



**400 SOUTH WELL NO. 2
FURNISHING A 400 HP VARIABLE FREQUENCY DRIVE
MOTOR CONTROLLER AND HARMONIC FILTER FOR
A VERTICAL TURBINE PUMP MOTOR**

BID REQUEST

Project Engineer

**HANSEN, ALLEN, & LUCE, INC.
Consultants/Engineers
859 West South Jordan Pkwy Ste 200
South Jordan, Utah 84095
(801) 566-5599**

**11/2018
260.44.200**

**INSIDE COVER
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SALT LAKE AREA OFFICE
859 W South Jordan Pkwy – Ste 200
South Jordan, Utah 84095
Phone: (801) 566-5599
www.hansenallenuce.com

VFD Suppliers

November 30, 2018

Re: Springville City – 400 South Well No. 2
Furnishing a 400 HP Variable Frequency Drive Motor Controller and Harmonic Filter for
a Vertical Turbine Pump Motor

Dear VFD Suppliers:

Springville City intends to pre-order several “long lead” items that are required for their proposed new 400 South Well No. 2 Pump House. One of those items includes the VFD motor controller and matrix filter. We invite you to review the attached documents and specifications and ask you to provide a bid to supply the VFD as defined herein.

Please direct your response to: **SPRINGVILLE CITY**
 110 SOUTH MAIN
 SPRINGVILLE, UTAH 84663-1399
 ATTENTION: BRUCE RIDDLE, FINANCE DIRECTOR

Springville City will execute a purchase contract with the successful bidder. The purchase contract will be assigned to the successful bidder for the 400 South Well No. 2 Pump House.

Your bid must be received by the due date and time indicated in the attached document 00 11 13 – Advertisement for Bids.

All communication/questions relative to the project shall be submitted on-line (<https://tinyurl.com/springvillebids>) at the “Questions and Answers” section for this project. (From the link above, search for Springville City - 400 South Well No.2 VFD project).

Sincerely,

HANSEN, ALLEN & LUCE, INC.

A handwritten signature in black ink, appearing to read 'Vern Conder', is written over a horizontal line.

Vern G. Conder, P.E.
Associate

Attachments:

- 00 11 13 – Advertisement for Bids
- 00 41 43 – Bid Form
- 00 43 30 – Purchase Order Assignment
- 26 29 33 – Variable Frequency Drives

DOCUMENT 00 11 13

ADVERTISEMENT FOR BIDS

Notice is hereby given that SPRINGVILLE CITY, (OWNER) will accept bids for furnishing and delivering a 400 HP Variable Frequency Drive Motor Controller and Harmonic Filter for their new 400 South Well No. 2 Pump House. The work is described in general as:

The work is comprised of furnishing and delivering to the project site (located at approximately 900 East and 400 South in Springville City, Utah), a 400 HP Variable Frequency Drive motor controller and harmonic filter complete and other requirements as specified herein in contract specification 26 29 23 – Variable Frequency Drives.

Separate sealed bids will be received by OWNER in their office located at Springville City, 110 South Main, Springville, Utah 84663-1399 Attention: Bruce Riddle, Finance Director, until 11:00 a.m. On December 13, 2018 and then at said office publicly opened and read aloud. Bids shall be addressed and delivered to the City offices prior to the bid opening.

Bidding Documents may be obtained on or after November 30, 2018 on-line at <https://tinyurl.com/springvillebids>. (From the link above, search for Springville City - 400 South Well No.2 VFD project).

Bid security in the amount of 5% of the base bid will be required to accompany bids.

A pre-bid conference will not be held.

All communication/questions relative to the project shall be submitted on-line (<https://tinyurl.com/springvillebids>) at the "Questions and Answers" section for this project. (From the link above, search for Springville City - 400 South Well No.2 VFD project).

The OWNER reserves the right to reject any or all bids; or to accept or reject the whole or any part of any bid; or to waive any informality or technicality in any bid in the best interest of Springville City. Only bids giving a firm quotation properly signed will be accepted.

Note that it is the intent of OWNER to execute a purchase contract with the successful BIDDER for work defined herein and in the attached documents. The purchase contract will then be assigned to the successful bidder for the contract for the 400 South Well No. 2 Pump House.

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DOCUMENT 00 41 43
BID FORM

Project Identification: **SPRINGVILLE CITY – 400 SOUTH WELL NO. 2 FURNISHING A 400 HP VFD MOTOR CONTROLLER AND HARMONIC FILTER FOR A VERTICAL TURBINE PUMP MOTOR**

Contract Identification and Number:

ARTICLE 1 – BID RECIPIENT

1.01 This Bid is submitted to:

**SPRINGVILLE CITY
110 SOUTH MAIN
SPRINGVILLE, UTAH 84663-1399
ATTENTION: BRUCE RIDDLE, FINANCE DIRECTOR**

1.02 The undersigned BIDDER proposes and agrees, if this Bid is accepted, to enter into an Agreement with OWNER in the form of a Purchasing Contract to perform all Work as specified or indicated in the Bidding Documents for the prices and within the times indicated in this Bid and in accordance with the other terms and conditions of the Bidding Documents.

ARTICLE 2 – ASSIGNMENT OF PURCHASING CONTRACT

2.01 OWNER will execute a purchasing contract with successful BIDDER. The purchasing contract will be assigned to the successful bidder for the contract for the 400 South Well No. 2 Pump House, for which the Variable Frequency Drive (VFD) and associated appurtenances will become part of. The purchase order assignment will be made using attached document Section 00 43 30 – Purchase Order Assignment.

ARTICLE 3 – BIDDER'S ACKNOWLEDGEMENTS

3.01 BIDDER accepts assignment by OWNER of the purchasing contract for furnishing and delivering the Variable Frequency Drive and Harmonic Filter and associated appurtenances to the successful bidder for the 400 South Well No. 2 Pump House, which the VFD and associated appurtenances will become part of.

3.02 BIDDER acknowledges to OWNER that the Bid provided herein includes total costs required to furnish and deliver the items as outlined within Specification 26 29 23 Variable Frequency Drives.

ARTICLE 4 – BIDDER'S REPRESENTATIONS

4.01 In submitting this Bid, BIDDER represents that:

A. BIDDER has examined and carefully studied the Bidding Documents, and any data and reference items identified in the Bidding Documents, and hereby acknowledges receipt of the following Addenda:

Addendum No.

Addendum, Date

<u>Addendum No.</u>	<u>Addendum, Date</u>
_____	_____
_____	_____
_____	_____

- B. BIDDER has visited the Site, conducted a thorough, alert visual examination of the Site and adjacent areas, and become familiar with and satisfied itself as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.
- C. BIDDER is familiar with and has satisfied itself as to all Laws and Regulations that may affect cost, progress, and performance of the Work.
- D. BIDDER is aware of the general nature of work to be performed by OWNER and others at the Site that relates to the Work as indicated in the Bidding Documents.
- E. BIDDER has given ENGINEER written notice of all conflicts, errors, ambiguities, or discrepancies that BIDDER has discovered in the Bidding Documents, and confirms that the written resolution thereof by ENGINEER is acceptable to BIDDER.
- F. The Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance and furnishing of the Work.
- G. The submission of this Bid constitutes an incontrovertible representation by BIDDER that BIDDER has complied with every requirement of this Article, and that without exception the Bid and all prices in the Bid are premised upon performing and furnishing the Work required by the Bidding Documents.

ARTICLE 5 – BIDDER’S CERTIFICATION

5.01 BIDDER certifies that:

- A. This Bid is genuine and not made in the interest of or on behalf of any undisclosed individual or entity and is not submitted in conformity with any collusive agreement or rules of any group, association, organization, or corporation;
- B. BIDDER has not directly or indirectly induced or solicited any other bidder to submit a false or sham Bid;
- C. BIDDER has not solicited or induced any individual or entity to refrain from bidding; and
- D. BIDDER has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for the Contract. For the purposes of this Paragraph 5.01.D:
 - 1. “corrupt practice” means the offering, giving, receiving, or soliciting of anything of value likely to influence the action of a public official in the bidding process;
 - 2. “fraudulent practice” means an intentional misrepresentation of facts made (a) to influence the bidding process to the detriment of OWNER, (b) to establish bid prices at artificial non-competitive levels, or (c) to deprive OWNER of the benefits of free and open competition;
 - 3. “collusive practice” means a scheme or arrangement between two or more Bidders, with or without the knowledge of OWNER, a purpose of which is to establish bid prices at artificial, non-competitive levels; and

4. "coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Contract.

ARTICLE 6 – BASIS OF BID

6.01 BIDDER will complete the Work in accordance with the Contract Documents for the following price(s):

BID SCHEDULE

ITEM	DESCRIPTION	EST QUANTITY	UNIT	TOTAL AMOUNT
1	Furnish and Deliver 400 HP VFD motor controller with harmonic filter	1	LS	
BID SCHEDULE TOTAL				

ARTICLE 7 – TIME OF COMPLETION

7.01 If awarded, BIDDER will supply the VFD complete within: _____ weeks.

ARTICLE 8 – BID SUBMITTAL

9.01 This Bid is submitted by:

If BIDDER is:

An Individual

Name (typed or printed): _____

By: _____

(Individual's signature)

SEAL, if required

Doing business as:

A Partnership

Partnership Name: _____
By: _____
(Signature of general partner -- attach evidence of authority to sign)
Name (typed or printed):

SEAL,
if required

A Corporation

Corporation Name: _____
State or Jurisdiction of Incorporation: _____
Type (General Business, Profession, Service, Limited Liability):

By: _____
(Signature -- attach evidence of authority to sign)

Name (typed or printed):

Title: _____

Attest _____
(Signature of Corporate Secretary)

CORPORATE
SEAL,
if required by State

Date of Qualification to do business in _____ [State or other jurisdiction where
Project is located] is ___/___/_____

A Joint Venture

Name of Joint Venture: _____

SEAL,
if required by
State

First Joint Venture Name: _____

By: _____

(Signature of joint venture partner -- attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____

Second Joint Venture Name: _____

SEAL,
if required by
State

By: _____

(Signature of joint venture partner -- attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____

(Each joint venture entity must sign. The manner of signing for each individual, partnership, and corporation that is party to the venture should be in the manner indicated above.)

BIDDER's Business address: _____

Business Phone No. (____) _____

Business FAX No. (____) _____

Business E-Mail Address _____

State Contractor License No. _____ (If applicable)

Employer's Tax ID No. _____

Phone and FAX Numbers, and Address for receipt of official communications, if different from Business contact information:

9.02 Bid submitted on _____, 20____.

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SECTION 00 43 30
PURCHASE ORDER ASSIGNMENT

FOR VALUE RECEIVED, Springville City, a body of the State of Utah, Assignor, hereby assigns, transfers and sets over to _____,

All of Assignor's right, title and interest in and to the following described Purchase Order(s) (copies of which are attached hereto and incorporated by reference as though fully set forth herein), subject to all the terms and conditions thereof, to wit:

Purchase Order No. _____, dated _____

THIS ASSIGNMENT IS MADE pursuant to and in accordance with the terms of the Contract Documents and Specifications entered into by and between Assignor and Assignee for the "Springville City 400 South Well No. 2 Pump House", dated the _____ of _____ 2018.

ASSIGNOR HEREBY DELEGATES to Assignee and Assignee, upon execution hereof, hereby expressly assumes all of the obligations and duties to be performed by Assignor under the aforesaid Purchase Orders in accordance with the terms thereof and as provided in said Contract Documents and Specifications.

IN WITNESS WHEREOF, Assignor has executed this Assignment this _____ day of _____ 2018.

ASSIGNOR: Springville City

By _____ (Seal)

Its Mayor

Attest

BY: _____

Its Secretary- Treasurer

_____, Assignee, on this _____ day of _____, 2018, hereby accepts the assignment of the above-described Purchase Order(s), subject to the terms and conditions thereof and in accordance with the terms of this Assignment.

ASSIGNEE:

By _____ (Seal)

Title _____

- END OF SECTION -

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SECTION 26 29 23
VARIABLE FREQUENCY DRIVES

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes providing and installing of variable frequency controllers.
- B. The CONTRACTOR shall provide motor control centers (MCC's), complete and operable, in accordance with the Contract Documents.
- C. Related work includes but is not limited to:
 - 1. Section 26 05 05 - Electrical Equipment

1.2 REFERENCES

- A. IEEE C62.41 (Institute of Electrical and Electronics Engineers) - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
- B. NEMA FU 1 (National Electrical Manufacturers Association) - Fuses.
- C. NEMA ICS 3.1 (National Electrical Manufacturers Association) - Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems.
- D. NEMA ICS 7 (National Electrical Manufacturers Association) - Industrial Control and Systems: Adjustable Speed Drives.
- E. NEMA 250 (National Electrical Manufacturers Association) - Enclosures for Electrical Equipment (1000 Volts Maximum).
- F. NETA ATS (International Electrical Testing Association) - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

- A. Shop Drawings: Indicate front and side views of enclosures with overall dimensions and weights shown; conduit entrance location and requirements; and nameplate legends.
- B. Product Data; Submit catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protection devices, short circuit ratings, dimensions, and enclosure details.
- C. Test Reports: Indicate field test and inspection procedures and test results including a harmonic test that will demonstrate compliance with IEEE 519.
- D. Manufacturer's Field Reports: Indicate start-up inspection findings.

- E. Submittals with drawings not meeting this requirement will not be reviewed further and will be returned to the CONTRACTOR stamped "REJECTED".
- F. Manufacturer's warranty.

1.4 SUBMITTED AT SHIPMENT

- A. Include system manuals, complete with wiring diagrams, schematics, operating, and maintenance instructions, shall be provided with the VFD and VFD systems at the time of shipment, on both hard and digital copies.

1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Contract Closeout: Closeout procedures.
- B. Operation and Maintenance Data: Submit instructions complying with NEMA ICS 3.1. Include procedures for starting and operating controllers, and describe operating limits that may result in hazardous or unsafe conditions. Include routing preventive maintenance schedule.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience and service facilities within 100 miles of the project.

1.7 STANDARDS

- A. The VFD shall be UL listed and not require external fuses except where input power is supplied from multiple transformer secondaries.
- B. All VFD and VFD systems shall be designed in accordance with applicable portions of NEMA standards, and panel build ups manufactured by a UL508 listed manufacturer.
- C. The VFD shall be compatible with the installation requirements of interpretive codes such as National Electric Code (NEC) and Occupational Safety & Health Act (OSHA).
- D. The VFD shall be capable of operating in compliance with IEEE 519-1995.
- E. The VFD shall meet IEC 61200-2 for vibration levels.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

- C. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to components, enclosure, and finish.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements.
- B. Conform to NEMA ICS 7 service conditions during and after installation of variable frequency controllers.

1.10 WARRANTY

- A. Section 01 70 00 - Execution Requirements: Product warranties and product bonds.
- B. Equipment furnished under this Section shall be guaranteed against defective parts and workmanship for 1 year from date of acceptance of the system and shall include labor and travel time for necessary repairs at the job site.
- C. The manufacturer shall provide the service of a factory-trained service representative to verify the correctness of the Contractor's completed installation; to check all electronic circuitry and mechanical components to assure their proper function; and to make all necessary measurements in and around the unit to ensure proper operation. A minimum of 1 day startup service shall be provided. The manufacturer shall provide through the Contractor to owner a written certification that the installation is complete, correct and properly calibrated.

1.11 MAINTENANCE SERVICE

- A. Section 01 70 00 - Execution Requirements: Maintenance service.
- B. Provide service and maintenance of variable frequency controller for one year from Date of Substantial Completion.

1.12 MAINTENANCE MATERIALS

- A. Section 01 70 00 - Execution Requirements: Spare parts and maintenance products.
- B. Supply two of each air filter.
- C. Provide three of each fuse size and type

PART 2 PRODUCTS

2.1 VARIABLE FREQUENCY CONTROLLER

- A. Manufacturers:

1. Allen Bradley Corporation.
 2. Mitsubishi Corporation.
 3. Eaton.
 4. GE/Fuji.
 5. Square D.
 6. Toshiba
 7. WEG.
 8. Approved equal
- B. Product Description: NEMA ICS 7, enclosed 6 pulse variable frequency controller suitable for operating the indicated loads. Select unspecified features and options in accordance with NEMA ICS 3.1.

2.2 RATINGS

- A. Rated Input Voltage: 480 Volts, three phase, 60 Hertz. The VFD shall be able to withstand voltage variations of -15% to +10% without tripping or affecting VFD performance.
- B. Motor Nameplate Voltage: 460 Volts, three phase 60 Hertz.
- C. Motor Nameplate Horsepower:
1. 400 Horsepower, Design B.
- D. True Power Factor: Between 1.0 and 0.95 lagging over entire range of operating speed and load. Filters which have any no load current shall include an isolation contactor to automatically remove power from the VFD/harmonics filter when not in use. VFDs 100 hp and larger must have a automatic staged harmonics filter system to limit leading power factor at lite loads.
- E. Operating Ambient: -10 degrees C to 50 degrees C (14 degrees F to 122 degrees F).
- F. Relative Humidity: 5 to 95 percent non-condensing.
- G. Minimum Efficiency at Full Load: 96 percent at half speed, 98% at full speed.
- H. Elevation: The VFD shall be suitable for operations up to 4,500 feet.
- I. Starting Torque: 100% starting torque shall be available from 0.5 Hz. To 60 Hz.
- J. Overload Capability: 110% of rated FLA. (full load amps) for 60 seconds; 180% of rated FLA, instantaneously.
- K. Radio Frequency Interference (RFI): The VFD must meet the requirements for Radio Frequency Interference (RFI) above 7 MHz as specified by FCC regulations, part 15, subpart J, Class A devices.
- L. In compliance with IEEE 519-1992, the Total Harmonic Voltage Distortion for the

VFD shall be no greater than 3%. And the harmonic current distortion shall be no greater than 12%. Compliance with these requirements shall be shown by a vendor provided harmonics test. The point of common coupling for the purpose of the test shall be the input terminals to the VFD system. Units which fail to meet the above limits will be removed and replaced at the VFD vendors expense.

2.3 DESIGN FEATURES

- A. Employ microprocessor-based inverter logic isolated from power circuits.
- B. VFD shall include surface mounted technology, with conformal coating.
- C. Employ pulse-width-modulated inverter system.
- D. Design for ability to operate controller with motor disconnected from output.
- E. Design to attempt five automatic restarts following fault condition before locking out and requiring manual restart.
- F. The VFD shall be capable of 4 different acceleration and different deceleration rates, each rate independently adjustable from 0.01 to 3600 seconds. Selectable accel/decel patterns to include linear, S-curve, and non-linear for variable torque loads.
- G. The VFD shall have the capability of determining motor characteristics to optimize its operation with the use of pre-programmed motor data information or self-tuning operation. Self-tuning is to be available with or without the motor coupled to the load. Tuning shall also include an online mode that automatically and dynamically compensates the VFD regulator for changes in motor temperature.
- H. An input harmonics filter shall be part of the input section and shall meet the harmonics distortion limits set by this specification regardless of electrical distribution system configuration. The harmonic filter shall incorporate contactor switched capacitors. The contactor shall close when the VFD is greater than 30% load and shall open when the VFD is less than 20% load. 18 pulse input sections are acceptable if they are series rectifier, isolation transformer type design. Active rectifier designs are also acceptable. Auto transformer parallel rectifier 18 pulse designs are not acceptable.

2.4 INDICATORS AND MANUAL CONTROLS

- A. Door Mounted Display:
 - 1. Provide integral LCD display to indicate output voltage, output frequency, output current, fault codes and drive status.
 - 2. Upon a fault condition, the LCD shall display VFD output current, voltage, frequency, torque, DC link voltage, operating hours, I/O terminal status, and temperature at the time of fault. The last four (4) faults will be stored in memory and selectively be displayed on the LCD.

- B. Door Mounted Indicator Lights:
 - 1. Amber to indicate VFD failure.
 - 2. Red to indicate VFD Running.
 - 3. Green to indicate VFD Off.
- C. Door Mounted Switches:
 - 1. Hand-Off-Remote selector switch and manual speed potentiometer.
- D. The drive shall have a built-in keypad that shall include Forward/Reverse/Stop/Jog keys, Drive reset key and Reference increment/decrement keys.
- E. Volts Per Hertz Adjustment: Plus or minus 10 percent.
- F. Current Limit Adjustment: 60 - 110 percent of rated.
- G. Acceleration Rate Adjustment: 0.5 - 30 seconds.
- H. Deceleration Rate Adjustment: 1 - 30 seconds.
- I. Control Power Source: Integral control transformer.

2.5 SAFETIES AND INTERLOCKS

- A. Includes under-voltage release.
- B. Door Interlocks: Mechanical means to prevent opening of equipment with power connected, or to disconnect power if door is opened; include means for defeating interlock by qualified persons.
- C. Safety Interlocks: Terminals for remote contact to inhibit starting under both manual and automatic mode.
- D. Control Interlocks: Furnish terminals for remote contact to allow starting in automatic mode.
- E. The VFD shall be able to automatically reset up to ten (10) times after over-current, over-voltage, overheating, and overload faults. Reset attempts and reset intervals must be programmable.
- F. Disconnecting Means: Integral circuit breaker on the line side of each controller.

2.6 VFD INPUT/OUTPUT PARAMETERS

- A. Inputs: The VFD shall accept and follow a selectable external frequency reference of either analog 0-5 VDC, 0-10 VDC, 4-20mA with signal inversion.
- B. Outputs: The VFD shall provide a 4-20 mA signal, programmable by parameter selection.

- C. The VFD shall maintain the output frequency to within 0.2% of reference when the reference is analog, and to within .01% of reference when the reference is digital (Speed level inputs from keypad, contact closure, digital interface, or serial communication).
- D. The VFD shall have a reference filter to reduce noise in the analog signals and a low noise control power supply system .
- E. The VFD shall accept inputs from external dry contacts for the following functions:
 - 1. Run forward command
 - 2. Run reverse command
 - 3. Multi-step frequency selection
 - 4. Acceleration/Deceleration time selection
 - 5. Stop command
 - 6. Coast to stop command
 - 7. Alarm reset
 - 8. Trip command (external fault)
 - 9. Jogging operation
 - 10. Frequency reference selection (2)
 - 11. DC brake command
 - 12. Torque limits (2)
 - 13. Switching operation between line and inverter (50 and 60 Hz)
 - 14. Speed Increase command
 - 15. Speed Decrease command
 - 16. Write enable for keypad
 - 17. PID control cancel
 - 18. Inverse mode changeover
 - 19. Interlock signal
 - 20. Serial communications enable
 - 21. Universal DI
 - 22. Pick up start mode
 - 23. Forced stop command
 - 24. Forced stop command with Deceleration time
- F. The frequency reference shall be from, selectively, an external speed potentiometer, external analog signals (0-5 VDC, 0-10 VDC, 4 to 20mA with signal inversion), from the built in keypad, or from serial communication.
 - 1. The VFD shall provide five selectable digital outputs indicating the following:
 - a. Inverter running
 - b. Frequency equivalence signal
 - c. Frequency level detection
 - d. Torque polarity
 - e. Torque limiting
 - f. Auto-restarting
 - g. Overload early warning
 - h. Keypad operation mode

- i. Inverter stopping
- j. Ready input
- k. Line/Inverter changeover
- l. Motor 2 / Motor 1
- m. Auxiliary terminal
- n. Time-up signal
- o. Cycle completion time
- p. Stage No Indication (1, 2, and 4)
- q. Alarm Indication (1, 2, 4, and 8)
- r. Fan operation signal
- s. Auto resetting
- t. Universal DO
- u. Overheat early warning
- v. Second frequency level detection
- w. Second overload early warning
- x. Terminal C1 off signal

2.7 PROTECTIVE AND DIAGNOSTIC FEATURES

A. When a fault occurs, the VFD shall have a controlled shut down sequence. A Form C relay fault output shall be available. The reason for the fault condition shall be enunciated on the LED display, and the LCD graphic screen shall display the current, temperature, frequency, and voltage at the time of the fault as well as potential reasons for the condition. The VFD shall monitor, sense, and display the following fault conditions:

- 1. Over-current during acceleration
- 2. Over-current during deceleration
- 3. Over-current during constant speed operation
- 4. Ground fault
- 5. Input phase loss
- 6. Fuse blown
- 7. Over-voltage during acceleration
- 8. Over-voltage during deceleration
- 9. Over-voltage during constant speed operation
- 10. Under-voltage
- 11. Overheating of heatsink
- 12. External thermal relay
- 13. Over-temperature of internal air
- 14. Overheating at Dynamic Braking circuit
- 15. Motor 1 overload
- 16. Motor 2 overload
- 17. Inverter unit overload
- 18. Over-speed
- 19. Memory Error
- 20. Keypad panel communication error
- 21. CPU error
- 22. Option error
- 22. Operational procedure error
- 23. Output wiring error / Impedance imbalance
- 24. Modbus-RTU error

- B. The VFD shall have a selectable Torque Limiting function for both motoring and braking that will sense an overload condition and will reduce frequency and current temporarily until the load reaches acceptable levels. If the overload condition is not settled in the proper amount of time, the Drive will trip on overload. The Torque Limiting shall be programmable from 20-150% of Drive rated motor torque (30 HP and below) and from 20-150% of Drive rated motor torque (40 HP and above), with 1% resolution.
- C. The VFD shall have a selectable electronic inverse time thermal overload function as required by NEC and UL Standard 991 for an AC Induction Motor (Refer to applicable codes for specific installation requirements). The overload shall be programmable from 20 - 135% of Drive rated current.
- D. The VFD shall have an over-voltage protection function that operates if supply voltage rises above rated value or by motor's regeneration.
- E. The VFD shall treat short circuits in either the output load or the output module as an over-current.
- F. If the VFD heat sink temperature exceeds approximately 100-degrees C, the Drive will shut down on over temperature fault.
- G. The VFD shall provide output ground fault protection.
- H. The VFD shall provide LED indication of DC bus voltage, which, when lit, will signify to maintenance people the presence of potentially dangerous voltage.

2.8 VFD CONSTRUCTION

- A. The VFD shall be a sinusoidal PWM type Drive with sensor-less vector control capability. Drive shall be of modular construction for ease of access to control and power wiring, and maintenance. It shall consist of the following general components:
 1. Full wave diode AC/DC rectifier, to eliminate line voltage notching of the three phase source and maintain an input displacement power factor of 0.95 or greater, regardless of speed or load. SCR front ends with gate firing electronics are unacceptable.
 2. DC link capacitors standard, DC link reactor available at all ratings, standard on systems 100HP+.
 3. Input surge protection performed by internal MOV'S (metal oxide varistors) or devices providing equal protection.
 4. Insulated Gate Bipolar Transistor (IGBT) power section. The power section control shall use vector dispersal pulse width modulated (PWM) control and fourth generation soft switching IGBTs to reduce noise and allow longer cable length from VFD to motor without the need for output filters.
 5. The VFD shall be microprocessor based and fully transistorized with a 32 bit MCU and 33 MIPS processing speed.
 6. Separate control and power terminal boards, with option plug shall be provided by the VFD to allow for remote operation.

7. The VFD shall have an RS485 serial communications port as a standard with options for communicating with recognized industry standard device level networks such as DeviceNet, Interbus-S, Profibus, Modbus Plus, LonWorks and Metasys N2. The VFD shall be supplied with a universal ethernet adapter for interface with the serial communications port.
8. The VFD shall have a Keypad capable of copying, uploading and downloading Drive function codes.
9. Enclosure:
 - a. The VFD for this project shall be mounted in a NEMA 1 Motor Control Center enclosure. All components of the VFD system including the harmonics filters, output dv/dt filters and all other VFD system components shall be contained in the enclosure.
 - b. Enclosure cooling shall be filtered forced air cooling sized at 10 CFM per horsepower. Filters shall be disposable pleated filters similar to 3M filtrate type filters. Filters shall be sized to handle two times the fans rated CFM so that they will not restrict flow even at 50% filter loading.
 - c. Provide six spare filters with each VFD system.

2.9 INPUT FILTER

- A. Harmonic Filter: Provide a Matrix Harmonic Filter to reduce the harmonic currents going back into the utility power grid and power system. The total harmonic voltage distortion factor (DF) at the main 480 volt bus for voltage shall be less than 5 percent.
- B. The filter shall include a contactor that shall de-energize the capacitors when the drive is less than 30% output.

2.10 MOTOR RTD TEMPERATURE MONITOR

- A. The VFD enclosure shall be supplied with a 12-channel temperature monitor. The monitor shall accept 100 ohm platinum RTD sensors. The motor will be supplied with 2 embedded RTD sensors in each winding and 2 for the motor bearings. The temperature monitor shall scan all eight sensors. The unit shall provide four programmable Form C relays, plus provide an audible alarm.
- B. The unit shall be provided with a display showing the highest, lowest or any other zone temperature as programmed.
- C. The alarm relays shall be programmable to react to any or all scanned input zones. The audible alarm shall sound when certain relays trip and also at its own setpoint. The unit shall be supplied with a silence pushbutton to quiet the alarm.
- D. The unit shall operate on 115 VAC, single phase, plus/minus 10-percent, 50/60 hertz.
- E. Manufacturer:
 1. Minco CT224
 2. Or approved equal.

2.11 POWER MONITOR

- A. The VFD enclosure shall be supplied with a power monitor/meter. The meter shall be UL listed and CE marked. Meter shall be designed for Multifunction Electrical Measurement on 3 phase power systems.
1. Meter shall support 3-Element Wye, systems.
 2. Surge withstand shall conform to IEEE C37.90.1 and ANSI C62.41 (6 kV)
 3. The meter shall be user programmable for voltage range to any CT or PT ratio.
 4. Meter shall have a burden of not more than 0.36VA per phase, Max at 600V, 0.014VA at 120 Volts.
 5. Meter shall have a burden of not more than 0 .005VA per phase, Max at 11 Amps.
 6. The meter shall accept a voltage input range from 20 up to 576 Volts Line to Neutral, and a range from 0 up to 721 Volts Line to Line
 7. Meter shall accept a current reading of up to 10 Amps continuous. Start-up current for a 5 Amp input shall be no greater than 0.005 Amps
- B. Power meter shall use a dual input method for current inputs. Method one shall allow the CT to pass directly through the meter without any physical termination on the meter, ensuring the meter cannot be a point of failure on the CT circuit. The second method shall provide additional termination pass-through bars, allowing the CT leads to be terminated on the meter. The meter must support both termination methods.
1. Fault Current Withstand shall be 100 Amps for 10 seconds, 300 Amps for 3 seconds, and 500 Amps for 1 second.
 2. Pass through wire gauge dimension of 0.177" / 4.5 mm shall be available.
 3. All inputs and outputs shall be galvanically isolated to 2500 Volts AC.
 4. The meter shall accept current inputs of class 10: (0 to 10) A, 5 Amp Nominal, and class 2 (0 to 2) A, 1A Nominal Secondary.
- C. The meter shall have an accuracy of +/- 0.1% or better for volts and amps, and 0.2% for power and energy functions. The meter shall meet the accuracy requirements of IEC687 (Class 0.2%) and ANSI C12.20 (Class 0.2%)
1. The meter shall provide true RMS measurements of voltage, - phase to neutral and phase-to-phase; and current, per phase and neutral.
 2. The meter shall calculate RMS readings, sampling at over 400 samples per cycle on all channels measured readings.
 3. The meter shall utilize 24 bit Analog to Digital conversion.
 4. The meter shall provide %THD (% of total Harmonic Distortion). Harmonic magnitude recording to the 40th order shall be available for voltage and current harmonics.
- D. The meter shall include a three-line, bright red, .56" L ED display.
1. The meter shall fit in both DIN 92mm and ANSI C3 9.1 round cut-outs.
 2. The meter must display a % of Load Bar on the front panel to provide an analog feel. The % Load bar shall have not less than 10 segments.
- E. Power meter shall include the following measurements
1. Volts
 2. Amps

3. kW
 4. kVAR
 5. PF
 6. kVA
 7. Freq.
 8. kWh
 9. kVAh
 10. kVARh
 11. Power Quality Harmonics
- F. The meter shall be provided with a Ethernet communication card with 10 BaseT Ethernet functionality and allow auto transmit/receive detection for straight or null RJ45 cables. Software for remote programming and integration shall also be provided.
- G. The meter shall have a standard 4 -year warranty.
- H. Power meter shall be able to be stored in (-20 to +70) degrees C.
- I. Operating temperature shall be (-20 to +70) degrees C.
- J. Manufacturer:
1. Electro Industries / Gauge Tech, SHARK 200
 2. Or App roved equal.

2.12 SURGE PROTECTIVE DEVICE

- A. This section describes the materials and installation requirements for an integrated Transient Voltage Surge Suppressor (TVSS), also referred to as Surge Protective Device (SPD), inside VFD enclosure. These devices are used to protect AC electrical circuits from the effect of lightning induced currents, substation switching transients and internally generated transients resulting from inductive and or capacitive load switching.
- B. References
1. UL 1449 Second Edition 2005 - Transient Voltage Surge Suppressors
 2. UL 1283 - Electromagnetic Interference Filters
 3. ANSI/IEEE C62.41.1-2002 - IEEE Guide on the Surge Environment in Low Voltage (1000 V and Less) AC Power Circuits; C62.41.2-2002 - IEEE Recommended Practice on Characterization of Surge Voltages in Low Voltage AC Power Circuits; and C62.45-2002 - IEEE Recommended Practice on Surge Testing for Equipment Connected to Low -Voltage AC Power Circuits.
 4. NEC 2008, Article 285
- C. Internal TVSS
1. TVSS shall be Listed in accordance with UL 1449 Second Edition 2005 and UL 1283, Electromagnetic Interference Filters.
 2. Integrated surge protective devices (S PD) shall be Component

Recognized in accordance with UL 1449 Second Edition, Revision 2/9/2005 Section 37.3 and 37.4 at the standard's highest short-circuit current rating (SCCR) of 200 kA, including intermediate level of fault current testing that will be effective 2/9/2007.

3. TVSS shall be tested with the ANSI/IE EE Category C High exposure waveform (20kV -1.2/50?s, 10kA-8/20's).
 4. TVSS shall provide suppression for all modes of protection: L-N, L-G, and N-G in WYE systems
 5. Recommended TV SS ratings:
 - a. Minimum surge current rating shall be 160 kA per phase (80 kA per mode) for service entrance and 80 k A per phase (40 kA per mode) for distribution applications.
 - b. UL 1449 clamping voltage must not exceed the following : 480Y/277
 - c. Pulse life test: Capable of protecting against and surviving 5000 ANSI/IE EE Category C High transients without failure or degradation of clamping voltage by more than 10%.
 6. TVSS shall be designed to withstand a maximum continuous operating voltage (MCOV) of not less than 115% of nominal RMS voltage.
 7. TVSS shall be constructed of one self-contained suppression module per phase.
 8. Visible indication of proper TVSS connection and operation shall be provided. The indicator lights shall indicate which phase as well as which module is fully operable. The status of each TVSS module shall be monitored on the front cover of the enclosure as well as on the module. A push-to-test button shall be provided to test each phase indicator. Push-to-test button shall activate a state change of dry contacts for testing purposes.
 9. TVSS shall be equipped with an audible alarm which shall activate when any one of the surge current modules has reached an end-of-life condition. An alarm on/off switch shall be provided to silence the alarm. The switches and alarm shall be located on the front cover of the enclosure.
 10. A connector shall be provided along with dry contacts (normally open or normally closed) to allow connection to a remote monitor or other system. The output of the dry contacts shall indicate an end-of-life condition for the complete TVSS or module.
 11. Terminals shall be provided for necessary power and ground connections.
 12. The TV SS shall be equipped the following optional items:
 - a. A transient voltage surge counter shall be located on the diagnostic panel on the front cover of the enclosure. The counter shall be equipped with a manual reset and battery backup to retain memory upon loss of AC power.
- D. TVSS shall have a warranty for a period of ten (10) years from date of invoice. Warranty shall be the responsibility of the electrical distribution equipment manufacturer and shall be supported by the irrespective field service division.
- E. Manufacturer:

1. Eaton
2. Square D
3. Raycap
4. Or approved equal.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 31 13 - Coordination: Coordination and project conditions.
- B. Verify that building environment can be maintained within the service conditions required by the manufacturer.

3.2 INSTALLATION

- A. Install in accordance with NEMA ICS 3.1.
- B. Tighten accessible connections and mechanical fasteners after placing controller.
- C. Select and install overload heater elements in motor controllers to match installed motor characteristics.
- D. Provide engraved plastic nameplates under the provisions of Section 26 05 00.
- E. Motor Data: Neatly type label inside controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating. Place label in clear plastic holder.
- F. Ground and bond controller under the provisions of Section 26 05 13.

3.3 QUALITY ASSURANCE

- A. All VFD's shall be 100% factory tested to ensure proper performance upon delivery.
- B. VFD's installed in panels shall be 100% factory tested as a system by the VFD supplier.

3.4 FIELD QUALITY CONTROL

- A. Section 01 43 00 - Quality Assurance and Startup Procedures Section 01 75 16 for: Testing, adjusting, and balancing.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.16 and NEMA ICS 3.1.

3.5 MANUFACTURER'S FIELD SERVICES

- A. Prepare and startup variable frequency controller.
- B. VFD and VFD system operational and maintenance training and startup service shall be provided by the VFD supplier. The VFD vendor shall have factory trained personnel at field locations convenient to the installation site, available for trouble shooting and/or startup assistance 24/7. Provide 4 hours for each VFD at the owners facility.
- C. Coordinate factory startup with the VFD factory representatives.

3.6 DEMONSTRATION AND TRAINING

- A. Provide 4 hours of instruction each for 2 persons, to be conducted at project site with manufacturer's representative.

3.7 WARRANTY

- A. The VFD vendor shall provide a warranty for material and workmanship, for a period of twenty-four months after start up or 30 months after shipment, whichever occurs first.
- B. Warranty and non-warranty service shall be available in house and in the field. There shall be authorized service centers locally available within 4 hours.

3.8 SPARE PARTS

- A. Provide a list of all spare parts to the Owner at Substantial Completion.

3.9 RTD TEMPERATURE MONITOR

- A. Install the temperature monitor in the front of th VFD enclosure, at +50-inches above the floor, but not exceeding +60-inches (to the top of the unit).
- B. Wiring:
 - 1. Wire Relay #1 shall be wired to stop the motor on high temperature alarm.
 - 2. Wire Relay #2 to provide a high temperature warning alarm to the SCADA RTU.
 - 3. Alarm setpoints to be determined during startup.
- C. Nameplate:
 - 1. Provide an engraved nameplate above the unit.

- END OF SECTION -

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