

SECTION 23 29 23
VARIABLE FREQUENCY MOTOR CONTROLS

PART 1 GENERAL

1.1 RELATED WORK

- A. Specified Elsewhere
- B. Drawings and general provisions of Contract, including, but not limited to, General, Special and Supplementary Conditions and other Division-1 Sections, apply to the work of this Section.
 - 1. Division 23 - applicable sections
 - 2. Divisions 25, 26, 27, & 28 - applicable sections

1.2 DIVISION 1 REQUIREMENTS

- A. Shop Drawing: All motor starters and enclosures
- B. Product Data: All components

1.3 WARRANTY

- A. Provide 5-year coverage on parts and labor.

1.4 COMMISSIONING

- A. Commissioning of a system or systems specified in this section is part of the construction process.
- B. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative and the Commissioning Authority.
- C. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure.
- D. Refer to Section 01 77 00 - Contract Closeout, for substantial completion details.
- E. Refer to Section 01 91 00 - Commissioning, for detailed commissioning requirements.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Magnetek
- B. Emerson
- C. ABB
- D. Toshiba
- E. Siemens
- F. Cutler Hammer
- G. Vacon
- H. Square-D
- I. Trane (DanFoss)

2.2 MATERIALS

- A. Provide an adjustable frequency drive unit as a complete UL listed assembly and rated for continuous duty at maximum service factor and full load horsepower as indicated on the drawings.
 - 1. All adjustable frequency drives supplied, per job or project, shall be of the same manufacturer and model unless different horsepower requires different model.
- B. Unit shall operate in condition of 0% to 95% non-condensing humidity and 0° to 40°C ambient temperatures.
- C. House the adjustable frequency drive in a NEMA 1 enclosure with the manufacturer's standard paint system finish. (NEMA 3R, NEMA 12, NEMA 4, & NEMA 4X enclosures shall be available as an option from the same manufacturer).
 - 1. All power and control electronics shall be of modular construction for ease of maintenance

and replacement.

- D. Power input to the unit shall be as 480 VAC ($\pm 10\%$), 3-phase.
 - 1. The Unit shall have an integral high-interrupting (65,000 ACC) minimum circuit breaker disconnects sized in accordance with line current input to the drive.
 - 2. Door interlock shall disconnect the unit from line power upon opening.
 - 3. Provide input line reactors with a minimum 5% impedance to protect the AFD, minimize line interference, voltage transients, and short circuit currents. Internal DC link reactors/chokes alone are not acceptable.
 - 4. Efficiency of the unit shall be 95% minimum at rated load and speed.
 - 5. Unit power factor shall not be less than 95% lagging throughout the speed range.
- E. Provide the inverter unit with a 3-conductor type manual by-pass control, allowing the motor to continue operating at nominal speed when removing VF drive components for service.
 - 1. The inverter shall utilize the two-step (AC to DC, DC to AC) pulse width modulated type with capacitor bank filtered output or voltage vector control (VVC) technology.
 - 2. The RFI/EMI filters shall be factory installed Class A devices per FCC Regulations, Part 15, and Subpart J.
 - 3. Surge arrestors with capabilities to reduce RFI are not acceptable.
 - 4. Power electronics components:
 - a. Do not run in parallel.
 - b. Rate them to withstand maximum short circuit conditions without damage.
 - 5. Unit shall be capable of catching a motor spinning in the forward or reverse direction upon starting.
 - 6. Unit shall be able to perform a Motor Stator resistance measurement each time the drive is enabled and run
 - 7. Provide a separate grounding connection for the inverter output.
 - 8. Unit input shall include a non-reversing NEMA rated contactor to fully isolate the drive input power from the system without the need to use the main disconnect.
 - 9. Unit output shall include full voltage, non-reversing NEMA rated output motor starter to provide a positive disconnection means, inverter power disconnect and NEMA rated full voltage non-reversing bypass starter mechanically and electrically interlocked to allow connection to the line voltage source and its safety ground in event of inverter failure.
 - 10. Bypass contactor shall be isolated from inverter output by mechanical and electrical interlocking.
 - 11. Inverter output shall be constant volts per Hertz as follows:
 - a. Volts 0 to 460 VAC, 3-phase, 3 wire plus ground
 - Frequency 0 to 1500 Hertz
 - Service Factor 1.15
 - Overload 110% for 1-minute
 - 12. Unit fault conditions shall de-energize output and require manual reset by an operator.
 - a. Output shall be protected against faults with front panel indication provided for each of the following conditions:
 - DC bus under/over voltage
 - Short circuit
 - Overload
 - Phase Loss
 - Over/Under frequency
 - Over temperature
- F. Unit shall include a microprocessor based control system with non-volatile memory.

1. Control power shall be electrically isolated from the power electronics using a dedicated step-down control power transformer, power supplies, and filters. The secondary voltage output shall be controlled by 3 phase voltage monitor, with built in adjustable time delay relay.
 2. Make all electrical interfaces between the unit and other control equipment on dedicated and labeled terminal blocks.
 3. All manual operation interfaces and indications shall be front panel mounted.
 4. Provide the following readily accessible interface inputs and outputs:
 - a. INVERTOR ON-OFF-INVERTOR BYPASS selector switch
 - b. MANUAL/AUTO selector switch
 - c. RUN/STOP Pushbuttons (Manual Mode)
 - d. RESET Pushbuttons
 - e. Local speed adjustment potentiometer (Manual Mode)
 - f. Remote RUN-STOP input (dry contact closure)
 - g. 0 to 10 VDC, Current input 0 to 20mA, 4 to 20mA, 20 to 0mA, 20 to 4mA remote speed reference
 - h. External Trip (dry contactor closure)
 - i. RUN/STOP/BYPASS pilot lights
 - j. (0 to 10 VDC) User programmable analog output
 - k. Programmable Dry Output Contact
 5. Provide the following readily accessible user adjustments:
 - a. Minimum frequency
 - b. Maximum frequency
 - c. Speed default upon loss of speed reference signal
 - d. Acceleration time
 - e. Deceleration time
 - f. Overload current
 - g. Speed input reference signal bias
 - h. Speed input reference signal gain
 - i. Motor noise reduction via carrier frequency or
 - j. Motor control mode Fan/Pump HVAC mode.
 - k. PID control
- G. The following communication features shall be provided to interface with the existing Energy Management System:
1. Serial communications interface hardware.
 - a. Provide a serial communications interface board that provides RS485 communications capability to computers or programmable controllers.
 - b. It shall be able to access all drive set up parameters and all diagnostic information with the proper software program. Software shall be able to trend a minimum of 4 parameters.
 2. Serial communications interface software.
 - a. Provide a software program for setting up all drive operating parameters and accessing all diagnostic information for interface to IBM or compatible computers.
- H. Units shall be factory pre-tested prior to shipment, operation at full load and speed for 24 hours.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Equipment motors to be controlled, shall be suitable for variable frequency drive operation,

- premium efficiency, AC inverter duty rated.
- B. Mount the variable frequency drive unit plumb and level, in accordance with manufacturer's recommendation, in locations shown on the drawings.
 - 1. To minimize the harmonics the distance between the variable frequency drive and the motor shall not exceed 20 ft.
 - 2. Variable Frequency Drive shall not be mounted directly against wall, provide a minimum of ½" space between drive and wall.
 - C. The original equipment manufacturers certified and qualified technician shall energize and test the adjustable frequency drive.
 - 1. This service shall be included in the base bid cost.
 - 2. The Contracting Officer shall witness and document the testing on test standard forms.
 - 3. Test adjustable frequency drive in accordance with manufacturer's requirements and include the following operational tests:
 - a. Verify proper operation and indications for manual operation including run/stop and full range manual speed control.
 - b. Verify bypass across the line operation and indications including manual and automatic run/stop operation.
 - c. Verify automatic operations and indications including run/stop and full range speed control.
 - d. De-energize unit and verify non-volatile memory and reset.
 - 4. Final acceptance shall depend upon the satisfactory performance of the motor-control centers and adjustable frequency drive under test.
 - a. Do not energize any motor-control center until the Contracting Officer approves recorded test data.
 - b. Initial start-up may be prior to acceptance, provide cover protection during construction and external filtration if operated.
 - c. Each Variable Frequency Drive shall be labeled to match corresponding unit or motor being controlled.
- 3.2 MANUFACTURER'S FIELD SERVICES
- A. Prepare and start systems under provisions of Section 01 60 00 and 23 08 00.
 - B. Contractors' startup shall be scheduled and documented in accordance with the commissioning requirements.
 - 1. Refer to Section 01 91 00, Commissioning, for further details.
- 3.3 FUNCTIONAL PERFORMANCE TESTING
- A. System Functional Performance Testing is part of the Commissioning Process.
 - 1. The Contractor shall perform the Functional Performance Testing and the Commissioning Authority shall witness and document the test.
 - 2. Refer to Section 01 91 00, Commissioning, for functional performance tests and commissioning requirements.
 - B. Systems Readiness Checklists shall be completed and submitted for each piece of equipment included in this section.
 - C. Include the Functional Performance Testing of HVAC pumps as part of the Chilled Water System Functional Performance testing.
- 3.4 DEMONSTRATION AND TRAINING
- A. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner's Representative.
 - 1. Provide competent, factory-authorized personnel for instruction to Facilities personnel concerning the location, operation, and troubleshooting of the installed systems.

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2. Schedule the instruction in coordination with the Owner's Representative after submission and approval of formal training plans.
 3. Refer to Section 01 91 00, Commissioning, for further contractor training requirements.
- B. Provide training for all equipment covered by this section installed in this project.

END OF SECTION