

**SECTION 23 05 13 – COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT**

**PART 1: GENERAL**

**1.01** This design guidelines contained herein includes the requirements electric motors utilized for electric motor driven systems at Texas State University. It is the intention of this document to provide a standard for electric motors at Texas State University to provide the highest level of quality and standardization possible; it is not intended to be a guide specification.

**1.02 Motors**

- A. Fan motors and associated equipment shall be sized to operate at 110% of calculated loads and capacities.
- B. Equipment shall be designed and installed to operate continuously under all actual site conditions and variations (i.e. typical voltages of 125/215 for 120/208 volt circuits).
- C. Motor controls (i.e. starters) shall be properly identified, labeled and located in a sheltered and secure location (mechanical room when possible).
- D. All motors 2 HP & larger will be 3 phase.

**1.03 Motors and Bearings**

- A. In general do not use motor speeds in excess of 1800 RPM.
- B. On air handling units requiring motors of 7-1/2 horsepower and larger, provide fan shaft and motor shaft with key way slot.
- C. Use ball bearings in preference to sleeve bearings in motors and air units where noise limits permit.
- D. Position air units to allow replacement of bearings without necessity for demolition to gain access.
- E. Extend bearing lubrication points to central accessible points and provide alemite fittings for lubrication.
- F. For energy conservation, energy efficient motors should be used where practical.
- G. Use inverter rated motors on all motors that are controlled by VFD's.

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**1.04 Standards**

- A. Motors shall be designed, built, and tested in accordance with the latest revision of the following standard documents.
1. NEMA MG 1 - Motors and Generators.
  2. ANSI/IEEE 112 - Test Procedures for Motors / Generators.
  3. UL 1004 - Motors, Electric.
  4. UL 674 - Motors, Generators, Electric, for Use in Hazardous Locations: Class I, Groups C and D; Class II, Groups E, F, and G.

**1.05 Submittals**

- A. It will be required as a Standard to submit test results verifying guaranteed minimum efficiency and power factor at rated load and rated voltage for 3-phase motors larger than ½ hp. Report test results on Form A-1, IEEE Standard 112.
- B. Submittal data on motors shall include, but not be limited to the following information:
1. Manufacturer;
  2. Rated horsepower;
  3. Rated voltage(s);
  4. Number of phases;
  5. Frequency in hertz;
  6. Motor no-load current at rated voltage;
  7. Full load amperes (FLA) at rated voltage;
  8. Full load current at 110 percent voltage.
  9. Starting current at rated voltage.

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10. Locked rotor amperes (LRA) or code letter;
11. Safe stall time (motors 30 horsepower and larger);
12. Nominal speed at full load;
13. Motor Performance Characteristics:
  - a. Guaranteed minimum efficiency at rated load at rated voltage.
  - b. Guaranteed minimum power factor at rated load at rated voltage.
  - c. Expected efficiency at  $\frac{1}{2}$ ,  $\frac{3}{4}$ , and full load at rated voltage.
  - d. Expected power factor at  $\frac{1}{2}$ ,  $\frac{3}{4}$ , and full load at rated voltage.
  - e. Provide certified factory test and test reports for identical motor tested in accordance with the Procedures for Polyphase Induction Motors and Generators No. 112A, NEMA MG 1-12.53a and IEEE Standard 112, Test Method B, to confirm that the motor full load efficiency and power factor meets the specified values. Motors not as specified will be rejected.
    - (1) Measurements of no-load current and speed at normal voltage and frequency.
    - (2) Measurement of locked rotor current at rated frequency.
    - (3) Results of high-potential test.
    - (4) Determination of efficiency and power factor at  $\frac{1}{2}$ ,  $\frac{3}{4}$ , full-load, and service factor load.
14. Maximum power factor correction capacitor “kvar” recommended by motor manufacturer and expected new motor-capacitor power factor at rated full load (motors 30 horsepower and larger);
15. Winding insulation system as defined by IEEE;
16. NEMA design letter;
17. Temperature rise (reference NEMA MG-1, 12.41 and 12.42);

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18. Bearing type and duty, including bearing life calculations.
19. Motor outline dimensions, weight and frame number
20. 20 NEMA machine type classifications (ODP, TEFC, etc.).
21. Manufacturer's descriptive information relative to specified features.
22. Vertical Motor Data:
  - a. Thrust bearing life.
  - b. Type of thrust bearing lubrication.
  - c. Type of guide bearing lubrication.
23. Operation and Maintenance Manuals, including:
  - a. Complete information for storage and installation.
  - b. Complete operating and maintenance instructions.
  - c. Bill of materials.

**1.06 Warranties**

- A. Vendor shall provide the standard form of written guarantee and warranty covering defects in materials and workmanship for the equipment. Said guarantee and warranty shall be for a period of one year from the date of final acceptance of the equipment by Texas State University-San Marcos. Date of acceptance shall be defined as the date that Texas State University-San Marcos assumes operation of the unit.

**PART 2: PRODUCTS**

**2.01 Acceptable Manufacturers**

- A. Allis Chalmers.
- B. Century MagnaTek

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- C. General Electric.
- D. Gould
- E. Reliance Electric
- F. Siemens.
- G. Toshiba
- H. Westinghouse.

**2.02 Motors Less Than ½ Hp**

- A. Unless otherwise specified, motors less than ½ hp shall be squirrel-cage, induction type, capacitor start with copper stator windings as the Standard low-horsepower motor.
- B. Motors shall be continuously rated with 1.15-service factor for operation at 115 volts, single-phase, 60 Hz.
- C. The driven load for constant speed applications shall not exceed the motor's continuous nameplate rating, exclusive of any service factor, under any normal operating condition.

**2.03 Motors Larger Than ½ Hp Through 250 Hp**

- A. Motors shall be 3-phase, continuously rated, squirrel-cage, random-wound copper, induction motors designed for 460 volt, 60 Hz operation. Provide motors rated for continuous operation with 1.15-service factor. Motors 7.5 HP and larger shall be 3-phase only.
- B. Provide motors with Class F insulation and a Class B temperature rise based on 40 degrees C ambient. When ambient temperatures exceed 40 degrees C, temperature rise shall be adjusted according to MG 1-12. Locked Rotor Current: Provide motors with locked rotor starting currents not exceeding Code L under 3 hp, Code K for 3 and 5 hp, Code H for 7-1/2 and 10 hp, and Code G for 15 hp and above.

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- C. Provide motors meeting the energy efficiency and power factor requirements in paragraph 3.01 of this section, when tested in accordance with NEMA MG 1-12.53a and IEEE Standard 112, Test Method B.
- D. Provide motors rated for continuous operation with 1.15-service factor. For constant speed motors, the driven load shall not exceed the motor's brake horsepower nameplate rating, exclusive of any service factor, under any normal operating condition.
- E. Provide all TEFC motors with anti-friction grease lubricated ball bearings, with a bearing AFBMA B-10 life of 100,000 hours, and sealed from the environment. Provide factory lubrication of all motors prior to shipment. Provide all grease-lubricated bearings with relief fittings.
- F. Provide all ODP motors with sealed anti-friction grease lubricated ball bearings, with a bearing AFBMA B-10 life of 100,000 hours. Provide factory lubrication of all motors prior to shipment. Provide all grease-lubricated bearings with relief fittings.
- G. Motors which are located outside or wherever specified shall be provided with space heaters sized to prevent moisture condensation, rated 120 volts, with a separate conduit box for heater leads only.
- H. For motors 5 horsepower and larger, provide a snap action normally closed klixon embedded in the stator winding at the 12:00 position with tee leads wired out to the wiring compartment. The temperature of the klixon shall be set for 25% of the insulation temperature rating.
- I. Provide motors with conduit boxes that are fully rotatable, diagonally split, including gasket between cover and box, and box and frame, with threaded hubs and a grounding lug located within the box for ground conductor connection.
- J. Provide nameplates of stainless steel or other approved corrosion resistant material to provide a permanent legible marking, containing NEMA data plus guaranteed minimum efficiency. Attach nameplates and connection plates to the motor frame by rivets or screws.
- K. Variable torque, inverter duty rated motors shall be provided for variable speed applications. Insulated bearings shall be used for motors driven by variable frequency drives.

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**2.04 Motor Types**

- A. The following Standard motor types shall conform to the following requirements:
1. Horizontal Dripproof: Provide horizontal motors with an enclosure that meets NEMA Standard MG 1 for open, dripproof construction. Provide screen over all air openings.
  2. Horizontal Totally Enclosed Fan-Cooled: Provide totally enclosed fan-cooled (TEFC) motors with frame sizes 182 and larger with cast iron frames and end shields. Smaller frame sizes may be constructed of rolled steel with cast metal end shields. Provide motors with condensate drain holes. For frame size 286 and larger, provide automatic breather/drain device in drain hole.
  3. Vertical Weather Protected Type I: Provide vertical motors with an enclosure that meets NEMA Standard MG 1 for weather protected Type I (WP-I) enclosure. Provide screens over all air openings.
  4. Vertical Totally Enclosed Fan-Cooled: Provide vertical motor with an enclosure identical to the requirements for the horizontal TEFC motors.
  5. Explosion proof: Provide all horizontal and vertical motors with TEFC explosion proof enclosures, UL listed for Class 1, Division 1, and Group D hazardous atmosphere. Provide motors manufactured by Reliance Electric.
  6. Submersible: Submersible motors UL listed for explosion proof atmospheres in accordance with subsequent sections of this specification. In addition, provide submersible motors with two mechanical seals; the lower one outside the motor and protecting the upper one, which is in an oil filled chamber. Provide moisture detector probes in the oil filled seal chamber to indicate the presence of moisture in the seal chamber. Provide a temperature detector and switch rated 3 amperes, 120 volts minimum, set to operate when the internal motor temperature exceeds a preset limit. Provide any relays or solid-state controls for separate mounting.
  7. Horizontal, Totally Enclosed, Fan-Cooled, Severe Duty: Provide horizontal (TEFC), severe duty motors suitable for contaminated environments, including gasketed conduit box, stainless steel drains, double-shielded bearings, and corrosion resistant paint. Provide motors

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manufactured by Reliance Electric SXT-XT-XE, Century Type SCE E-Plus.

8. Vertical, Totally Enclosed, Fan-Cooled, Severe Duty: Provide vertical (TEFC), severe duty motors with the requirements identical to horizontal (TEFC), severe duty motors, above.

**2.05 Motors For Use With Variable Frequency Drives**

A. Motor Application Considerations:

1. NEMA Standard MG1 definite purpose inverter duty rated motors shall be used for all IGBT Pulse Width Modulated drive installations. Inverter duty motors shall be designed and manufactured to meet NEMA Standard MG1 for definite purpose inverter duty motors. The inverter duty motors shall be able to withstand voltages greater than 1600 volts peak and rise times of 0.1 microsecond.
2. Applications where the motor specification does not meet NEMA MG1 Part 31 (1600V peak and 0.1 microsecond rise time), and the cable length between the inverter and motor exceeds the drive manufacturer recommended maximum cable length; load sideline reactors shall be used. The load sideline reactor shall be design and constructed to operate with pulse width modulated IGBT inverter drives with switching frequencies up to 20 Khz. Line reactor insulation dielectric strength shall be greater than or equal to 4000 volts and shall carry a UL506 & UL508 approval.
3. Insulated or isolated bearings shall be used for the inverter duty rated motors.
4. The inverter duty motor shall be constructed with triple film wire, increased winding slot insulation, increased insulation between phases, and increased first turn insulation. The inverter duty motor shall use slot fillers as required to avoid loose windings.
5. The inverter duty motor insulation class shall be class F insulation and a class B temperature rise based on 40 degrees C.
6. The inverter duty motor nameplate shall indicate that the motor is an inverter duty motor.



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**PART 3: EXECUTION**

**3.01 Minimum Efficiency**

<u>HP</u>	Nominal Speed <u>rpm</u>	Percent Guaranteed Minimum Rated Load Efficiency		Percent Guaranteed Minimum Rated Load Power Factor	
		<u>ODP</u>	<u>TEFC</u>	<u>ODP</u>	<u>TEFC</u>
1	1,800	85.5	85.5	85.0	85.0
	1,200	82.5	82.5	74.0	74.0
1.5	3,600	84.0	84.0	86.0	86.0
	1,800	86.5	86.5	88.0	88.0
	1,200	86.5	87.5	69.5	69.5
2	3,600	86.5	85.5	88.0	88.0
	1,800	86.5	86.5	84.0	84.0
	1,200	87.5	88.5	69.0	69.0
3	3,600	85.5	86.5	91.0	88.0
	1,800	89.5	89.5	79.5	79.5
	1,200	88.5	89.5	71.0	71.0
5	3,600	86.5	88.5	87.0	91.5
	1,800	89.5	89.5	81.0	81.0
	1,200	89.5	89.5	75.5	75.5
7.5	3,600	88.5	89.5	90.0	90.0
	1,800	91.0	91.7	86.5	86.5
	1,200	90.2	91.0	80.0	80.0
10	3,600	89.5	90.2	90.0	90.0
	1,800	91.7	91.7	86.0	86.0
	1,200	91.7	91.0	80.5	81.0
15	3,600	90.2	91.0	87.0	89.5
	1,800	93.0	92.4	83.5	83.5
	1,200	91.7	91.7	84.5	84.5
20	3,600	91.0	91.0	90.0	90.0
	1,800	93.0	93.0	84.5	85.0
	1,200	92.4	91.7	85.0	85.0
25	3,600	91.7	91.7	89.0	91.0
	1,800	93.6	93.6	87.0	87.0
	1,200	93.0	93.0	83.5	83.5
30	3,600	91.7	91.7	91.0	91.5
	1,800	94.1	93.6	87.0	87.0
	1,200	93.6	93.0	83.5	83.5
40	3,600	92.4	92.4	86.6	86.1
	1,800	94.1	94.1	78.2	78.2
	1,200	4.10	94.1	81.5	81.5

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50	3,600	93.0	93.0	85.1	86.7
	1,800	94.5	94.5	79.5	79.4
60	1,200	94.1	94.1	81.5	81.5
	3,600	93.6	93.6	85.8	88.3
	1,800	95.0	95.0	80.5	79.9
	1,200	94.5	94.5	81.5	81.5
75	3,600	93.6	93.6	87.1	88.5
	1,800	95.0	95.4	81.0	81.5
	1,200	94.5	94.5	82.0	82.0
100	3,600	93.6	94.1	87.0	88.2
	1,800	95.4	95.4	81.0	81.0
	1,200	95.0	95.0	82.1	81.7
125	3,600	93.6	95.0	86.4	89.1
	1,800	95.4	95.4	85.4	85.5
	1,200	93.6	95.0	82.7	82.3
150	3,600	94.1	95.0	89.5	86.5
	1,800	95.8	95.8	87.5	82.5
	1,200	95.4	95.8	85.5	81.5
200	3,600	95.0	95.4	94.0	87.8
	1,800	95.8	96.2	90.0	85.2
	1,200	95.4	95.8	83.0	79.0
250	3,600	95.0	95.8	88.0	85.0
	1,800	95.8	96.2	83.0	79.0
	1,200	95.4	95.8	86.0	82.0

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**PART 4: INSTALLATION**

4.01 Coordinate with electrical designs.

4.02 Motors and associated devices shall be installed as per NEC requirements.

END OF SECTION 23 05 13