

DIVISION 26 - ELECTRICAL

SECTION 262923 – VARIABLE FREQUENCY DRIVE UNITS

PART 1 -- GENERAL

1.01 THE SUMMARY

A. General

1. The CONTRACTOR shall provide variable frequency drive (VFD) units, complete and operable, as indicated in accordance with the Contract Documents.
2. It is the intent of this Section to require complete, reliable, and fully tested variable frequency drive systems suitable for attended or unattended operation.
3. This section applies to VFD's in motor control centers and free standing type.

B. The requirements of Section 26 00 00 – ELECTRICAL WORK, GENERAL, apply to the WORK of this Section.

C. Single Manufacturer

1. Like products shall be the end product of one manufacturer in order to standardize appearance, operation, maintenance, spare parts, and manufacturer's services.
2. This requirement, however, does not relieve the contractor of overall responsibility for the work.

D. Coordination

1. Equipment provided under this Section shall operate the electric motor driver and the driven equipment as indicated under other equipment specification Sections.
2. The CONTRACTOR'S attention is specifically directed to the need for proper coordination of the WORK under this Section and the equipment specifications.

1.02 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of shop drawings, product data and samples, except that Shop Drawing information for the drives shall be coordinated with the information for the driven equipment.

B. Shop Drawings: Include the following information:

1. Equipment Information
 - a. Name of drive manufacturer
 - b. Type and model
 - c. Assembly drawing and nomenclature
 - d. Maximum heat dissipation capacity in kw
2. Conduit entrance provisions
3. Circuit breaker type, frames, and settings

4. Information related to relays, timers, pilot devices, control transformer va, and fuse sizes, including catalog cuts
 5. Ladder Diagram
 - a. Submit the system schematic ladder diagram and interconnection diagrams.
 - b. The schematic ladder diagram shall include remote devices.
 - c. The ladder diagram shall incorporate the control logic on the corresponding elementary schematic as indicated.
 - d. Submittals with drawings not meeting this requirement will not be reviewed further and will be returned to the contractor stamped "REJECTED."
 6. Factory test data certifying compliance of similar equipment from the same manufacturer with requirements of this Section.
 7. Where shown on drawings, provide bypass RVSS starters.
- C. The Technical Manual shall include the following documentation:
1. Manufacturer's 2-year warranty
 2. Field test report
 3. Programming procedure and program settings
- D. Spare Parts List
1. Submit information for parts required by this Section plus any other spare parts recommended by the controller manufacturer.

E. Harmonic Study

1. The manufacturer of the VFD equipment shall prepare a harmonic study to demonstrate that the system will meet IEEE 519. The equipment provided shall consist of passive and/or active filters, reactors and harmonic correction units. The vendor may use a combination of methods based on the following:
 - a. Assume the pad mounted transformer serving the plant is rated 2500KVA.
 - b. Assume that the loads not including VFD loads include 300 amps of linear load and 10 amps of non-linear load.
 - c. See list of large motors that show how many can run at one time.

Motor	HP	Total	Number that can run concurrently
Effluent Pump	150	4	3
RAS Pump	60	4	3
Air Scour Blowers	75	4	3
Aeration Blower	100	3	2
Digester Blower	75	2	1
DO Transfer Pump	20	2	1
Plant Drain Pump	30	2	1

- d. Provide equipment as required to meet IEEE 519. Note that dimensions of equipment must not be exceeded

PART 2 -- PRODUCTS

2.01 GENERAL

- A. The contractor shall provide variable frequency drives where shown on the drawings. Coordinate rating of VFD with equipment provided.

2.02 EQUIPMENT

A. General

1. The power supply shall be an adjustable frequency inverter designed to convert incoming 3-phase, 480-volt, 60-Hertz power to a DC voltage and then to adjustable frequency AC by use of a 3-phase inverter.
2. Current-source inverters will not be accepted.
3. Inverters shall be sized to match the KVA and inrush characteristics of the motors actually provided.
4. The contractor shall be responsible for matching the controller to the load (variable torque or constant torque) as well as the speed and current of the actual motor being controlled.
5. The contractor shall provide "clean power" 18-pulse VFD's or 6 pulse VFD's integrated with AP Broadband Filters for VFDs that are operating motors greater than or equal to 50 HP. Alternatively, Active Front End VFD designs with 3-level type active rectification will be acceptable, given the harmonic THDi contributed at the drive input terminals is no more than 5%. Drives for Effluent Pumps must be 18 pulse "clean power" drives.
6. Harmonic Correction Unit
 - a. Provide harmonic correction unit integral with switchboard to meet IEEE 519.
 - b. The unit shall provide dynamic harmonic correction as required by harmonic study.
 - c. The drawings show an estimate size. Final sizing to be as required by study. Include all costs in the project bid.
 - d. Unit shall be 97% minimum efficiency.
 - e. Provide reactors on all VFD's as required by harmonic correction unit and by study.

B. Inverter

1. The inverter shall be of a voltage-source design, producing a pulse-width-modulated type output.
2. All VFDs shall be 6, 12, 18 pulse drive. Provide equipment to meet IEEE 519.
3. Motor Coordination
 - a. Inverters shall be capable of operating with 460-volt, 3-phase, 60-Hertz, squirrel-cage, high-efficiency, inverter duty, induction motors.
 - b. Inverters shall be capable of operating motors over the range of 50-100 percent of base speed without derating or requiring any motor modifications.
 - c. Provide proper size VFD's for high torque applications.

4. Inverters shall be capable of delivering the nameplate horsepower exclusive of service factor without the need for mandatory thermostats or feedback tachometers.
 5. The VFD shall vary both the AC voltage and frequency simultaneously in order to operate the motor at required speeds.
- C. The minimum VFD inverter efficiency shall be 95 percent at 100 percent speed and load, and 85 percent efficiency at 50 percent speed and load.
- D. Power Outage
1. The VFD shall shut down in an orderly manner when a power outage occurs on one or more phases.
 2. Upon restoration of power and a START signal, the motor shall restart and run at the speed corresponding to the current process input signal.
- E. The VFD shall be provided with the following features:
1. Inrush current adjustment between 50 and 110 percent of motor full load current (factory set at 100 percent)
 2. Overload capability at 110 percent for 60 seconds for variable torque loads and 150 percent for constant torque loads.
 3. Adjustable acceleration and deceleration
 4. Input signal of 4 - 20 ma from process
 5. Output speed signal of 4 - 20 ma; signals other than 4 - 20 mA will not be accepted.
 6. Upon loss of input signal, the VFD shall operate at a preset speed.
 7. A minimum of 2 selectable frequency jump points in order to avoid critical resonance frequency of the driven system.
 8. Additional devices and functions as indicated
 9. Ethernet communications to transmit VFD data to/from a plant PLC-based control system.
 10. For VFD's serving submersible motors, provide leak and high temp interface devices. Where motors are provided with internal temp monitoring, provide thermal modules as required.
- F. The VFD shall be provided with, as a minimum, the following protection features:
1. Input line protection with metal oxide varistor (MOV) and RC network
 2. Protection against single phasing
 3. Instantaneous overcurrent protection
 4. Electronic overcurrent protection
 5. Ground fault protection
 6. Overtemperature protection for electronics
 7. Protection against internal faults
 8. Ability to start into rotating motor (forward or reverse rotation)
 9. Additional protection and control as indicated and as required by the motor and driven equipment
- G. The VFD shall be designed and constructed to satisfactorily operate within the following service conditions.

1. Elevation
 - a. Elevation to 3300 feet
 - b. For elevation greater than 3300 feet, the VFD shall be derated in accordance with the manufacturer's recommendation
 2. Ambient Temperature: 0 to 40 degrees C
 3. Humidity: 0 to 95 percent, non-condensing
 4. AC Line-Voltage Variation: plus 10 percent to minus 10 percent
 5. AC Line-Frequency Variation: plus and minus 2 Hertz
- H. Electrical equipment provided in addition to the adjustable frequency inverter for each drive shall include:
1. 2-1/2-percent (minimum) line reactors integral to the drive enclosure.
 2. Provide a dV/dT filter device at the motor or VFD output per the manufacturer's recommendation for all motors over 100ft from VFD and as shown on the drawings. Submit documentation demonstrating where such devices are required, along with mounting and cabling requirements.
 3. Fused 480-to-120-volt control transformer to provide system control power for the logic and pilot lamps.
 4. Provide an input circuit breaker.
- I. Inverter Signal Circuits
1. The inverter signal circuits shall be isolated from the power circuits and shall be designed to accept an isolated 4-20 mA signal in the automatic mode of operation.
 2. The inverter shall follow the setting of a remote or local potentiometer control while in the manual mode.
 3. Refer to the Elementary Schematic indicated on the Drawings for speed control and START/STOP methods.
 4. Access to set-up and protective adjustments shall be protected by key-lockout.
 5. The following operator monitoring and control devices for the inverter shall be provided on the face of the VFD enclosure, either as discrete devices or as part of a multi-function microprocessor-based keypad access device:
 - a. AUTO/HAND selection from a remote logic relay or switch
 - b. While in AUTO, the inverter shall operate from the remote 4-20 mA input, where applicable, and while in HAND control shall operate from a local or remote manually operated speed potentiometer; speed pot ratings shall be coordinated with the supplier of the Local Control Station.
 - c. Speed indicator calibrated in percent speed
 - d. Inverter fault trip pilot light and output alarm contacts
 - e. Trip reset pushbutton
 - f. RUN and OFF indicating lights
 - g. Provide amber pilot lights for internal safeties with manual reset pushbuttons.
 - h. Provide other controls and readouts normally furnished as standard equipment, or as otherwise indicated on the Elementary Schematics indicated on the Drawings.

- J. Properly identified screw type terminal boards shall be provided for interconnection to remote controls and instrumentation
- K. Pilot devices, control relays, time delay relays, elapsed time meters, and indicators provided as a part of the VFD equipment package. For each VFD, provide HOA switch with additional contacts. Provide all auxiliary contacts required per plant controls requirements.
- L. All VFDs shall be provided with a Modbus TCP/IP ethernet connection for interface to Emerson SCADA. Connection shall be natively without a gateway.

2.03 SPARE PARTS

- A. The CONTRACTOR shall furnish the spare parts listed below, suitably packaged and labeled with the corresponding equipment number.
- B. Modified Parts
 - 1. At any time prior to Substantial Completion, the CONTRACTOR shall notify the ENGINEER in writing about any manufacturer's modification of spare part numbers, interchangeabilities, or model changes.
 - 2. If the ENGINEER determines that the modified parts no longer apply to the equipment provided, the CONTRACTOR shall furnish other applicable parts as part of the WORK.
- C. The following spare parts shall be furnished:
 - 1. Provide one set of spare power fuses of each form, voltage, and current rating.
 - 2. Provide 10 spare control and power fuses of each type and rating.
 - 3. Provide 10 panel lamps of each type (form, voltage, and current rating).
 - 4. Provide one set of any special tools required for maintenance of the VFD units

2.04 MANUFACTURERS

- A. Schneider Electric/Square D
- B. Eaton
- C. ABB
- D. For other manufacturers to be considered, provide verification that VFD can interface with Emerson SCADA system per paragraph 2.02.L.

PART 3 -- EXECUTION

3.01 MANUFACTURER'S SERVICES

A. General

1. An authorized service representative of the manufacturer shall be present at the Site to furnish the services listed below.

B. The authorized service representative shall supervise the following and shall certify that the equipment and controls have been properly installed, aligned, and readied for operation:

1. Installation of the equipment
2. Inspection, checking, and adjusting the equipment
3. Startup and field testing for proper operation
4. Performing field adjustments such that the equipment installation and operation comply with requirements
5. Document all settings of VFD's and RVSS in record drawings

C. Instruction of OWNER's Personnel

1. The authorized representative shall instruct the OWNER's personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with test equipment.
2. The instruction shall be specific to the VFD models provided.
3. Training shall be scheduled a minimum of 3 weeks in advance of the first session.
4. Training shall include individual sessions for 4 shifts of plant personnel.
5. Proposed training materials shall be submitted for review, and comments shall be incorporated.
6. Training materials shall remain with the trainees.
7. The OWNER may videotape the training for later use with the OWNER's personnel.

3.02 INSTALLATION

A. Conduit stub-ups for interconnected cables and remote cables shall be located and terminated in accordance with the drive manufacturer's recommendations.

B. Programming

1. The CONTRACTOR shall perform programming of drive parameters required for proper operation of the VFDs included in this project.
2. Submit records of programming data in the equipment Technical Manual, including setup and protective settings.

3.03 FIELD TESTING

A. Testing, checkout, and startup of the VFD equipment in the field shall be performed under the technical direction of the manufacturer's service engineer.

- B. Under no circumstances shall any portion of the drive system be energized without authorization from the manufacturer's representative.
- C. Verify proper operation of control logic in every mode of control.
- D. Document all settings of all values in record documents.

END OF SECTION