UTILITIES & ENERGY SERVICES
TEXAS A&M UNIVERSITY

Design Standard

Electric Motors

This standard was revised on July 31, 2020, and the latest changes are underlined. Please refer to Part 5 of this standard for full revision history.

Detailed specifications follow.

PART 1 - GENERAL

1.01 SCOPE

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

1.02 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.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS [1]

A. Toshiba

B. Teco - Westinghouse

C. General Electric

D. Marathon

E. Baldor/Reliance

F. WEG

G. Siemens

H. Emerson

I. U.S.

J. ABB

K. Rockwell

2.02 MOTORS LESS THAN ½ Hp:

A. Unless otherwise specified, motors less than 1/2 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 only.

B. Provide motors with Class F insulation and a Class B temperature rise based on 40°C ambient. When ambient temperatures exceed 40°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.

C. Provide motors meeting the energy efficiency and power factor requirements in section 3.01 of this document, 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. Provide factory lubrication of all

motors prior to shipment. Provide all motors with grease-lubricated bearings with all grease and relief fittings. [5]

F. Provide all ODP motors with 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 motors with grease-lubricated bearings with all grease and relief fittings.

G. 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. The conduit box shall be of a size to permit connections without undue crowding. All 3 phase motors with a specific voltage shall have 3 leads only.

H. 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.

I. Variable torque, inverter duty rated motors shall be provided for variable speed applications.

J. All hermetic sealed motors shall be of the type recommended by the chiller Mfg.

2.04 MOTOR TYPES

A. The following Standard motor types shall conform to the following requirements:

1. **Horizontal Drip Proof**: Provide horizontal motors with an enclosure that meets NEMA Standard MG 1 for open, drip proof 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. **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.

6. **Horizontal, Totally Enclosed, Fan-Cooled, Severe Duty:** Provide horizontal (TEFC), severe duty motors suitable for contaminated environments, including gasketed conduit box, stainless steel drains, and corrosion resistant paint.

7. **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 microseconds.

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 designed 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. Mfg. Standard grease 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°C.

6. The inverter duty motor nameplate shall indicate that the motor is an inverter duty motor.

7. All inverter duty motors shall be equipped with factory installed winding heater with separate termination box. Winding heater shall be 120 volt AC / Wattage sized to maintain temperature 10 deg. C above ambient when motor is at rest. [2]

8. All inverter duty motors shall be equipped with insulated opposite drive end bearing. [3]

9. Motor manufacturer shall supply shaft grounding bushings/brushes in a size and configuration that reduces stray shaft voltage to 300 mV max. Additional bushings/brushes shall be added to meet the stray shaft voltage requirement, if single-ended configuration is not adequate. Shaft grounding bushings/brushes shall be provided with wear indicators that are visible during normal operating conditions, and bushings/brushes shall be capable of being serviced/replaced during normal operating conditions with minimal to zero downtime. Motor manufacturer shall supply supporting documentation reflecting compliance with equipment approval submittals. Provide Helwig Carbon Products or approved equal". [4]

PART 3 - PERFORMANCE

HP	Nominal Speed (rpm)	Percent Guaranteed Minimum Rated Load Efficiency		Percent Guaranteed Minimum Rated Load Power Factor	
		ODP	TEFC	ODP	TEFC
1.0	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
2.0	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
3.0	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
5.0	3,600	86.5	88.5	87.0	91.5
	1,800	89.5	89.5	71.0	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
10.0	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
	3,600	90.2	91.0	87.0	89.5
15.0	1,800	93.0	92.4	83.5	83.5
	1,200	91.7	91.7	84.5	84.5
	3,600	91.0	91.0	90.0	90.0
20.0	1,800	93.0	93.0	84.5	85.0
	1,200	92.4	91.7	85.0	85.0
	3,600	91.7	91.7	89.0	91.0
25.0	1,800	93.6	93.6	87.0	87.0
	1,200	93.0	93.0	83.5	83.5

HP	Nominal Speed (rpm)	Percent Guaranteed Minimum Rated Load Efficiency		Percent Guaranteed Minimum Rated Load Power Factor	
		ODP	TEFC	ODP	TEFC
	3,600	91.7	91.7	91.0	91.5
30.0	1,800	94.1	93.6	87.0	87.0
	1,200	93.6	93.0	83.5	83.5
	3,600	92.4	92.4	86.6	86.1
40.0	1,800	94.1	94.1	78.2	78.2
	1,200	94.1	94.1	81.5	81.5
	3,600	93.0	93.0	85.1	86.7
50.0	1,800	94.5	94.5	79.5	79.4
	1,200	94.1	94.1	81.5	81.5
	3,600	93.6	93.6	85.8	88.3
60.0	1,800	95.0	95.0	80.5	79.9
	1,200	94.5	94.5	81.5	81.5
	3,600	93.6	93.6	87.1	88.5
75.0	1,800	95.0	95.4	81.0	81.5
	1,200	94.5	94.5	82.0	82.0
	3,600	93.6	94.1	87.0	88.2
100.0	1,800	95.4	95.4	81.0	81.0
	1,200	95.0	95.0	82.1	81.7
	3,600	93.6	95.0	86.4	89.1
125.0	1,800	95.4	95.4	85.4	85.5
	1,200	93.6	95.0	82.7	82.3
	3,600	94.1	95.0	89.5	86.5
150.0	1,800	95.8	95.8	87.5	82.5
	1,200	95.4	95.8	85.5	81.5

	3,600	95.0	95.4	94.0	87.8
200.0	1,800	95.8	96.2	90.0	85.2
	1,200	95.4	95.8	83.0	79.0
	3,600	95.0	95.8	88.0	85.0
250.0	1,800	95.8	96.2	83.0	79.0
	1,200	95.4	95.8	86.0	82.0

PART 4 - INSTALLATION

4.01 Coordinate with electrical designs.

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

PART 5 – REVISIONS TO DESIGN STANDARD

Revision #	Date	Location	Brief Description
1	7/31/2020	2.01	Acceptable Manufacturers added to standard
2	7/31/2020	2.05 A7	Section added to standard
3	7/31/2020	2.05 A8	Section added to standard
4	7/31/2020	2.05 A9	Section added to standard
5	7/31/2020	2.03 E	TEFC motor standards changed