

**SECTION 26 29 23****VARIABLE FREQUENCY DRIVES****PART 1 GENERAL****1.01 SCOPE**

- A. Furnish and install individual freestanding variable frequency AC drives (VFD) as shown on the Drawings and specified herein.

**1.02 SUBMITTALS**

- A. Submit shop drawings and manufacturer's literature to the Engineer for approval in accordance with Specification Section 01 33 00.
- B. Shop drawings shall be complete in all respects and shall indicate all dimensions, installation methods, size, weight, capacity, ratings, integral controls, elevations, and sections.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

**1.03 QUALITY ASSURANCE**

- A. The VFD assembly shall be built to applicable NEMA standards and be suitable for use as a component to meet NEC requirements. The VFD assembly is to be listed by UL.

**1.04 FACTORY TESTING**

- A. The completed drive / starter unit shall be functionally tested by the manufacturer with a motor before shipment to assure proper operation per specification.
- B. Contractor shall coordinate with the requirements associated with the process mechanical equipment. This coordination shall be provided to the VFD manufacturer to determine the specific requirements for the equipment to be furnished.
- C. The VFD unit shall meet all requirements as outlined by IEEE 519 for individual and total harmonic voltage and current distortion.

## 1.05 OPERATION AND MAINTENANCE DATA

- A. Maintenance Data: Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

## 1.06 REGULATORY REQUIREMENTS

- A. Conform to the requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. or other testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

## 1.07 DELIVERY, STORAGE, AND HANDLING

- A. All equipment and materials shall be delivered, stored and handled in strict accordance with the manufacturer's recommendations.

## 1.08 MAINTENANCE MATERIALS

- A. Provide maintenance materials as recommended by the manufacturer.

# **PART 2 PRODUCTS**

## 2.01 VARIABLE FREQUENCY DRIVES

- A. General:
  - 1. The VFD shall convert a fixed frequency; three phase input power to an adjustable AC frequency and voltage source for controlling the speed of a standard, NEMA Design B, AC induction motor.
  - 2. The VFD shall be as specified on the Contract Documents or as directed by the AW Project Manager. The drive shall be fully digital; microprocessor controlled, and shall incorporate a diode bridge rectifier and a transistorized inverter section. Insulated-gate bipolar transistor (IGBT) type power transistor modules shall be utilized in the inverter section to invert a fixed DC bus voltage to a symmetrical three-phase pulse-width modulated (PWM) output voltage.
  - 3. The drives shall accept incoming 480 V, 60 Hz line power, and shall not be affected by voltage fluctuations of +/-10% or frequency fluctuations of +/-2%. The drive shall include phase-to-phase and phase-to-ground protection.
  - 4. Drive Enclosure / Mounting Locations (as indicated on the Drawing):

- a. Each VFD shall be mounted in a freestanding or wall mounted NEMA 1 enclosure sized to dissipate the heat generated by the unit.
  - b. For outdoor applications, the VFD shall be furnished in a NEMA 3R enclosure.
  - c. A main power input circuit breaker or disconnect switch, with flange mounted operator handle, shall be mounted in the drive enclosure. The disconnecting means shall be sized for the full output current rating of the drive.
5. Compliance with IEEE 519 will determine if a phase shifting transformer is required. If a phase shifting transformer or isolation transformer is required, the transformer shall be integral to the VFD assembly. Separate isolation transformers and external transformer arrangements are not acceptable.
6. The VFD shall be suitable for use with a stand by generator.
- B. Operating Characteristics:
1. The drive operation shall be fully digital with microprocessor control of frequency, voltage and current. All drive set-up operations and adjustment shall be digital and stored in a non-volatile memory (EEPROM).
  2. To control the rate of change of output frequency for a step change in input reference, the drive shall have two independently adjustable acceleration and deceleration rates.
  3. The drive shall have a fold-back current limiting circuit. During acceleration, the circuit shall automatically reduce the acceleration rate to a slower rate should the load inertia cause excessive currents.
  4. The drive shall have a selectable deceleration voltage limiting circuit. The circuit shall extend the set deceleration ramp should the bus voltage approach high limits due to regeneration.
  5. The drive output frequency shall be adjustable from 0-60 Hz.
  6. The drive shall have selectable pre-programmed V/Hz ratios and the capability of programming a custom V/Hz pattern.
  7. The drive shall maintain set frequency to within 0.6 Hz during power line fluctuations.

8. The drive speed reference signal shall be an analog 4-20 mA signal from a PLC output module or a signal received from the human interface module.
  9. The drive output current rating shall equal or exceed the full load nameplate rating of the motor provided. The drive shall be capable of maintaining 110% of rated output current continuously, and shall be capable of delivering 150% of rated output current for up to one minute. The drive shall have a continuous output current rating of 100% of the motor nameplate current.
  10. The drive shall be capable of restoring motor operation after a 0.5 second line loss without shutting down on a fault.
  11. The drive input circuitry shall not generate line notches or large voltage transients on the incoming line.
  12. The drive shall present a displacement power factor of 0.95 or better to the AC line at any speed or load.
  13. The drive efficiency at rated load and frequency shall be 98% or better.
  14. The drive shall be suitable for use on constant torque or variable torque motor loads as indicated on the VFD schedule.
- C. Drive Controls:
1. The VFD shall be furnished with start-stop controls and speed controls as indicated on the Contract Drawing and in the Description of Operation.
  2. Control interfaces shall include, but not be limited to, the following:
    - a. Drive Run Auxiliary Contact
    - b. Common Drive Fault Contact
    - c. Isolated Analog Input Board
    - d. 120 V Control Interface Board
    - e. 4-20mA output signal proportional to % speed for report to the facility PLC
- D. Human Interface Module: A Human Interface Module (HIM) shall be mounted on the drive enclosure for digital set-up of the drive, drive parameter review, and drive fault annunciation. The module shall have a LCD display and a digital speed pot for local control of the drive speed.

- E. Drive Protection and Diagnostics: The VFD shall incorporate internal diagnostic and fault sensing circuits as an integral part of the drive. The following drive protection functions shall be monitored:
1. Momentary Overload Protection - Adjustable from 50 to 115% of Drive Rating
  2. Motor Overload Protection
  3. Under-voltage Sensing
  4. Overvoltage Sensing
  5. Phase Protection
  6. Drive Over-temperature
  7. Ground Fault Detection
  8. Signal isolation for control/monitor inputs and outputs

Each of the above fault conditions shall be annunciated on the digital display panel, and shall shut down the drive.

## 2.02 MISCELLANEOUS DRIVE CONTROL COMPONENTS

- A. Line Reactors: Provide line reactors in the drive enclosure for each drive to reduce nuisance overvoltage tripping and harmonic distortion. The line reactors shall be sized for the motor horsepower and shall be manufactured by TCI, provided by the VFD manufacturer.
- B. Control Power Transformers: Provide a control transformer(s) for each drive assembly control circuit as indicated on the Drawings. Control transformers shall be 480 V to 120 V and shall be provided with primary and secondary fused protection. Control transformer sizes shall be as required plus 250VA (minimum) additional capacity.
- C. Selector Switches: Selector switches shall be non-illuminated. Switches shall be 30.5 mm, heavy-duty, oil tight. Switches shall have double-break silver contacts. All switches shall be maintained contact type unless otherwise indicated on the Drawing. Provide auxiliary contact blocks as indicated on the Drawing or as directed by the AW Project Manager.
- D. Pilot Lights: Pilot lights shall be push-to-test, LED type. They shall be 30.5 mm, heavy-duty, oil tight. Voltage rating shall be 120 V. Color caps shall be red for "run", green for "off" or "stop", amber for "alarm," white for "open" and blue for "closed" unless otherwise noted.

- E. AC Magnetic Interposing Relays - 120 V:
1. Power Relays used for inductive load switching / control shall be 120 volt ac magnetic type, shall have convertible contacts and shall be rated for 120 V inductive, 30 amp make, 30 amp break, 20 amp continuous, with a minimum of 2 DPDT contacts (timing), 4 DPDT (non-timing).
  2. Control Relays used for interlock control functions to be general purpose, plug-in type construction, 10 amp continuous duty rated, and shall operate on 120 V, unless indicated otherwise on the Drawings. Relays shall have terminals which plug-in to a socket, mounted to the inside of the drive enclosure. Contact configuration shall be 3PDT, unless otherwise required or indicated on the Drawings. Provide complete with mating socket base and indicator light to indicate the relay coil is energized. Contact configuration and timing ranges to be as indicated on the Drawings.
  3. Terminals shall be provided with pressure wire connectors.
  4. Motor DV/DT Filter: Provide motor dv/dt filters in the drive enclosure for each drive to reduce transient voltage and peak voltages at the motor terminals that are associated with the distance between the drive and the motor.

## 2.03 SPARE PARTS

- A. Provide the following spare parts for each size VFD provided:
1. Three (3) fuses for each size and type utilized
  2. One (1) Bridge Rectifier Kit
  3. One (1) Base Driver/Power Supply PCB Kit
  4. One (1) Main Control PCB Kit
  5. One (1) Pre-charge PCB Kit
  6. One (1) Pre-charge Switch Kit
  7. One (1) Surge Suppressor Kit
  8. One (1) Transistor Kit
- B. Contractor shall also provide the following other spare parts:
1. Five (5) of each type/color Pilot light bulbs with special tool to remove bulb.

2. Four (4) fuses for each type and size utilized
- C. Spare parts shall be the same type and size utilized in the drives and equipment provided for this Contract. Spare parts shall be packaged individually in boxes that are clearly labeled with part name and manufacturer's part/stock number. Contractor shall deliver all spares as one lot with parts list identifying each part and the equipment wherein the part is applied.

## **PART 3 EXECUTION**

### **3.01 FIELD SERVICES**

- A. Start-up and Testing:
  1. Contractor shall provide the services of a manufacturer's representative to start-up, adjust and test each variable frequency drive assemblies. Demonstrate start/stop control, fault diagnostics and variation of motor speeds in response to both the manual and automatic variable speed controls. Verify accuracy of speed variation and speed indication by means of a Strobotach which utilizes a light beam focused on the motor shaft. (Strobotach shall be furnished by the manufacturer's representative for testing.)
  2. All start-up and testing shall be performed in the presence of the AW Project Manager. All startup data and controls configuration and programming shall be recorded at startup or training on approved data recording sheets and verified. Completed data sheets shall accompany the Operations and Maintenance manuals provided for use in training. Scheduling and coordination arrangements are to be made a minimum of two weeks in advance, approved by AW.
- B. Training:
  1. Contractor shall provide a training session for one (1) normal workday at the project site. Training shall be specific for the VFD unit(s) provided and shall include theory of operation, maintenance and troubleshooting procedures. Training shall include control and monitoring/metering systems with specific emphasis on use and performance of these systems with VFD applications.
  2. The time associated with Start-up and Testing of the VFD equipment is NOT to be considered applicable to this training time.

**END OF SECTION 26 29 23**

