PROJECT: WPCF Effluent Pump Station Upgrade

ADDENDUM # 4

DATE: May 2, 2018

TO: Invited prime bidders and others who have secured bid documents from the Owner.

ACKNOWLEDGE receipt of this addendum by inserting its' number and date in the proposal form. Failure to do so may subject bidders to disqualification. This addendum forms a part of the Bid Documents.

It modifies them as follows:

Insert Fuss & O'Neill Addendum No.4 dated 5/1/18.

Bid opening has been rescheduled for May 10, 2018 at 2:00pm in Community Room 2 of the Town Hall Annex.

- End of Addendum # 4 -
May 1, 2018

ADDENDUM No. 4

RE: Effluent Pump Station Upgrade
    Groton, CT
    Fuss & O’Neill Reference No. 1994171.P12

TO ALL PROSPECTIVE BIDDERS:

Enclosed is a copy of Addendum No. 4 for the referenced project. Please retain this with your Contract Documents. Information provided herein shall be considered part of the Contract Documents.

This Addendum forms a part of the Contract Documents and modifies the original Bidding Documents dated March 2018. Acknowledge receipt of this Addendum in the space provided on the Bid Form. Failure to do so may subject Bidder to disqualification.

Include the costs associated with the work of this Addendum into the Bid.

Sincerely,

Kevin M. Flood, P.E.
Associate

Enclosure
LIST OF CONTENTS

A.) Clarifications

B.) Revised Specifications

A. Attachment A – Revised Specifications
   i. Section 11317 – Large Vertical Turbine Effluent Pump (ADDENDUM NO. 4)

A. CLARIFICATIONS

1.) The Bid Opening has been postponed one (1) week. Sealed bids for “Effluent Pump Station Upgrade” will now be received by the Director of Finance at the office of the Public Works Department, 134 Groton Long Point Road (across from Fitch High School) Groton, CT until 2:00 PM prevailing time, on Thursday, May 10, 2018.

2.) Prospective bidders are responsible for carrying the cost for Woodard & Curran to conduct the SCADA programming. The cost shall be included in the lump sum bid item.

B. REVISED SPECIFICATIONS

1.) Specification section 11317 – Large Vertical Turbine Effluent Pump has been revised. Prospective bidders shall use the specification section 11317 – Large Vertical Turbine Effluent (ADDENDUM NO. 4) attached hereto.
Attachment A
Revised Specifications
SECTION 11317 - LARGE VERTICAL TURBINE EFFLUENT PUMPS

PART 1 - GENERAL

1.1 SCOPE

A. Pumps that are supplied under this specification shall be vertical turbine open lineshaft design with product lubrication, including a bowl assembly, column assembly, discharge head and driver. The discharge head shall be designed to carry the entire weight of the bowl and column assembly along with the specified driver without excessive vibration or noise. All of the supplied equipment shall conform to this specification.

B. The required units shall be Gould's Water Technology Model 46DXC-16RGLC with 43 stages

1.2 QUALITY ASSURANCE

A. Warranty: The manufacturer shall warrant their pumps to be free of defects for a period of one year after the product is put into operation or eighteen months from the shipment date, whichever occurs first.

B. Certifications

1. The pump manufacturer shall be certified to the ISO 9001 standard for design and manufacture of vertical turbine pumps.

2. The manufacturer shall be capable of producing vertical turbine pumps certified to NSF/ANSI 61 & 372.

3. Pressure containing fabrications shall be welded only by those whom are qualified on ASME code section IX. Welder certification shall be provided with the submittal package.

C. Foundry: The manufacturer shall own and operate its own U.S. based foundry producing vertical turbine components.

D. Testing Standards: All vertical turbine pumps shall conform to ANSI/AWWA E101-88 and to the most current edition of Hydraulic Institute Standards.

1.3 SUBMITTALS

A. With the proposal, the contractor shall submit complete fabrication and assembly drawings together with detailed specifications covering materials, parts, devices, and accessories. The data and specifications for each pumping unit shall include, but not be limited to the following:

1. Name of Manufacturer
2. Type and Model
3. Motor Details
4. Design Rotational Speed
5. Number of Stages
6. Type of Bowl Bearings
7. Type of line shaft bearings
8. Size of Shafting
9. Size of Pump Column
10. Size of Discharge Outlet
11. OD of Pump Bowls
12. Weight
13. Type of Finish
14. Total Weight
15. Total Pump Length
16. Complete certified performance curves showing capacity versus head, NPSH required, efficiency, and BHP plotted scales consistent with performance requirements.

PART 2 - PRODUCTS

2.1 LARGE VERTICAL TURBINE EFFLUENT PUMP

A. PUMP MANUFACTURER

1. Goulds Water Technology, A Xylem Brand

2. The equipment covered by this specification shall be standard products as manufactured by Gould’s Water Technology or an equivalent having a minimum of 20 years’ experience in the production of such equipment. All pumps and pump components specified in this specification shall be supplied by a single pump manufacturer. The pump manufacturer shall be required to supply the pumps and drivers, and shall be responsible for their compatibility only.

3. A factory authorized service facility shall have trained service technicians and be able to show evidence of parts inventory for routine maintenance items such as bearings, gaskets, shafts, and sleeves. Corrosion-Resisting (Weathering Steel), Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 3, round-head assemblies, consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.
B. PUMP OPERATION SYSTEM

1. Stated total dynamic head (TDH) includes lift and all system pressure. Pump manufacturer shall include pump's internal loses.
   a. Number of required units: Four (4)
   b. Condition “A” (Design Point):
      1) Capacity, GPM: 3500
      2) TDH, head in feet: 315
   c. Condition “B” (On the Curve and Left of Design Point):
      1) Capacity, GPM: 1750
      2) TDH, head in feet: 100
   d. Condition “C” (On the Curve and Right of Design Point):
      1) Capacity, GPM: 3750
      2) TDH, head in feet: 315
   e. Condition “D” (Assuming all 3 large effluent pumps running in parallel)
      1) Capacity, GPM: 10,500
      2) TDH, head in feet: 315
   f. Driver horsepower: 350
   g. Minimum bowl efficiency, Percent (design point): 82.9
   h. Maximum pump operating speed: 1760
   i. Minimum column and discharge diameter, inches: 12”
   j. NPSHR not to exceed: 14.8 Feet

2. Condition “A” as listed above is the design point and will be used for any performance evaluation in accordance with the 1B grade standards of the Hydraulic Institute.

3. The pump horsepower requirements for any point on the curve shall not utilize the service factor nor exceed the motor nameplate horsepower rating.

C. PUMP SERVICE CONDITIONS

1. Liquid to be pumped: Treated Wastewater Effluent
2. Pumping temperature: 52-degrees Fahrenheit to 77-degrees Fahrenheit
3. Available liquid level from sump floor: 3 feet to 7 feet
4. Distance from bottom of base plate to the bottom of pump: 12 feet

D. PUMP MATERIALS AND CONSTRUCTION
1. The vertical turbine lineshaft pump shall conform to the materials of construction for open lineshaft design.

SECTIONAL TYPE “Vertical Industrial Turbine – Fabricated Head with Underground (Under Slab) Discharge”
LINESHAFT, W/L, ‘U’ FABRICATED HEAD, FLANGED COLUMN, PACKING, Vertical Hollow Shaft – TYPE A

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Pumps shall also include:
- 416 stainless steel impeller lock collets
- 416 stainless steel bowl fasteners
- 416 stainless steel column fasteners
- 416 stainless steel motor top shaft and threaded coupling

2. Bowl Assembly
   a. The suction bell shall be designed to provide conservative entrance velocities and direct the flow to the first stage impeller. The inner surface of the suction bell shall be smooth and free of sharp projections which could cause turbulence or cavitation. The suction casing shall be designed to house the suction bell bearing by means of four vanes.
   
   b. The bowls shall be smooth and free of sharp projections and shall have register fits for alignment and be connected by flanged and bolted construction. Bowl sizes 6" to 15" shall be porcelain enameled on the bowl interior. Bowl sizes 16" and larger shall be epoxy-lined.
   
   c. The impellers shall be machined and finished smooth to insure proper performance. They are to be dynamically balanced prior to assembly. The impellers shall be connected to the bowl shaft by means of collet design.

3. Column Assembly
   a. The column shall include flanged connections and shall be of open design with product lubrication.
   
   b. The bearing spacing shall be selected to insure operation at a minimum of 25% above or below the first critical speed. Bearing spacing shall not exceed 5 feet.
   
   c. The column shall be designed with drop-in steel or cast-iron bearing retainers. The interior of the column shall be free of offsets, burrs, discontinuities and irregularities.
   
   d. The lineshaft shall be of adequate size to transmit the full power of the pump without slip, excessive vibration or elongation, and shall have threaded joints. Lineshaft lengths shall not exceed 10 feet. The lineshaft shall have left hand threads that tighten during pump operation.

4. Discharge Head Assembly
   a. For underground service with a motorstand, the discharge head shall be fitted with a flanged discharge connection. The flange shall be a 150 LB R.F. ANSI flange for fabricated steel heads. The discharge head shall be designed to carry the entire weight of the complete pump and driver without distortion when
spanning an opening of sufficient size to permit removal of the complete pump assembly. The discharge head shall be provided with a coupling guard. Lifting lugs shall be provided as standard.

b. Stuffing Box

1) The stuffing box shall be designed for 6 rings of packing and lantern ring. An extra-long bearing shall be located below the packing in the stuffing box. Packing lubrication leakage through the stuffing box shall be drained back to the sump. The packing gland shall be of a two piece design.

5. Driver

a. The driver will be a VHS electric motor. The driver and any related equipment will ship unmounted from the pump to ship.

b. The motor shall be 1800 RPM, 3/60/460V, VHS, premium efficient WP-1 enclosure.

E. COATING

1. The bowl assembly exterior shall be coated with Goulds Water Technology Standard Blue Enamel.

2. The column assembly exterior shall be coated with Goulds Water Technology Standard Blue Enamel.

3. The head assembly exterior shall be coated with Goulds Water Technology Standard Blue Enamel.

F. TESTING

1. All factory testing shall conform to the most current edition of the Hydraulic Institute Standards. All pump performance testing shall be performed at the manufacturer’s facility.

2. Performance testing shall be virtually witnessed and performed on the fully assembled unit with job motor. The test shall cover seven points including the design point. The design point shall be used for any performance evaluation.

3. Hydrostatic testing shall be virtually witnessed in compliance with HI14.6. Hydro testing is to be performed on the pressure containing components. Certified test results shall be provided prior to shipment.

4. A standard 10 business days’ notice shall be given to the engineer before starting any witness testing. The manufacturer shall not be responsible for expenses including, but not limited to travel, food, and lodging to observe all witness testing.

5. A written approval for all witness testing is required prior to release for shipment. All non-witness testing shall require written approval prior to release for shipment.
6. Field/functional testing will be performed by the Contractor to insure proper mechanical operation at the jobsite. All testing data to be used for evaluation shall be performed at the pump manufacturer's facility.

7. Motor tests and test reports shall be provided. Short commercial motor testing shall be provided.

8. Pump Manufacturer representative shall provide performance test to verify pumps can pump at the various targets including the maximum rate.

9. All newly installed pumps shall be tested simultaneously as a fully functioning system.

2.2 VARIABLE FREQUENCY DRIVE

A. GENERAL

1. Description

a. The drive shall be an Ultra Low Harmonic Adjustable Speed AC Drive that complies with standard IEEE 519 at the VFD input power terminals. Any Ultra Low Harmonic drive submitted for review must be constructed with a minimum of an input LCL filter and 6 IGBTs within the rectifier or convertor section.

b. This specification describes a complete Variable Frequency AC Drive (VFD) used to control the speed of NEMA design B induction motors used in areas where low harmonic content is desired or mandated.

c. The drive manufacturer shall supply the VFD and all necessary controls as herein specified.

d. The VFD shall be manufactured by a company with at least ten (10) years of experience in the production of this type of equipment.

2. Quality Assurance

a. The VFD manufacturing facility shall be ISO 9001 and ISO 14001 certified.

b. All printed circuit boards shall be completely tested before being assembled into the complete VFD. The VFD shall be subjected to a functional test and load test. The load test shall be at full rated load, or cycled load. All printed circuit boards shall have conformal coating.

c. The drive manufacturer shall have an analysis laboratory to evaluate the failure of any component.

3. Qualifications

a. The VFD shall meet the following specifications:

   1) UL 508A and 508C - Underwriter's Laboratory. The VFD shall be UL listed and carry the UL mark.
2) CAN/CSA-C22 No. 14-M91 - Canadian Standards Association. The VFD shall be C-UL or CSA listed and carry the appropriate mark.

3) Institute of Electrical and Electronic Engineers (IEEE). Standard 519, IEEE Guide for Harmonic Content and Control.

b. The VFD shall comply with the following European Union’s CE directives and shall carry CE mark:
   1) EMC Low Voltage Directive 73/23 EEC
   2) EMC Directive 89/336 EEC
   3) Machinery Directive 98/37 EC

c. Acceptable manufacturers:
   1) ABB ACQ Ultra Low Harmonic (ULH) VFD.
   2) VFDs that are manufactured by a third party and “brand labeled” shall not be acceptable.
   3) VFD power structures that are manufactured by a third party and “brand labeled” shall not be acceptable.
   4) Engineered prior approval required for any substitutions.

d. Submittals
   1) The Submittals shall include the following information:
      a) Outline Dimensions and Weight.
      b) Customer connection and power wiring diagrams.
      c) Complete technical product description including a complete list of options provided.
      d) Compliance to IEEE 519 – Harmonic analysis for particular jobsite including total voltage harmonic distortion and total current distortion. In case an alternative low harmonics solution is offered, the drive manufacturer shall provide calculations, specific to this installation, showing total harmonic current distortion (TDD), at the Point of Common Coupling (PCC), is less than required.

B. DESIGN

1. Description
   a. The drive shall be an Ultra Low Harmonic Adjustable Speed AC Drive that complies with standard IEEE 519 at the VFD input power terminals. Any Ultra Low Harmonic drive submitted for review must be constructed with a minimum of an input LCL filter and 6 IGBTs within the rectifier or convertor section.
2. Harmonics
   
a. The Ultra Low Harmonic construction of the VFD shall maintain current
distortion levels at the VFD’s input terminals to levels at or below those listed
in “Harmonic Control in Electrical Power Systems, IEEE Std. 519.” The input
current to the VFD shall have a total harmonic content less than 5% of full
rated capability at the input terminals of the VFD on power system sized
according to IEEE 519 at line voltage unbalance up to 3% and under all motor
load conditions. All harmonic management devices must be internal to the
VFD enclosure and supplied as a complete solution.

b. To maintain system integrity, the VFD must maintain UL519 compliance, at
the input terminals of the VFD, without exception, with up to and including a
3% voltage imbalance, phase to phase.

c. The VFD shall have an active line supply unit which controls the waveform of
the input current and reduces the low order harmonic current drawn from the
power line. Line currents and voltages shall be nearly sinusoidal. IGBTs shall
be used in the rectifier and inverter circuits.

d. Each input phase of the VFD shall incorporate a symmetrical LCL filter
arranged in a T-configuration. The inductors are to be series power
components that carry the full current of the VFD. Internally built with in the
input section of the VFD to prevent high level harmonics.

e. The VFD shall operate at fundamental power factor 1.0 on the supply side
under all motor load conditions. The input power factor shall be
programmable from 0.8 lagging to 0.8 leading, allowing the VFD to be used as
a compensating device for installations that are excessively inductive or
excessively capacitive in reactive power.

3. Ratings
   
a. The VFD shall be rated to operate from 3-phase power at 380 VAC to 500
VAC +10/-10. The overvoltage trip level shall be a minimum of 30% over
nominal, and the under voltage trip level shall be a minimum 35% under the
nominal voltage.

b. The VFD shall be rated to operate at the following environmental operating
conditions: ambient temperature 0 to 40°C continuous. VFDs that can operate
at 40°C intermittently (during a 24 hour period) are not acceptable and must
be oversized. Altitude 0 to 3300 feet above sea level without derating, less than
95% humidity, non-condensing.

c. The VFD shall be offered from 10 HP to 550 HP in similar construction and
operation, using the same technology.

d. The VFD shall be rated to operate from input power from 48 Hz to 63 Hz.

e. Output voltage and current ratings shall match the adjustable frequency
operating requirements of standard NEMA design A or NEMA design B
motors.
f. The normal duty overload current capacity shall be 110% of rated current for one (1) minute out of five (5) minutes.

g. The heavy duty overload current capacity shall be 150% of rated current for one (1) minute out of five (5) minutes.

h. The VFD efficiency shall be 97% or better of the full rated capability of the VFD at full speed and load. In case an alternative low harmonics solution is offered, the overall efficiency of the VFD and the harmonic mitigation components shall meet the efficiency requirement.

4. Construction

a. All models shall provide a complete, ready-to-install solution.

b. The VFD shall use the same main control board for all ratings.

c. Control connections shall remain consistent for all power ratings.

d. The VFD shall employ an active AC to DC rectifier constructed of a minimum of 6 IGBTs.

e. The VFD shall be offered in UL Type 1 and UL Type 12.

f. VFD’s at and above 60 HP shall be available in a free-standing construction and shall include the following standard features:

1) Disconnect switch and fuses.

2) The power modules in the cabinet shall be of a modular construction for quick removal and replacement.

3) To ensure fast and easy handling of the modules in high power range at or above 250 HP, modular power modules and heavy power components such as line filters and power transformers shall be constructed on a wheeled frame and roll directly into and out of the cabinet with bus bar connections.

4) Door Mounted Devices shall include the following:

   a) VFD Ready, Run, Fault pilot lights
   
   b) Motor Temp, Moisture pilot lights
   
   c) E-Stop button

5. Operator Interface

a. The VFD shall be equipped with a front mounted operator control panel consisting of a four- (4-) line by 20-character back-lit alphanumeric LCD display and a keypad with keys for Run/Stop, Local/Remote, Increase/Decrease, Reset, Menu navigation and Parameter select/edit.

b. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs.
c. The display of the control unit shall have the following features:
   1) The LCD display shall have contrast adjustment provisions to optimize viewing at an angle.
   2) All parameter names, fault messages, warnings and other information shall be displayed in complete American English words or standard American English abbreviations.
   3) Additional languages including British English, French, Spanish, Portuguese, German, Italian, Dutch, Danish, Swedish, Finnish, Czech and Polish shall be selectable.
   4) During normal operation, one (1) line of the control panel shall display the speed reference, and run/stop forward/reverse and local/remote status. The remaining three (3) lines of the display shall be programmable to display the values of any three (3) operating parameters. The selection shall include at least the following values:
      a) Speed/torque in percent (%), RPM or user-scaled units
      b) Output frequency, voltage, current and torque
      c) Input voltage, power and kilowatt hours
      d) Heatsink temperature and DC bus voltage
      e) Status of discrete inputs and outputs
      f) Values of analog input and output signals
      g) Values of PID controller reference, feedback and error signals

d. An intelligent start-up assistant shall be provided as standard. The Start-up routine will guide the user through all necessary adjustments to optimize operation.
   1) The Start-Up routine shall include “plug and produce” operation, which automatically recognizes the addition of options and fieldbus adapters and provides the necessary adjustment assistance.
   2) The Start-Up routine shall prompt the user for Motor Nameplate Data including power, speed, voltage, frequency and current.
   3) An auto-tune function shall identify the optimal motor tuning parameters for typical applications.
   4) An auto-tune function shall also be available to tune the PID speed regulator loop. Manual adjustments shall also be allowed.
   5) A selection of at least five (5) preprogrammed application macro parameter sets shall be provided to minimize the number of parameter adjustments required during start-up. Macros offered shall include Hand/Auto, Level Control, PFC (Pump, fan control) traditional, Multi-
pump, Anti-Jam. A selection of two (2) user defined macros shall also be available.

6. Protective Features
   a. For each programmed warning and fault protection function, the VFD shall display a message in complete English words or Standard English abbreviations. The five (5) most recent fault messages and times shall be stored in the VFD’s fault history.
   b. The VFD shall include internal MOV’s for phase to phase and phase to ground line voltage transient protection.
   c. Output short circuit and ground fault protection rated for 100,000 amps without relying on line fuses shall be provided per UL508C.
   d. Motor phase loss protection shall be provided.
   e. The VFD shall provide electronic motor overload protection qualified per UL508C.
   f. To ensure continuous protection during a low input voltage condition, the Active Front End Drive must maintain UL approved overload protection of the motor, without exception and without nuisance overload trip, continuously, with up to and including a 10% voltage drop.
   g. Protection shall be provided for AC line or DC bus overvoltage at 130% of maximum rated voltage or under voltage at 65% of min. rated voltage.
   h. The VFD shall protect itself against input phase loss.
   i. A power loss ride through feature shall allow the VFD to remain fully operational after losing power as long as kinetic energy can be recovered from the rotating mass of the motor and load.
   j. Stall protection shall be programmable to provide a warning or stop the VFD after the motor has operated above a programmed torque level for a programmed time limit.
   k. Underload protection shall be programmable to provide a warning or stop the VFD after the motor has operated below a selected underload curve for a programmed time limit.
   l. Over-temperature protection shall provide a warning if the power module temperature is less than 5°C below the over-temperature trip level.
   m. Input terminals shall be provided for connecting a motor thermistor (PTC type) to the VFD’s protective monitoring circuitry. An input shall also be programmable to monitor an external relay or switch contact.

7. Control Inputs and Outputs
   a. Discrete Inputs
      1) A minimum of six (6) discrete inputs shall be provided.
2) A minimum of six (6) of the inputs shall be independently programmable with function selections (run/stop, hand-off-auto, etc.).

3) Inputs shall be designed for use with either the VFD's internal 24 VDC supply or a customer supplied external 24 VDC supply.

b. Discrete Outputs

1) Minimum of three (3) form C relay contact outputs shall be provided.

2) All outputs shall be independently programmable to activate with at least 30 function selections including:
   a) Operating conditions such as drive ready, drive running, reversed and at set speed
   b) General warning and fault conditions
   c) Adjustable supervision limit indications based on programmed values of operating speed, speed reference, current, torque and PID feedback.
   d) Relay contacts shall be rated to switch 2 Amps at 24 VDC or 115/230 VAC.

c. Analog Inputs

1) Minimum of three (3) analog inputs shall be provided:
   a) Resolution of analog inputs must be at least 11 bit total resolution.

2) All inputs shall be independently programmable with input function selections.

3) A differential input isolation amplifier shall be provided for each input.

4) Analog input signal processing functions shall include scaling adjustments, adjustable filtering and signal inversion.

5) If the input reference is lost, the VFD shall give the user the option of the following (the VFD shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus):
   a) Stopping and displaying a fault
   b) Running at a programmable preset speed
   c) Hold the VFD speed based on the last good reference received
   d) Cause a warning to be issued, as selected by the user.

6) When inputs are used as speed references, reference signal processing shall include increase/decrease floating point control and control of speed and direction using a “joystick” reference signal. Two (2) analog inputs shall be programmable to form a reference by addition, subtraction, multiplication, minimum selection or maximum selection.
d. Analog Outputs
   1) Minimum of two (2) 0 / 4-20 mA analog outputs shall be provided.
   2) Outputs shall be independently programmable to provide signals proportional to output function selections including output speed, frequency, voltage, current and power.

8. Serial Communications
   a. The VFD shall be capable of communicating with other VFDs or controllers via a serial communications link. A variety of communications interface modules for the typical overriding control systems shall be available.
   b. Interface modules shall be provided for the following protocols including:
      1) Ethernet IP
      2) Modbus RTU
   c. Interface modules shall mount directly to the VFD control board or be connected via fiber optic cables to minimize interference and provide maximum throughput.
   d. I/O shall be accessible through the serial communications adapter. Serial communication capabilities shall include, but not be limited to:
      1) Run-Stop control
      2) Speed Adjustment
      3) PID (proportional/integral/derivative) control adjustments
      4) Current Limit
      5) Accel/Decel time adjustments
   e. The VFD shall have the capability of allowing the overriding controller to monitor feedback such as process variable feedback, output speed/frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), relay outputs, and diagnostic warning and fault information.
   f. A connection shall also be provided for personal computer interface. Software shall be available for VFD setup, diagnostic analysis, monitoring and control. The software shall provide real time graphical displays of VFD performance.

9. Control Functions and Adjustments
   a. Output frequency shall be adjustable between 0 Hz and 300 Hz. Operation above motor nameplate shall require programming changes to prevent inadvertent high-speed operation.
   b. The VFD shall be capable of controlling deceleration of a load without generating an overvoltage fault caused by excessive regenerated energy. Overvoltage control on deceleration shall extend the ramp time beyond the
programmed value to keep the amount of regenerated energy below the point that causes overvoltage trip.

c. The VFD shall be capable of starting into a rotating load (flying start) regardless of motor direction. It should then accelerate or decelerate to the active reference without tripping on fault or causing component damage. The VFD shall also be capable of flux braking at start to stop a reverse spinning motor prior to ramp.

d. The VFD shall have the ability to automatically restart after an overcurrent, overvoltage, under voltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between reset attempts shall be programmable.

e. Control functions shall include two (2) sets of acceleration and deceleration ramp time adjustments with linear and an s-curve ramp time selection.

f. Speed control functions shall include:
   1) Adjustable min/max speed limits.
   2) Selection of up to fifteen (15) preset speed settings for external speed control.
   3) Three sets of critical speed lockout adjustments.
   4) A built-in PID controller to control a process variable such as pressure, flow or fluid level.

g. Functions shall include flux optimization to limit the audible noise produced by the motor and to maximize efficiency by providing the optimum magnetic flux for any given speed operating point.

h. The VFD shall be capable of sensing a loss of load (broken belt / broken coupling) and signal the loss of load condition. The VFD shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. Relay output shall include programmable time delays that will allow for VFD acceleration from zero speed without signaling a false underload condition.

i. Three (3) programmable critical frequency lockout ranges shall be provided to prevent the VFD from operating the load continuously at an unstable speed.

j. The VFD shall have fifteen (15) internal adaptive programming blocks capable of twenty (20) different functions. These blocks shall be connectable to VFD’s actual signals and functions allowing the user to tailor the VFD to the specific application requirements without additional hardware. These blocks shall be programmable through the standard operator panel and through the use of programming software.
PART 3 - EXECUTION

3.1 LARGE VERTICAL TURBINE EFFLUENT PUMP

A. SHIPPING

1. Pumps that are less than 30 feet in length shall be shipped fully assembled with the driver and shaft seal unmounted. The discharge flange shall be protected with a wooden flange cover.

B. STORAGE, HANDLING AND INSTALLATION

1. The skidded pump and related equipment shall be unloaded, stored, and installed in agreement with the Manufacturer’s operation and installation manuals. If storage is planned to be longer than six months or in harsh environment, long term storage practices should be followed per the Manufacturer’s operation and installation manuals.

C. START-UP FIELD SERVICES

1. The pump manufacturer shall include two days of start-up field services with the proposal for the purpose of supervising the start-up and instructions of proper maintenance and operations.

<table>
<thead>
<tr>
<th>SERVICE PROVIDED BY FACTORY REPRESENTATIVE</th>
<th>TIME ON SITE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspect and Approve Installation</td>
<td>1/2 Day</td>
</tr>
<tr>
<td>Supervise Initial Adjustment</td>
<td>1/2 Day</td>
</tr>
<tr>
<td>Supervise Field Run Test</td>
<td>1/2 Day</td>
</tr>
<tr>
<td>Instruct Owner in Proper Start-Up and O&amp;M</td>
<td>1/2 Day</td>
</tr>
</tbody>
</table>

Additional time on site shall be billed at the rate deemed by the manufacturer.

3.2 VARIABLE FREQUENCY DRIVE

A. INSTALLATION

1. The drive manufacturer shall provide adequate drawings and instruction material to facilitate installation of the VFD by qualified electrical and mechanical personnel employed by others.
B. START-UP
   1. Certified factory start-up shall be provided for each VFD by a factory authorized service center. A certified start-up form shall be filled out for each VFD with a copy provided to the owner, and a copy kept on file at the manufacturer.
   2. The VFD supplier shall provide harmonic measurements at the input terminals of the VFD after start-up. A report shall be provided to the Engineer demonstrating that the total harmonic current distortion is less than 5%.

C. PRODUCT SUPPORT
   1. Factory trained application engineering and service personnel that are thoroughly familiar with the VFD products offered shall be located within 100 miles of the jobsite.
   2. A 24/365 technical support line shall be available on a toll-free line.

D. WARRANTY
   1. The warranty shall be 24 months from the date of start-up, not to exceed 30 months from the date of shipment. The warranty shall include all parts, labor, travel time, and expenses.

END OF SECTION