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ADDENDUM NO. 2

Lincoln County
Killian Creek WWTP Upgrade Phase 3
WKD Project Number #20170294.00.CL

ADDENDUM NUMBER NO. 2 March 19, 2020

BID DATE: April 2, 2020 @ 2 p.m.

TO ALL BIDDERS:

This Addendum forms a part of the Contract Documents and modifies the Bidding Documents dated November 9, 2018 and all previous Addenda.

Acknowledge receipt of this Addendum in the space provided in the Bid Form. Failure to do so may disqualify the Bidder.

Below are changes, additions, and/or clarifications to the bid documents for this project.

Specifications

Item 1: Document EJCDC® C-200 – Instructions to Bidders

Article 11 – Substitute and "Or-Equal" Items

REVISE the submittal deadline of "or-equal" or substitute material or equipment from 15 days to 10 days prior to the receipt of Bids.

Item 2: Document EJCDC® C-520 – Agreement of Stipulated Price

Article 4.02.A to be revised as follows:

The Work will be substantially completed within 700 calendar days after the date when the Contract Times commence to run as provided in Paragraph 4.01 of the General Conditions, and completed and ready for final payment in accordance with Paragraph 15.06 of the General Conditions within 730 calendar days after the date when the Contract Times commence to run.

Item 3: Section 01 10 00 – Summary of Work

ADD: 1.4.E
The existing plant facilities shall remain secure at all times. Temporary security fencing shall be provided to secure the existing plant facilities during construction. Temporary 6' high chain link fencing without 3 strand barb wire shall be provided. Gates for Contractor access to the work area

may be utilized. Temporarily connecting the fencing to structures is subject to preapproval by the Owner.

ADD: 1.4.F
The new UV system will utilize an existing 24" DIP pipe currently serving the effluent filters and a new 24" DIP tie-in to the existing UV system effluent chamber. The UV system must remain in operation. The piping tie-ins can be coordinated with plant operations to utilize a brief storage time provided by the SBR post equalization basin and/or scheduling for off-peak flow periods.

Item 4: Section 33 31 00 – Sanitary Utility Sewerage Piping, Article 2.1

REVISE Article 2.1 as follows:

2.1 SANITARY SEWER PIPE AND FITTINGS

A. Ductile Iron Gravity Sewer Pipe: AWWA C151 "Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand Lined Molds, for Water and Other Liquids".
   1. Pressure Class:
      a. 12-inch and smaller: Class 350
      b. 14-inch to 24-inch: Class 250
      c. 30-inch and larger: Class 150
   2. Thickness Class:
      a. Class 51 for push-on and MJ pipe
      b. Class 53 for flanged pipe.
   3. Fittings: Ductile iron, AWWA C110. Compact fittings, AWWA C153.
   4. Joints: Rubber gaskets per AWWA C111.
   5. Linings: AWWA C104 cement lining, standard thickness
   6. Coating:
      a. PROTECTO 401 Ceramic Epoxy Lining or Equivalent
      b. Bituminous Outer Coating, AWWA C110 for buried service.
      c. Section 09 90 00 Painting for exposed service.

Item 5: Section 33 34 00 – Sanitary Utility Sewerage Force Mains

REVISE Article 2.1 as follows:

2.1 FORCE MAIN PIPING

A. Ductile Iron Pipe (4-inch through 12-inch)
   1. Pipe: AWWA C151 "Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand Lined Molds, for Water and Other Liquids."
   2. Pressure Class:
      a. 12-inch and smaller: Class 350
      b. 14-inch to 24-inch: Class 250
      c. 30-inch and larger: Class 150
   3. Thickness Class:
      a. Class 51 for push-on and MJ pipe
      b. Class 53 for flanged pipe
   4. Fittings: Ductile Iron, AWWA C110. Compact Fittings, AWWA C153

5. Joints:
    a. Mechanical Joints: AWWA C111.
    b. Push-On Joints: AWWA C111.
    c. Flanged Joints inside structures: AWWA C115.
    d. Boltless Restrained Joints: Boltless, push-on type, joint restraint independent of joint seal. Conform to pipe manufacturers specifications.
    e. Tied Restrained Joints: Per Section 33 05 19.
6. AWWA C111 push-on or mechanical for general buried service; flanged for exposed service unless shown otherwise on the drawings
7. Coating:
    a. PROTECTO 401 or approved equal interior lining unless otherwise noted on drawings.
    b. Bituminous Outer Coating, AWWA C110 for buried service.
    c. Section 09 90 00 Painting for exposed service.

Item 6: Section 40 20 00 - Process Piping, Fittings, Valves, and Accessories

REVISE Article 2.2.1.A as follows:

2.2.1 DUCTILE IRON PIPE

A. Ductile iron pipe shall conform to the requirements of ANSI/AWWA C150/A21.50 and ANSI/AWWA C151/A21.51. Minimum thickness Classifications for ductile iron pipe for pipe shall be as follows unless otherwise noted:
    1. Pressure Class:
        a. 12-inch and smaller: Class 350
        b. 14-inch to 24-inch: Class 250
        c. 30-inch and larger: Class 150
    2. Thickness Class:
        a. Class 51 for push-on and MJ Pipe
        b. Class 53 for flanged pipe

REVISE Article 2.7 as follows:

2.7 Components

A. Bolts and nuts are to be ASTM F594, 304 Stainless Steel with hexagonal nuts.

B. Gaskets for flanged water and sewage conveyance are to be Thoruseal® or equal, 1/8" Styrene Butadiene (SBR rubber conforming to ANSI 21.011/AWWA C111 for Ductile Iron Pipe and ASTM F-477 for plastic pipe. Gaskets for all air piping shall be EDPM or Viton rated for a minimum of 400ºF. Gaskets for alum or polyaluminum chloride chemical piping are to be EDPM or Viton.

Item 7: Section 40 92 49 – Variable Frequency Drives (VFD's)

ADD Section 40 92 49 – Variable Frequency Drives (VFD's) to the specifications.

Item 8: Section 44 46 16 – Rotary Sludge Press

DELETE Article 1.2.A and REPLACE with the following:

A. The manufacturer shall provide a written performance guarantee that the rotary press system performance shall be equal to or exceed the Owner's existing equipment or provide a minimum final sludge cake consistency of greater or equal to 15% solids with a minimum solids capture of 90% and maximum polymer usage less than 20 lbs (active polymer)/dry ton and capable of compliance with the "Paint Filter Test" as described in EPA Publication SW-486 Method 9095.

Drawings

None

Clarifications

Item 1: Who will be responsible for removing sludge from existing SBR basins to provide access for the required modifications?

Answer: The Owner shall provide for drainage of the basin utilizing the existing waste sludge pumps and SBR basin drains. When the basin is empty of standing sludge liquid, the Contractor shall be responsible for additional wash down utilizing existing plant hose hydrants of the basin in areas required for access. Washdown activities shall be coordinated and scheduled with the Owner in advance. Cost of water for final wash down will be at the Owners expense. In the event that an accumulation of grit material is encountered, removal options shall be evaluated and associated cost shall be the responsibility of the Contractor.

Item 2: Specification Section 33 05 19 – Is a MJ Wedge Action Restraint system- similar to EBAA Mega Lug – acceptable as an alternate to the tie rod system described for pressure RJ piping?

Answer: The tie rod systems as described is intended for use where specifically called for in the contract documents or in case by case situations, as directed by the engineer, when a MJ Wedge Action Restraint system or other boltless pipe joint restraint systems or thrust blocking cannot be used.

Item 3: Which specification section defines the pipe class for the DI yard piping – individual sections 33 11 00, 33 34 00 or overall Process Piping section 40 20 00?

Answer:

- *Section 33 11 00 applies to potable and non-potable (final effluent) water distribution piping.*
- *Section 33 34 00 applies to sanitary sewage force main piping systems (untreated or partially treated wastewater.)*

- *Section 40 20 00 applies to wastewater force main and pressure piping systems within the plant containing untreated, partially treated wastewater or waste sludge materials.*

Item 4: Specification Section 33 11 00 – is C153 fittings acceptable for C-900 pipe in lieu of the C-110 specified – this will match the Specifications Section 33 34 00?

Answer: Yes, compact fittings conforming to AWWA C153 are acceptable.

Item 5: Does each pipe joint of the C-900 water piping need to be restrained with a Bell Joint clamp?

Answer: Thrust restraint for the PVC water line piping should be accomplished with concrete thrust blocking at fittings, dead ends, etc. as shown on Lincoln County Public Works standard detail WS-01 found on drawing sheet C.20. If concrete thrust blocking cannot be provided, an alternate thrust restraint system shall be provided as directed by the Engineer. See related question; Item 2 above.

Item 6: Specifications Section 33 34 00 – is C153 fittings acceptable in lieu of the C-110 specified – this will match the specifications for other DI pipe?

Answer: Yes, compact fittings conforming to AWWA C153 are acceptable.

Item 7: Specification Section 33 34 00, 40 20 00 – Please clarify that all DI piping on the project except air lines and drains are to be P401 lined?

Answer: PROTECTO 401, or equal, coating is only required on DI piping carrying sewage. DI air piping and drain piping are to be unlined. All other DI piping carrying sewage is to be ceramic epoxy lined unless otherwise noted.

Item 8: Will there be a pipe schedule issued defining RJ pressure pipe / force mains versus gravity lines?

Answer: Drawing C.9 will be revised and issued through a subsequent addendum to reflect the following required RJ pressure piping:

- *New 14" DIP RJ FM extending from connection at existing SBR inlet to new SBR Flow Splitter structure.*
- *New 6' DIP RJ Sludge Piping from Sludge Pump Station G.40/G.41 to Sludge Dewatering Building.*

Item 9: Drawing C.9 – FM shown from Existing PS to existing splitter box at SBR#1 & 2 – where are details?

Answer: This piping is existing up to the existing SBR basin inlet with new force main piping extending from the existing basin inlet area to the new flow splitter as shown on Drawing C.9. Refer to additional information provided in Addendum No. 1, Drawing Section, Item 4.

Item 10: Drawing C.9 & C.10 – Sewer Line A – Sta 1+34.95 called out as "Prop Cleanout" but shown as MH in profile. Please clarify.

Answer: The profile is correct as a manhole. Replace the cleanout reflected on the plan views with a manhole. Refer to additional information provided in Addendum No. 1, Clarification Section, Item 11. Revised drawings sheets will be issued through a subsequent addendum.

Item 11: Drawing C.9 shows 1" yard hydrants while the detail on C.19 notes ¾" yard hydrants – please clarify?

Answer: The yard hydrant shown on Drawing C.19 is to be 1" per agreement with C.9. A fitting is to be provided to permit a ¾" hose connections.

Item 12: PW & W lines shown on Drawing C.9 do not match layout on G.10 thru G.14 – please clarify?

Answer: Drawing C.9 will be revised and issued through a subsequent addendum with PW and W lines revised to agree with G.10, G.11 and G.14.

Item 13: Drawing G.14 Note 6 specifies all chemical piping for PAC system to be CPVC however the interior chemical piping is noted as SSTL on G.45 – please clarify?

Answer: All chemical piping for PAC is to be CPVC. Delete reference to 1" Stainless Steel piping and PVC pipe and replace with CPVC on Drawing G.45, Section 1.

Item 14: Specification Section 40 20 00 2.3.J specifies DI Wall Pipe and Wall Sleeves to be used on project and the drawings show DI MJ Wall Sleeves – please clarify if you want pass thru wall sleeves or true MJ sleeves or if steel body wall sleeves with Link-Seal are acceptable?

Answer: All ductile iron piping passing through new concrete walls shall be wall pipes. New ductile iron piping passing through existing concrete walls is to be core drilled and the opening between concrete and pipe sealed using link seals or equal. Wall Sleeves are specified for provisional use.

Item 15: Please provide the wall thickness for the Precast pipe trench shown on drawings C-6, C-9, C.19 & G.45.

Answer: Precast trench wall thickness shall be the responsibility of precast trench manufacturer to meet HS20 loading requirements. Change reference to Detail B on C-6 from C-19 to G.45. Also see Detail B, G.15 and Section 5, G.15.

Item 16: Please provide the specifications for the removable top sections.

Answer: Specification for the trench cover is noted on Section 5, G.15.

Receipt of this addendum must be acknowledged on Page 1 of your Bid Form.

Sincerely,

W. K. Dickson & Co., Inc.
N.C. License F-0374

Ryan W. Hager, PE
Project Manager

RWH/aeh

Enclosures: Specification Section 40 92 49 – Variable Frequency Drives (VFD's)

SECTION 40 92 49
VARIABLE FREQUENCY DRIVES (VFD'S)

PART 1 - GENERAL

1.1 SUMMARY

A. This specification covers all variable frequency drives (VFDs) designated on the drawing schedules. All standard and optional features detailed herein shall be included within the VFD panel.
   1. The VFD shall be factory installed by the HVAC original equipment manufacturer.
   2. The VFD shall have been evaluated by UL and found acceptable for mounting in a
   3. plenum or other air handling compartment. Manufacturer shall supply a copy of
   4. the UL plenum evaluation upon request.
   5. The VFD shall be tested to UL 508C and bear the appropriate UL label. VFDs designated for use in Canada shall have C-UL certifications.
   6. The VFD shall be CE marked and conform to the European Union Electro Magnetic Compatibility directive.
   7. The VFD shall be UL listed for a short circuit current rating of 100 kA and labeled with this rating either in the instruction manual or with a drive marking, in accordance with UL.
   8. The VFD manufacturer shall supply the VFD and all necessary controls as herein specified. The manufacturer shall have been engaged in the production of this type of equipment for a minimum of twenty years.
   9. VFD shall be manufactured in ISO 9001, 2000 certified facilities.

B. Related Sections
   1. 33 32 16 Rotary Drum Filter Pump Station
   2. 43 12 19 Positive Displacement Blowers
   3. 43 21 36 Rotary Lobe Pumps
   4. 43 21 39 Submersible Pumps
   5. 44 46 16 Rotary Sludge Press Equipment and Conveyors
   6. 46 61 46 Automatic Backwash Disc Filter
   7. 49 71 33 Rotary Dum Thickening Equipment

C. In the event of conflict between this specification and a variable speed drive specification within the individual equipment specification, the equipment specification governs.

PART 2 - PRODUCTS

2.1 The VFD shall convert incoming fixed frequency three-phase AC power into an adjustable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for the driven load and to eliminate the need for motor de-rating.

A. Additionally, the VFD shall have the capability to control non-salient permanent magnet (PMAC) motors up to 22kW (30 HP). When properly sized, the VFD shall allow the motor

to produce full rated power at rated motor voltage, current, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.

B. The VFD shall include an input full-wave bridge rectifier and maintain a fundamental (displacement) power factor near unity regardless of speed or load.

C. The VFD shall be capable of full output current at frequencies in the range of 0 to 120 Hz without de-rating.

D. The VFD shall have a dual 5% impedance DC link reactor on the positive and negative rails of the DC bus to minimize power line harmonics and protect the VFD from power line transients. The DC link reactors shall be non-saturating. DC link reactors using swinging chokes that do not provide full harmonic filtering throughout the entire load range are not acceptable.

E. The VFD shall be able to provide full rated output current continuously and up to 110% of rated output current for 60 seconds.

F. The VFD shall provide full motor torque at any selected frequency from 20 Hz to base speed while providing a variable torque V/Hz output at reduced speed. This is to allow driving direct drive fans without high speed de-rating or low speed excessive magnetization, as would occur if a constant torque V/Hz curve was used at reduced speeds. Breakaway current of 130% shall be available for 0.5 seconds.

G. A programmable automatic energy optimization selection feature shall be provided standard in the VFD. This feature shall automatically and continuously monitor the motor’s speed and load to adjust the applied voltage to maximize energy savings.

H. The VFD must be able to operate a direct drive fan through its full operating range.

I. VFD shall be capable of controlling multiple induction motors simultaneously. Multiple motor operation will require additional protective devices per motor.

J. Input and output power circuit switching shall be accomplished without interlocks or damage to the VFD. Switching rate may be up to 1 time per minute on the input and unlimited on the output.

K. An automatic motor adaptation algorithm shall be provided in the VFD to measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to perform the test.

L. VFD shall minimize the audible motor noise through the use of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD operation while reducing motor noise. VFDs with fixed carrier frequency are not acceptable.

M. All VFDs rated at 480V and below shall contain integral EMI filters to attenuate radio frequency interference conducted to the AC power line.

N. Galvanic and/or optical isolation shall be provided between the VFD's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents.

PART 3 - EXECUTION

3.1 PROTECTIVE FEATURES

A. A minimum of Class 20 I2t electronic motor overload protection for single motor applications shall be provided. Overload protection shall automatically compensate for changes in motor speed.

B. The VFD shall provide protection against input transients, loss of AC line phase, output short circuit, output ground fault, over voltage, under voltage, VFD over temperature and motor over temperature. The VFD shall display all faults in plain language. Codes are not acceptable.

C. The VFD shall be protected from input phase loss. The VFD should be able to protect itself from damage and indicate the phase loss condition. During an input phase loss condition, the VFD shall be able to be programmed to either trip off while displaying an alarm, issue a warning while running at reduced output capacity, or issue a warning while running at full commanded speed. This function is independent of which input power phase is lost.

D. The VFD shall be protected from under voltage. The VFD shall provide full rated output power with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output power, without faulting, with an input voltage as low as 85% of the nominal voltage as required by EN/IEC 61800-3.

E. The VFD shall be protected from over voltage. The VFD shall continue to operate without faulting with a momentary input voltage higher than 110% of the nominal voltage.

F. VFD design shall comply with IEC Part 34-17 to prevent breakdown of the motor winding insulation.

G. The VFD shall incorporate a programmable motor preheat feature which provides the motor stator with a controlled level of current to keep the motor warm and prevent condensation build up in idle motors operating in damp environments.

H. VFD shall include a "signal loss detection" algorithm with adjustable time delay to sense the loss of an analog input signal. It shall also include a programmable time delay to eliminate nuisance signal loss indications. The functions after detection shall be programmable.

I. VFD shall function normally when the keypad is removed while the VFD is running. No warnings or alarms shall be issued as a result of removing the keypad.

J. VFD shall be capable of catching a rotating motor operating forward or reverse up to full speed without VFD fault or component damage.

K. Selectable over-voltage control shall be provided to protect the VFD from power regenerated by the motor while maintaining control of the driven load.

L. VFD shall include current sensors on all three output phases to accurately measure motor current, protect the VFD from output short circuits, output ground faults, and act as a motor overload. If an output phase loss is detected, the VFD will trip off and identify which of the output phases is low or lost.

M. If the temperature of the VFD's heat sink rises to approximately 80□C, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. It shall also be possible to program the VFD so that it reduces its output current limit value if the VFD's temperature becomes too high. The VFD shall automatically increase the carrier frequency and current limit to normal values as the heat sink temperature decreases.

N. The VFD shall store in memory the last 10 alarms. A description of the alarm and the relative sequences of the alarms shall be recorded.

3.2 INTERFACE FEATURES

1. Hand, Off and Auto keys shall be provided to start and stop the VFD and determine the source of the speed reference. It shall be possible to either disable these keys or password protect them from undesired operation.
2. The VFD shall be programmable to provide a digital output signal to indicate whether the VFD is in Hand or Auto mode. This is to alert the Building Automation System whether the VFD is being controlled locally or by the Building Automation System.
3. The VFD shall be provided with a keypad with alphanumeric, backlit display. The display shall be capable of remote mounting up to 10 ft. from the VFD. Main Menu password protection shall be provided to guard against unauthorized parameter changes.
4. All VFDs shall have the same customer interface. The keypad and display shall be identical and interchangeable for all sizes of VFDs.
5. To set up multiple VFDs, it shall be possible to upload all setup parameters to the VFD's keypad, place that keypad on all other VFDs in turn and download the setup parameters to each VFD. To facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only size independent parameters. Keypad shall provide visual indication of copy status.
6. Display shall be programmable to communicate in multiple languages including English, Spanish and French.
7. A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.
8. A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD.
9. A two-feedback PI controller to control the speed of the VFD shall be standard.
    a. This controller shall accept up to two feedback signals. It shall be programmable to follow the sum of the feedback signals, a preset reference (common set point or up to 8 individual setpoints), or the sum of both. It shall also be possible to calculate the controlling feedback signal as the average, maximum, minimum or the difference between two feedback signals.
10. The VFD shall be able to apply scaling to the feedback signal.

a. For fan flow tracking applications, the VFD shall be able to calculate the square root of any or all individual feedback signals so that a pressure sensor can be used to measure air flow.
b. The VFD's PI controller shall be able to actively adjust its set point based on flow. This allows the VFD to compensate for a pressure feedback sensor which is located near the output of the pump rather than out in the controlled system.

11. Customized meter displays shall be available. They shall include at a minimum, speed/flow, pressure, and power units relative to motor speed.
12. Programmable Sleep Mode shall be able to stop the VFD. When its output frequency drops below set "sleep" level for a specified time, the VFD may be programmed to stop. When the VFD's speed is being controlled by its PI controller, it shall be possible to program a "wake-up" feedback value that will cause the VFD to start. To avoid excessive starting and stopping of the driven equipment, it shall be possible to program a minimum run time before sleep mode can be initiated and a minimum sleep time for the VFD.
13. A run permissive circuit shall be provided to accept a "system ready" signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of initiating an output "run request" signal to indicate to the external equipment that the VFD has received a request to run.
14. VFD shall be programmable to sense the loss of load. The VFD shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. To ensure against nuisance indications, this feature must be based on estimated motor torque, not current, and must include a proof timer to keep brief periods of no load from falsely triggering this indication.
15. Standard Control and Monitoring Inputs and Outputs
    a. Four dedicated, programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
    b. Two terminals shall be programmable to act as either as digital or analog outputs.
    c. Two programmable relay outputs, Form C 250 VAC, 3 A, shall be provided for remote indication of VFD status.
        1) Each relay shall have an adjustable on delay / off delay time.
        2) Two programmable analog inputs shall be provided that can be either direct- or reverse-acting.
        3) b) Each shall be independently selectable to be used with either an analog voltage or current signal.
        4) The maximum and minimum range of each shall be able to be independently scalable from 0 to 10 V dc and 0 to 20 mA.
        5) A programmable low-pass filter for either or both of the analog inputs must be included to compensate for noise.
    d. Two programmable analog current outputs (0/4 to 20 mA) shall be provided for indication of VFD status. This output shall be programmable to show the reference or feedback signal supplied to the VFD and for VFD output frequency, current and power. It shall be possible to scale the minimum and maximum values of the outputs.
    e. It shall be possible through serial bus communications to read the status of all analog and digital inputs of the VFD.
    f. It shall be possible to command all digital and analog output through the serial communication bus.

16. Standard programmable firefighter's override mode allows a digital input to control the VFD and override all other local or remote commands. It shall be possible to program the VFD so that it will ignore most normal VFD safety circuits including motor overload. The VFD shall display FIREMODE whenever in firefighter's override mode. Fire mode shall allow selection of forward or reverse operation and the selection of a speed source or preset speed, as required to accommodate local fire codes, standards and conditions.
17. The VFD shall be able to store load profile data such as counters for operating hours, running hours, and kilowatt-hours, to assist in analyzing the system demand and energy consumption over time.
18. The VFD shall include a sequential logic controller to provide advanced control interface capabilities. This shall include:
    a. Comparators of VFD analog values to programmed trigger values
    b. Logic operators to combine up to three logic expressions using Boolean algebra
    c. Delay timers
    d. A 20-step programmable structure

B. SERIAL COMMUNICATIONS
1. The VFD shall include a standard EIA-485 communications port and capabilities to be connected to the following serial communication protocols at no additional cost and without a need to install any additional hardware or software in the VFD:
    a. BACnet MS/TP
    b. Johnson Controls Metasys N2
    c. Modbus RTU
    d. Siemens FLN P1
    e. FC protocol

C. ADJUSTMENTS
1. The VFD shall have a manually adjustable carrier frequency that can be adjusted in 1 kHz increments up to 6 kHz, 2 kHz increments up to 12 kHz, and 4 kHz up to 16 kHz to allow the user to select the desired operating characteristics. The VFD shall also be programmable to automatically reduce its carrier frequency to avoid tripping due to thermal loading.
2. Two independent setups shall be provided.
3. Eight preset references per setup shall be provided for a total of 16.
4. Each setup shall have two programmable ramp up and ramp down times. Acceleration and deceleration ramp times shall be adjustable over the range from 1 to 3,600 seconds. The shape of these ramps shall be automatically contoured to ensure no-trip acceleration and deceleration.
5. Each setup shall be programmable for a unique current limit value. If the output current from the VFD reaches this value, any further attempt to increase the current produced by the VFD will cause the VFD to reduce its output frequency to reduce the load on the VFD. If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: external interlock, under-voltage, over-voltage, current limit, over temperature, and VFD overload.
6. The number of restart attempts shall be selectable from 0 through 20 or infinity and the time between attempts shall be adjustable from 0 through 600 seconds.

7. An automatic “start delay” may be selected from 0 to 10 seconds. During this delay time, the VFD shall be programmable to either apply no voltage to the motor or apply a DC braking current if desired.
8. Three programmable critical frequency lockout ranges to prevent the VFD from operating the load at a speed that causes vibration in the driven equipment shall be provided. Semi-automatic setting of lockout ranges shall simplify the set-up.
9. When incorporated in the air handler’s design with an optional electromechanical bypass, provide a manual 2-contactor bypass consisting of a door interlocked main disconnect pad lockable in the off position, a built-in motor starter and a three position DRIVE/OFF/BYPASS switch controlling two contactors. In the DRIVE position, the motor is operated at an adjustable speed from the VFD. The VFD can be remotely controlled in this position with a pilot relay and analog signal or can be controlled manually using the hand function on the VFD LCD. In the OFF position, the motor and VFD are disconnected. In the BYPASS position, the motor is operated at full speed form the AC power line. In case of an external safety fault, a customer supplied normally closed dry contact shall be able to stop the motor whether in DRIVE or BYPASS mode.

D. SERVICE CONDITIONS
1. Ambient temperature, continuous, full speed, full load operation:
   a. VFD shall be available in enclosure types: UL Type 1 (NEMA 1) and IP20.
   b. VFD shall be able to operate at full output current in the temperature range of 0 to 40°C (32 to 104°F).
   c. VFD must be capable of operation at 50°C (122°F). The nameplate shall indicate any reduced VFD output current.
   d. VFD shall be capable of operation to a minimum of -10°C (14°F) with reduced performance.
2. VFD shall be capable of operation in an environment with a relative humidity of 0% to 95%, non-condensing.
3. VFD shall be capable of operation up to an elevation to 1000m (3,280 feet) without de-rating.
4. VFD shall be capable of full output current with an AC line voltage variation of -10 to +10% from nominal input voltage.
5. All VFDs shall be plenum rated.
6. VFD shall require no side clearance for cooling. All power and control wiring shall be done from the bottom.

E. QUALITY ASSURANCE
1. To ensure quality, the VFD shall be tested by the manufacturer. The VFD shall drive a motor connected to a dynamometer at full load and speed and shall be cycled during the automated test procedure.

F. SUBMITTALS
1. This specification lists the minimum VFD performance requirements for this project. Each supplier shall list any exceptions to the specification. If no departures from the specification are identified, the supplier shall be bound by the specification.
2. Total harmonic distortion level estimation. If requested, the manufacturer shall perform an analysis to initially demonstrate the supplied equipment will meet the IEEE 519-1992 recommendations after installation. In such instances, the owner or engineer shall

provide the manufacturer with detailed electrical power single line diagram showing all impedances in the power path to the VFDs. Analysis shall provide the estimated total harmonic distortion levels. Point of common coupling shall be the secondary of the utility transformer. Any additional harmonic filtering equipment required to meet the IEEE 519-1992 recommendations shall not be the responsibility of the HVAC manufacturer.

3.3 EXECUTION

1. Start-up Service - The manufacturer shall provide start-up commissioning of the VFD and its optional circuits by a factory certified service technician who is experienced in start-up and repair services. Sales personnel and other agents who are not factory certified shall not be acceptable as commissioning agents. Start-up services shall include checking for verification of proper operation and installation for the VFD, its options and its interface wiring to the building automation system.
2. Warranty - The VFD shall be warranted by the manufacturer for a period of 36 months from initial start-up or 42 months from date of shipment, whichever is less. The warranty shall include replacement equipment or parts as well as a labor allowance for expenses incurred by the manufacturer to provide factory authorized on-site service.

PART 4 - SCHEDULE OF VFD'S

Specification Section	Description	Equipment No.
33 32 16	Rotary Drum Filter Pump Station Pumps	P-501, P-502
43 12 19	Positive Displacement Blowers	B-201, B-202, B-203, B-204, B-205, B-206, B-207, B-208
43 21 36	Rotary Lobe Pumps	P-504, P-510, P-511, P-512
43 21 39	Submersible Pumps – SBR 3 & 4 Post EQ Pumps	P-206, P-207, P-208, P-209, P-210
44 46 16	Rotary Sludge Press & Conveyors	RSP-3, RSP-4, PF-601, PF-602, C-601, C-602, C-603, C-604
46 61 46	Automatic Backwash Disc Filters	DF-4, DF-5, P-301, P-302
49 71 33	Rotary Drum Thickening Equipment	M-500, M-501