**SECTION 33 05 12**

**Common Motor Requirements for Utility Equipment**

**BASED ON DFD MASTER SPECIFICATION DATED 10/01/2012**

***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 section 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 Instructions

Electrical Coordination

Product Criteria

PART 2 - PRODUCTS

Three Phase, Single Speed Motors

Single Phase, Single Speed Motors

Motors Used for Reduced Voltage Starting

PART 3 - EXECUTION

Installation

**RELATED WORK**

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 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, and full load efficiency. Include project wiring diagrams prepared by the contractor specifically for this work.

**OPERATING AND MAINTENANCE INSTRUCTIONS**

Include manufacturer's instructions in the manuals with the specific equipment to which they apply. Also include the following information if not previously documented on shop drawings: full load power factor, service factor, NEMA design designation, insulation class, and frame type.

**ELECTRICAL COORDINATION**

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 furnished and installed by the Electrical Contractor, except as specifically noted elsewhere in this division of specifications.

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.

***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.

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**

ELECTRICAL

Motors shall be NEMA Design B (normal starting torque, low starting current), squirrel cage, induction type for full voltage starting and continuous duty.

Motors shall be 460 220 volt, 3 phase, and 60 Hertz. All motors shall have copper windings and leads. Motor leads to have same insulation class as windings.

All motors shall have polyester or epoxy insulation systems for moisture and chemical resistance, suitable for heating plant conditions.

Insulation shall be Class F, non-hygroscopic, 1.15 service factor. The temperature rise as determined by resistance above a 40° C ambient shall not exceed 80° C at rated load and 115° C at the 1.15 service factor.

Low voltage above NEMA frame motor rotors shall be copper bar or cast aluminum type. Any other proposed type requires the engineer’s approval. Brazing on rotor bars shall be 45% non-phosphorous silver copper brazing alloy (due to corrosive atmosphere).

MECHANICAL

Enclosures

All motors with frames 143T through 449T shall be totally enclosed, fan-cooled (TEFC). Foot mounted motors are preferred. Any other frame or arrangement must be approved by the engineer.

Motor enclosures shall be of cast iron including frame, end brackets, fan shroud, and conduit box. Materials and construction shall conform to "Chemical Motor" requirements - special interior and exterior hardware and epoxy or polyurethane paint treatment to provide high resistance to moisture and chemical corrosion.

All motors frame 143T and larger shall be supplied with shouldered lifting eyebolts or suitable lifting arrangement (eyebolts preferred).

All TEFC motors shall have a drain hole (preferably tapped) and a drain plug located at the lowest point of the motor to prevent accumulation of moisture within the motor due to condensation during storage. T-slot design plug is preferred.

Motor nameplates shall be stainless steel and shall include at least the following information:

|  |  |  |  |
| --- | --- | --- | --- |
| a) | Horsepower | j) | Class of Insulation |
| b) | RPM | k) | Locked Rotor KVA Code |
| c) | NEMA Design | l) | Full Load Amps |
| d) | Phase | m) | Model or Catalog Number |
| e) | Hertz | n) | AFBMA Bearing Identification Number |
| f) | Service Factor | o) | Guaranteed Minimum Efficiency |
| g) | Ambient Temperature | p) | Manufacturer's Nominal Efficiency |
| h) | Frame Size | q) | Motor Weight |
| i) | Duty | r) | Voltage |

Each motor is to have a stainless steel plate attached to the stator frame with two stainless steel knock-in rivets. Name plate data will be engraved or stamped thereon with numbers preferably not less than 3/8" in height.

Bearings

On motors through Frame 449T, bearings shall be anti-friction, re-lubricatable in service with motors running or stopped and shall have internal bearing caps. All motors shall have an INPRO rotating shaft seal installed on the drive end.

Motor bearing temperature rise at rated load shall not exceed 50°C measured on the outer race or 45°C measured on the bearing housing surface when measured by thermocouple or RTD.

Low voltage above NEMA frame motors shall be equipped with anti-friction bearings unless otherwise specified when ordered. When oil lubricated split type sleeve bearings are to be used, it shall be stated in the submittal. They will be furnished with oil standpipes, sight glasses and labyrinth type stationary seals to prevent moisture and contamination from entering the bearing housings. Split end shields shall be provided where appropriate to facilitate inspection and reduce downtime. The magnetic center shall be indicated by permanent markings. Each sleeve bearing shall be provided with a 10 ohm copper RTD to sense bearing shell temperature.

Motors with frames 213T and larger that are grease lubricated shall be supplied with inlet and relief Alemite fittings on each end, mounted on pipe extensions to bring fittings level with motor cooling fins. Manufacturer is to supply a copy of the recommended lubrication procedure with each motor. Grease shall be grade NLGI 2 - polyurea based.

Anti-friction bearings shall be chosen to ensure reliable, trouble-free, service in the specific motor application. Bearings shall be selected to provide a minimum L-10 life of 100,000 hours in direct coupled and 50,000 hours in belt driven applications. Ball bearings to be used unless specified L-10 life cannot be achieved with ball bearings in identified belted applications. Belting data shall be provided in the submittal when required

Both the drive end and opposite drive end bearings to be the same size.

All motors 1800 RPM and below will be furnished with long shafts. All 3600 RPM motors Frame 284T and larger shall have short shafts unless specified otherwise. Direct or V-belt drive application will be specified at time of order.

Conduit Boxes

Conduit boxes shall be cast iron, diagonally split, fully rotatable, and gasketed between cover and box, and between box and frame. Three non-wicking numbered leads with compression type lugs are to be provided and the motor lead opening in the frame shall be sealed with a neoprene gasket.

. The minimum conduit connection size is listed below.

|  |  |
| --- | --- |
| **Motor Frame Size** | **Conduit Size (inches)** |
| 143T - 215T | ¾ |
| 254T - 256T | 1 ¼ |
| 284T - 286T | 1 ½ |
| 324T - 326T | 2 |
| 364T - 365T | 2 ½ |
| 404T - 445T | 3 |
| 447T - 449T | 3 |

. A clamp type terminal shall be provided inside each motor conduit box for grounding.

Balancing

All rotors shall be two plane dynamically balanced to G1.0 balance grade with a full length half key in the keyway.

Noise Requirements

Noise sound level shall be in accordance with IEEE Standard 85-1973. The sound pressure (at three feet) of electrical motors 1800 RPM and less shall not exceed 80 dBA and 3600 RPM shall not exceed 85 dBA.

Vibration

Bearing vibration shall not exceed 0.075 inches/second at motor speeds up to 3600 RPM.

EFFICIENCY

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.

----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****.*

**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.

**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. Check parallel and angular misalignment of the two shafts. Adjust motor position as necessary so that the misalignment of the shafts does not exceed the limits in the table:

|  |  |  |  |
| --- | --- | --- | --- |
| RPM | Parallel Offset  (mils) | Angularity  (mils/inch) | Parallel Offset per Inch of Spacer Length (mils) |
| 600 | 5 | 1 | 1.8 |
| 900 | 3 | 0.7 | 1.2 |
| 1200 | 2.5 | 0.5 | 0.9 |
| 1800 | 2 | 0.3 | 0.6 |
| 3600 | 1 | 0.2 | 0.3 |
| 7200 | 0.5 | 0.1 | 0.15 |

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. Misalignment on V-belt drives should be less than 0.1” per foot of center distance. Misalignment for synchronous belts should be less than 0.0625” per foot of center distance. 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.

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