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 (± 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 invertor 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.

- 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