

SECTION 16150

MOTORS, ACCESSORIES, VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 Summary

A. This Section includes the following

1. Motors for all mechanical equipment or other equipment.
2. Motor 3/4-horsepower or larger shall be polyphase.
3. Variable-frequency drives.

B. Related Sections

1. Submersible Sewage Pumps as specified in Section 11313.

1.2 References

A. American National Standards Institute (ANSI)

B. Anti-Friction Bearing Manufacturers Association (AFBMA)

C. Institute of Electrical and Electronic Engineers (IEEE)

112 - Test Procedures for Polyphase Induction Motors and Generators.

519 - Harmonic Control and Reactive Compensation of Static Power Converters.

D. National Electrical Manufacturers Association (NEMA)

MG1 - Motors and Generators.

E. National Safety Council

F. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)

Low-Velocity Duct Manual.

G. National Fire Protection Association

National Electrical Code, NFPA 70

Standard for Electrical Safety in the Workplace, NFPA 70E

H. National Electrical Safety Code, IEEE C2.

I. Occupational Safety and Health Administration, OSHA.

J. All electrical and control equipment and material shall bear the recognized Underwriters Laboratories, Inc. (UL) seal of approval. It is Vendor's responsibility to obtain local inspection approval for all non-UL labeled equipment and pay all fees in connection with the same.

1.3 Submittals

A. Submit as specified in Section 1330.

B. Include, but not limited to, the following

1. Nameplate information consisting of the following

- a.** Manufacturer's name and serial number.
- b.** Horsepower output.
- c.** Temperature rise and method indicated.
- d.** Maximum ambient temperature.
- e.** Insulation class.
- f.** Rpm at rated load.
- g.** Frequency.
- h.** Number of phases.
- i.** Voltage.
- j.** Rated load amperes.
- k.** Locked rotor amperes or code letter.

- l. Service factor.
- m. Maximum noise level of pump/motor unit (dBA).
- n. Efficiency, determined in accordance with IEEE Standard 112, Method B.
- 2. Dimensions for enclosure and shafts.
- 3. Weight.
- 4. Bearing information.
- 5. Certification from motor manufacturer for motors controlled by variable frequency drives that the motor is “inverter ready” and complies with NEMA MG1 – Part 31 for all operational load and speed conditions specified as required.

PART 2 - PRODUCTS

2.1 Acceptable Manufacturers

A. Variable-Frequency Drives

- 1. Allen-Bradley.
- 2. Square “D”.

2.2 Vertical Submersible Polyphase Motors

- A. See also Section 11315. Rated for 460-volt, 3-phase operation with Adjustable Frequency drive.
- B. Squirrel cage, induction type.
- C. Hollow shaft design with nonreversing ratchet.
- D. **NEMA Design**
 - 1. Minimum starting torque 100% of full load.
 - 2. Maximum starting torque greater than 200% of full load.

- 3. Maximum starting current 650% of full load.
- E. NEMA Class F insulation or higher with temperature rise limited to Class-B over a 40°C ambient, except for installations where a higher class is recommended by the manufacturer for the application.
- F. Submersible Type enclosure unless specified otherwise.

G. Horsepower Rating Requirements

- 1. Ambient Temperature: 50° C.
- 2. Temperature Rise Per Table:

Continuous Rated Motors (all enclosures)	Class B Insulation	Class F Insulation	Class H Insulation
<u>Temperature Rise by Resistance - °C</u>			
S.F. 1.0	80	105	125
S.F. 1.15	90	115	---

<u>Temperature Rise by Embedded Detector - °C</u>			
S.F. 1.0 (1500 hp & less)	90	115	140
S.F. 1.15 (1500 hp & less)	100	125	---

- 3. Service factor of 1.15.
- 4. 1800 rpm unless specified or indicated otherwise.
- 5. Adequate to drive equipment without using service factor except in emergency conditions.
- 6. Rated for continuous duty and capable of withstanding unlimited number of starts per hour when operating with adjustable speed drive.

H. Bearings

- 1. Designed for static and dynamic, and continuous and momentary thrusts as required by the drive equipment.
- 2. Grease- or oil-lubricated bearings with relubrication fittings and flushing system.

3. Antifriction or Kingsbury type.
 4. Visual level indicator for oil-lubricated bearings.
 5. Minimum L10 bearing life for continuous operation of 50,000 hours to conform to AFBMA.
- I. Screened openings or other suitable means for safety and protection from rodents or other animals.
 - J. Stainless steel nameplate with all electrical and lubrication information.
 - K. Provide water seal leak detector between first and second mechanical seals with wiring included in power cable.

2.3 Variable-Frequency Drives

- A. Furnish AC variable-frequency drives to control the speed of the pumps.
- B. **Basic Drive**
 1. An input circuit breaker shall be supplied to provide NEC required branch circuit protection. The circuit breaker shall have a door interlocked external operator. Circuit breaker shall be 480-volt, 3-phase, 25,000-AIC rms symmetrical minimum.
 2. Current limiting fuses shall be installed in the drive input.
 3. A converter stage shall change fixed voltage, fixed frequency, ac line power to a fixed dc voltage. The converter shall consist of a 3-phase, full-wave bridge configuration. The converter shall be insensitive to the phase rotation of the ac line and shall not cause displacement power factor of less than 0.95 lagging under any speed and load conditions. Provide filtering per IEEE 519 (Total Harmonic Distortion (THD) not more than 5% voltage and 10% current at the drive terminals). The controller shall not require an isolation transformer and shall not produce voltage/current spikes and notches back into the power supply.

4. An inverter stage shall change fixed dc voltage to variable frequency, variable voltage, ac for application to a standard NEMA design B squirrel cage motor. The inverter shall utilize gate-turn-off (GTO) or giant-transistor-technology devices switched in a manner to produce a sinusoidal pulse-width-modulation (PWM) output waveform.
5. The drive shall be furnished in a NEMA 1 enclosure with gaskets to be installed in an Electrical Room.
6. Minimum acceptable efficiency shall be 96% at full load.
7. The drive shall be capable of supplying 115% of rated full load current for one minute at maximum ambient temperature.
8. The drive shall be designed to operate from a nominal 480-volt, 3-phase, 60-hertz system and control an induction motor rated 460 volts.
9. Adjustable full-time current limiting shall limit the current to a preset value that shall not exceed 150% of the controller rated current. The current limiting action shall maintain the V/Hz ratio constant. Short-time starting override shall allow starting current to reach 175% of controller rated current to maximize starting torque.
10. The drive shall be capable of producing an output frequency over the range of 30 to 60 hertz (2 to 1 speed range) without low speed cogging. Over frequency protection shall be included such that a failure in the controller electronics circuitry shall not cause frequency to exceed 110% of the maximum controller output frequency selected (60 hertz).
11. Minimum and maximum output frequency shall be adjustable over the following ranges:
 - a. Minimum frequency 50% to 70% of maximum selected frequency.
 - b. Maximum frequency 40 hertz to 60 hertz.
12. The time for drive acceleration (0-100%) and deceleration (100%-0) shall be independently adjustable from 0-5 minutes.

- 13.** The drive shall be capable of being restarted into a motor coasting in either the forward or reverse direction without tripping.
- 14.** Protection of power semiconductor components shall be accomplished without the use of fast acting semiconductor output fuses. Subjecting the controller to any of the following conditions shall not result in component failure or the need for fuse replacement:

 - a.** Short circuit at drive output.
 - b.** Open circuit.
 - c.** Input undervoltage.
 - d.** Dc bus overvoltage.
 - e.** Loss of input phase.
 - f.** Ac line switching transients.
 - g.** Instantaneous overload.
 - h.** Sustained overload exceeding 100 percent of controller-related current.
 - i.** Overtemperature.
- 15.** Solid-state motor overload protection shall be included such that current exceeding an adjustable threshold shall activate a 60-second timing circuit. Should current remain above the threshold continuously for the timing period, the controller will automatically shut down. The timing circuits shall include a memory such that current exceeding the threshold for less than 60 seconds and dropping back below the threshold momentarily shall not cause the time to reset to zero but shall cause the timing circuit to pick up at a point dependent upon the length of the time the current was below the threshold.
- 16.** A slip compensation circuit shall be included which will sense changing motor load conditions and adjust output frequency to provide speed regulation of NEMA B motors to within +0.5%

of maximum speed without the necessity of a tachometer generator.

- 17.** The drive electronics shall contain displays to monitor and indicate the following conditions:
 - a.** Drive lockout.
 - b.** Undervoltage.
 - c.** Overvoltage.
 - d.** Overtemperature.
 - e.** Ground fault.
 - f.** Shoot through.
 - g.** Overload threshold exceeded.
 - h.** Overload shutdown.
 - i.** Power up delay.
 - j.** Instantaneous overcurrent.
 - k.** Power supply OK.
 - l.** Controller enabled.
 - m.** Current limit operating (motor mode).
 - n.** Input follower signal loss.
 - o.** Contact for drive failure.
 - p.** Contact for normal run.

- 18.** Harmonic Filtering:
 - a.** Provide Input and Output line reactors and filters. Manufacturer equal to TCI HG7 Filter with Line Reactor. Provide filters and reactors matched appropriately to drive and load.

- b. The drive shall have sufficient harmonic filtering and suppression, when operated from the normal power source over its entire load and speed range, that it will not cause operational problems or degrade the performance of any of the electrical equipment on the equipment rack, such as the lighting, instrumentation and control systems. (max. THDv = 5%, THDi = 10%)

19. Door-mounted control devices shall include

- a. Local-off-remote switch.
- b. Elapsed time meter, Electro/Mechanical type.
- c. Red and green indicating lights.
- d. Start-stop push buttons.
- e. Ammeter for motor running currents.
- f. Potentiometer for manual speed adjustment.
- g. Output speed 0-100%.

20. In automatic mode speed will be controlled by a remote 4-20 mA input signal from a PLC. In manual mode, speed will be controlled by a potentiometer on front of unit.

- a. Provide terminals for remote start-stop push buttons, or contacts, where indicated on schematic diagrams.

21. The VFD controls shall be wired to the motor overtemperature switches or protective device to automatically stop the motor from operating if required.

PART 3 - EXECUTION

3.2 Installation

- A. Install to conform to manufacturer's instruction.

3.3 Manufacturer's Field Services

- A. Provide as specified in Section 1750.

- B. For adjustable frequency drives provide the services of a manufacturer's representative for a period of one day to assist in start-up tests and instruct Owner's personnel in the operation of the equipment.

3.4 Field Testing

- A. Provide as specified in Section 16950.

PART 4 - MEASUREMENT AND PAYMENT

4.1 Measurement

- A. No measurement will be made for this item.

4.2 Payment

- A. Payment will be made at the contract lump sum price bid and shall be considered full payment for providing labor and materials to perform this work.

**** END OF SECTION 16150 ****