CITY OF Tulsa
A New Kind of Energy.

FAX TRANSMITTAL

Date: March 28, 2023

To: Plan Holders

Company: Contractors

Number of Pages: 24 (Including Cover)

From: Kelsi Teel - Contract Administration
Telephone No. 918-596-9406
Email – kteel@cityoftulsa.org

RE: **PROJECT NO. WPC 23-1 FY"23**
Water Pollution Control Capital Equipment Replacements

ADDENDUM NO. 1

Please email a signed cover sheet to tcurry@cityoftulsa.org as acknowledgement of receipt.

Thank you,

Signature	Company	Date

TULSA METROPOLITAN UTILITY AUTHORITY

175 E. 2nd Street TULSA, OKLAHOMA 74103

March 28, 2023

ADDENDUM NO. 1
TO
PROJECT NO. WPC 23-1
FY'23 WATER POLLUTION CONTROL
CAPITAL EQUIPMENT REPLACEMENTS

This Addendum No. 1, consisting of fourteen (14) item is hereby made a part of the Contract Documents to the same extent as though it were originally included therein, and shall supersede anything contained in the Plans and Specifications with which it might conflict. **This Addendum shall be attached to the Index Sheet of the Contract Documents and submitted with bid. Failure to do so shall result in the bid being deemed non-responsive.**

All other provisions of the Plans and Specifications shall remain in full force and effect.

CITY OF TULSA WATER AND SEWER DEPARTMENT

Digitally signed by Matt Vaughan
Date: 2023.03.28 08:40:08 -05'00'

Matt Vaughan, PE
Water Pollution Control Section Manager

ELECTRONIC BID PROPOSAL INSTRUCTIONS - EXCEL SPREADSHEET

FY'23 WATER POLLUTION CONTROL CAPITAL EQUIPMENT REPLACEMENTS

TMUA PROJECT NO. WPC 23-1

Please read the following instructions carefully.

1. After opening this file re-save it as your company's name.
2. Open the BID FORM Sheet from the tabs below.
3. Input the unit price of the appropriate pay item in the cells highlighted in blue.
4. Review all data input and check calculations to ensure accuracy of Bid.
5. Print 1 hardcopy of the "PROPOSAL" tab, BID FORM and the "SIGNATURE PAGE" tab.
6. Complete and sign the "Signature Page" document.
6. Submit hardcopy and electronic disk with Contract Documents and Specifications for Bid opening date.

NOTES:

1. The sheet named "FOR CONTRACTOR USE" shall be used by the contractor to export data to estimating software.

LEGEND

$	1.00	Cells Requiring Data Input.
$	1.00	Internal Data Transfer.
$	2.00	Calculated Results.

AGREEMENT FOR USING ELECTRONIC BID PROPOSAL

By and Between: Holloway, Updike & Bellen, Inc. (ENGINEER) and RECIPIENT. The enclosed electronic media is provided pursuant to your request and is for your limited use in connection with your submittal of Bid Proposal for Project No. WPC 23-1, WATER POLLUTION CONTROL CAPITAL EQUIPMENT REPLACEMENTS. In no event shall the information be used for any other purpose or be released to third parties without the written consent of the ENGINEER. In the event of a discrepancy between the hard copy and this electronic media at delivery or in the future, the hard copy shall govern. ENGINEER hereby disclaims any and all liability for the consequences from use of the electronic media and makes no warranty or guarantee of accuracy. RECIPIENT shall assume full responsibility for the uses and consequences of the electronic media. It is agreed that ENGINEER has and retains ownership of the electronic media. ENGINEER does not warrant or guarantee that the electronic data is compatible with RECIPIENT'S computer hardware or software, and ENGINEER'S responsibility for the electronic media is limited to replacement of defective media for a period of thirty (30) days after delivery to RECIPIENT. !!! By opening and using this FILE, You AGREE to these TERMS AND CONDITIONS!!!

PROPOSAL
FY'23 WATER POLLUTION CONTROL CAPITAL EQUIPMENT REPLACEMENTS
TMUA PROJECT NO. WPC 23-1

TO: TULSA METROPOLITAN UTILITY AUTHORITY
CITY OF TULSA, OKLAHOMA

THE UNDERSIGNED BIDDER, having carefully examined the drawings, specifications, and other Contract Documents of the above project presently on file in the City Clerk, City of Tulsa, Oklahoma:

CERTIFIES THAT he has inspected the site of the proposed work and has full knowledge of the extent and character of the work involved, construction difficulties that may be encountered, and materials necessary for construction, class and type of excavation, and all other factors affecting or which may be affected by the specified work; and

CERTIFIES THAT he has not entered into collusion with any other bidder or prospective bidder relative to the project and/or bid; and

HEREBY PROPOSES to enter into a contract to provide all necessary labor, materials, equipment and tools to completely construct and finish all the work required by the Contract Documents referred to therein; to complete said work within **365 calendar days** after the work order is issued; and to accept in full payment therefore the amount set forth below for all work actually performed as computed by the Engineers as set forth in the Contract.

Basis of Award

IT SHOULD BE NOTED THAT THE LOWEST RESPONSIBLE BID SHALL BE DETERMINED BY THE TOTAL BASE BID PLUS ADDITIVE ALTERNATES NO. 1-6. THE ITEMS IN ADDITIVE ALTERNATES NO. 1-6 MAY OR MAY NOT BE INCLUDED IN THE CONTRACT AWARD AT THE SOLE DISCRETION OF THE CITY OF TULSA. ANY PROPOSAL SUBMITTED WITH ADDITIVE ALTERNATES NO. 1-6 INCOMPLETE SHALL BE CONSIDERED NON-RESPONSIVE.

Note: - Item numbers omitted are not a part of the Contract.

PROPOSAL FOR
FY'23 WATER POLLUTION CONTROL CAPITAL EQUIPMENT REPLACEMENTS
TMUA PROJECT NO. WPC 23-1

ITEM NUMBER	SPEC NUMBER	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
1	203.998	Mobilization	LS	1		
2	203.100	All materials, labor, equipment, and supervision required for the Aeration Basin Gallery #2 (North) Waste Activated Sludge (WAS) 6" Flow Meter Improvements at the NSWWTP per these specifications.	LS	1		
3	203.800	All materials, labor, equipment, and supervision required for the Headworks Thickener Facility Lighting Improvements at the NSWWTP per these specifications.	LS	1		
4	203.820	All materials, labor, equipment, and supervision required for the Digester #1 and #2 Building Make Up Air Unit Replacement at the NSWWTP per these specifications.	LS	1		
5	203.200	All materials, labor, equipment, and supervision required for the Lift Station Basement Floor Drainage Improvements at the Interceptor Lift Station per these specifications.	LF	120		
6	203.720	All materials, labor, equipment, and supervision required for the Replacement of the Sodium Hypochlorite RAS Chemical Metering Pumps at the SSWWTP per these specifications.	LS	1		
7	203.740	All materials, labor, equipment, and supervision required for the Replacement of the Sodium Bisulfite Chemical Metering Pumps at the SSWWTP per these specifications.	LS	1		
8	203.760	All materials, labor, equipment, and supervision required for the 30" Flow Meter Replacements at the Main Lift Station SSWWTP per these specifications.	LS	1		
9	203.780	All materials, labor, equipment, and supervision required for the Surface Aerator Bearing Plates Rehabilitation at the LBCWWTP per these specifications.	LS	1		
		TOTAL BASE BID				

PROPOSAL FOR
FY'23 WATER POLLUTION CONTROL CAPITAL EQUIPMENT REPLACEMENTS
TMUA PROJECT NO. WPC 23-1

ITEM NUMBER	SPEC NUMBER	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
ADDITIVE ALTERNATE NO. 1						
10	203.300	All materials, labor, equipment, and supervision required for the Contact Basin Level Instrument and Sampling System Improvements at the NSWWTP per these specifications.	LS	1		
		TOTAL ADDITIVE ALTERNATE NO. 1				
ADDITIVE ALTERNATE NO. 2						
11	203.400	All materials, labor, equipment, and supervision required for the Disinfection and Dechlorination Buildings Shower/Eyewash Station and Water Heater Replacements at the NSWWTP per these specifications.	LS	1		
		TOTAL ADDITIVE ALTERNATE NO. 2				
ADDITIVE ALTERNATE NO. 3						
12	203.765	All materials, labor, equipment, and supervision required for the 24" Flow Meter Replacement at the Cherry Creek Lift Station per these specifications.	LS	1		
		TOTAL ADDITIVE ALTERNATE NO. 3				
ADDITIVE ALTERNATE NO. 4						
13	203.850	All materials, labor, equipment, and supervision required for the Rotary Drum Thickeners (RDT) Variable Frequency Drive (VFD) Replacements at the SSWWTP per these specifications.	LS	1		
		TOTAL ADDITIVE ALTERNATE NO. 4				
ADDITIVE ALTERNATE NO. 5						
14	203.880	All materials, labor, equipment, and supervision required for the Surface Aerator Variable Frequency Drive (VFD) Improvements at the LBCWWTP per these specifications.	LS	1		
		TOTAL ADDITIVE ALTERNATE NO. 5				
ADDITIVE ALTERNATE NO. 6						
15	203.999	Mechanical, Electrical, Plumbing and Unforeseen Circumstances Allowance for various mechanical, electrical, plumbing, and unforeseen work not shown on the construction drawings or specified in the contract documents.	ALLOW	1	$100,000.00	$100,000.00
		TOTAL ADDITIVE ALTERNATE NO. 6				**$100,000.00**
		TOTAL BID				**$100,000.00**

TOTAL TMUA BASE BID	
ADDITIVE ALTERNATE NO. 1	
ADDITIVE ALTERNATE NO. 2	
ADDITIVE ALTERNATE NO. 3	
ADDITIVE ALTERNATE NO. 4	
ADDITIVE ALTERNATE NO. 5	
ADDITIVE ALTERNATE NO. 6	$100,000.00
TOTAL BASIS OF AWARD (BASE BID)	$100,000.00

Enclosed is a ( ) Bidder's Surety Bond, ( ) Certified Check, ( ) Cashier's Check for

_____ Dollars ($_____)
Figures

which the City of Tulsa may retain or recover as liquidated damages in the event that the undersigned fails to enter into contract for the work covered by this proposal., provided the Contract is awarded to the undersigned within thirty (30) days, or within ninety (90) days if Federal funds are utilized, from the date fixed for opening of bids and the undersigned fails to execute said Contract and furnish the required bonds and other requirements as called for in these Contract Documents within thirty (30) days after award of Contract.

Dated at Tulsa, Oklahoma, this _____ day of _____, 20__.

Respectfully submitted,

_____
(Complete legal name of company)

_____
(State of Organization)

By: _____
Title:
Printed Name:

ATTEST: _____
Title: Corporate Secretary
Printed Name:

(SEAL)

Address: _____

Telephone Number: _____ Fax Number: _____

The undersigned acknowledge receipt of the following Addenda (give number and date of each):

_____
_____
_____
_____

818 East Side Boulevard
Post Office Box 1543
Muskogee, OK 74402
P: (918) 682-7811
F: (918) 682-4551

2001 N Willow Avenue
Broken Arrow, OK 74012
P: (918) 251-0717
F: (918) 251-0754
hubengineers.com

ENGINEERS

ADDENDUM NO. 1
March 28, 2023

PROJECT NO. WPC 23-1
FY'23 WATER POLLUTION CONTROL
CAPITAL EQUIPMENT REPLACEMENTS

This Addendum No. 1, consisting of fourteen (14) items is hereby made a part of the Contract Documents to the same extent as though it were originally included therein, and shall supersede anything contained in the Plans and Specifications with which it might conflict. **This Addendum shall be attached to the Index Sheet of the Contract Documents and submitted with bid. Failure to do so shall result in the bid being deemed non-responsive.**

CONTRACT DOCUMENTS:

VOLUME I – BIDDING DOCUMENTS:

1. BID PROPOSAL:

   DELETE THE EXISTING PROPOSAL IN ITS ENTIRETY AND REPLACE WITH THE ATTACHED REVISED PROPOSAL. FOR CLARIFICATION, THE NEW PROPOSAL HAS DELETED BID ITEMS FOR THE SSWWTP WASTE ACTIVATED SLUDGE (WAS) STORAGE BLOWER AND PIPING IMPROVEMENTS AND THE SSWWTP ROTARY DRUM THICKENERS (RDT) REHABILITATION. ADDITIONALLY, THE BID ITEMS FOR THE LBCWWTP SURFACE AERATOR VARIABLE FREQUENCY DRIVE (VFD) IMPROVEMENTS AND THE MECHANICAL, ELECTRICAL, PLUMBING AND UNFORESEEN CIRCUMSTANCES ALLOWANCE HAVE BEEN MOVED TO ADDITIVE ALTERNATES.

   THE REVISED ELECTRONIC PROPOSAL IS FOUND AT:
   HTTPS://WWW.CITYOFTULSA.ORG/GOVERNMENT/DEPARTMENTS/ENGINEERING-SERVICES/CONSTRUCTION-BIDS/

   IT IS THE BIDDERS RESPONSIBILITY TO DOWNLOAD THE REVISED PROPOSAL ONTO THEIR THUMB DRIVE.

VOLUME II – TECHNICAL SPECIFICATIONS:

2. REFER TO SPECIFICATION SECTION 203.100, 203.760, 203.765 – MAGNETIC FLOW METERS:

a. Replace paragraph 203.100.11.1 Manufacturer with the following:

"Manufacturer: Endress+Hauser Promag 400 W Series, ABB Reduced Bore Watermaster, or equal".

3. SPECIFICATION SECTION 203.640 – ROTARY-LOBE POSITIVE DISPLACEMENT BLOWER SYSTEM:

a. Delete specification section entirely. For clarification, this work has been removed from the contract.

4. SPECIFICATION SECTION 203.880 – REDUCED HARMONIC VARIABLE FREQUENCY DRIVES:

a. Add the attached Specification Section 203.880 – REDUCED HARMONIC VARIABLE FREQUENCY DRIVES to Volume II Specifications.

CONSTRUCTION DRAWINGS:

5. REFER TO DRAWINGS 203.640.A THROUGH 203.640.I (SHEETS 15 THROUGH 24):

a. Delete these Drawings entirely. For clarification, this work has been removed from the contract.

6. REFER TO DRAWINGS 203.700.A THROUGH 203.700.B (SHEETS 25 AND 26):

a. Delete these Drawings entirely. For clarification, this work has been removed from the contract.

7. REFER TO DRAWING 203.300.B (SHEET 10) – NSWWTP CONTACT BASIN LEVEL INSTRUMENT AND SAMPLING:

a. Reference Detail B/10 showing the dimensions of the platform and steps. Revise the dimensions to be 27" tall with a top operating platform area 3'-0" by 9'-0".

8. REFER TO DRAWING 203.400.B (SHEET 12) – NSWWTP DECHLORINATION BUILDING SHOWER/EYE WASH REPLACEMENT.

a. On the Equipment Schedule replace Symbol "A" model number Bradley S19-31400 with Bradley S19-314SS.

9. REFER TO DRAWING 203.400.C (SHEET 14) – NSWWTP DECHLORINATION BUILDING SHOWER/EYE WASH REPLACEMENT.

a. Reference photo Detail B/14. Add callout note to dash line: "PROVIDE A 1" PVC SCHEDULE 40 DRAIN PIPE ALONG WALL AND FLOOR DRAIN. INSTALL A 1"-90 BEND LOOKING DOWN INTO DRAIN AND 3" TO 1" REDUCERS AT THE BACKFLOW PREVENTORS."

10. REFER TO DRAWING 203.720.A (SHEET 27) – SSWWTP SODIUM HYPOCHLORITE RAS CHEMICAL METERING PUMPS:

    a. Add the following Notes:

    "9. PROVIDE UP TO 3 LF OF NEW PIPING BOTH ABOVE PANEL BOARD AND BELOW THE TABLE FOR ALL CONNECTIONS.

    10. NEW CHEMICAL METERING PUMPS SHALL BE WATSON MARLOW MODEL NO. 520UMAN/REL OR EQUIVALENT AS MANUFACTURED BY BLUE-WHITE INDUSTRIES."

11. REFER TO DRAWING 203.740.A (SHEET 33) – SSWWTP SODIUM BISULFITE CHEMICAL METERING PUMPS:

    a. Add the following Notes:

    "9. PROVIDE UP TO 3 LF OF NEW PIPING BOTH ABOVE PANEL BOARD AND BELOW THE TABLE FOR ALL CONNECTIONS.

    10. NEW CHEMICAL METERING PUMPS SHALL BE WATSON MARLOW MODEL NO. 520UMAN/REL OR EQUIVALENT AS MANUFACTURED BY BLUE-WHITE INDUSTRIES."

12. REFER TO DRAWING 203.780 (SHEET 39) – LBC WWTP SURFACE AERATOR BEARING PLATE REHABILITATION:

    a. Replace Note 3 with the following:

    "3. SAND BLAST BEARING PLATES TO SP-5 WHITE METAL BLAST. LEAVE 6" OF THE ADJACENT CONCRETE UNMASKED DURING BLASTING. FOR CLARIFICATION, THE SPECIFICATION SECTION 204.5.1 SURFACE PREPARATIONS DOES NOT APPLY AT THIS LOCATION AND AREA OF WORK."

13. REFER TO DRAWING 203.880 (SHEET E4) – ELECTRICAL DETAILS (LBC VFD):

    a. Delete Trench Detail. For clarification, existing duct bank conduits are intended for reuse. No Trenching or duct bank installation is required. New above ground conduits are required for new work.

14. REFER TO DRAWINGS 203.880.C THROUGH 203.880.E (SHEETS E2 THROUGH E4):

a. Add a text box to each sheet identifying the work as "ADDITIVE ALTERNATE #5"

HOLLOWAY, UPDIKE AND BELLEN, INC.

Stephen Tolar, P.E., S.E.
President

END ADDENDUM NO. 1

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:
   1. Reduced harmonic 18 pulse or active front end, variable frequency drives (VFD), 60 to 500 horsepower for control of standard NEMA Design B squirrel cage induction motors.
   2. NOTE: VFD's SHALL BE SIZED AND RATED TO DELIVER APPROVED MOTOR NAMEPLATE FLA AT 50 DEGREES C. WHERE 40 DEGREE C EQUIPMENT IS PROPOSED, VFD SHALL BE SIZED AT A MINUMUM OF 125% OF MOTOR NAMEPLATE FLA AND ASSOCIATED FEEDER SIZES SHALL BE INCREASE TO MATCH AT NO CHANGE IN CONTRACT PRICE.

1.2 REFERENCES

A. As specified in the Common Work Results for Electrical section.

B. National Electrical Manufacturers Association (NEMA).

C. Underwriters' Laboratories (UL):
   1. 50 – Standards for Enclosures for Electrical Equipment.
   2. 508A – Standard for Safety for Industrial Control Panels.

1.3 DEFINITIONS

A. As specified in the Common Work Results for Electrical section.

B. Specific Definitions
   1. VFD: Variable Frequency Drive.
   2. AFE: Active Front End.
   3. IGBT: Insulated Gate Bipolar Transistor.

1.4 SYSTEM DESCRIPTION

A. Design requirements:
   1. Each VFD system shall consist of all components required to meet the performance, protection, safety, testing and certification criteria of this Section.
   2. The VFD system:
      a. Is a fully integrated package.
      b. Includes all material necessary to interconnect VFD system elements, even if shipped separately.
   3. Any modifications to a standard product necessary to meet this Section shall be made only by the VFD manufacturer.
   4. Each VFD shall be completely factory pre-wired, assembled and then tested as a complete package by the VFD manufacturer to ensure a properly coordinated, fully integrated drive system.
   5. The VFD shall be capable of operating standard NEMA Design B motors. It is the responsibility of the VFD manufacturer to ensure that the drive will not damage motor insulation due to high carrier frequency, reflected wave, dv/dt or other drive electrical characteristics:
      a. The VFD manufacturer shall furnish equipment necessary to mitigate potential damage to motor insulation.

b. Coordinate bearing protection methods with the supplier of the driven equipment.
c. Motors as specified in the Low Voltage Motors section up to 500 Horsepower.

B. Performance:
1. Operating envelope:
a. Speed and torque requirements:
1) Provide a variable torque or constant torque VFD as required by the driven load.
2) The VFD shall be capable of producing a variable alternating voltage/frequency output to provide continuous operation over the 40 to 110 percent (25 to 66 hertz) speed range.
b. Current requirements:
1) Provide 100 percent of rated output current on a continuous basis.
2) Variable torque VFD :
a) Minimum 110 percent current overload for 1 minute.
3) Constant torque VFD :
a) Minimum 150 percent current overload for 1 minute.
2. Harmonics:
a. The VFD shall meet the following distortion limits at 2 percent line voltage unbalance measured at the input terminals of the VFD:
1) Voltage harmonics: The maxmimum allowable total harmonic distortion, THD, for each VFD shall not exceed 5 percent.
2) Current harmonics: The maximum allowable total harmonic current distortion limit, TDD, for each VFD shall not exceed 5 percent as measured at the input terminals of the VFD system.
3. Efficiency:
a. VFD system minimum efficiency shall be 93 percent at rated kilowatt output of the VFD. VFD system efficiency shall be calculated as follows:

$$Efficiency\ (\%) = \frac{Power\ (Load)}{Power\ (Supply)}\ x\ 100$$

b. Power:
1) Load power is the total 3-phase power measured at the output terminals of the drive system, including the output filter.
2) Supply power is the total power measured at the input terminals of the VFD including phase shifting transformer or active front end components and auxiliary equipment (e.g., controls, fans) for complete system operation.
4. Total power factor:
a. Minimum of 0.96 lagging across the entire speed range.
b. Under no operating conditions shall the VFD have a leading power factor.
5. Frequency accuracy:
a. Minimum of within 0.01 percent.
6. Speed regulation:
a. Minimum of within 0.5 percent across the entire speed range.
7. Capable of working with all available power sources (utility and on-site generation) and with all new and existing VFDs.

1.5 SUBMITTALS

A. Furnish submittals as specified in the Common Work Results for Electrical section:
1. Custom prepared by the VFD manufacturer and specific for the equipment furnished.

B. Product data:
   1. Manufacturer of the VFD.
   2. Manufacturer of all components of the VFD.
   3. Dimensions:
      a. Height.
      b. Width.
      c. Depth.
   4. Weight.
   5. Nameplate schedule.
   6. Bill of material.
   7. Ratings:
      a. Voltage.
      b. Phase.
      c. Input current.
      d. Output current.
      e. Interrupting rating.
      f. Momentary current rating.
   8. Catalog cut sheets for major components.
   9. Surge protection data.
   10. Design data:
      a. Efficiency and power factor values.
      b. Certification that the drive is sized for the full nameplate motor horsepower and current (at rated RPM) of the driven load at the installed altitude.
      c. Certification that based upon VFD design, cable length to motor, and motor dielectric insulation level that the VFD will not damage motor insulation due to carrier frequency, reflected wave, dv/dt, or other VFD produced characteristics.
      d. Certification that all electronic circuits and printed circuit boards are conformably coated.
      e. Certification that the VFD will operate with all power sources (including alternate utilities and on-site generation when applicable).
   11. List of recommended spare parts.
   12. For equipment installed in structures designated as seismic design category C, D, E, or F submit the following as specified in the Common Work Results for Electrical section:
      a. Manufacturer's statement of seismic qualification with substantiating test data.
      b. Manufacturer's special seismic certification with substantiating test data.

C. Shop drawings:
   1. Complete plan and elevation drawings showing:
      a. All dimensions.
      b. Panel, sub-panel and component layout indexed to the bill of material.
      c. Conduit connections.
      d. Required clearance around equipment.
   2. Block diagram showing the basic control and protection systems identifying the protection, control, trip and alarm functions, the reference signals and commands and the auxiliary devices.
   3. Complete schematic, wiring and interconnection diagrams showing connections to both internal and external devices:
      a. Wiring diagrams shall include terminal number and wire numbers.
   4. Complete 1-line and 3-line diagrams including, but not limited to, circuit breakers, motor circuit protectors, contactors, instrument transformers, meters, relays, timers, control devices, and other equipment comprising the complete system:
      a. Device electrical ratings shall be clearly indicated on the Drawings.

D. Certifications:
   1. Certification letter from the VFD manufacturer stating that the VFD(s) are capable of operating with all new and existing sources (utility sources and on-site generation).
   2. Certification letter from the VFD manufacturer stating that the VFD(s) are capable of operating with all new and existing VFDs on site.

E. Installation instructions:
   1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
   2. For equipment installed in structures designated as seismic design category A or B:
      a. Provide manufacturer's installation instructions and anchoring details for connecting equipment to supports and structures.
   3. For equipment installed in structures designated as seismic design category C, D, E, or F:
      a. Provide project-specific installation instructions and anchoring details based on support conditions and requirements to resist seismic and wind loads as specified in the Common Work Results for Electrical section.
      b. Submit anchoring drawings with supporting calculations.
      c. Drawings and calculations shall be stamped by a professional engineer registered in the state where the Project is being constructed.

F. Test forms and reports:
   1. Submit complete factory acceptance test procedures and all forms used during the test.
      a. For VFD units less than 250 horsepower, provide certified test results for the actual VFD being furnished or prototype units. For VFD units 250 horsepower and larger, provide certified test results for the actual VFD being furnished.
      b. Provide the following certified test reports:
         1) Efficiency at rated power output and output frequency of 60 hertz.
         2) Power factor at 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent speed.
         3) Harmonics at the input terminals of the VFD at 100 percent speed and 100 percent load.
            a) Voltage distortion: Measure individual harmonics up to and including the 50^{th} harmonic and total harmonic distortion.
            b) Current distortion: Measure individual harmonics up to and including the 50^{th} harmonic and total demand distortion.
      c. Submit complete field acceptance test procedures and all forms used during the test:
         1) Certification that the actual measured harmonic distortion for both voltage and current is within the specification limits at the installed site.
         2) Certification that the actual measured peak voltage at the motor terminations is less than 90 percent of the motor insulation dielectric withstand level.

G. Record documents:
   1. Certified record documents of all equipment with information listed above.

H. Manufacturer's field reports:
   1. Certification letter from the VFD manufacturer that the VFD(s) has been inspected and installed in accordance with the manufacturer's requirements.
   2. Report listing the setting of all VFD adjustable parameters and their values after start-up.

3. Certification letter from the VFD manufacturer stating that the VFD(s) are programmed to avoid system resonances when connected to high impedances sources like standby generator.

I. Operation and maintenance manuals:
   1. Spare parts list with supplier names and part numbers.
   2. Start-up and commissioning instructions and data.
   3. Complete bill of material indexed to the drawings, identifying the catalog or part numbers, manufacturer, and quantities of components of the VFD system.
   4. Operating manuals:
      a. Submit operating instructions and a maintenance manual presenting full details for care and maintenance of each model of VFD provided under this Contract.
   5. Operating instructions:
      a. The written descriptions shall detail the operational functions of all controls on the front panel including keypad functions and parameters.
   6. Maintenance manual:
      a. Furnish maintenance manuals with instructions covering all details pertaining to care and maintenance of all equipment as well as identifying all parts.
      b. Manuals shall include but are not limited to the following:
         1) Adjustment and test instructions covering the steps involved in the initial test, adjustment and start-up procedures.
         2) Detailed control instructions that outline the purpose and operation of every control device used in normal operation.
         3) All schematic wiring and external diagrams:
            a) Furnish drawings in a fully legible reduced 11-inch by 17-inch format.

1.6 QUALITY ASSURANCE

A. As specified in the Common Work Results for Electrical section.

B. Qualifications:
   1. Any third party certification, safety or protection requirements shall be applied to the VFD system as a whole. Certification or protection of system elements or individual components by themselves is not acceptable.
   2. VFDs shall be UL 508C listed and labeled.
   3. VFD systems (packaged VFD panels) shall be UL 508A listed and labeled.
   4. VFDs shall be manufactured by the VFD manufacturer at its own facility, which shall have a quality assurance program that is certified in accordance with ISO 9001.

1.7 DELIVERY, STORAGE, AND HANDLING

A. As specified in the Common Work Results for Electrical section.

B. Ship VFDs to the job site on a dedicated air ride vehicle that will allow the Contractor to utilize on site off-loading equipment:
   1. VFDs shall be delivered to the site pre-assembled and wired.
   2. Ship each VFD with 2 tamperproof accelerometers that record the maximum shock and vibration experienced by the VFD during shipping and handling.

C. Furnish temporary equipment heaters within the VFD to prevent condensation from forming.

1.8 PROJECT OR SITE CONDITIONS

A. As specified in the Common Work Results for Electrical section.

1.9 SEQUENCING

A. Conduct factory acceptance test and submit certified test results for Engineer's review.

B. Ship equipment to Project Site after successful completion of factory acceptance test.

C. Assemble equipment in the field.

D. Conduct field acceptance tests including harmonic testing and submit results for Engineer's review.
   1. All utility power sources and on-site generation shall be installed and operable for field test.

E. Submit manufacturer's certification that equipment has been properly installed and is fully functional for Engineer's review.

F. Conduct Owner's training sessions.

G. Commissioning and process start-up as specified in the Commissioning section.

1.10 SCHEDULING

A. As specified in the Common Work Results for Electrical section.

1.11 WARRANTY

A. As specified in the Common Work Results for Electrical section.

1.12 SYSTEM START-UP

A. As specified in the Common Work Results for Electrical section.

B. The VFD manufacturer shall be responsible for start-up of the VFDs in the presence of the equipment suppliers, Contractor, Engineer, and Owner.

1.13 OWNERS INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE

A. As specified in the Common Work Results for Electrical section.

B. Maintenance service: Manufacturer shall describe the field service system available to support the proposed VFD system. As a minimum describe:
   1. Type of technical support available (e.g., system engineering and technician).
   2. Location of field service personnel.
   3. Field service daily rates in dollars per hour and dollars per day.
   4. Guaranteed response times to service requests.

C. Spare parts:

1. The following spare parts shall be furnished:
   a. Any special dedicated tools for emergency service and troubleshooting.
   b. All hardware and software required for configuration, maintenance, troubleshooting and inquiry of all drive parameters.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. One of the following or equal:
   1. Eaton.
   2. Allen-Bradley.
   3. Schneider-Electric.
   4. ABB.

2.2 EXISTING PRODUCTS (NOT USED)

2.3 MATERIALS (NOT USED)

2.4 MANUFACTURED UNITS (NOT USED)

2.5 EQUIPMENT

A. General:
   1. Sinusoidal pulse width modulated, (PWM), voltage source type drive shall consist of the following:
      a. Rectifier section.
      b. Direct current link with capacitors.
      c. Insulated gate bipolar transistor (IGBT), inverter section.
      d. Microprocessor based controls.
      e. Output filter.
   2. Rectifier section:
      a. Provide VFDs with either an 18-pulse rectifier section or an active front end:
      b. 18-pulse rectifier:
         1) Integral phase shifting auto-transformer:
            a) Converts 3-phase utility power to 3 sets of 3 power circuits with each set phase shifted and powering its own 3-phase bridge rectifier.
         2) Minimum 18-pulse diode rectifier section consisting of 3 three-phase bridge rectifiers.
            a) Specifically designed as a system to share currents between the bridges to within 1 percent.
      c. Active front end rectifier:
         1) IGBT based converter module.
            a) Six IGBTs minimum.
         2) Inductor/capacitor/inductor, LCL, harmonic filter.
            a) Low pass filter.
            b) The filter shall be disconnected from the line when the VFD is off.

B. Ratings:
   1. Voltage:
      a. Input voltage: 480 Volts plus or minus 10 percent, 3-phase, 3-wire, 60 hertz.

b. Solidly grounded.
2. Short-circuit rating:
a. 65 kA RMS symmetrical.

C. Operational features:
1. Protective features:
a. Annunciated at the keypad and available via network connection.
b. Include the following protective features:
1) Motor overload protection.
2) Instantaneous overcurrent.
3) Instantaneous overvoltage.
4) Undervoltage.
5) Power unit overtemperature.
6) Phase loss.
7) VFD output short circuit.
8) VFD output ground fault.
9) Blown fuse with blown fuse indication.
10) IGBT protection.
11) Cooling fan failure.
12) Component failure.
2. Control mode:
a. The VFD shall operate in a either a constant volts/hertz or sensorless vector mode. Selectable using the programming keypad.
3. Frequency control:
a. Minimum of 3 selectable skip frequencies with adjustable bandwidths.
b. Programmable minimum frequency.
c. Programmable maximum frequency.
4. Acceleration/Deceleration:
a. Separately adjustable acceleration and deceleration rates.
b. Each rate shall be adjustable from 0.01 to 1,800 seconds.
5. Spinning load:
a. Capable of determining the speed and direction of a spinning load, "catch" the load and accelerate or decelerate it without damage to the load.
6. Programmable loss of signal:
a. Upon loss of reference speed signal the VFD shall be programmable to either stop, maintain current speed, or default to preselected speed.
7. Power interrupt ride through:
a. Capable of continuous operation in the event of a power loss of 5 cycles or less.
8. Hardwired inputs and outputs:
a. Manufacturer's standard number the following:
1) Analog inputs:
a) Configurable as either 0 to 10 volts or 4 to 20 milliamperes.
2) Analog outputs:
a) Programmable 4 to 20 milliamperes isolated.
3) Discrete inputs:
a) Programmable.
4) Discrete outputs:
a) Programmable.
b) Form C relay contacts.
5) Potentiometer 3-wire input.
b. Provide additional inputs and outputs as required to meet the control functions indicated on the Drawings.
9. Communications:
a. Provide each VFD with a EtherNet i/P communications interface module.

b. The use of gateways is not acceptable.
c. Control and monitoring of the bypass starter shall be available over the communications network.
d. All protocols shall be certified by the governing authority.

10. Real-time clock:
    a. Capable of providing time-stamped events.
    b. Set locally or via a remote controller.
    c. Programable for day, month, year, local time zones in hours, minutes and seconds.
11. Diagnostics:
    a. Minimum of 4 fault conditions in memory on a first in - first out basis.
    b. Time stamped.
    c. Operating frequency, drive status and power mode shall also be stored at the time of the fault.
    d. Fault memory shall be maintained in the event of a power outage.
    e. The fault memory shall be accessible via RS-232, RS-422 or RS-485.
12. Automatic restart:
    a. User selectable, automatic restart feature allowing the VFD to restart following a momentary power failure or other VFD fault:
        1) Programmable for up to 9 automatic restart attempts with an adjustable time delay between restart attempts.

2.6 COMPONENTS

A. Enclosure:
1. NEMA Type 12.
2. Provide cooling devices required to maintain the VFD within the manufacturer's specified temperature limits for the Project conditions:
    a. Provide cooling device alarm.

B. Power disconnect:
1. Flange mounted thermal magnetic circuit breaker:
    a. Lockable in the OFF position.

C. Phase shifting transformer:
1. Auto-transformer.
2. Integral part of the VFD assembly and factory mounted and wired within the VFD enclosure.
3. Embedded thermal protection.
4. Rated for rectifier duty.
5. Copper or aluminum windings with 180-degree Celsius insulation.

D. Keypad:
1. Furnished with a keypad for programming and control.
2. Password security to protect drive parameters.
3. Mounted on the door of the VFD.
4. Back-lit LCD with a minimum of 2 lines of a minimum of 16 characters each.
5. Programming and display features language: English.
6. Capable of displaying the following parameters:
    a. Speed (percent).
    b. Input current (amperes).
    c. Output current (amperes).
    d. Output frequency (hertz).
    e. Input voltage.

f. Output voltage.
g. Total 3-phase kilowatt.
h. Kilowatt hour meter.
i. Elapsed run time meter.
j. Revolutions per minute.
k. Direct current bus voltage.

7. In addition to all keys required for programming, the keypad shall have the following:
   a. Automatic/Manual selector.
   b. Start pushbutton.
   c. Stop pushbutton.
   d. Jog pushbutton.
   e. Speed increment.
   f. Speed decrement.
   g. Forward/Reverse selector.
   h. RUN indicator.
   i. PROGRAM indicator.
   j. FAULT indicator.
   k. DRIVE READY indicator.
   l. Diagnostics.
8. Provide the VFD with the hardwired controls indicated on the Drawings.

E. Control power transformer:
   1. Furnish a control power transformer mounted and wired inside the drive enclosure:
      a. Primary and secondary fusing.
   2. Size the transformer to supply power to all VFD controls and options as well as any external devices indicated on the Drawings including the motor winding heater.

2.7 ACCESSORIES

A. Surge protection:
   1. Metal oxide varistors:
      a. Provide protection for the VFD against:
         1) Line transients: 5,000 volt peak minimum.
         2) Line to ground transients: 7,000 peak minimum.

B. Conformal coating:
   1. Provide conformal coating material applied to electronic circuitry and printed circuit boards to act as protection against moisture, dust, temperature extremes, and chemicals such as H_2S and chlorine.

C. Air filters:
   1. Mounted on the outside of the VFD enclosure:
      a. Replaceable without requiring that the VFD be turned off or the door opened.
   2. Located on the front or top of the VFD enclosure.
      a. Side or rear mounted air filters are not acceptable.

2.8 MIXES (NOT USED)

2.9 FABRICATION (NOT USED)

2.10 FINISHES

A. Enclosure finish shall be manufacturer's standard gray.

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.1 EXAMINATION (NOT USED)

3.2 PREPARATION (NOT USED)

3.3 INSTALLATION

A. As specified in the Common Work Results for Electrical section.

B. Install the equipment in accordance with the accepted installation instructions and anchorage details to meet the seismic and wind load requirements at the Project site.

C. General:
1. Furnish all cables, conduit, lugs, bolts, expansion anchors, sealants, and other accessories needed to complete installation of the VFD (free-standing or within motor control center).
2. Assemble and install the VFD in the locations and with the layouts indicated on the Drawings.
3. Perform Work in accordance with the manufacturer's instructions and shop drawings.
4. Furnish components, and equipment as required to complete the installation.
5. Replace any hardware lost or damaged during the installation or handling to provide a complete installation.
6. Install free-standing enclosures on a raised concrete housekeeping pad:
   a. Provide structural leveling channels in accordance with the manufacturer's recommendations to provide proper alignment of the units.
   b. Weld and/or bolt the VFD frame to the leveling channels.
7. Provide openings in top or bottom of the VFD (free-standing or within motor control center) enclosure for conduit only, no additional openings will be allowed:
   a. Improperly cut holes will require that the entire panel be replaced:
      1) No hole closers or patches will be allowed.
8. Bundle circuits together and terminate in each unit:
   a. Tie with nylon wire ties. As specified in the 600-Volt or Less Wires and Cables section.
   b. Label all wires at each end with wire numbers shown on the approved Control Drawings.
   c. All connections to and from the VFD (free-standing or within motor control center) enclosure must be made via terminal blocks.

3.4 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.5 REPAIR/RESTORATION (NOT USED)

3.6 RE-INSTALLATION (NOT USED)

3.7 COMMISSIONING

A. Factory testing:
1. Owner and Engineer will witness the factory acceptance test as specified in the Common Work Results for Electrical section.

2. General:
   a. All VFDs furnished under this Section shall be tested and inspected as specified below.
   b. The testing procedures specified are the minimum acceptable requirements. The manufacturer may perform additional tests at its discretion.
3. Failure of any component during testing requires replacement of the faulted component and a complete retest.
4. Testing sequence:
   a. Submit a detailed test procedure for the VFD factory test:
      1) A minimum of 8 weeks in advance of the proposed testing date.
      2) No tests shall be performed until the test procedure is reviewed and accepted by the Engineer.
5. Component tests:
   a. Preliminary inspection:
      1) Verify that all components are correct.
      2) Verify that all connections are properly torqued.
   b. Printed circuit boards:
      1) Test each printed circuit board per the manufacturer's standard testing procedure.
   c. Wiring:
      1) Control and power wiring continuity verified point-to-point.
      2) Hi-pot power and control wiring at manufacturer's recommended levels.
      3) Verify ground bond resistance.
   d. Load testing:
      1) No load testing in accordance with the manufacturer's standard factory test procedure.
      2) Full load testing:
         a) Test each VFD and all control logic with a representative motor or dynamometer load to simulate field operation conditions at 25 percent, 50 percent, and 100 percent full load current.
         b) Tests shall be conducted in a manner in which the inverter (IGBT) section supplies all the output power (kw) of the VFD system. Control strategies using a contactor or other means of bypassing the VFD when operating at the line frequency shall not be permitted.
         c) Tests shall be conducted using a minimum output frequency of 60 hertz, and a minimum switching frequency of 2.5 kHz.

B. Owner training:
   1. As specified in the Commissioning section and the Common Work Results for Electrical section.

3.8 FIELD QUALITY CONTROL

A. As specified in the Common Work Results for Electrical section.

B. Provide the services of a VFD manufacturer representative for start-up assistance and training:
   1. Inspection and field adjustment:
      a. Supervise the following and submit written certification that the equipment and controls have been properly installed, aligned, adjusted, and readied for operation.
   2. Start-up field testing:
      a. Provide technical direction for testing, checkout, and startup of the VFD equipment in the field.

b. Under no circumstances are any portions of the drive system to be energized without authorization from the manufacturer's representative.
c. Compliance with the following specified parameters shall be verified by the VFD manufacturer:
    1) Motor terminal voltage:
        a) Make field measurements at the motor connection box.
        b) Make measurements of the full speed range of the VFD.
        c) Make measurements with a recording type oscilloscope.
    2) Harmonics:
        a) Make field measurements at the input terminals of the VFD with and without the VFD in operation.
        b) Make measurements with a recording type harmonic analyzer displaying individual and total harmonic currents and voltages:
            (1) Record currents and voltages for a minimum of 10 minutes.
            (2) Analyzers using snapshots are not acceptable.
d. All utility sources and on-site generation shall be operational for start-up field testing.

3.9 ADJUSTING

A. Make all adjustments as necessary and recommended by the manufacturer, Engineer, or testing firm.

B. Provide the services of a VFD manufacturer factory technician to make all drive parameter and protective device settings:
    1. Protective device settings provided by the VFD manufacturer in accordance with the manufacturer of the driven equipment requirements.
    2. Provide documentation of VFD settings included but not limited to:
        a. Minimum speed.
        b. Maximum speed.
        c. Skip speeds.
        d. Current limit.
        e. Acceleration time.
        f. Deceleration time.
        g. Carrier frequency.

3.10 CLEANING

A. As specified in the Common Work Results for Electrical section.

3.11 PROTECTION

A. As specified in the Common Work Results for Electrical section.

3.12 SCHEDULES (NOT USED)

END OF SECTION