SECTION 23 05 13
ELECTRIC MOTORS FOR HVAC EQUIPMENT

PART 1 – GENERAL

1.01 WORK INCLUDED

A. The work of this Section shall include, but is not limited to, the following:

1. Constant speed, variable speed and two-speed squirrel cage, polyphase electric induction alternating current (AC) motors for mechanical equipment.

2. Direct-current (DC) electronically commutated type motors (ECM).

1.02 RELATED DOCUMENTS

A. Section 23 05 01 – HVAC General Provisions

B. Section 23 05 14 – Variable Frequency Drives for HVAC

C. Section 23 05 48 – Vibration and Seismic Controls for HVAC

D. Section 23 33 19 – Acoustics

E. Division 26 – Electrical Specifications

F. Division 28 – Fire Alarm Specifications

1.03 REFERENCE STANDARDS

A. Published specifications standards, tests or recommended methods of trade, industry or governmental organizations apply to work in this Section where cited below:

1. IEEE – Institute of Electrical and Electronic Engineers: IEEE 11, IEEE Approved Draft Standard Test Procedure for Polyphase Induction Motors and Generators
2. NEMA – National Electrical Manufacturers Association: NEMA MG 1 Motors and Generators
3. NFPA – National Fire Protection Association: NFPA 70 National Electrical Code
4. UL – Underwriters Laboratories Inc.

1.04 QUALITY ASSURANCE

A. Electrical coordination

1. Unless specified or otherwise indicated on the drawings, all starters, overload relay heater coils, disconnect switches and fuses, relays, wire, conduit, pushbuttons, pilot lights, and other devices required for the control of motors or electrical equipment are provided as specified by Division 26.
2. Division 26 drawings and specifications show number and power rating of all motors furnished by this Contractor. Should any discrepancy in size, power rating, electrical characteristics or means of control be found for any motor or other electrical equipment after contracts are awarded, Contractor shall immediately notify the Architect of such discrepancy. Refer to Section 23 05 01 - HVAC

General Provisions.

3. Furnish project-specific wiring diagrams to Division 26 Contractor for all equipment and devices furnished under this Section.

B. Motors intended for variable speed applications shall have UL approval for use on 'Generic' pulse width modulated and/or 6-step waveforms. Motors requiring one specific manufacturer of VFD to meet the UL criteria are not acceptable.

C. Motors shall conform to applicable requirements of ANSI, IEEE, NEMA, and NEC standards and shall be UL Listed for the service specified.

D. Furnish motors for starting in accordance with utility requirements and compatible with starters as specified.

1.05 SUBMITTALS

A. Submit motors under the sections covering the driven equipment.

B. Submit motor efficiencies at full load, 75 percent full load, and 50 percent full load.

C. Submit certified dimensions, weights, insulation class, service factors, NEMA frame size, materials of construction, base details and mounting details.

D. Include, with the motor-driven equipment submittal, the following motor information: manufacturer, horsepower, voltage, phase, hertz, speed, full load efficiency. Include project-specific wiring diagrams prepared by the Contractor specifically for this work.

E. Include manufacturer’s instructions in the operating and maintenance manuals for the specific equipment. Include the following information, if not previously documented on shop drawings: full load power factor, service factor, NEMA design designation, insulation class, frame type.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Constant speed applications: Toshiba EQP Global, Century E-Plus 3, Baldor-Reliance Super-E, General Electric Energy Saver, Marathon Series E.

B. Variable speed applications: U.S. Electrical Motors Inverter Duty, Baldor-Reliance Inverter/Vector, or approved equal.

C. Whenever variable frequency PWM drives are installed to control AC motors greater than 1 HP or as otherwise indicated, a maintenance free, circumferential, conductive micro fiber shaft grounding assemblies shall be installed in the AC motor to discharge shaft currents to ground. AEGIS SGR Bearing Protection Ring, Inpro/Seal Smart Current Diverter Ring (CDR), or approved equal.

2.02 GENERAL

A. Provide electric motors for driving the mechanical equipment. Motors shall be selected for power, construction and speed to suit the specified manufacturers of equipment. If other manufacturers of equipment are accepted, the correct adjustment of motor speed, torque

and power shall be included without additional cost. Submit drawings for review before the equipment is purchased.

B. Motors scheduled for use with variable speed drives shall meet NEMA MG-1 Part 31.4.4.2. Motor shall incorporate ISR or PD-free (Inverter Spike Resistant or Partial Discharge-free) copper windings and Class F insulation. Motor shall withstand 1600 volt spikes. Motors shall be suitable for 10:1 speed reduction.

C. Unless otherwise indicated on the drawings, one-half horsepower and larger motors shall be rated:

1. 460 volts alternating current (VAC) and suitable for operation on a 480 VAC (plus or minus 5 percent) – 3-phase – 60 hertz

2. Unless otherwise indicated on the drawings, fan coil unit and fan powered terminal unit motors shall be rated [277 VAC – single phase – 60 hertz]

3. [120 VAC – single phase – 60 hertz] and shall be provided with integral thermal overload protection.

4. One-third horsepower and smaller motors shall be rated 120 VAC – single phase – 60 hertz and shall be provided with integral thermal overload protection.

D. Motors shall be generally constant speed, squirrel-cage type, open drip-proof or totally enclosed fan cooled (TEFC) design. Single phase motors shall be high efficiency capacitor start, induction run, or split phase type as approved for the service.

E. Motor temperature rise when operating at a service factor of 1.15, and on a variable frequency drive shall not exceed Class F insulation limits at full load, with 115 degrees C allowable temperature rise based on a reference ambient temperature of 40 degrees C across its nameplate speed and torque envelope. Sine-wave temperature rise shall be Class F or better.

F. Motors shall have minimum Class B insulation for continuous full load duty at 130 degrees C operating temperature, with a service factor of 1.15, and a maximum altitude of 3,300 feet above sea level. Operation temperature is based on the reference temperature plus allowable temperature rise plus allowance for hotspots in the windings. Where normal operating temperatures will exceed the Class B insulation rating, provide Class F insulation. For all motors driven by variable frequency drives, provide Class F insulation.

G. Motors shall be of quiet operating type, guaranteed to fulfill the specified requirements without producing any objectionable sound exceeding room NC levels as specified. All belt-connected motors shall have adjustable bases and set screws to maintain correct belt tension. Provide belt guards in accordance with OSHA Standards.

H. Motors and accessories shall be UL Listed and comply with NEMA standards.

I. Minimum Service Factor:

1. Constant speed applications: 1.15.
2. Variable speed application: Nameplate sine-wave service factor shall be 1.15 or greater.
3. No motor shall be selected to operate within the Service Factor range.

J. Coordinate the NEMA type of each motor with the torque and inertia load of the equipment served, and the in-rush current characteristics of the motor with the motor starter selection, so that all items furnished constitute a complete motor control and protection package.

K. Motors located in ducted air streams or subject to outside air elements including cooling towers shall be totally enclosed fan cooled (TEFC) unless required otherwise; other motors shall be open drip-proof design. Motors one horsepower or larger shall have encapsulated stator windings of the epoxy or silicone type.

L. Fan motors shall be capable of accelerating their respective fans from zero speed to design or synchronous speed within a maximum of ten seconds.

M. All motors ½ horsepower and larger, except two-speed motors, specially wound motors and in-line pump motors frame size 56 and smaller, shall be of NEMA Premium design with full load efficiencies which meet or exceed the minimum efficiencies listed in the NEMA MG-1 Tables. The nominal efficiency levels shall be nameplated on the motor.

N. For motors 5 horsepower and greater, provide grease-lubricated ball bearings with housings equipped with plug or cap for relubrication. Bearings shall be rated for minimum AFBMA L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum belt sheave with belt center line at the end of NEMA standard shaft extension. Vertically mounted motors shall be provided with thrust bearings.

O. Motors shall be capable of making starts as frequently as the driven equipment may demand, with a minimum rating of four starts per hour without damage.

P. Explosion-proof motors or motors in hazardous locations shall be TEFC motors designed and listed to meet UL and NEC requirements for use in Divisions 1 and 2 hazardous locations as required by local regulatory agencies and insurance companies.

Q. Each motor shall be factory-wired to a junction box mounted on the motor or on the driven piece of equipment to facilitate single point of field power connection under Division 26.

1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.
2. Enclose terminal lugs in terminal box shall be sized in accordance with NFPA 70, threaded for conduit.
3. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.03 ELECTRONICALLY COMMUTATED MOTOR

A. Motor enclosures shall be either open drip-proof or totally enclosed non-vented.

B. Provide a direct-current electronic commutation type motor specifically designed for fan applications. Alternating current induction type motors are not acceptable. Shaded pole, permanent split capacitor, split phase, capacitor start or 3 phase induction type motors are not acceptable.

C. Motors shall be permanently lubricated, ball bearing type matching the fan load and pre-wired to the specific voltage and phase.

D. Internal motor circuitry shall convert AC power supplied to the fan to DC power to operate

the motor.

E. Motor shall be speed controllable down to 20 percent of full speed providing an 80 percent turndown. Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0 to 10 volt DC signal.

F. Motor shall be a minimum of 85 percent efficient at all speeds.

G. Harmonic filter

1. Provide a choke, filter, or line reactor device that creates a magnetic field to increase the impedance of the power line and reduce the total harmonic content injected from the ECM onto the facilities electrical system.
2. The device shall add the necessary impedance for harmonic reduction without a drop in voltage.
3. The device shall protect against current surges.
4. Include grounding to prevent ground fault currents through the drive. The device shall provide a ground path.
5. Following an undervoltage condition, the DC bus capacitor shall be recharged to match the source voltage level. The pre-charge circuit shall limit inrush current and protect rectifier components when the power goes back to normal. The device shall provide additional inductance to resist the high current inrush protecting the front end rectifiers and DC bus capacitors in the drive.
6. The choke shall be a rated for 5 percent.

2.04 VARIABLE SPEED APPLICATIONS

A. Motors used with variable frequency drives shall be designed specifically for use on AC inverter power and adjustable speed applications, with the following requirements:

1. Frame materials shall be cast iron, aluminum or rolled steel.
2. Motor insulation shall be Class F and designed to meet the voltage spike limits defined by NEMA MG-1, Part 31. Insulation systems shall utilize 200 degree C magnet wire with a Pulse Endurance Index greater than 100. Insulation systems utilizing heavy film wire are not acceptable. Complete insulation of the slot, cell and phase groups is required. The system shall be rated for Class F rise or better.
3. Stator core designs shall be of high rigidity with reinforced end turn construction to minimize mechanical fatigue of the winding, and to reduce resonant noise. Varnished materials shall be double dip, double bake using polyester phenolic Class F varnish. Single dip and bake cycles are not acceptable.
4. Winding thermal protection, utilizing normally closed contacts, shall be sized to match the maximum safe operating temperature of the insulation system. Contacts shall open when winding temperature reaches 155 degrees C. Hazardous location motors shall have winding thermal protection sized as required to meet UL or as auxiliary devices where not required by UL.
5. Low loss electrical steel shall be utilized in the stator and rotor core assemblies.
6. Maximized copper content shall be utilized to achieve high motor efficiency and thermal transfer.
7. Rotor cores and/or assemblies shall be of a low vibration design that meets one-half of the NEMA MG-1 recommended levels for balance.
8. The final motor design shall be evaluated by factory test on inverter power over the full range of speeds.

B. Variable Torque, Variable Speed Motors:

1. Motors shall meet NEMA design 'B' performance levels. Design 'A' motors are acceptable when higher than normal efficiencies are required.
2. Motors shall be nameplated for 6 to 60 hertz operation. Hazardous location motors may be nameplated 10 to 60 hertz.

C. Motors used in variable-speed applications shall be of NEMA Premium design with full load efficiencies which meet or exceed the minimum efficiencies listed in the NEMA MG-1 Tables. The nominal efficiency levels shall be nameplated on the motor.

2.05 MOTOR NAMEPLATES

A. Nameplate data shall be stamped on a steel data plate and permanently attached to the motor frame.

B. Nameplate data shall include:

1. Frame type and designation.
2. Time rating.
3. Maximum ambient temperature.
4. Insulation system designation.
5. Voltage, frequency, and number of phases.
6. Code letter for locked rotor kilovolt-amps.
7. Service factor
8. Overload and/or thermal protection.
9. Maximum approved continuous torque.
10. Approved speed and frequency operating range at rated load.
11. Full load current.
12. Horsepower output.

PART 3 – EXECUTION

3.01 INSTALLATION

A. When motor will be flexible coupled to the driven device, mount coupling to the shafts in accordance with the coupling manufacturer’s recommendations. Using a dial indicator, check angular misalignment of the two shafts; adjust motor position as necessary so that the angular misalignment of the shafts does not exceed 0.002 inches per inch diameter of the coupling hub. Again, using the dial indicator, check the shaft for run-out to assure concentricity of the shafts. Adjust as necessary so that parallel misalignment does not exceed 0.002 inches, and angular misalignment does not exceed 0.002 inches per inch diameter of the coupling hub for an 1800 rpm motor. Set all direct driven equipment with not more than one-half of the coupling manufacturer’s recommended maximum tolerance for parallel and angular variance in alignment.

B. Align all belt-driven equipment to provide minimum wear on belts and drives, with belts correctly tensioned.

C. Mount motors on a rigid base designed to accept a motor, using shims if required under each mounting foot for a secure and level installation.

D. When motor will be connected to the driven device by means of a belt drive, mount sheaves

on the appropriate shafts in accordance with the manufacturer's instructions. Use a straight edge to check alignment of the sheaves; reposition sheaves as necessary so that the straight edge contacts both sheave faces squarely. After sheaves are aligned, loosen the adjustable motor base so that the belt(s) can be added and tighten the base so that the belt tension is in accordance with the drive manufacturer's recommendations. Frequently re-check belt tension and adjust if necessary during the first day of operation and again after 80 hours of operation.

3.02 START UP

A. Coordinate overload heater requirements with motor starter provider.

B. Verify the correct rotation of each three-phase motor as it is being wired or before the motor is energized for any reason.

C. Lubricate all motors requiring lubrication. Record lubrication material used and the recommended frequency of lubrication. Include this information in the maintenance manuals.

END OF SECTION 23 05 13