

## **SECTION 23 09 15 – VARIABLE FREQUENCY DRIVES**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Included are variable frequency drives (VFD) in variable torque applications for Division 23 work.

#### **1.2 RELATED WORK:**

- A. Section 23 05 13: Electric Motors for Mechanical Equipment
- B. Section 23 09 00: Environmental Control System
- C. Section 23 05 93: Testing, Adjusting, and Balancing
- D. Section 26 05 53: Identification for Electrical Systems

#### **1.3 SUBMITTALS**

- A. Submit product manuals and drawings including wiring diagrams, dimensions and catalog information indicating all electrical and mechanical characteristics.
- B. Submit one set of operating, troubleshooting, repair and maintenance manuals.
- C. Submit wiring diagrams to external devices including Environmental and Fire Alarm Controls.

#### **1.4 REGULATIONS**

- A. All provided products shall be listed as a package with Underwriters Laboratories (UL).
- B. **PRODUCTS**

#### **1.5 REQUIREMENTS**

- C. **Manufacturers:** Provide VFDs that meet all specifications and are manufactured by Allen Bradley Powerflex 70, Danfoss VLT 6000, or Yaskawa GPD 506. No substitutions will be accepted.  
**Construction:** The adjustable speed drive and all associated equipment shall be mounted in a NEMA 1 enclosure(s). This entire package will be referred to as the VFD.

1. Provide the VFD enclosure with an electric disconnect switch which can be locked in the OFF position with a padlock.
2. Provide the VFD enclosure with door interlocks that prevent the door from opening when the operating handle is in the ON position. This feature must be defeatable through a simple but not obvious means.
3. Provide between 3 percent and 5 percent input reactance in the form of line and DC bus reactors.
4. Provide output devices as necessary to limit peak output voltage to less than 1,000 volts to ground, at the motor when connected to the VFD by less than 50 feet of wire, and to reduce the VFD output rise time to less than 1,000 volts per microsecond. These output filter devices shall be designed for constant duty with the VFD operating at full rated load.
5. Provide a bypass contactor as a means to manually connect the motor “across the line” to the input power source while electrically isolating the VFD from both the input power source and the motor. Provide a full voltage, non-reversing contactor for line operation of the motor and a manual “VFD/Bypass” switch mounted to the VFD enclosure door. For motors above 50 HP, use reduced voltage starters. Include auxillary contact that will allow damper control to operate in bypass.
6. The VFD shall have at least 65,000 RMS symmetrical ampere interrupting capacity.

D. Interface:

1. All VFDs shall use one common type of operator interface.
2. Provide complete programming software for use in a laptop PC so that changes to the VFD program can be made by directly connecting the laptop to the VFD.
3. Primary control of ON/OFF, speed and failure annunciation shall be through hardwire connection to the Environmental Control system. Provide the following:
  - a. A dry contact output enunciating VFD failure
  - b. An ON/OFF input which responds to a remote dry contact closure
  - c. A speed control input which responds to remote 4-20 ma. and 0-10 VDC signals
4. The direct digital control system will be used to diagnose VFD conditions and to reconfigure resident VFD software. Provide all hardware, software and connecting cable as necessary to digitally communicate and exchange information with the direct digital control system using Johnson N2 bus, Siemens P1 LAN or equal interface appropriate for use with the installed DDC equipment.
  - a. The exchanged information shall include motor speed, electric load in kW, volts, amps, VFD fault description, Hand/Off/Auto/Bypass mode and network point address.
  - b. It shall be possible to modify VFD settings including acceleration and deceleration times and skip frequency ranges using the environmental control system operator station.
5. Fire Alarm Interface:
  - a. Provide an override input so that opening dry contacts will absolutely stop the motor under any operating condition.

- b. Provide an override input so that closing dry contacts will cause the motor to operate at a speed predetermined by VFD programming.
- c. Provide a Summary Alarm dry contact for connection to the Fire Alarm system, indicating that the VFD is not operable.
- d. Include auxiliary contact that will allow damper control to operate in bypass.

## 1.5 PERFORMANCE

- A. The VFD shall not create a voltage rate of change greater than 1000 volts/microsecond nor a peak voltage greater than 1000 volts to ground at the motor when the motor is connected to the VFD by less than 50 feet of wire.
- B. The carrier frequency of pulse width modulated VFDs shall be variable and adjusted so motor noise resulting from the VFD, measured at 3 feet from the motor, is less than 3 dB greater than the motor noise when operating across the line. Carrier frequency adjustment shall be available such that the average carrier frequency can be maintained at less than 9 kHz while meeting acoustical noise requirements.
- C. Configure the VFD so, when turned ON, it will accommodate for motor rotation in either direction and drive the motor to control setpoint.

## PART 2 - EXECUTION

### 2.1 INSTALLATION, START-UP, TESTING

- A. The VFD shall be sized to continually operate at equal to or greater than 105 percent of nameplate load of the motor to which it is applied.
- B. Installation and field wiring
  - 1. Mounting and control wiring shall be by Division 23. VFD shall be mounted so power wires connecting the VFD to the motor are less than 50 feet in length.
  - 2. VFD shall be mounted to rigid Unistrut type and/or building structures.
  - 3. Power wiring shall be by Division 26.
- C. Field start up and testing
  - 1. Start up and testing shall be provided at the installation site by the manufacturer or other agent deemed acceptable by the Owner's Representative. The Owner's Representative shall witness the final operational demonstration.
  - 2. Verify all installation connections and controls.
  - 3. Field-adjust all safety controls.
  - 4. Field-adjust VFD parameters as follows:
    - a. Acceleration Time: 60 seconds for fans and 10 seconds for pumps.
    - b. Deceleration Time: 65 seconds for fans and 20 seconds for pumps.
    - c. Minimum Fan Speed: 15 Hz for supply fans and 6 Hz for return/exhaust fans.

- d. Minimum Pump Speed: as stated by pump manufacturer or 450 RPM as default.
  - e. Program the VFD so that, upon reapplication of power after a power failure, the VFD shall automatically reapply power and drive the motor to control setpoint.
  - f. Program the VFD so that up to 3 automatic restart attempts will be made within one hour after shutdown due to input power problems.
  - g. Adjust the carrier frequency to provide optimum efficiency while not increasing motor noise more than 3 dB measured at 3 feet from motor.
5. Demonstrate operation of the VFD including control, display of information and programming by the environmental control system and a laptop PC, return to operation after a power failure, and the by-pass contactor.
- D. Training:
- 1. Provide on-site operation and maintenance training for two identical 4-hour sessions. Coordinate training times with the Owner's Representative.
  - 2. Provide 6 sets of operating, troubleshooting, repair and maintenance manuals. Provide final settings programmed into the VFDs in the O&M Manuals.
- E. Service during the Warranty Period:
- 1. The VFD shall be serviced by an agency located within 50 miles of the installed location.
  - 2. Qualified technical support shall be available on site within 24 hours of request.
- F. Repair Parts:
- 1. During the warranty period, replacement parts shall be available on site within 48 hours of initial request for service.

**END OF SECTION 23 09 15**