

SECTION 15170 – MOTORS AND CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 WORK INCLUDED

- A. Furnish and install all motors required for all mechanical equipment specified under this Division.
- B. Furnish and install all individual motor controllers, starters and disconnect switches not provided under Division 16 – Electrical.
- C. All motors shall be premium efficiency suitable for the duty and voltage service available and as indicated on the contract drawings.
- D. Provide all necessary control transformers so all motors, starters, disconnect switches, etc. are compatible with the control and operating sequences specified.

1.3 RELATED SECTIONS

- A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.4 REFERENCES

- A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.
- B. Material standards shall be as specified or detailed hereinafter and as follows:
 - 1. AFBMA: Anti-Friction Bearing Manufacturers Association.
 - a. 1-84 – Terminology for Anti Friction Ball and Roller Bearings and Parts.
 - b. 9-84 – Load Ratings and Fatigue Life for Ball Bearings.
 - c. 11-78 – Load Ratings and Fatigue Life for Roller Bearings.

- d. 20-77 – Metric Ball and Roller Bearings Conforming to Basic Boundary Plans
- 2. ANSI: American National Standards Institute.
 - a. 50-84 – Mechanical Vibration of Rotating and Reciprocating Machinery.
- 3. ASTM: American Society for Testing and Materials.
 - a. A48-83 – Gray Iron Castings.
 - b. B117-85 – Method of Salt Spray (Fog) Testing.
- 4. IEEE: Institute of Electrical and Electronic Engineers.
 - a. 1-86 – General Principals for Temperature Limits in the Rating of Electrical Equipment.
 - b. 85-73 – Test Procedures for Airborne Sound Measurements on Rotating Electric Machinery.
 - c. 112-84 – Standard Test Procedures for Polyphase Induction Motors and Generators.
 - d. 114-82 – Test Procedures for Single-Phase Induction Motors.
 - e. 117-74 – Test Procedures for Evaluation of Systems of Insulating Materials for Random-Wound AC Electric Machinery. Single-Phase Induction Motors.
- 5. NEMA: National Electrical Manufacturer’s Association.
 - a. MG 1-78 – Motors and Generators.
- 6. NFPA: National Fire Protection Association.
- 7. National Electrical Code.
- 8. SAE: Society of Automotive Engineers.
- 9. SAE Grade 5.

1.5 SYSTEM DESCRIPTION

- A. Furnish and install all premium efficiency motors for all systems and equipment.
- B. Motor Controllers: Provide individual motor controllers not provided under Division 16. Coordinate with the Division 16 Contractor to determine the location, size and number of individual motor controllers to be provided under this Division.
- C. Mounting and installing of motors and drives.
- D. Installation of motor controllers supplied under this Division.
- E. Work shall be done in accordance with requirements of Division 16 “Electrical Work”. Wiring shall be done under Division 16.

- F. Disconnect switches; Provide combination motor controller and disconnect switch where required under Division 15 as specified in Division 16. If not specified under individual product sections, then disconnect switches shall be furnished and installed under Division 16.

1.6 SUBMITTALS

- A. See Section 15050 and General Conditions for Additional Requirements.
- B. Product Data: Provide product description and list of materials including all motor efficiency ratings.
- C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.7 QUALITY ASSURANCE

- A. Manufacturer regularly engaged in the design, testing and manufacturing of specified products and issuing complete catalog data on such products.
- B. Manufacturers must prove expertise in the design, testing and production of specified or similar to specified products for at least ten (10) years prior to date of bid.
- C. Manufacturer must provide written certification that the products provided meet or exceed the specification requirements. An executive officer of the company must sign the written certification.

1.8 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery of materials shall be made to the project by the materials supplier in accordance with the instructions of the Contractor.
- B. The Contractor shall provide adequate storage space for the materials, shall be responsible for all items of materials after receipt from the supplier, and shall replace all materials lost or damaged after delivery and receipt.
- C. The Contractor shall furnish the materials supplier with receipts for all materials and accessory items received, and shall send copies of these receipts to the Architect.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER CONTINGENT ON COMPLIANCE WITH SPECIFICATIONS

A. Motors:

1. Toshiba
2. General Electric Company
3. Reliance Electric Company
4. Baldor

B. Motor controllers:

1. General Electric
2. Square D.
3. Allen Bradley
4. Westinghouse/Cutler-Hammer

2.2 GENERAL

- A. All control wiring shall be installed in conduits and in accordance with the respective equipment manufacturer requirements. All connections shall be provided by the HVAC Contractor. All conduit and wiring provided by the Mechanical Contractor shall be installed in accordance with the requirements of Division 16 of these Specifications.
- B. Motors shall be built in accordance with latest Standards of NEMA and as specified. Motors shall be specifically and expressly wound for voltage required.
- C. Motors shall be tested in accordance with ANSI 50 and conform thereto for insulation resistance and dielectric strength.
- D. Motors shall be provided with adequate starting and protective equipment as specified or required and with conduit terminal box of size adequate to accommodate conduits and wires.
- E. Capacity shall be sufficient to operate motors under job conditions of operation and load, without overload and shall be at least the horsepower size indicated or specified.
- F. All motors shall be suitable for continuous duty at rated horsepower, with temperature rise not to exceed 90°C above a 40° (with a 1.15 SF (before rise). All motors shall be capable of 15% overload without overheating. All motors shall be rated and certified for use with VFD's per NEMA MG1 section 31.

- G. All motors shall be rated for inverter duty, and stamped as such. All motors shall have Class F insulation or higher temperatures.
 - 1. Manufactured to maximize Corona Inception Voltage (CIV) rating.
 - a. The minimum acceptable shall be 2500 Volts at 155°C.
 - 2. Windings shall be in-slot wound type
- H. Direct connected motors shall be furnished with adjustable base. Motors connected to driven equipment by belt or shaft shall be furnished with adjustable sliding bases, except for fractional motors which shall be furnished with slotted mounting holes.
- I. Motors shall have nameplates giving manufacturer's name, serial number, horsepower, speed and current characteristics.
- J. Motors smaller than 1/2 HP shall be capacitor, starter or split-phase type. Motors 1/2 HP and larger shall be squirrel cage, induction type. Motors 1 HP and larger shall have grease lubricated ball bearings and approved grease fittings. Motors provided shall have voltage, phase and hertz characteristics, as scheduled on the drawings.
- K. Except for electrical apparatus specifically called for to be provided under this Contract, all motor starters, disconnect switches, controllers and other electrical appurtenances required under the HVAC, Plumbing, Fire Protection, etc. work, shall be provided under Division 16. Study the Electrical drawings and coordinate requirements and quantities with the Electrical Contractor.
- L. All electrical apparatus and controls furnished as a part of the HVAC, Plumbing, Fire Protection, etc. work shall conform to applicable requirements under Electrical Section.
- M. Each Contractor shall provide the Electrical Contractor with all motor size and wiring requirements within (30) days from date of Contract to allow proper coordination of Trades by the Construction Manager.
- N. Each Contractor shall verify with the Electrical Contractor available electrical characteristics before ordering any equipment or motors.
- O. Equipment which includes a number of correlated electrical control devices mounted in a single enclosure or on a common base with equipment, shall be supplied for installation completely wired internally with terminal strip ready for external wiring. Unless specifically directed otherwise in the Contract Documents, if these control devices are separately mounted they shall be furnished by the HVAC Contractor and wired by ATC Contractor or Electrical Contractor in accordance with the manufacturer's wiring diagram, as shown on the drawings and as specified hereinafter.
- P. All motors shall meet NEMA vibration requirements and shall be less than 0.15 in./sec.

2.3 MOTORS

- A. In accordance with NEMA, IEEE and ANSI 50 Standards.
- B. Capacity: Minimum of indicated horsepower and to operate driven devices under all conditions without overload.
- C. Provide all of the same manufacturers, except those provided integrally with equipment.
- D. Motor type and application (1/2 hp and above):
 - 1. Conditioned areas and heated ventilated areas protected from weather:
 - a. Squirrel-cage induction type, open drip-proof, NEMA B design, rated for 90 degree C rise over 40 degree C ambient, Class B insulation up to 1 hp and class f insulation above 1 hp, 1.15 service factor, continuous rating per NEMA MG1-1.40.
 - b. Unless otherwise noted on the mechanical contract drawings or specified.
 - 2. Motors installed outdoors, on roofs and out of building airstreams:
 - a. Squirrel-cage induction type, totally enclosed fan cooled, NEMA B design, class B insulation, up to 1 hp and Class F insulation above 1 hp 1.15 service factor, continuous duty unless otherwise noted on the contract drawings or specified.
- E. Motor shall be 1800 rpm single speed motors unless otherwise noted on the contract drawings.
- F. Motor type and application (less than 1/2 hp).
 - 1. Built in overload protection.
 - 2. Rewinding tap, permanent split capacitor type, unless otherwise noted on the contract drawings or specified.
 - 3. Suitable for service and location.
 - 4. Motor shall be 1800 rpm single speed motors, unless otherwise noted on the contract drawings.
- G. Motor voltages:
 - 1. Motors less than 1/2 hp: Single phase, 60 hertz, 120 volt, AC, unless otherwise indicated on the contract drawings.
 - 2. Motors 1/2 hp and up. Suitable for 3 phase, 60 hertz, 480 volt, AC power source, unless otherwise indicated on the contract drawings.

H. Motor Efficiency Ratings And Construction:

1. Motors 1.0 hp up to 250 hp: Suitable for 3 phase, 60 hertz, 480 volt, AC power source, premium-efficient type, unless otherwise noted on the contract drawings as specified.
2. Guaranteed minimum power factor at full load and rated voltage and guaranteed minimum efficiency at full load and rated voltage when tested in accordance with IEEE Test Procedure 112A, Method B.
3. Premium-efficient type motors shall conform to the following efficiencies:

HP	Open Drip Proof			Totally Enclosed Fan-cooled		
	6 pole	4 pole	2 pole	6 pole	4 pole	2 pole
	1	82.5	85.5	77.0	82.5	85.5
1.5	86.5	86.5	84.0	87.5	86.5	84.0
2	87.5	86.5	85.5	88.5	86.5	85.5
3	88.5	89.5	85.5	89.5	89.5	86.5
5	89.5	89.5	86.5	89.5	89.5	88.5
7.5	90.2	91.0	88.5	91.0	91.7	89.5
10	91.7	91.7	89.5	91.0	91.7	90.2
15	91.7	93.0	90.2	91.7	92.4	91.0
20	92.4	93.0	91.0	91.7	93.0	91.0
25	93.0	93.6	91.7	93.0	93.6	91.7
30	93.6	94.1	91.7	93.0	93.6	91.7
40	94.1	94.1	92.4	94.1	94.1	92.4
50	94.1	94.5	93.0	94.1	94.5	93.0
60	94.5	95.0	93.6	94.5	95.0	93.6
75	94.5	95.0	93.6	94.5	95.4	93.6
100	95.0	95.4	93.6	95.0	95.4	94.1
125	95.0	95.4	94.1	95.0	95.4	95.0
150	95.4	95.8	94.1	95.8	95.8	95.0

4. Motors less than 1 hp shall be manufacturer's standard premium efficiency design.
5. Motor nameplate shall be specially marked "energy efficient motor" or similar nomenclature.
6. Motors built in accordance with current NEMA Standard MG-1 except as noted.
 - a. Motors NEMA Design B, NEMA T-frame sizes.
 - b. Insulation tested by manufacturer, Class F or better. Test per NEMA MG1-12.03.
 - c. Temperature rise limits in accordance with NEMA limits for insulation class, service factor and enclosure specified.

I. Materials and Construction:

1. Motors up to 5 hp:
 - a. Steel motor frames, cast aluminum end brackets, steel terminal box, copper windings.
2. Motors 5 hp and larger:
 - a. Cast iron motor frames, cast iron end brackets, cast iron terminal box, copper windings.
3. TEFC Motors:
 - a. Cast iron motor frames, cast iron end brackets, cast iron terminal box, copper windings, corrosion resistant fan internals, epoxy varnish coated for corrosion protection, cadmium plated hardware.
 - b. Severe duty motors:
 - 1) Cast iron construction (frame, end brackets and terminal box). External hardware, fan and fan cover coated or plated to prevent corrosion or corrosion-resistant material. Air gap surfaces coated with epoxy or zinc chromate. Shafts with rotating shaft mounted slingers or seals to prevent entry of contaminants at each end. Epoxy insulation system where used in high-moisture and corrosive atmospheres.
4. Explosion proof motors:
 - a. UL listed for application or duty.
 - b. Motors shall conform to requirements defined in Article 500, 501, 502, 503 of the National Electric Code.
 - c. Motor nameplate shall be specifically marked "explosion proof" or similar such nomenclature.
5. Sound-power levels no greater than recommendations of NEMA (MG1-12-49).

J. Motors 1/2 hp and above, conform to following:

1. Bearings: Antifriction type with bearing housings equipped with easily accessible plugged provisions for relubrication. Minimum L-10 life of 100,000 hours based on direct drive equipment. Bearing housings shall be equipped with grease openings for simultaneously adding new grease and purging the old grease. Provide corrosion resistant plugs or caps on grease openings.
2. Belt-connected motors: NEMA foundation slide base and shaft as required for aligning pulleys. Minimum L-10 life based on belt drive shall be 40,000 hrs.
3. Motor enclosure: Suitable for service and location.

2.4 MOTOR DISCONNECT

- A. Provide only devices of Specification Grade, UL listed and labeled, manufacturer's certification to meet applicable Federal Specifications, and to meet NEMA performance standards.
- B. Disconnects shall be "Heavy Duty Type".
- C. Single phase disconnect switches: Two pole toggle operated AC manual motor starting switch without overload protection for single phase motors.
- D. Three phase disconnect switches: 3 pole fusible or unfusible as required; 250 or 600 volt as required in NEMA 4 enclosures.
- E. The operating handle for three phase disconnect switches shall be of the box-mounted type that directly drives the switch mechanism.
- F. Three phase disconnect switches shall have a defeatable, front accessible, interlock to prevent the opening of the cover when the switch is in the "ON" position and prevent turning the switch "ON" when the door is open.
- G. Solid neutral: Provide as required.
- H. Provide ground lug for ground wire termination.
- I. All disconnects shall be lockable.
- J. Operating handle: Lockable in either open or closed position.
- K. All motor disconnects shall be horsepower rated.
- L. Feed through or double lugged: UL approved for the purpose.
- M. Installation:
 - 1. All switches shall have a nameplate indicating the circuit number feeding the switch. Nameplate shall be laminated black with white letters engraved.
 - 2. Install a motor disconnect switch with every motor unless noted otherwise on mechanical equipment schedules.

2.5 MOTOR CONTROLLERS

- A. Manual motor controller:
 - 1. For single phase motors, provide H-O-A switches with thermal overload.

2. 2-speed: Fast-slow-off selector switch with overload protection for each speed, with pilot lights for slow and fast speed.

B. Magnetic motor controller:

1. Provide magnetic contactors with three overload relays, for motor running overload protection, per NEC.
2. 120 Volt holding coil.
3. Provide status pilot light in cover, red for energized. Pilot light shall be operated by an extra interlock (not placed across holding coil). Pilot light shall be long life (130 volt) type 6S6 incandescent lamps.
4. Provide reset button, and Hand-Off-Automatic switch in cover, field convertible to Off-Auto or Start/Stop pushbutton.
5. Provide one set of convertible auxiliary contacts in addition to standard auxiliary holding contacts supplied with each contactor.
6. Provide control transformer 120 volt secondary of sufficient capacity to handle operating coil and associated controls plus 75 volt amps.
7. Provide surface mounted starters in NEMA Type 1 enclosure for indoor applications and NEMA Type 4 enclosure for outdoor applications.
8. Contacts shall be solid-silver cadmium oxide alloy which will not require any filing, dressing or cleaning throughout the life of the control equipment. Bare copper or silver flashed contacts shall not be permitted.
9. Operating coils shall be pressure molded. When a coil fails under over-voltage condition, the motor controller shall drop out.
10. Overload relays shall be of the hand-reset, trip-free variety so that blocking the reset mechanism in the reset position will not prevent the starter from dropping out if the motor is overloaded. This specifically excludes those overload relays which change to automatic reset from hand-reset when the reset mechanism is blocked unless the automatic reset feature can be removed or voided. Accidentally depressing the reset button or mechanism shall not shut off the motor. Overload relays shall not be field convertible from hand to automatic reset type.
11. Disconnect switch shall be provided under Division 16 unless otherwise noted.
12. Where specified, motor hp rated disconnect switches shall be provided in NEMA 1 enclosure for indoor applications and NEMA 4 enclosures for outdoor applications.
13. Provide full coordination between settings or ratings of protective devices in accordance with the NEC.

C. Combination motor controller (only where indicated on the contract drawings or specified).

1. Provide molded case circuit breakers with rotary operating handle and lock-off facility.
2. Restrict opening of switch enclosure by the use of a defeater screw unless switch is in the OFF position.
3. Provide contactors with three overlay relays.
 - a. 120 Volt holding coil.

- b. Provide status pilot light in cover, red for energized. Pilot light shall be operated by an extra interlock (not placed across holding coil) Pilot lights shall be long life (130 volt) type 6S6 incandescent lamps.
- 4. Provide reset button, and Hand-Off-Automatic switch in cover, field convertible to Off/Auto or Start/Stop pushbutton.
- 5. Provide one set of auxiliary contacts in addition to standard auxiliary hold contacts supplied with each contactor.
- 6. Provide control transformer 120 volt secondary of sufficient capacity to handle operating coil and associated controls plus additional 75 volt amps.
- 7. Time-delay relays shall be adjustable, pneumatic type, 2 to 60 seconds and operate on 120 volts, 60 hertz. They shall have at least one normally open and one normally closed timed contact. The type of operation is as indicated or required.

PART 3 – INSTALLATION

3.1 MOTORS

- A. Coordinate with appropriate trades.
 - 1. Motor and base mounting requirements.
 - 2. Motor electrical requirements.
- B. Motors shall be installed in accordance with manufacturer's installation instructions.
- C. Motors shall be installed in accordance with all applicable codes.

3.2 CONTROLLER

- A. Provide all controllers not indicated on Electrical drawings.

END OF SECTION