care should be taken to ensure that the air is properly cooled before entering the PVC piping and diffusers. The diffuser manufacturer shall be responsible for calculating and providing cooling loops.

G. Layout and install support anchors in accordance with equipment manufacturer's recommendations and anchor setting plan.

H. Level aeration system such that all diffusers connected to a header are within plus or minus 1/4-inch of a common horizontal plane. At the end of the break-in period, the air distribution shall be uniform over the entire basin.

I. The tanks shall not be filled with wastewater until the Engineer receives certification from the supplier that the complete system has been installed and tested in accordance with the written instructions of the supplier and that the system is ready for operation.

3.02 FACTORY SERVICE REPRESENTATIVE

A. The Contractor shall provide the services of a trained, competent, qualified and experienced factory field representative during inspection, testing and start-up of the equipment. The factory representative shall have a complete knowledge of proper operation and maintenance of the fine bubble diffused aeration system. The Contractor shall provide factory representative services for a minimum of four (4) 8-hour days in four (4) separate visits. The first two (2) visits shall be during installation to check and inspect the equipment. A third visit shall be for start-up of the equipment. The fourth visit shall be allocated solely to the instruction of the

Owner's personnel in the proper operation and maintenance of the equipment. Provide additional visits as required to ensure correct installation and operation of equipment at no additional cost to the Owner. Contractor shall be responsible for any additional cost.

B. The purpose of the services provided by the factory representative will be for the performance of the following work:

1. Verify that the Contractor is proceeding properly during the installation of equipment.

2. Following installation, but before the equipment is operated by others, the representative shall inspect the completed installation for soundness, completeness, correctness, alignment, arrangement, equipment setting, and operation of the equipment. The field engineer shall make, or cause to be made, any and all adjustments, corrections or repairs necessary.

3. Start-up of the equipment in the presence of the Contractor and Owner's operating personnel.

4. Train Owner's operating personnel in proper operation and maintenance procedures, startup/shutdown procedures, response to emergency conditions, and troubleshooting. The responsibility of the Contractor and the factory service representative with regard to start-up shall be fulfilled when the start-up is complete, the equipment is functioning properly and has been accepted by the Owner.

a. The training period for the Owner's operating personnel shall be scheduled at least ten (10) days in advance with the Engineer and shall take place after plant start-up and acceptance by the Engineer. The preliminary copies of operation and maintenance manuals specified in Special Conditions must have been delivered to the Engineer prior to scheduling start-up.

C. Upon completion of his work, the manufacturer's field engineer shall submit to the Engineer, six (6) copies of a written report for each diffused air system, as a result of his inspection, adjustments, corrections, repairs, start-up and testing. The report shall include descriptions of the inspection, adjustments, corrections and repairs made, testing and start-up, and training of the Owner's personnel. The report shall also include a notarized certification signed by the manufacturer's field engineer that the installed equipment:

1. Has been installed per manufacturer's requirements.

2. Has been accurately aligned, set and leveled and that proper running clearances have been established.

3. Is free from undue stress imposed by mounting bolts or equipment setting.

4. The equipment has been tested as required below in Paragraph 3.03 and is in conformance with normal operating parameters. Test procedures and results shall be included in the report.

5. Is ready for permanent operation on a continuous basis, is free from any known defects and that nothing in the installation will render the manufacturer's warranty null and void.

D. The Contractor's attention is directed to the fact that the services specified for the manufacturer's field engineer represent an absolute minimum acceptable level of service, and are not intended to limit the responsibilities of the Contractor to comply with all requirements of the Contract Documents. The Contractor shall procure, at no additional cost to the Owner, all services required, including additional or extended visits to the jobsite by manufacturer's representatives, to comply with said requirements.

3.03 INSPECTION AND TESTING

A. Upon completion of installation, the Contractor, in the presence of the Engineer and a qualified manufacturer's representative, shall perform tests necessary to demonstrate functioning of all component parts and compliance with these Specifications. The Contractor shall furnish all labor, equipment, water and power required to perform each test.

B. If the diffused aeration equipment performance does not meet these Specifications, corrective measures shall be taken or the equipment shall be removed and replaced with equipment which satisfies the conditions specified. A 24-hour operating period of the equipment shall be required before acceptance.

C. Equipment Field Testing:

1. Upon completion of all the mechanical work, the Contractor shall conduct testing as specified herein to demonstrate that the equipment performs in accordance with all Specifications.

2. The Contractor shall perform initial testing of the equipment to insure himself that the equipment will perform adequately during subsequent testing.

3. After installation of the fine bubble membrane strip diffuser equipment is complete, functional testing shall be conducted by the Contractor to check for leaks, uniformity of air release, and verification of level installation. Functional testing shall be performed with clean water at a depth over the diffusers as recommended by the aeration system manufacturer for the range of operating airflows. The Contractor shall repair any leaks in the headers, diffusers, pipes, or any part of the system. The test shall be repeated until the installation is void of air leaks.

4. After the functional and leakage tests, fill the tank to the normal operating level with reuse water and operate the diffused aeration equipment for 72 hours. Check for uniform air distribution over the range of operating airflows.

END OF SECTION

SECTION 16485

VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment and incidentals required, and install, place in operation and field test variable frequency drive(s) (VFD's).

B. The variable frequency drive shall be a space vector Pulse-Width Modulated (PWM) design. Modulation methods which incorporate "gear-changing" techniques are not acceptable. The final responsibility of distributor or packager modifications to a third-party standard product will reside with the VFD manufacturer. The VFD manufacturer shall have overall responsibility for the drives. The City has officially standardized on Yaskawa America, Inc. VFD's – no alternates will be considered. The Standardizaition Certificated of Conditions and Circumstances is included hereinafter.

C. VFD's shall be six pulse units. Refer to 2.02A.8 for the power unit rating requirements of the VFD.

D. VFD to be provided by Pump Supplier listed in Specification Section 11209 to assure coordination with pump and pump protective requirements.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Pumps, General

B. Section 16050 - Motors

C. Division 13 – Special Contstruction

1.03 QUALITY ASSURANCE

A. The entire VFD system as described in section 2.01B shall be factory assembled and system tested by the VFD manufacturer to assure a properly coordinated system.

B. Codes: Provide equipment in full accordance with the latest applicable rules, regulations, and standards of:

1. Local Laws and Ordinances.
2. State and Federal Laws.
3. National Electric Code (NEC).
4. Underwriters Laboratories (UL).

5. American National Standards Institute (ANSI).
6. National Electrical Manufacturers Association (NEMA).
7. Institute of Electrical and Electronics Engineers (IEEE).

C. The complete drive system shall be UL listed.

D. Acceptable Manufacturers:

1. Yaskawa America, Inc. – Model iQ Pump 1000 by ICON Technologies.

1.04 SUBMITTALS

A. Submittals shall conform in all respects to Section 01040 Project Coordination.

B. Submittals shall be custom prepared by the VFD manufacturer for this specific application.

C. Submittal information shall include, but not be limited to:

1. Equipment dimensions, including stub-up locations, shipping splits and shipping weights.

2. Catalog cuts of major components.

3. Spare parts list, per Paragraph 3.03.

4. Certifications, including:

a. Warranty.

~~b. Efficiencies, per section 2.02.A.1.~~

~~5. Harmonic Distortion Analysis, per section 2.01D.~~

PART 2 - PRODUCTS

2.01 Material and Equipment

A. Any modifications to a standard product required to meet this specification shall be performed by the VFD manufacturer only. Distributor or system integrator changes to the VFD manufacturer's product are specifically disallowed.

B. The VFD system shall consist of a main circuit breaker/disconnect, 3% input line reactor, 6 pulse converter section, control logic section, output inverter section, and 3% output reactor. ~~Isolation and bypass contactors shall be provided to allow across-the-line starting if the VFD fails. All components listed shall be integral to the VFD lineup, factory wired and tested as a complete system.~~ The entire VFD

system shall meet the requirements of NEC article 409 and IEEE 508A for fault current withstand ratings as indicated on the project electrical drawings.

C. Input circuit breaker, interlocked with the enclosure door, with through-the-door handle to provide positive disconnect of incoming AC power and shall be capable of being locked in the open position.

D. VFD system shall maintain a 0.95 minimum true power factor throughout the entire speed range.

2.02 VARIABLE FREQUENCY DRIVES

A. Ratings

1. VFD must have the range of horsepower ratings: 0.75 to 175 HP at 240 VAC; 0.75 to 1000 HP at 480 VAC; 1 to 250 HP at 600 VAC. VFD must have Variable Torque ratings and to optimize the VFD size for fan and pump applications.

2. Rated Input Power: 460 Volts 60 Hz, +10%, -5% at rated load, 3-phase.

a. Voltage Dip Ride-Through: VFD shall be capable of sustaining continued operation with a 40% dip in nominal line voltage. Output speed may decline only if current limit rating of VFD is exceeded.

b. Power Loss Ride-through: VFD shall be capable of a minimum 3 cycle power loss ride-through without fault activation.

3. Output Power: As required by motors supplied.

4. Ambient Temperature Range: 0 to 40°C.

5. Elevation: Up to 3300 feet (1000 meters) above MSL without de-rating.

6. Atmosphere: Non-condensing relative humidity to 95%.

7. AC Line Frequency Variation: +/- 3 Hertz.

8. Power Unit Rating Basis: 100% rated current continuous, 120% rated current for one minute, at rated temperature. If the power unit rating of the VFD does not meet the above requirements, provide VFD with one standard size larger than the nameplate motor horsepower.

9. Displacement Power Factor: 0.98 over entire range of operating speed and load.

10. Service Factor: 1.0

~~11. Vibration: 9.81m/s^2 (1 G) from 10 to 20 Hz; 2.0 m/s^2 (0.2 G) from 20 Hz to 55 Hz.~~

12. Minimum Efficiency: 96% at half speed; 98% at full speed.

13. Starting Torque: 120% starting torque shall be available from 3 Hz to 60 Hz.

14. Overload capability: 120% of rated FLA for 60 seconds; 170% of rated FLA peak.

15. Controlled speed range: 10:1.

B. Construction

1. The controller shall produce an adjustable AC voltage/frequency output. It shall have an output voltage regulator to maintain correct output V/Hz ratio despite incoming voltage variations.

2. The controller shall have a continuous output current rating of 100% of motor nameplate current.

3. The converter section shall be 6 pulse utilizing diodes.

4. The inverter output shall be generated by IGBTs. Pulse Width Modulation strategy will be of the space vector type implemented to generate a sine-coded output voltage. The VFD shall not induce excessive power losses in the motor. The worst case RMS motor line current measured at rated speed, torque and voltage shall not exceed 1.05 times the rated RMS motor current for pure sine wave operation. The inverters shall be able to sustain 1600 volt surges.

~~5. The controller(s) shall be suitable for use with any standard NEMA B squirrel cage induction motor(s) having a 1.15 Service Factor or with existing standard NEMA B squirrel cage induction motor(s) with nameplate data as shown on the plans. Provide drives with dV/dT output filters. At any time in the future, it shall be possible to substitute any standard motor (equivalent horsepower, voltage and RPM) in the field.~~

6. The control logic section shall be fully digital and not require analog adjustment pots or fixed selector resistors. A power failure will not necessitate a reload of any drive parameter or configuration.

7. Minimum Starting Speed: When called to operate, the VFD shall amp to a minimum speed. The minimum speed shall be adjustable but initially set at 60% of maximum speed. The 4-20 mA speed signal from the PLC and

~~potentiometer on the front of the drive~~ shall modulate the signal between the minimum speed set point and the maximum output speed of the drive; i.e., at the 4 mA signal, the VFD shall run at the minimum speed. At the 20 mA signal, the VFD shall run at full speed. The potentiometer shall also adjust speed between the minimum speed set point and the maximum running speed. Below the minimum speed set point, the potentiometer shall have no effect.

8. All 6 pulse VFD's shall be provided with 3% line and load reactors.

C. Basic Features

~~1. The door of each power unit shall include: a keypad with a manual speed device, "HAND / OFF / REMOTE/BYPASS" mode selector switch, "POWER ON" light, "VFD FAIL" light, VFD "RUNNING" light, fault reset pushbutton, "MOTOR OVER TEMPERATURE" light, "MOTOR SEAL LEAK ON" light, "ENCLOSURE OVER TEMPERATURE" light, "DRIVE LOCKOUT" light, CONTROL POWER ON light, START and STOP pushbuttons and a TEST / NORMAL selector switch. All lights shall be LED type.~~

2. The VFD shall include a customer selectable automatic restart feature. When enabled, the VFD shall automatically attempt to restart after a trip condition resulting from instantaneous overcurrent, overvoltage, out of saturation or overload. For safety, the drive shall shut down and require manual reset and restart if the automatic reset/restart function (programmable for up to 3 attempts) is not successful within a customer programmable time period. Auto-Restart shall be programmable to allow for individual fault selection.

3. A door-mounted membrane keypad with integral 2-line minimum, 24-character LCD display shall be furnished, capable of controlling the VFD and setting drive parameters. The keypad shall include the following features:

   a. The digital display must present all diagnostic message and parameter values in English engineering units when accessed, without the use of codes.

   b. The digital keypad shall allow the operator to enter exact numerical settings in English engineering units. A user menu written in plain English (rather than codes) shall be provided in software in nonvolatile memory as a guide to parameter setting and resettable in the field through the keypad. Multiple levels of password security shall be available to protect drive parameters from unauthorized personnel. The drive set up parameters must be able to be transferred to new boards to reprogram spare boards.

c. The following digital door-mounted keypad indications may be ~~selectively~~ displayed:

1) Speed demand in percent.
2) Output current in amperes.
3) Output Frequency in hertz.
4) Input voltage.
5) Output voltage.
6) Total 3-phase KW.
7) Kilowatt hour meter
8) Elapsed time running meter.
9) RPM.
10) DC bus voltage.

d. VFD shall have the capability of communicating via an RJ-45 Ethernet port with a General Electric RX3i PLC using MODBUS Ethernet protocol.

e. VFD parameters, fault log and diagnostic log shall be downloadable via a RJ-45 Ethernet port.

4. Refer to the VFD wiring diagram in the Drawings for remote signals and alarms.

D. Enclosure

1. All VFD components shall be factory mounted and wired on a dead front, grounded, NEMA-12 enclosure. If a free-standing enclosure is provided, it shall be suitable for mounting on a concrete housekeeping pad. Properly size enclosure to dissipate heat generated by VFD within limits of specified service conditions. Provide NEMA enclosure type as specified on drawings. Provide integral fans or cooling systems as required by the application. Circuit breaker interlocks to be able to be bypassed via lever on front door surface. NEMA 12 type enclosures to have keypad controls located on exterior of enclosure. ~~Provide visual alarm indicator on cabinet door.~~

E. Protective Features and Circuits: The controller shall include the following alarms and protective features:

1. Instantaneous overcurrent and overvoltage trip.

2. Undervoltage and power loss protection.

3. Power unit overtemperature alarm and protection. Upon sensing an overtemperature condition, the VFD is to automatically trip.

4. Electronic motor inverse time overload protection.

5. Responsive action to motor winding temperature detectors or thermostatic switches. A dry contact (NC) input to the VFD is required.

6. When power is restored after a complete power outage, the VFD shall be capable of catching the motor while it is still spinning and restoring it to proper operating speed without the use of an encoder.

7. The VFD shall be protected from damage due to the following, without requiring an output contactor:

   a. Three-phase short circuit on VFD output terminals.

   b. Loss of input power due to opening of VFD input disconnecting device or utility power failure during VFD operation.

   c. Loss of one (1) phase of input power.

~~8. The VFD shall continue to operate at a reduced capacity under a single-phase fault condition.~~

9. The VFD shall be able to withstand the following fault conditions without damage to the power circuit components:

   a. Failure to connect a motor to the VFD output.

   b. VFD output open circuit that may occur during operation.

   c. VFD output short circuit that may occur during operation.

~~10. Three phase lightning and surge protection across the line input at each VFD.~~

F. Parameter Settings

1. The following system configuring settings shall be provided and field adjustable, without exception, through the keypad/display unit. Except for Motor Nameplate Data, all parameters must be adjustable while the processor is on-line and the drive is running.

   a. Motor Nameplate Data.
      1) Motor frequency.
      2) Number of poles.

3) Full load speed.
4) Motor volts.
5) Motor full load amps.
6) Motor HP.
7) Current limit, max.

b. VFD Configuration Parameters.
1) Independent accelerate/decelerate rates.
2) Max/Min speed (frequency)
3) Catch-a spinning load selection.
4) No load boost.
5) Full load boost.
6) Volts/Hertz ratio.
7) Overspeed trip.
8) Overload trip curve selection.
9) Overload trip time selection
10) Adjustable Ramp Stop.

c. Automatic VFD Control.
1) PID utilizing an internal or external setpoint.
2) Three selectable critical speed avoidance bands with programmable bandwidths.
3) Auto start functions: On/Off, Delay On/Off. Operable from a 4-20mA signal or from the PID output, command, or feedback signal.
4) Speed Profile: Programmable entry and exit points.
5) Programmable loss of signal control: Stop, maintain last speed, or default to preselected setpoint.

2. All drive setting adjustments and operation parameters shall be stored in a parameter log which lists allowable maximum and minimum points as well as the present set values. This parameter log shall be accessible via a RJ-45 Ethernet port capable of communicating with a GE RX3i PLC using MODBUS Ethernet protocol as well as on the keypad display.

G. Input/Output Features

1. Two programmable analog inputs: VFD speed in, spare.
2. Three programmable analog outputs: VFD speed output, Drive (output) current in Amps, spare.
3. Two programmable digital inputs: Run, spare.
4. Ten programmable digital outputs: VFD fault, VFD running, VFD in remote, 6 spare.
5. One Pot input (three wire control, +10 V, wiper and common).

6. System Program providing built-in drive control or application specific configuration capability.

H. Diagnostic Features and Fault Handling

1. The VFD shall include a comprehensive microprocessor based digital diagnostic system that monitors its own control functions and displays faults and operating conditions.

2. A “Fault Log” shall be accessible via a RJ-45 Ethernet link capable of communicating with a GE RX3i PLC using MODBUS Ethernet protocol as well as line-by-line on the keypad display. ~~The "FAULT LOG" shall record, store, display and output to a serial port upon demand, the following for the 64 most recent events:~~

a. Date and time of day.

b. Type of fault.

c. All faults and events shall be stored and displayed in English, not fault codes.

3. A "HISTORIC LOG" shall record, store, and output via a RJ-45 Ethernet link port capable of communicating with a GE RX3i PLC via MODBUS Ethernet protocol upon demand~~, the following selectable control variables at 1 msec. intervals for the 58 intervals immediately preceding and the 20 intervals immediately following a fault trip:~~

~~a. Torque demand.~~
~~b. Torque command.~~
~~c. Torque feedback.~~
~~d. Torque error.~~
~~e. Torque maximum.~~
~~f. Current demand.~~
~~g. Peak current.~~
~~h. Motor current.~~
~~i. DC bus voltage.~~
~~j. Line voltage.~~
~~k. Velocity demand.~~
~~l. Velocity reference.~~
~~m. PI min/max limit.~~
~~n. Boost.~~
~~o. VFD mode (Auto/Manual).~~

PART 3 - EXECUTION

3.01 FACTORY TESTING

A. The VFD manufacturer shall provide as a minimum, the following quality assurance steps within his factory:

1. Manufacturer's standard tests to be provided. ~~Incoming inspection of components and raw materials based on strategic supplier base and experience. Sampling plans based on MIL STD 105E.~~

~~2. MIL STD 45662 calibration system.~~

~~3. All products subject to 100% testing and final inspection; no sampling plans permitted.~~

~~3.02 PRE-DELIVERY TESTING COORDINATION~~

~~A. One VFD unit of each specified type and application shall be shipped to the pump manufacturer's test facility for complete operational testing. The VFD Manufacturer shall provide a qualified representative at the pump Manufacturer's test facility during testing. All costs incurred by the VFD Manufacturer to meet this requirement shall be included in the bid.~~

~~B. Certified test reports shall be submitted to the ENGINEER before the equipment is shipped to the project site.~~

3.03 STARTUP AND TRAINING

A. VFD manufacturer shall provide the services of a factory technician for startup assistance and training. Verification of VFD input harmonic voltage and current distortion limits ~~specified must be verified as part of final startup and acceptance. If harmonic distortion requirements are not met, it is the responsibility of the VFD supplier to meet the specification at the supplier's expense. A recording type Fluke 41 or equivalent harmonic analyzer displaying individual and total harmonic currents and voltages must be utilized~~.

~~B. A 10% payment retainage will be released upon field test verification of harmonic specification requirements and final acceptance.~~

3.04 SPARE PARTS

A. The following spare parts shall be furnished:

1. Complete VFD power chassis. ~~Three of each type of fuse rated 460V or less.~~

~~2. Two of each type of converter power semiconductor.~~

~~3. Two of each type of inverter power semiconductor.~~

~~4. One of each type of type control printed circuit board and gate firing boards.~~
~~5. One keypad assembly.~~

3.05 FIELD QUALITY CONTROL

A. Functional Test:

1. Conduct on each VFD.

2. Inspect controller for electrical supply termination connections, interconnections, proper installation, and quiet operation.

3. Vibration Test: Complete assembly, consisting of motor, load, and flexible shafting, connected and in normal operation, shall not develop amplitudes of vibration exceeding limits recommended by current edition of Hydraulic Institute Standards. Where pumps and motors are separated by intermediate flexible shafting, measure vibration both at top motor bearing and at two points on top pump bearing, 90 degrees apart.

4. Record test data for report.

B. Performance Test:

1. Conduct on each VFD.

2. Perform under actual or approved simulated operating conditions.

3. Test for continuous 48-hour period without malfunction.

4. Demonstrate performance by operating the continuous period while varying the application load, as the input conditions allow, in order to verify system performance.

5. Record test data for report.

END OF SECTION