**SECTION 23 05 13**

**Common Motor Requirements for HVAC Equipment**

**BASED ON DFD MASTER SPECIFICATION DATED 12/20/2023**

***This section has been written to cover most (but not all) situations that you will encounter. Depending on the requirements of your specific project, you may have to add material, delete items, or modify what is currently written. The Division of Facilities Development expects changes and comments from you.***

**P A R T 1 - G E N E R A L**

**SCOPE**

This sections includes requirements for single and three phase motors that are used with equipment specified in other sections. Included are the following topics:

PART 1 - GENERAL

 Scope

 Related Work

 Reference

 Reference Standards

 Quality Assurance

 Shop Drawings

 Operating and Maintenance Data

 Electrical Coordination

 Product Criteria

PART 2 - PRODUCTS

 Three Phase, Single Speed Motors

 Single Phase, Single Speed Motors

 Two Speed Motors

 Motors Used for Reduced Voltage Starting

 Motors Used on Variable Frequency Drives

PART 3 - EXECUTION

 Installation

**RELATED WORK**

Section 01 91 01 or 01 91 02 – Commissioning Process

Section 23 09 14 - Pneumatic and Electric Instrumentation and Control Devices for HVAC

Section 23 05 14 - Variable Frequency Drives

Division 26 00 00 - Electrical

***Include section references for refrigeration and heat rejection equipment starters when they are specified with the equipment.***

**REFERENCE**

Applicable provisions of Division 1 govern work under this section.

**REFERENCE STANDARDS**

ANSI/IEEE 112 Test Procedure for Polyphase Induction Motors and Generators

ANSI/NEMA MG-1 Motors and Generators

ANSI/NFPA 70 National Electrical Code

**QUALITY ASSURANCE**

Refer to division 1, General Conditions, Equals and Substitutions.

**SHOP DRAWINGS**

Refer to division 1, General Conditions, Submittals.

Include with the equipment which the motor drives the following motor information: motor manufacturer, horsepower, voltage, phase, hertz, rpm, full load efficiency. Include project wiring diagrams prepared by the contractor specifically for this work.

# OPERATION AND MAINTENANCE DATA

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

***Delete the following if there are no additional requirements.***

In addition to the general content specified under GENERAL REQUIREMENTS supply the following additional documentation:

1. Lubrication instructions, including list/frequency of lubrication
2. Table noting full load power factor, service factor, NEMA design designation, insulation class and frame type for each motor provided
3. ***[A/E and commissioning provider to define detailed operation and maintenance data requirements for equipment specifications added to this section.]***

**ELECTRICAL COORDINATION**

Electrical drawings and/or specifications show number, and horsepower rating of all motors furnished by this Contractor, together with their actuating devices if these devices are furnished by the Electrical Contractor. Should any discrepancy in size, horsepower rating, electrical characteristics or means of control be found for any motor or other electrical equipment after contracts are awarded, Contractor is to immediately notify the architect/engineer of such discrepancy. Costs involved in any changes required due to equipment substitutions initiated by this contractor will be the responsibility of this contractor. See related comments in Section 23 05 00 - Common Work Results for HVAC, under Shop Drawings.

***The intent of the preceding paragraph is to indicate motor horsepower in one location only and to coordinate this information before bids are received. It is not the intent to have the Contractor become responsible for last minute motor size changes made by the consultant. If a contractor uses one of the listed manufacturers for a piece of equipment, DFD would not consider that a change initiated by the contractor. Follow DFD guidelines and good design practice when selecting motors for electrically driven equipment and coordinate this information before bidding documents are issued.***

***A/E must coordinate specified voltages with the electrical consultant for the project.***

Electrical Contractor will provide all power wiring and control wiring, except temperature control wiring.

Furnish project specific wiring diagrams to Electrical Contractor for all equipment and devices furnished by this Contractor and indicated to be wired by the Electrical Contractor.

**PRODUCT CRITERIA**

Motors to conform to all applicable requirements of NEMA, IEEE, ANSI, and NEC standards and shall be listed by U.L. for the service specified.

Select motors for conditions in which they will be required to perform; i.e., general purpose, splashproof, explosion proof, standard duty, high torque or any other special type as required by the equipment or motor manufacturer's recommendations.

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

 **P A R T 2 - P R O D U C T S**

**THREE PHASE, SINGLE SPEED MOTORS**

Use NEMA rated [200][230][460] volt, three phase, 60 hertz motors for all motors 1/2 HP and larger unless specifically indicated.

***Most projects can use one of the voltages indicated for three phase motors. Some projects, however, will need motors specially wound for 208, 220, 240, 440, or 480 volt applications due to the electrical conditions at the site. If it is felt that these special voltages will be needed on a project, contact DFD engineering personnel.***

Use NEMA general purpose, continuous duty, Design B , normal starting torque, T-frame or U-frame motors with Class B or better insulation unless the manufacturer of the equipment on which the motor is being used has different requirements. Use open drip-proof motors unless totally enclosed fan-cooled, totally enclosed non-ventilated, explosion-proof, or encapsulated motors are specified in the equipment sections.

***Motors that are located in a contaminated exhaust air stream must be specified so the motor will not ignite any flammable material in the air stream. It is usually simpler to select a fan that has the motor outside the air stream and use a standard motor.***

Use grease lubricated anti-friction ball bearings with housings equipped with plugged/capped provision for relubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at the end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

For motors on \_\_\_\_\_[list equipment]\_\_\_\_\_\_\_, furnish epoxy sealed or coated motor windings and protect rotor and stator surfaces with epoxy enamel. Double shield bearings; use waterproof non-washing grease.

***Use preceding paragraph only when the motor is located in a contaminated air stream; verify that epoxy is available for the motor size needed. This epoxy coating can increase the cost of the motor by as much at 70%, depending on the motor horsepower.***

All open drip-proof motors to have a 1.15 service factor. Other motor types may have minimum 1.0 service factors.

All motors 1 HP and larger, except specially wound motors and inline pump motors 56 frame and smaller, to be high efficiency design with full load efficiencies which meet or exceed the values listed below when tested in accordance with NEMA MG 1.

FULL LOAD NOMINAL MOTOR EFFICIENCY BY MOTOR SIZE AND SPEED

 -----Open Drip-Proof Motors------

 MOTOR -------Nominal Motor Speed-------

 HP 1200 rpm 1800 rpm 3600 rpm

 1 82.5 85.5 77.0

 1-1/2 86.5 86.5 84.0

 2 87.5 86.5 85.5

 3 88.5 89.5 85.5

 5 89.5 89.5 86.5

 7-1/2 90.2 91.0 88.5

 10 91.7 91.7 89.5

 15 91.7 93.0 90.2

 20 92.4 93.0 91.0

 25 93.0 93.6 91.7

 30 93.6 94.1 91.7

 40 94.1 94.1 92.4

 50 94.1 94.5 93.0

 60 94.5 95.0 93.6

 75 94.5 95.0 93.6

 100 95.0 95.4 93.6

 125 95.0 95.4 94.1

 150 95.4 95.8 94.1

 200 95.4 95.8 95.0

 ----Totally Enclosed Fan-Cooled----

 MOTOR -------Nominal Motor Speed------

 HP 1200 rpm 1800 rpm 3600 rpm

 1 82.5 85.5 77.0

 1-1/2 87.5 86.5 84.0

 2 88.5 86.5 85.5

 3 89.5 89.5 86.5

 5 89.5 89.5 88.5

 7-1/2 91.0 91.7 89.5

 10 91.0 91.7 90.2

 15 91.7 92.4 91.0

 20 91.7 93.0 91.0

 25 93.0 93.6 91.7

 30 93.0 93.6 91.7

 40 94.1 94.1 92.4

 50 94.1 94.5 93.0

 60 94.5 95.0 93.6

 75 94.5 95.4 93.6

 100 95.0 95.4 94.1

 125 95.0 95.4 95.0

 150 95.8 95.8 95.0

 200 95.8 96.2 95.4

***Delete the larger size motors from this table if they are not needed on the project.***

**SINGLE PHASE, SINGLE SPEED MOTORS**

Use NEMA rated 115 volt, single phase, 60 hertz motors for all motors 1/3 HP and smaller.

Use permanent split capacitor or capacitor start, induction run motors equipped with permanently lubricated and sealed ball or sleeve bearings and Class A insulation. Service factor to be not less than 1.35.

***Many fractional horsepower motors have inherent overtemperature protection. When this is the case, manual starters or relays may be used rather than magnetic starters with overload protection. Coordinate with the electrical design consultant.***

**TWO-SPEED MOTORS**

Unless otherwise indicated, three phase two speed motors to be [one winding, consequent pole, variable torque type] [two winding, variable torque] and single phase motors to be capacitor start capacitor run type having two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

Standard motors with VFD’s are generally preferred over two-speed motors and starters due to the higher cost and poorer availability of two-speed motors and starters. Where two-speed motors are used, reference the appropriate equipment section under Part 1 Related Work and coordinate with the electrical consultant making sure they include a deceleration relay for three phase two-speed starters.

**MOTORS USED FOR REDUCED VOLTAGE STARTING**

Furnish motors compatible with reduced voltage starting for the following motors:

 Equipment Starter Type

***This paragraph requires careful coordination with the local utility company requirements and the electrical design consultant. It must be edited and expanded specifically for each project. As a general guide only, 200 volt or 230 volt motors over 20 hp and 460 volt motors over 50 hp may need some means of limiting the inrush current on startup.***

**MOTORS USED ON VARIABLE FREQUENCY DRIVES**

In addition to the requirements specified above, the motor must be suitable for use with the drive specified in Section 23 05 14, including but not limited to motor cooling. Motor shall comply with NEMA MG1 Part 31 to provide windings capable to withstand up to 1600 peak Volts with a rise time of 0.1 µs. Provide brush style bearing protection to bleed current from the motor shaft to the motor casing to suit motor application. Brushes shall be field replaceable. Manufacturers: Shaft Grounding Systems (SGS), Helwig Carbon Bearing Protection Kits (BPK), or equal.

**P A R T 3 - E X E C U T I O N**

**INSTALLATION**

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

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 run-out does not exceed 0.002 inch.

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 recheck belt tension and adjust if necessary during the first day of operation and again after 80 hours of operation.

***The 80 hour operation check is a recommendation of NEBB.***

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

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

\*\*\*END OF SECTION\*\*\*