THE CITY OF WESTMINSTER

REQUEST FOR BID

The City of Westminster has owned and operated a complete water system to serve the City residents and commercial/industrial customers since 1934. Since the beginning of the Westminster Water System, there have been many changes and upgrades in accord with available technologies to more economically operate. The following project (s) are in alignment with that objective – to operate more economically:

1. The present basic constructs of the City Water System are:
   a. Two 500HP "Raw Water" pumps located at the Chauga River pumping station to transport the water to the City Water Treatment plant
   b. Numerous pumps within the City Water Treatment Plant moving the water between the water treatment stages
   c. Finished water pumps to transport the purified water to the City Water Towers which maintain pressure and storage of the water distributed to the residents and commercial companies in the City.
   d. Water Treatment Plant lighting, heating, and air conditioning, etc. are of "less efficient" operating costs.
2. Each of the above constructs have opportunities for improvement in efficiency (read savings of City expense toward the Water System)
   a. The Raw Water pumps are tasked to push approximately 2 million gallons per day over a distance of 2 miles.
      The flow resistance of the piping over that distance represents the horsepower needed to get that amount of water transported.
      i. If the flow rate is reduced, the energy to pump water to the Treatment Plant is reduced exponentially
      ii. Instead of keeping the Raw Water pumps running and reducing the flow to match the City's water demand by choking the flow with valves, electronically controlling the Raw Water pumps' flow to only what is necessary during daily operation is where the huge difference of pump energy is realized (Money savings for the City)
      iii. The existing Raw Water pumps are capable of approximately 4 million gallons/day and the City usage is approximately 2 million gallons/day. It is anticipated that the aged 500HP (Already de-rated to 300HP) pumps shall be replaced with more efficient (VFD Capable) 300HP pumps.
      iv. Modern "Variable Speed Drive" control systems are capable of remotely controlling (utilizing the City's "remote data acquisition system") the Raw Water Pumps such that the most economical flow rate from the Chauga River pump station can be achieved.
      v. Modern "Variable Speed Drive" control systems are also designed to protect motors (in this case the City's water pumps) to avoid costly motor rewinds and other costly maintenance. (Also money savings for the City).
      vi. This bid request is for two (2) 300HP VFDs in accord with the attached technical specification.

b. The numerous pumps with the City Water Treatment System are utilized as a "choreographed" set of pumps to match the Raw Water Pump subsystem and Water Treatment Plant with the City water demand.
    i. The Water Treatment Plant water pumps presently are semi-automatic and are manually choreographed by the Water Plant operation Experts.
    ii. By utilizing the modern "Variable Speed Drive" control systems, the efficiency of the pumps are improved and more importantly, the pumps are controlled by the advanced VFD control system which utilizes the "remote data acquisition system" to "load follow" the City Water usage which is in synch with the Raw Water Pump flow.
c. The Water Treatment Plant finished Water Pumps (two of the three 125HP) are presently VFD controlled by the Water Plant expert operators. The third (and old) 125HP pump is "emergency only" and exercised monthly to keep bearings lubricated in the event it is actually needed.
    i. These finished water pumps have been elevated in their efficiency by the modern VFD control system and experience the enhanced protection of the motors and expected extended life.
    ii. The choreographed utilization of the finished water pumps will also reduce their energy requirements in accord with the Raw Water pump reduction in flow which will also reduce their flow requirements and afford the City reduction in operational expense.
d. The existing City Water Treatment Plant was constructed in 1979. The internal heating, cooling, lighting and small motor controls are very dated and much less efficient than that of more recent technologies.

3. We respectfully request bids on the above (2a vi) project requiring (2) 300HP 480V VFDs. The attached documents contain technical requirements and general and accepted Industry Standards for design. Ultimately, each of the projects above shall be integrated and controlled either by one central control or by distributed control such that optimum efficiency of the City Water System is obtained. The City's "Water System data retrieval system" shall be interfaced with the new 300HP VFDs such that the VFDs' data is available for overall water system optimization.

   The bids shall be received by the City of Westminster by March 8, 2021 at 3:00 PM. The Bid openings shall occur on March 9, 2021 with appropriate study of the Bids by the City of Westminster to result in a "Bid winner" to be announced on March 16, 2021 by email to the representatives of the submitted Bids.

With Best Regards,

Kevin Bronson, City Administrator

VARIABLE FREQUENCY DRIVE SPECIFICATIONS

Part 1 – General

1.1 Description

A. This specification sheet covers a complete Variable Frequency Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use with a standard induction motor.

B. The VFD manufacturer shall supply the VFD and all necessary options as herein specified.

1.2 Submittals

A. Standard brochure sheets showing voltage, horsepower, and maximum current ratings shall be available.

B. Recommended spare parts, layout drawings with part numbers shall be available.

C. An instruction manual shall be included with each VFD at the time of shipment.

1.3 Quality Assurance

A. Referenced standards

1. Institute of Electrical and Electronic Engineers (IEEE)
   a. Standard 519-2014, IEEE Guide for Harmonic Content and Control
2. Canadian Safety standard (CSA)
   a. CSA C22.2 No. 274-17 - Adjustable speed drives
3. IEC/UL 61800-5-1, UL 508C
   a. Safety standard for Adjustable speed electrical power drive systems.
4. CE (EN 50178:1997, EN 61800-3:2004+A1:2012, EN 61800-5-1:2007, EN 61800-5-2:2007)

B. The manufacturer of the VFD shall have quality system certified as per ISO 9001-2015

C. The VFD manufacturer shall have minimum 20 years of experience in the design, construction and application of variable frequency drives.

1.4 Testing

A. All printed circuit boards shall be completely tested before being assembled into the complete VFD module. The VFD shall be tested on computerized systems, performed cold test and heat run test for minimum 2 hours.

1.5 Delivery, Storage, and Handling

A. Contractor shall coordinate the shipping of equipment with the manufacturer.

B. Contractor shall store the equipment in a clean and dry space at an ambient temperature range of -4°F to 158°F (-20° to 70° C).

C. The contractor shall protect the units from dirt, water, construction debris and traffic.

Part 2 – Product

2.1 General Description

A. The VFD shall have a 480/277V 4W 3ph power input and shall be the fixed dc bus type with a full wave diode/thyristor-diode bridge rectifier and latest 7th generation Insulated Gate Bi-Polar Transistors (IGBTs) inverter. VFD converts three phase, 50 or 60 Hz input power to three phase adjustable voltage and adjustable frequency output power using Pulse Width Modulation (PWM) switching techniques.

B. The VFD shall be capable of operating any standard squirrel cage induction motor (including submersible motor) with a full load current rating or less than the full load current rating of the VFD.

C. The VFD shall be operate a 300Hp, 480 3ph motor housed within a stainless steel NEMA 12 enclosure with Stainless 12" legs with stainless steel skirt. Each VFD system shall have:
   a. SCADA controlled VFD operation
   b. Soft Start operation by SCADA or manual control if SCADA is inoperable
   c. Manual "Across-the-Line" motor starting.

2.2 Harmonic Distortion Control

A. VFD System design shall incorporate mechanisms that lower the harmonic currents caused by the VFD as compared to standard six-pulse drives onto the AC power line.The calculations shall be made with the point of common coupling being the point where the utility feeds multiple customers.

2.3 VFD Ratings

A. VFD shall be designed for input line voltage ranging from 380~480 VAC, -15%, +10%.

B. The input voltage frequency range shall be 47 Hz to 63 Hz.

C. The speed range shall be from a minimum of 0.1 Hz to a maximum of 599 Hz, adjustable by increments of 0.01 Hz.

D. The efficiency of the VFD at 100% speed and load shall not be less than 97%.

E. Frequency accuracy shall be +/- 0.01% (Digital Reference) at 25°C and +/- 0.1% (Analog reference) at 25°C.

F. Frequency setting resolution shall be 0.012 Hz/50 Hz analog (12 bit) with analog reference and 0.01 Hz with digital reference.

G. The VFD's output frequency resolution shall be 0.0001 Hz (20-bit)

H. The VFD shall minimize the audible motor noise through the use of an adjustable carrier frequency. Carrier frequency range shall be 2~10 kHz up to 250 Hp and 2~6 kHz for above 250 Hp.

I. The Speed Control Range shall be 20:1 while running between 3 and 60 Hz.

2.4 Construction

A. The VFD shall be UL/CSA certified and conformal coating on electronic boards as standard to protect printed circuit boards against harsh environment.

B. The VFD shall have Diode Bridge or SCR Bridge on the input rectifier.

C. The VFDs (500 HP and higher) shall have capability to operate with a 12 pulse phase shift transformer.

D. The VFD shall have latest 7^{th} generation IGBT in inverter section

E. The high power VFD (200 HP and above) shall be designed with laminated bus bars technology to minimize stray inductance in power circuit and increase life of IGBT.

F. The VFD shall have Transient Chokes in series with 480V 3ph input power.

G. The VFD shall have a "push/pull" set of two internal fans to insure sufficient Cooling air across the VFD internal circuitry.

H. The VFD shall employ built-in RS-485 communication via terminal block.

I. The VFD shall employ a graphical display with built-in parameter copy functionality.

J. The VFD shall employ a removable control terminal block and shall be of the clamp / vibration resistant type .

K. The VFD shall employ sink/source selectable control logic.

L. The VFD shall have Real Time Clock with configurable date & time formatting.

M. The VFD shall have a detachable graphical LCD keypad with back light & membrane type Keypad with 8~12 keys.

N. The VFD shall have on board option mounting slot within the VFD for the below options;

1. Line Driver Encoder
2. HTL Encoder (5...24V)
3. Modbus TCP
4. Ethernet IP
5. ProfiNet
6. Ethercat
7. DeviceNet
8. Profibus-DP
9. Additional Input/output module

2.5 Environmental Rating

A. The VFD shall be designed to operate in the ambient temperature from 5 °F to 122 °F (-15 °C to 50° C), non -freezing.

B. The VFD storage temperature shall be -4°F to 158°F (-20° to 70° C), non-condensing. Applicable for short periods, such as during transit.

C. The relative humidity shall be 0~95% maximum, non-condensing.

D. The VFD shall be operate at altitudes less than or equal to 3,300 feet (1000 meters) above sea level without de-rating.

E. The VFD Enclosure shall be constructed from such material that provide better bonding, safe and good performance against corrosion and EMI/EMC.

F. The VFD vibration test shall be as per EN 60068-2-6, acceleration: 1g at frequency range 10 Hz ~ 150 Hz.

2.6 Operational Feature

A. VFD shall have open loop v/f, close loop v/f, sensor less vector & close loop vector control modes to operate induction motor for industrial application.

B. The VFD shall be configurable for normal duty & heavy duty to meet over load requirement of variable and constant torque application. The VFD allows overload current 120% for 60 sec and 140% for 2.5 sec in normal duty and 150% for 60 sec and 175% for 2.5 sec in normal duty.

C. The VFD shall have two independently adjustable acceleration and deceleration time, settable up to 600000 seconds with a linear ramp or an s-curve shaped ramp.

D. The VFD shall have v/f selection for linear curve, s-curve and custom setting with three different points for the curve to get the profile suitable for the application.

E. The VFD shall have power loss ride through (PLCT) function that allows up to 5 seconds for smooth operation of system during power loss with no output torque.

F. The VFD shall have auto-restart functions with adjustable restarts up to 10 times with individual fault conditions. The time between restarts shall be adjustable from 1 second to 30 seconds.

G. The VFD shall have fully functional built-in PID controller.

H. The VFD shall have multi-pump controlling function. The VFD shall control a maximum five (5) pumps as per process requirements. The VFD shall be change pump sequence based upon programmed pump duty cycle.

I. The VFD shall have eight (8) programmable preset speeds.

J. The VFD shall have has built-in PLC with functional block based programming for creating sequential logic as per the requirement.

K. The VFD shall have Heat-sink/IGBT over temperature alarm functions.

L. The VFD shall have pre-configured macro for general industrial application like fan, pump and compressor to reduce programming time.

M. The VFD shall have built-in function macros for optional peripherals control device connections to VFD.

N. The VFD shall have commissioning mode to guide the user step by step to set

basic parameters as per application.

O. The VFD shall have panel debug mode for the logic verification without rotating motor. The IGBT firing pulses shall not generate during this mode, but all the other functions shall work normally.

P. The VFD shall have a self-diagnosis mode to identify faulty components like current sensor, IGBT etc.

Q. The VFD shall have diagnosis functions like Load Analyzer, Peak monitoring, fault counters etc

R. The VFD shall store last 20 faults with date & time, status and 8 operational parameters (Output frequency, Output current, DC bus voltage, Heat-sink/IGBT temperature, Input voltage, Total power ON time, kWH, MWH) information at the time of fault.

S. The VFD shall record following critical number of events/faults since product shipment.

1. No. of Power ON
2. No. of Over Temperature Fault
3. No. of Over Voltage Fault
4. No. of Over Current Fault
5. No. of Earth Fault
6. No. of Over Load Fault
7. No. of Auto Restart

T. The VFD shall have built-in energy meter and ability to calculate and display the approximate cost of electricity consumed by the VFD over a given period of time (kWh and MWh).

U. The VFD shall have high efficiency operation mode to minimize flux current in a lightly loaded motor thus reducing kW usage. When the load increases, the drive shall automatically return to normal operation.

V. The VFD shall have programmable cooling fans' operation. The VFD shall be programmable to turn ON/Off "push/pull fans of VFD (internal fans) with control via run command, heat sink temperature and time base.

W. The VFD shall have user programmable DC injection braking to stop the motor's rotation. DC injection braking current is adjustable between 15 to 150%.

2.7 Signal Interface

The VFD shall have terminal block of different color for the signal interface for easy identification and prevent mistake.

A. Digital Inputs

1. The VFD shall have ten (10) digital inputs. Two (2) inputs shall be dedicated

for the Safe Torque Off (STO) function and the other eight (8) inputs shall be user programmable.

2. All digital inputs shall be +24V operated and configurable as sink/source logic with normally open/close position.

B. Digital Outputs

1. The VFD shall have four (4) open collector type digital outputs, 24 VDC operated and normally open/close selectable.

C. Relay Outputs

1. The VFD shall have three (3) relays outputs.
2. Relays shall be a voltage free "form C" contact rated min. 120 VAC at 5 amps.
3. Relays shall be programmable to multiple conditions including: Fault, Warning, timer At Speed, Drive Ready and PLC output.

D. Analog Inputs

1. The VFD shall have three (3) analog inputs for speed/torque reference, two (2) inputs shall be configurable as voltage or current input and one (1) as +/- 10 V input.
2. Each analog input shall be user programmable and scalable proportional to speed and torque reference.

E. Analog Outputs

1. The VFD shall have three (3) analog outputs, two (2) outputs shall have configurable as voltage or current output and one (1) as +/-10 V output.
2. Each analog output shall be user programmable and scalable proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference and other data.

2.8 Network Interfacing Configuration

A. The VFD shall have a RS-485 port with Modbus-RTU connectivity as a standard.

B. The VFD shall operate through WiFi connectivity with smart phone.

C. The VFD shall have optional Protocols; Profibus-DP(Slave), ProfiNet, Ethercat, Ethernet IP, Modbus-TCP and DeviceNet.

D. The VFD shall be compatible to connect with Mobile through mobile app.

2.9 Operator Interface Unit shall be;

A. Graphical Displays with backlit to improve the visibility of the display

B. Built-in RTC (Real Time Clock) with replaceable lithium battery

C. Keypad with self-explanatory 8~12 function keys

D. LED indication for Run, Stop and Fault

E. At least 8 selectable parameters can be seen in a single screen

F. All normal screens can be auto rotational facility with settable time

G. The VFD's parameter shall be display with engineering units.

1. Output Frequency
2. Motor Speed (RPM, %)
3. Motor Current
4. Motor Power (kW)
5. DC Bus Voltage
6. Output Voltage
7. Heat-sink/IGBT Temperature (°C and/ or °F)
8. PID Reference Values
9. PID Output Values
10. KWh meter
11. MWh meter
12. Total Run Time
13. Total Power Conducting Time

2.10 Protective Feature

A. The VFD shall have current limiting that reduces output frequency and avoids tripping of VFD in over load condition.

B. The VFD shall have DC bus voltage control function that holds output frequency in ramp down stop condition to avoid VFD tripping in DC bus over voltage.

C. The VFD has Metal Oxide Varistors (MOVs) for transient voltage suppression on all three phases of the incoming power line.

D. The VFD has "Magnetic Choke" inductors in series with the input 480/277/V power in addition to the MOV protection.

E. STOP key on the keypad shall be functional at all time.

F. The VFD shall be insensitive to input power phase sequence. Input and output phase loss detection shall be shown on VFD screen with alarm.

G. The VFD shall have below protection;

1. Over current
2. Adjustable Overcurrent
3. Under current
4. Drive Over Load
5. Motor Over Load
6. Input & Output Phase Loss
7. Output Current Unbalance
8. Ground Fault

9. DC bus overvoltage
10. DC bus undervoltage
11. Drive over temperature
12. Motor PTC short fault
13. Motor over temperature
14. External fault
15. EEPROM error
16. 4…20mA Reference missing
17. Communication loss
18. Control Power fault
19. IGBT Driver fault
20. Current Sensor fault
21. Charging fault
22. Over speed fault
23. Speed deviation fault
24. CPU Error

Part 3 – Execution

3.1 Installation

A. Installation shall be in compliance with all manufacturer requirements, instructions and drawings.

B. The contractor shall install the VFD in accordance with the recommendations of the VFD manufacturer as outlined in the VFD installation manual.

C. Power wiring shall be completed by the contractor based on the VFD input current. The contractor shall complete all wiring in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.

3.2 Start-Up

A. The VFD start-up shall be provided by VFD manufacturer engineer. A Start up report shall be filled out for each VFD with a copy provided to the customer and a copy kept on file at service center.

B. At a minimum, the start-up service shall include:

1. Perform pre-power check
2. Verify power and signal grounds
3. Check connections
4. Check environment

C. VFD Power-up and Commissioning:

1. Measure Incoming Power Phase-to-Phase and Phase-to-Ground
2. Measure DC Bus Voltage
3. Measure AC Current Unloaded and Loaded

4. Measure Output Voltage Phase-to-Phase
5. Verify input reference signal

D. All measurements shall be recorded

E. VFD parameters shall be tuned for process requirement

F. VFD parameter listing shall be provided.

3.3 Product Support

A. Manufacturer's trained application engineering and/or service personnel shall provide technical support on call and on site location.

3.4 Training

A. Manufacturer's engineer shall provide on-site training that includes the operational and preliminary maintenance requirements of the VFD.

3.5 Warranty

A. The manufacturer shall provide 12 months product warranty against manufacturing defect from date of startup or 18 months of shipment date, whichever occurs first.

END of SPECIFICATIONS