SECTION 20 05 13 – motors

1. GENERAL
	* + 1. RELATED DOCUMENTS
				1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
				2. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.
			2. SUMMARY
				1. Perform all Work required to provide and install high efficiency single- and three-phase electric motors required for equipment supplied under this division of Work as indicated by the Contract Documents, with supplementary items necessary for proper installation. Refer to Electrical Drawings for motor starter sizes. Disconnect switches to be furnished in Division 26.
				2. **The Fire Suppression, Plumbing and HVAC Subcontractor** shall furnish starters for Fire Suppression, Plumbing and HVAC Work. Motor starters shall be provided in accordance with Division 26 Specifications. Some motors furnished in mechanical equipment rooms shall have starters furnished and installed as part of Division 26 (as per Specification Section 26 29 14, Motor Starters). Coordinate with Division 26.
				3. Motors rated at less than 190 Watts and intended for intermittent operation need not conform to these Specifications.
				4. ECM (Electronically Commutated Motor) motors on terminal units, fan-coil units, and computer room air conditioning units are except from specification requirements that can not apply due to different electrical design characteristics.
			3. REFERENCE STANDARDS
				1. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
				2. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
				3. All materials, installation and Workmanship shall comply with the applicable requirements and standards addressed within the following references:

AFBMA 9 – Load Ratings and Fatigue Life for Ball Bearings.

AFBMA 11 – Load Ratings and Fatigue Life for Roller Bearings.

EISA - The Energy Independence & Securities Act EPAct92

ANSI/EEE 112 – Test Procedure for Polyphase Induction Motors and Generators.

ANSI/NEMA/ MG 1 – Motors and Generators.

NFPA 70 – National Electrical Code.

ANSI C19 – Industrial Control Apparatus.

NEMA ICS – Industrial Control and Systems.

NEMA RV 3 - Application and Installation Guidelines for Flexible and Liquidtight Flexible Metal and Nonmetallic Conduits

NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable

NEMA FB 2.20 - Selection and Installation Guidelines For Fittings for Use With Flexible Electrical Conduit and Cable

NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports

NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports

NEMA OS 3 - Selection and Installation Guidelines for Electrical Outlet Boxes

UL 508 – Industrial Control Equipment.

ANSI/EEE 117 – Standard Test Procedure for Evaluation of Systems of Insulating Materials for Random Wound AC Electric Machinery.

ANSI/NEMA MG 2 – Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors.

ANSI/UL 674 – Electric Motors and Generators for Use in Hazardous (Classified) Locations.

ANSI/UL 1004 – Electric Motors.

* + - 1. QUALITY ASSURANCE
				1. Motors associated with variable frequency drives (VFD) shall be inverter-duty rated, and provided with grounded shaft or ceramic bearings to insulate shaft, and Class F 105 degrees C rise insulation. Ref. NEMA MG1 Part 31.
				2. Conform to NFPA 70.
			2. SUBMITTALS
				1. All motors provided by the Contractor shall be of the same manufacturer unless they are an integral part of the piece of equipment to which they are attached.
				2. Product Data: Provide the following information for each motor:

Manufacturer.

Rated full load horsepower.

Rated volts.

Number of Phases.

Insulation Class.

Frequency in Hertz.

Full load amperes (FLA).

Locked rotor amperes (LRA) at rated voltage or NEMA code letter.

Nominal speed at full load (rpm).

Service factor.

NEMA design letter.

NEMA machine type (ODP, WP-I, TEFC, etc.).

* + - * 1. For motors one horsepower and larger, include the following additional information:

NEMA frame size.

NEMA insulation system classification. For motors required to be installed outdoors, include information showing compliance for outdoor application.

Maximum ambient temperature for which motor is designed.

Time rating.

Bearing size and type data.

Guaranteed efficiency and power factor at full load, 75% load, 50% load, 25% load and 0% load.

* + - * 1. For motors 20 horsepower and larger, include the following additional information:

No load amperes.

Safe stall time.

Guaranteed efficiency and power factor at full load, 75% load, 50% load, 25% load and 0% load.

Motor manufacturer’s recommended maximum power factor correction capacitor (kvar) that can safely be switched with the motor.

Expected value of corrected power factor at no load, 50 percent, 75 percent and full load.

Full load amperes with corrected power factor.

Maximum guaranteed slip at full load.

* + - * 1. Operation and Maintenance Data:

Submit operation and maintenance data including assembly Drawings, bearing data including replacement sizes, and lubrication instructions.

* + - * 1. Alternate Motors:

If a motor horsepower rating larger than indicated is offered as a substitute and accepted, provide required changes in size of conductors, conduits, motor controllers, overload relays, fuses, circuit breakers, switches and other related items at no change in the Contract price.

* + - 1. WARRANTY
				1. Provide minimum one-year manufacturer’s warranty including coverage for motors one horsepower and larger.
1. PRODUCTS
	* + 1. GENERAL
				1. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.
				2. Electrical Service: Refer to Drawing schedules for required electrical characteristics.
				3. Design for continuous operation in 40 degrees C environment and for temperature rise in accordance with ANSI/NEMA MG 1 limits for insulation class, Service Factor and motor enclosure type.

Totally Enclosed Motors: Design for a service factor of 1.00 and an 80 degrees C maximum temperature rise in the same conditions.

Explosion‑Proof Motors: UL approved and labeled for hazard classification, with over temperature protection.

* + - * 1. Visible Stainless Steel Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer’s name and model number, Service Factor, Power Factor, efficiency.
				2. Electrical Connection: Provide adequately sized metal electrical connection box for conduit connection. For fractional horsepower motors where connection is made directly, provide metal electrical box for conduit connection.
				3. Motors shall be built in accordance with the latest ANSI, IEEE and NEMA Standards and shall be fully coordinated with the equipment served, shall be of sizes and electrical characteristics scheduled and of approved manufacturer as listed below or of the same manufacturer as the equipment which they serve. Nameplate rating of motors shall match the characteristics scheduled.
				4. All motors shall be designed for normal starting torque unless the driven machine requires high starting torque and shall be selected for quiet operation, free from magnetic hum.
				5. All motors shall be provided with adequately sized electrical connection box for attachment of flexible conduit. Paragraph 1.03 of this specification refers to the NEMA standards and publications relevant to applications and use of both metal and liquid tight flexible conduit. When motors are connected to driven equipment by the use of a V-belt drive, they shall be furnished with adjustable rails.
				6. All air handling unit motor(s) with single and fan array arrangements, exhaust fan motors, chilled and hot water pump motors shall be compatible with variable frequency drive controllers. Equipment manufacturer shall coordinate with VFD manufacturer to ensure compatibility. Characteristics of motors furnished on equipment shall be furnished to VFD manufacturer for review, prior to installing motor on equipment. VFD’s shall be furnished with driven equipment and shall be run tested as an equipment unit at factory prior to shipment. Submit run test report prior to shipping. F.O.B. of motors to factory shall be by the equipment manufacturer.
				7. Motors shall be open drip‑proof type, except where specified or noted otherwise on the construction drawing.
				8. Motors ¼ to ¾ hp shall be Subtype II and meet the minimum requirements of EPAct92 for minimum NEMA nominal efficiency motors.
				9. Motors 1 to 200 hp shall be Subtype I and meet the minimum requirements of NEMA Table 12-12 for NEMA premium efficiency motors.
			1. Manufacturers
				1. Manufacturer: Company specializing in the manufacture of electric motors for HVAC and plumbing equipment use, and their accessories, with minimum three (3) years documented product development, testing and manufacturing experience.

Baldor - Super E – NEMA Premium Efficiency.

Marathon - NEMA Premium Efficiency.

 Siemens – NEMA Premium EfficiencyU.S. Electrical – NEMA Premium Efficiency.

* + - 1. SINGLE PHASE POWER ‑ SPLIT PHASE MOTORS
				1. Starting Torque: Less than 150 percent of full load torque.
				2. Starting Current: Up to seven times full load current.
				3. Breakdown Torque: Approximately 200 percent of full load torque.
				4. Drip‑proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.
				5. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.
				6. Single phase motors, shall be less than 3/4 horsepower and shall be permanent split phase, capacitor start, induction run, 120 volt, 60 hertz motors with dripproof enclosures except as hereinafter specified. These motors shall have built‑in thermal overload protection and shall be rated for temperature rise as hereinbefore specified for 3‑phase motors.
			2. SINGLE PHASE POWER ‑ PERMANENT‑SPLIT CAPACITOR MOTORS
				1. Starting Torque: Exceeding one fourth of full load torque.
				2. Starting Current: Up to six times full load current.
				3. Multiple Speed: Through tapped windings.
				4. Open Drip‑proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum Service Factor as specified herein, prelubricated sleeve or ball bearings, automatic reset overload protector.
				5. Single phase motors shall be less than 3/4 horsepower and shall be permanent split phase, capacitor start, induction run, 120 volt, 60 hertz motors. These motors shall have built‑in thermal overload protection with automatic reset and shall be rated for temperature rise as hereinbefore specified for 3‑phase motors.
			3. SINGLE PHASE POWER ‑ CAPACITOR START MOTORS
				1. Starting Torque: Three times full load torque.
				2. Starting Current: Less than five times full load current.
				3. Pull‑up Torque: Up to 350 percent of full load torque.
				4. Breakdown Torque: Approximately 250 percent of full load torque.
				5. Motors: Capacitor in series with starting winding; capacitor‑start/capacitor‑run motors shall have two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
				6. Enclosures shall be of the open dripproof type with a service factor as specified herein and Class B insulation rated at 90 degrees C temperature rise measured above 40 degrees C room ambient condition at full load, unless otherwise noted.
				7. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.
				8. Single phase motors, in general, shall be less than 3/4 horsepower and shall be permanent split phase, capacitor start, induction run, 120 volt, 60 hertz motors. These motors shall have built‑in thermal overload protection and shall be rated for temperature rise as hereinbefore specified for 3‑phase motors.
			4. THREE PHASE POWER ‑ SQUIRREL CAGE MOTORS
				1. Enclosures shall be of the open drip proof type with a service factor as specified herein and Class B insulation rated at 90 degrees C temperature rise measured above 40 degrees C room ambient condition at full load, unless otherwise noted.
				2. All motors 3/4 horsepower and larger, unless smaller motors are indicated to be supplied as 3‑phase, shall be 3‑phase and shall be squirrel cage high efficiency induction type with standard NEMA frame sizes.
				3. Three phase motors not connected to variable frequency drives are to be protected for phase loss and phase unbalance protection.
				4. Motors 1 HP and larger shall have integral frames.
				5. Starting Torque: Between one and one and one‑half times full load torque.
				6. Starting Current: Six times full load current.
				7. Power Output, Locked Rotor Torque, Breakdown or Pullout Torque: NEMA Design B characteristics.
				8. Design, Construction, Testing and Performance: Conform to ANSI/NEMA MG 1 for Design B motors.
				9. Insulation System: NEMA Class B or better.
				10. Testing Procedure: In accordance with ANSI/IEEE 112, Test Method B. Load test motors to determine freedom from electrical or mechanical defects and compliance with performance data.
				11. Motor Frames: NEMA standard T‑frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
				12. Bearings:

Ball or roller type, double shielded with continuous grease relief to accommodate excessive pressure caused by thermal expansion or over lubrication.

All motor bearings shall be factory prepacked with a nondetergent lubricant and shall be provided with lubrication fitting arranged to provide easy access when installed on the driven apparatus except as noted hereinafter.

Permanently lubricated factory‑sealed motors may be provided in fractional horsepower sizes only where they are an integral part of a piece of approved apparatus.

All bearings shall be designed for L-10, 40,000 hour minimum life hours of continuous service. Calculate bearing load with NEMA minimum V‑belt pulley with belt centerline at end of NEMA standard shaft extension. Direct driven fans may require specific bearings other then ball type, verify equipment specification where motor may be used where bearing life requirement may exceed L-10 rating. Stamp bearing sizes on nameplate.

* + - * 1. Sound Power Levels: Refer to ANSI/NEMA MG 1.
				2. Part Winding Start (Where Indicated): Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel. Bearings shall be double shielded with waterproof non-washing grease.
				3. Nominal Efficiency and Power Factor: Meet or exceed values as scheduled at load and rated voltage when tested in accordance with ANSI/IEEE 112.
				4. Motors one horsepower and larger shall be provided with a copper frame grounding lug of hydraulic compression design, for installation by the electrical subcontractor.
			1. STARTING EQUIPMENT
				1. Each motor shall be provided with proper starting equipment. Starting equipment shall be furnished by this Division.
				2. Relays and equipment supplied by this Contractor shall be integral with electrical equipment supplied.
			2. RATING
				1. Speed and Size: Speed and approximate horsepower ratings are specified in equipment Specification Sections or are indicated on the Drawings. Furnish motors sufficiently sized for the particular application and with full-load rating not less than required by the driven equipment at specified capacity. Size motors so as not to overload at any point throughout the normal operating range.
				2. Voltage:

Single phase: 115 volts for 120-volt nominal system voltage.

Three phase: 200 volts for 208-volt nominal system voltage.

Three phase: 230 volts for 240-volt nominal system voltage.

Three phase: 230/460 volts for 240/480-volt nominal system voltage.

Three phase: 460 volts for 480-volt nominal system voltage.

* + - * 1. Frequency: 60 Hertz.
				2. Efficiency: Provide energy-efficient motors meeting the requirements of NEMA MG1-12.55A, Table 12Y and MG 1.41.3. Efficiency to be determined by testing in accordance with NEMA MG 112.53 using IEEE 112A – Method B.
				3. Service Factor: According to NEMA MG 1-12.47 but not less than those indicated per the Table below.
				4. Table: NEMA Open Motor Service Factors:

| Horsepower | 3600 RPM | 1800 RPM | 1200 RPM | 900 RPM |
| --- | --- | --- | --- | --- |
| 1/6 – 1/3 | 1.35 | 1.35 | 1.35 | 1.35 |
| ½ | 1.25 | 1.25 | 1.25 | 1.15 |
| ¾ | 1.25 | 1.25 | 1.15 | 1.15 |
| 1 | 1.25 | 1.15 | 1.15 | 1.15 |
| 1.5-150 and above 150 | 1.15 | 1.15 | 1.15 | 1.15 |
|  |  |  |  |  |

1. EXECUTION
	* + 1. ApplicaTION
				1. Single-phase motors for shaft mounted fans shall be split phase type.
				2. Single-phase motors for shaft mounted fans or blowers shall be permanent split capacitor type.
				3. Single-phase motors for fans shall be capacitor start, capacitor run type.
				4. Motors located in exterior locations and in direct drive axial fans, roll filters, humidifiers and draw-through air units shall be totally enclosed weatherproof epoxy-sealed type.
			2. INSTALLATION
				1. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
				2. All installation shall be in accordance with manufacturer’s published recommendations.
				3. Properly install and align motors after installation on the driven equipment.
				4. Motor feeders shall be free of splices. In special cases when splice-free feeders are impractical, splices may be allowed given prior written approval from the Owner.
				5. Use crimp-on, solderless copper terminals on the branch circuit conductors. For motors 20 horsepower and larger, use 5300 Series 3M motor lead splicing kit or approved equal.
				6. When the motor and equipment are installed, the motor’s nameplate must be in full view.
			3. TESTING
				1. General: Provide all necessary instruments, labor and personnel required to perform motor inspection and testing.
				2. Inspection: Inspect all motors for damage, moisture absorption, alignment, freedom of rotation, proper lubrication, oil leaks, phase and rotation and cleanliness, and report any abnormalities to Owner before energizing.
				3. Tests: Motor full load current and full load voltage shall be measured. Motor phase loss and phase unbalance protection shall be tested. Motor Test Report forms included at the end of this Section shall be completed and submitted prior to Substantial Completion.
				4. Energizing: After installation has been thoroughly checked and found to be in proper condition, with thermal overloads in motor controllers properly sized and all controls in place, energize the equipment at system voltage for operational testing.
				5. Motor Test Report Form:

 DATE

 SHEET OF

PROJECT NAME

PROJECT NO.

MOTOR DESIGNATION , LOCATION

HP , FLA , LOCATION

PHASE LOSS AND PHASE UNBALANCE PROTECTION

INSULATION CLASS

SERVED FROM PANEL/MCC

MEASURED CONDITIONS

TEMPERATURE: degrees F

RELATIVE HUMIDITY: %

CURRENT (AMPS): ∅A , ∅B , ∅C

VOLTAGE (VOLTS): ∅B , ∅BC , ∅CA

 ∅AN , ∅BN , ∅CN

END OF SECTION 20 05 13