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(Revision of
IEEE Std 841-1994)

IEEE Standard for Petroleum and Chemical Industry—Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors—Up to and Including 370 kW (500 hp)

Sponsor

Petroleum and Chemical Industry Committee
of the
IEEE Industrial Applications Society

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IEEE-SA Standards Board

Abstract: This standard applies to high-efficiency totally enclosed fan-cooled (TEFC), horizontal and vertical, single-speed, squirrel cage polyphase induction motors, up to and including 370 kW (500 hp), in NEMA frame sizes 143T and larger, for petroleum, chemical, and other severe duty applications (commonly referred to as severe duty motors). Excluded from the scope of this standard are motors with sleeve bearings and additional specific features required for explosion-proof motors.
Keywords: NEMA frame motors, polyphase induction motors, severe duty motors, squirrel cage motors, totally enclosed fan-cooled (TEFC) motors

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Introduction

(This introduction is not a part of IEEE Std 841-2001, IEEE Standard for Petroleum and Chemical Industry—Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors—Up to and Including 370 kW [500 hp].)

This standard has been prepared in an effort to improve the reliability, efficiency, and performance of severe duty totally enclosed fan-cooled (TEFC) squirrel cage induction motors, 370 kW (500 hp) and below; and to promote uniform specification of such motors in petroleum and chemical industry applications. This standard reflects the thinking of representatives of the petroleum and chemical industry and their supplying motor manufacturers. It was prepared by the Motors Working Group of the Petroleum and Chemical Industry Committee (PCIC). At the time this standard was approved, the working group had the following membership:

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1. Overview

1.1 Scope

This standard applies to high-efficiency totally enclosed fan-cooled (TEFC), horizontal and vertical, single-speed, squirrel cage polyphase induction motors, up to and including 370 kW (500 hp), in National Electrical Manufacturers Association (NEMA) frame sizes 143T and larger, for petroleum, chemical, and other severe duty applications (commonly referred to as severe duty motors). Excluded from the scope of this standard are motors with sleeve bearings and additional specific features required for explosion-proof motors.

1.2 Purpose

The purpose of this standard is to define a specification that deals with mechanical and electrical performance, electrical insulation systems, corrosion protection, and electrical and mechanical testing for severe duty TEFC squirrel cage polyphase induction motors, up to and including 370 kW (500 hp), for petroleum and chemical industry application. Many of the specified materials and components in this standard stem from experience with severely corrosive atmospheres and the necessity for safe, quiet, reliable, high-efficiency motors.

2. References

This standard shall be used in conjunction with the following standards. When the following standards are superseded by an approved revision, the revision shall apply.

ABMA 9-1990, Load Ratings and Fatigue Life for Ball Bearings.[1]

ABMA 11-1999, Load Ratings and Fatigue Life for Roller Bearings.

ABMA 20-1996, Radial Bearings of Ball, Cylindrical Roller and Spherical Roller Types—Metric Design.

API Std 610-1995, Centrifugal Pumps for General Refinery Services.[2]

ASME B1.1-1989, Unified Inch Screw Threads (UN and UNR Thread Form).[3]

ASTM B117-97, Standard Practice for Operating Salt Spray (Fog) Apparatus.[4]

IEEE Std 112-1996, IEEE Standard Test Procedure for Polyphase Induction Motors and Generators.[5]

IEEE Std 117-1974 (Reaff 1991), IEEE Standard Test Procedure for Evaluation of Systems of Insulating Materials for Random-Wound AC Electric Machinery.

IEEE Std 275-1992 (Reaff 1998), IEEE Recommended Practice for Thermal Evaluation of Insulation Systems for Alternating-Current Electric Machinery Employing Form-Wound Preinsulated Stator Coils for Machines Rated 6900 V and Below.

IEEE Std 522-1992 (Reaff 1998), IEEE Guide for Testing Turn-to-Turn Insulation on Form-Wound Stator Coils for Alternating-Current Rotating Electric Machines.

NEMA MG 1-1998, Motors and Generators.[6]

NEMA MG 3-1974 (Reaff 1995, Reaff 2000), Sound Level Prediction for Installed Rotating Electrical Machines.

NEMA MG 10-1994 (Reaff 1999), Energy Management Guide for Selection and Use of Polyphase Motors.

NFPA 70-1999, National Electrical Code® (NEC®).[7]

[1]ABMA publications are available from Global Engineering Documents, 15 Inverness Way East, Englewood, Colorado 80112, USA (http://global.ihs.com/).

[2]API historical materials can be obtained (for a fee) from the American Petroleum Institute Library, 1200 L Street NW, Washington, DC 20005, USA (http://www.api.org/).

[3]ASME publications are available from the American Society of Mechanical Engineers, 3 Park Avenue, New York, NY 10016-5990, USA (http://www.asme.org/).

[4]ASTM publications are available from the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, USA (http://www.astm.org/).

[5]IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA (http://standards.ieee.org/).

[6]NEMA publications are available from Global Engineering Documents, 15 Inverness Way East, Englewood, Colorado 80112, USA (http://global.ihs.com/).

[7]NFPA publications are available from Publications Sales, National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101, USA.

3. Service conditions

3.1 Usual service conditions

Unless otherwise specified, motors conforming to this standard shall be suitable for operation within their rating under the following service conditions:

a) Exposure to an ambient temperature in the range of –25 °C to +40 °C
b) Exposure to a maximum altitude of 1000 m above sea level
c) Indoor or outdoor severe duty applications, such as humid, chemical (corrosive), or salty atmospheres
d) Full voltage across-the-line starting

3.2 Unusual service conditions

Unusual service conditions should be brought to the attention of those responsible for the design, manufacture, application, and operation of the motor. Such unusual conditions include the following:

a) Exposure to
   1) Flammable or explosive gases
   2) Combustible, explosive, abrasive, or conductive dust
   3) Lint or dirty operating conditions where the accumulation of dirt will interfere with normal ventilation
   4) Nuclear radiation
   5) Abnormal shock, vibrations, or mechanical loading from external sources
   6) Abnormal axial or side thrust imposed on the motor shaft
   7) Altitude or ambient temperature outside the range covered in 3.1
b) Conditions under which the variation from rated voltage or frequency, or both, exceeds the limits given in 5.3, item a)
c) Conditions under which the ac supply voltage is unbalanced by more than 1% (see Section 14.36 of NEMA MG 1-1998[8])
d) Operation at speeds other than rated speed
e) Operation from solid-state or other types of adjustable frequency or adjustable voltage power supplies for adjustable speed applications
f) Load inertia greater than and/or starting conditions more severe than specified in Section 12.55 of NEMA MG 1-1998

NOTE—The use of high-efficiency (low-slip) motors for reciprocating loads or special torque loads such as hoists should also be reviewed with the manufacturer.

4. Ratings

4.1 Basis of rating

Motors shall be rated on a continuous-duty basis. The output rating shall be expressed in power available at the shaft at the specified speed, frequency, and voltage.

NOTE—Motors should be applied within their rating based on a service factor of 1.0. In applications requiring a prolonged overload capacity, the use of a higher power rating is recommended to avoid the reduction of insulation and bearing life associated with operation above the 1.0 service factor.

[8]Information on references can be found in Clause 2.

4.2 Frame assignments

To the extent applicable, motors shall comply with the frame size assignments of NEMA MG 1-1998, Part 13.

4.3 Voltage and frequency ratings

The standard voltage ratings are 200 V, 230 V, 460 V, 575 V, 2300 V, and 4000 V at 60 Hz, 3 phase. Dual voltage motors are acceptable only for 2300 V and 4000 V ratings.

NOTE—It is not practical to build induction motors of all ratings at all of these voltages.

4.4 Synchronous speed ratings

Synchronous speed ratings at 60 Hz are 3600 r/min, 1800 r/min, 1200 r/min, or 900 r/min.

4.5 Enclosures

Enclosures shall be TEFC or totally enclosed nonventilated (TENV) and shall have a degree of protection of IP54 except as follows: For frame sizes 320 and larger, the degree of protection for bearings shall be IP55. If replaceable shaft seals are used to achieve this degree of protection, they shall be the noncontact or noncontacting-while-rotating type with a minimum expected seal life of 5 y under usual service conditions. The degree of protection for terminal boxes shall be IP55. Degrees of protection are defined in NEMA MG 1-1998, Part 5. Drain fitting holes are permitted to be plugged during the enclosure IP54 dust ingress test.

5. Electrical performance

5.1 General

Unless otherwise specified in this standard, motor electrical performance and characteristics shall be in accordance with NEMA MG 1-1998.

5.2 Motor designs and starting characteristics

Motors shall have Design B torque/current characteristics and starting capability as defined in NEMA MG 1-1998, Part 12. Where power and speed ratings fall outside Part 12, characteristics and capabilities shall meet or exceed the specifications defined in NEMA MG 1-1998, Part 20.

5.3 Power supply variations

a) Motors shall operate successfully under running conditions at rated load with variation in the voltage or frequency not exceeding the following conditions:
   1) ±10% of rated voltage, with rated frequency
   2) ±5% of rated frequency, with rated voltage
   3) Combination of voltage and frequency variation of 10% (sum of absolute values) of the rated values, provided that the frequency variation does not exceed ±5% of rated frequency

   NOTE—For the effects of voltage, voltage unbalance, and frequency on motor performance, see Sections 14.30 through 14.36 of NEMA MG 1-1998.

b) Motors shall operate successfully under running conditions at rated load and frequency when the voltage unbalance at the motor terminals does not exceed 1%. For voltage unbalance greater than 1%, the motor shall be derated in accordance with Section 14.36 of NEMA MG 1-1998.
c) When the motors supplied under this standard are to be applied on a nonsinusoidal source and/or an adjustable speed application, the manufacturer should be consulted to determine whether the motor will operate successfully over the required speed range. Refer to NEMA MG 1-1998, Part 30. Proper selection of the motor and drive is required to avoid the following conditions:
   1) Motor current (rms) exceeding the continuous sinusoidal nameplate rating due to excessive voltage harmonics or improper volt/hertz levels
   2) Excessive winding temperature due to insufficient cooling, excessive torque levels, or improper volt/hertz levels; and increased losses due to harmonics
   3) Insufficient motor accelerating torque at reduced speeds due to insufficient volt/hertz levels or limitations in the drive's momentary current capacity
   4) Increased noise levels due to increased fan noise (above base speed), excitation of mechanical resonances, and/or magnetic noise caused by supply source harmonics
   5) Mechanical failure of the motor or coupling due to torque pulsations, operation at or near mechanical resonances, or excess speed
   6) Winding failures due to repetitive high-amplitude voltage spikes created by the carrier frequency of the drive and the motor feeder cable system
   7) Damage to the motor and drive due to improper application of power factor correction capacitors or harmonic filters
   8) Higher motor temperatures that may limit application in Division 2 hazardous areas
   9) Shaft-to-bearing voltages and/or currents resulting from common mode currents flowing through stray system capacitances to ground via the bearings. These currents are induced from the adjustable speed drive's (ASD) high rate of change (dv/dt) of output voltage.

5.4 Insulation system and temperature rise

5.4.1 Insulation system

a) The motor shall have a nonhygroscopic, chemical- and humidity-resistant insulation system. The thermal rating of the insulation system shall be a minimum of Class F as defined in Section 1.66 of NEMA MG 1-1998. A lead wire with a temperature rating more than 5 °C less than the temperature rating of the insulation system in which it is connected shall be separated from the windings by a barrier or envelope of a material compatible with the insulation system. The temperature rating of the lead wire shall not be less than 125 °C.
b) The completed, non-energized stator with leads, without end bells or rotor, shall be capable of passing the condensation test in A.5.
c) The thermal classification of the insulation system shall be determined using IEEE Std 117-1974 for random windings and IEEE Std 275-1992 for form windings.
d) The 2300 V and 4000 V designs shall use vacuum-pressure-impregnated form windings, capable of withstanding a voltage surge of 3.5 per unit at a rise time of 0.1 μs to 0.2 μs and of 5 per unit at a rise time of 1.2 μs or longer. (One per unit equals 0.8165 V_{L-L}.) The test method and instrumentation used shall be per IEEE Std 522-1992. When specified by the purchaser, this requirement shall also apply to form windings supplied for voltages 575 V and below on motors rated above 150 kW (200 hp).
e) The insulation system for windings with form-wound coils shall be a sealed system as defined in Section 1.27.2 of NEMA MG 1-1998, capable of withstanding an immersion test in accordance with Paragraph 20.18 of NEMA MG 1-1998, Part 20. This standard shall not be interpreted to require the immersion test unless specified by the purchaser.
f) The stator end-windings shall be suitably supported to successfully withstand the electromagnetic and mechanical forces encountered per 3.1; 5.2; and, when specified, 3.2.
g) Phase insulation in addition to varnish shall be used between each phase group of random windings.
h) The insulation system, including leads, shall be compatible with mineral-oil-based lubricants.

5.4.2 Temperature rise

When operated at rated voltage, frequency, and power, the average temperature rise of any phase of the stator winding shall not exceed 80 °C by winding resistance.

NOTE—For inverter drive applications, consider optional winding surge withstand capabilities as defined in NEMA MG 1-1998, Part 31. Standard winding surge withstand capabilities are defined in NEMA MG 1-1998, Part 30 (2 µs rise time, 1 kV peak up to utilization voltages of 600 V).

6. Mechanical features

6.1 Bearings and lubrication

a) Horizontal and vertical ball bearing and roller bearing manufacturing tolerance limits shall be in accordance with Table 4 of ABMA 20-1996. Ball bearings used in horizontal motors shall have ABMA C/3 clearances.

b) Bearings shall be greasable without disassembly of fans or fan covers and shall contain a reservoir equipped with outlet plugs that extend beyond the fan cover for elimination of purged grease. Oil-lubricated bearings may be furnished for vertical motors. Inner bearing caps shall be provided so that entry of oil or grease into the motor interior is minimized. Bearings and grease reservoirs shall be protected from entry of contaminants per 4.5.

c) For vertical flange-mounted motors with a thrust-loading, angular contact ball (single or duplex type), Conrad deep-groove or spherical roller thrust bearings are recommended, depending on the requirements of the application. Filling-slot (maximum-load) antifriction bearings shall not be used in any motor. The manufacturer shall note thrust bearings of other construction. P-base motors shall have the thrust bearing at the nondrive end. Where the motor shaft is solidly coupled to the driven apparatus, the thrust capacity of the thrust bearing should be sufficient to carry the weight of the rotating element of the motor and the external axial thrust loads (in either or both directions) as well as the radial load specified.

NOTE—Vertical motors purchased in combination with pumps (vertical overhung and vertically suspended types) specified in accordance with API Std 610-1995 may have more stringent thrust-bearing loading definition and life requirements than specified in item c) and item d) of 6.1. For vertical overhung and vertically suspended applications, both the motor and the pump impose radial and thrust loading on the motor bearings. The maximum radial and thrust loading that occurs during start-up and end-of-pump-curve operation can be severe and difficult to predict, and conservatism in bearing specification is recommended.

d) Bearings shall be selected to provide an L-10 life of 26 280 h minimum per ABMA 9-1990 or ABMA 11-1999, as applicable. L-10 life calculations for vertical motors and horizontal motors mounted in a vertical position shall consider applicable thrust loading. L-10 life calculations shall be based on external side loads for NEMA belted application limits, in accordance with Section 14.42 of NEMA MG 1-1998, and internal loads defined by the manufacturer. For frame sizes above 445T, minimum sheave sizes in centimeters shall be defined by the Equation (1) or Equation (2) and shall be applied per NEMA requirements for narrow width belts:

$$\text{Sheave diameter} = 70.0\ (P/N_R)^{1/3} \qquad (1)$$

where

P is rated motor power (kW)

N_R is rated motor speed (r/min)

or,

$$\text{Sheave diameter} = 63.5\ (P/N_R)^{1/3} \quad (2)$$

where

P is rated motor power (hp)

N_R is rated motor speed (r/min)

NOTE—Two-pole belted applications are not recommended for motors above 19 kW (25 hp).

e) Antifriction bearings are acceptable where the dN factor is less than 300 000. [The dN factor is the product of bearing size (bore) in millimeters and the rated speed in revolutions per minute.]
f) When direct coupled, the stabilized bearing temperature rise at rated load shall not exceed 45 °C (50 °C on two-pole motors) as measured by a thermometer or thermocouple on the surface of the bearing housing as close to the outer race as possible.
g) Bearings shall be suitable for, and supplied with, rust-inhibiting grease compatible with polyurea-thickened grease.
h) Some modifications to motors may be required to accommodate oil mist lubrication. The manufacturer shall be consulted for oil mist applications.

6.2 Rotor and shaft

Rotor cage construction shall be of copper or aluminum, or their respective alloys.

The maximum permissible shaft runout on NEMA “T” and “TS” shaft extensions (see Section 4 of NEMA MG 1-1998), when measured at the end of the shaft extension on the assembled motor, shall be

a) 0.0254 mm total indicator reading (TIR) for shafts 0.476 cm to 4.13 cm in diameter (inclusive)
b) 0.0381 mm TIR (ball bearings) and 0.0508 mm TIR (roller bearings) for shafts 4.13 cm to 16.5 cm in diameter (inclusive)

6.3 Frames, endshields, and fan covers

a) Frames, endshields, and fan covers shall be of cast iron construction.
b) Fan covers shall be guarded as defined in Section 1.26.3 of NEMA MG 1-1998.
c) A drilled and tapped hole for a ground lug shall be provided on the motor frame, external to and on the same side as the terminal box. Minimum hole size shall be 1/4–20 unified inch coarse thread (UNC) for motors up to 37 kW (50 hp), 3/8–16 UNC for motors above 37 kW (50 hp) and up to 150 kW (200 hp), and 1/2–13 UNC for motors above 150 kW (200 hp).

NOTE—Unified inch coarse screw threads are specified in ASME B1.1-1989.

d) All fully assembled motors with mounting feet shall have a maximum coplanar tolerance of 0.127 mm when measured in accordance with Section 4.15 of NEMA MG 1-1998.
e) The draft angle of the top surface of the motor foot in the area surrounding the mounting bolt hole shall be a maximum of 1.5°.

6.4 Fans

Fans shall be nonsparking bronze alloy or conductive plastic, suitable for Class I, Division 2 applications as defined in the National Electrical Code® (NEC®) (NFPA 70-1999). Bidirectional fans are preferred. If a unidirectional fan is used, the rotation of the fan shall be indicated by a permanent, legible marker mounted on the motor.

6.5 Main terminal boxes and terminal leads

a) Main terminal boxes shall be of cast iron construction for voltages 600 V and below in frame sizes 445T and below, and the following additional requirements shall apply:
   1) Terminal boxes shall be diagonally split, rotatable in 90° increments, covered and gasketed, and supplied with tapped conduit entrance hole(s).
   2) Terminal box volume shall be, as a minimum, the values listed in Table 1. These volumes meet or exceed the requirements of the NEC.

Table 1—Minimum terminal box volume

Rated power (kW)	Rated power (hp)	Terminal box volume (cm^3)
0.75, 1.1, 1.5, 2.2	1, 1.5, 2, 3	393
3.7, 5.5	5, 7.5	524
7.5, 11, 15, 19, 22	10, 15, 20, 25, 30	852
30, 37	40, 50	1 803
45, 55	60, 75	3 277
75, 95	100, 125	5 900
110, 150	150, 200	10 815

   3) A moisture-resistant barrier shall be provided between the terminal box and the motor cavity.
   4) A grounding lug in accordance with Section 4.2 of NEMA MG 1-1998 shall be included in the terminal box.

b) The dimensions of terminal boxes for voltages above 600 V or for frame sizes exceeding 445T at 600 V and below shall comply as a minimum with NEMA MG 1-1998, Part 20, Figure 20-3. Terminal boxes shall be fabricated from cast iron, cast steel, or steel plate with a minimum thickness of 2.79 mm.
c) The internal temperature of the terminal box shall allow use of 75 °C rated supply conductors for motors rated 600 V or below and use of 90 °C rated supply conductor for motors rated above 600 V.
d) To minimize field connections and facilitate in-out replacement, motors with one connection point per phase shall be provided. Two leads per phase may be furnished when required by large conductor size for flexibility.
e) Stator winding lead terminals, if supplied, shall be of the copper alloy seamless compression type.

6.6 Drains

Corrosion-resistant, replaceable automatic drainage fittings shall be provided at the low point(s) of the motor enclosure for water drainage. Terminal boxes for voltages above 600 V or for frame sizes exceeding 445T at 600 V shall be provided with a corrosion-resistant, replaceable automatic drainage fitting.

6.7 Hardware

Fasteners shall be hex-head bolts or socket-head cap screws. Screwdriver slot fasteners shall not be used. Shouldered eyebolts or other suitable means for lifting shall be provided on frames 182T and above. The eyebolt receptacle shall be a blind threaded hole.

6.8 Airborne sound

a) Motor sound power level shall not exceed 90 dBA (reference = 10^{-12} W), determined in accordance with NEMA MG 1-1998, Part 9.
b) Motor sound tests shall be taken at no load and at rated voltage and frequency (on sine wave power) so that the motor sound can be isolated from other sound sources.

NOTE—Sound pressure decibel readings are not exact and are subject to many external influences. As an approximation, sound pressure level in a free field may be estimated by subtracting 7–10 dB from sound power levels. For more exact prediction of sound pressure levels in actual installations, see NEMA MG 3-1974.

6.9 Vibration

All fully assembled 2-, 4-, 6-, or 8-pole motors shall meet the levels of vibration below when tested at no load on elastic mounting per NEMA MG 1-1998, Part 7, and when bolted to a heavy, flat base whose natural frequency with motor mounted is removed by at least 25% from the motor speeds and frequencies referenced below:

a) Motor unfiltered vibration at rated voltage and frequency shall not exceed 2.03 mm/s peak velocity for 2-, 4-, and 6-pole machines nor 1.52 mm/s peak velocity for 8-pole machines, when measured in any direction on the bearing housing and tested uncoupled with 0.5 height key in the shaft extension key way.
b) Motor filtered vibration at rated voltage and frequency shall not exceed 1.27 mm/s peak at frequencies of $2n$ (twice speed) or $2f$ (twice frequency).
c) Motor unfiltered axial vibration shall not exceed 1.52 mm/s peak on bearing housings. This limit shall not apply to roller bearings.

7. Corrosion-resistant treatment

7.1 Frame paint

Motor frames, endshields, fan covers, and terminal housings shall meet the test requirements of A.2.

7.2 Assembly

The machined frame-to-endshield joints shall be protected by applying a corrosion-preventive material to the machined surfaces before assembly. A lubricant shall be applied to all unplated threaded surfaces to facilitate removal.

7.3 Exposed internal stator, rotor, and shaft surfaces

Exposed internal stator, rotor, and shaft surfaces shall be protected against moisture and corrosion by a suitable protective coating.

7.4 Miscellaneous

Assembly hardware for the motor and terminal box, grease fittings, and associated piping (if provided) shall meet the test requirements of A.3.

8. Efficiency

Motor efficiency shall be determined in accordance with Method B in 6.4 of IEEE Std 112-1996. As a minimum, the efficiency at rated full load shall meet the requirements of Table 2 of this standard. Thrust-bearing losses are not included in the efficiency determination.

9. Tests

9.1 Test methods

Unless otherwise specified, or noted in this standard, all electrical performance tests shall be conducted in accordance with IEEE Std 112-1996.

9.2 Tests on motors completely assembled in the factory

The following tests shall be performed on all motors that are completely assembled in the factory and furnished with a shaft and a complete set of bearings:

a) Measurement of winding resistance
b) No-load readings of current, power, and nominal speed at rated voltage and frequency
c) Mechanical vibration check in accordance with 6.9, using either elastic or rigid mount
d) High-potential test in accordance with Paragraph 12.3 of NEMA MG 1-1998, Part 12

9.3 Additional tests

Additional tests may be specified by the purchaser.

9.4 Test information supplied with motor

Winding resistance; no load current, voltage, and speed; and five unfiltered vibration readings (velocity) shall be supplied with the motor at the time of shipment. Vibration measurements shall include two readings, perpendicular to each other, in the radial plane on both ends of the motor (near each bearing) plus one axial reading.

9.5 Prototype tests

Refer to Annex A for prototype test requirements.

Table 2—Minimum full load efficiency of enclosed motors[a]

kW	hp	Voltage class	2-Pole		4-Pole		6-Pole		8-Pole	
			Nom. effic. %	Min. effic. %	Nom. effic. %	Min. effic. %	Nom. effic. %	Min. effic. %	Nom. effic. %	Min. effic. %
0.75	1	600 V	77.0	74.0	84.0	81.5	81.5	78.5	75.5	72.0
1.1	1.5	600 V	84.0	81.5	85.5	82.5	86.5	84.0	78.5	75.5
1.5	2	600 V	85.5	82.5	85.5	82.5	87.5	85.5	84.0	81.5
2.2	3	600 V	86.5	84.0	88.5	86.5	88.5	86.5	85.5	82.5
3.7	5	600 V	88.5	86.5	88.5	86.5	88.5	86.5	86.5	84.0
5.5	7.5	600 V	89.5	87.5	90.2	88.5	90.2	88.5	86.5	84.0
7.5	10	600 V	90.2	88.5	90.2	88.5	90.2	88.5	89.5	87.5
11	15	600 V	91.0	89.5	91.7	90.2	91.0	89.5	89.5	87.5
15	20	600 V	91.0	89.5	91.7	90.2	91.0	89.5	90.2	88.5
19	25	600 V	91.7	90.2	93.0	91.7	92.4	91.0	90.2	88.5
22	30	600 V	91.7	90.2	93.0	91.7	92.4	91.0	91.7	90.2
30	40	600 V	92.4	91.0	93.6	92.4	93.6	92.4	91.7	90.2
37	50	600 V	93.0	91.7	93.6	92.4	93.6	92.4	92.4	91.0
45	60	600 V	93.6	92.4	94.1	93.0	94.1	93.0	92.4	91.0
55	75	600 V	93.6	92.4	94.5	93.6	94.1	93.0	93.6	92.4
75	100	600 V	94.1	93.0	95.0	94.1	94.5	93.6	93.6	92.4
95	125	600 V	95.0	94.1	95.0	94.1	94.5	93.6	94.1	93.0
110	150	600 V	95.0	94.1	95.4	94.5	95.4	94.5	94.1	93.0
150	200	600 V	95.4	94.5	95.4	94.5	95.4	94.5	94.5	93.6
190	250	600 V	95.4	94.5	95.0	94.1	95.0	94.1	94.5	93.6
		2300/4000 V	95.0	94.1	95.0	94.1	95.0	94.1	95.0	94.1
220	300	600 V	95.4	94.5	95.4	94.5	95.0	94.1	-	-
		2300/4000 V	95.0	94.1	95.0	94.1	95.0	94.1	95.0	94.1
260	350	600 V	95.4	94.5	95.4	94.5	95.0	94.1	-	-
		2300/4000 V	95.0	94.1	95.0	94.1	95.0	94.1	95.0	94.1
300	400	600 V	95.4	94.5	95.4	94.5	-	-	-	-
		2300/4000 V	95.0	94.1	95.0	94.1	95.0	94.1	95.0	94.1
340	450	600 V	95.4	94.5	95.4	94.5	-	-	-	-
		2300/4000 V	95.0	94.1	95.0	94.1	95.0	94.1	95.0	94.1
370	500	600 V	95.4	94.5	95.4	94.5	-	-	-	-
		2300/4000 V	95.0	94.1	95.0	94.1	95.0	94.1	95.0	94.1

[a]Minimum efficiency based on 20% loss difference. Nominal efficiency values in this table for motors up to and including 150 kW (200 hp) exceed the requirements of the Energy Policy Act of 1992. For the definition of nominal and minimum efficiencies, see Section 12.59.2 of NEMA MG 1-1998.

10. Nameplate

10.1 Nameplate marking

A stamped, embossed, or etched nameplate shall be provided; and the information given on the nameplate shall include the following specifications in addition to the information noted in Section 10.40 of NEMA MG 1-1998:

a) AFBMA bearing identification number
b) Manufacturer date or date code
c) Whether in compliance with IEEE Std 841-2001
d) Motor weight
e) Maximum space heater surface temperature in degrees Celsius when operating at rated voltage in a 40 °C ambient temperature (if space heater is provided)
f) Guaranteed minimum efficiency

10.2 Nameplate material

The nameplate material and its fastenings shall be of stainless steel meeting the test requirements of A.4.

11. Space heaters—requirements

When required by the application, the purchaser shall specify space heaters for protection against condensation of moisture. Unless otherwise noted, space heaters shall

a) Maintain the temperature of the winding at not less than 5 °C above outside ambient temperature
b) Avoid raising the motor insulation temperature in excess of 130 °C
c) Be rated for 120 V, single-phase ac operation
d) Identify heater leads by the letter H (if more than two terminal leads are brought out, they should be designated H1, H2, H3, H4, etc.)

NOTE—Section 501-8(b) of the NEC requires the exposed surface of space heaters, when operated at rated voltage in a 40 °C ambient temperature, not to exceed 80% of the ignition temperature in degrees Celsius of the gas or vapor involved. The user shall specify the maximum heater surface temperature required for compliance with the NEC.

12. Data exchange—user and manufacturer

Annex B contains a data sheet for specifying ac squirrel cage induction motors, 370 kW (500 hp) and below, that comply with requirements in this standard.

Annex A

(normative)

Prototype motor tests

The following tests shall be utilized in testing for motor performance and resistance to corrosion and humidity. They are initial design or prototype tests and not production tests. The test results shall be made available upon request.

A.1 Performance tests

The manufacturer shall run the following performance tests for each power and speed combination produced:

a) Determination of locked-rotor (zero-speed) torque and current
b) Determination of speed-torque curve
c) Determination of speed-current curve
d) Bearing and winding temperature rise tests at rated horsepower
e) Determination of full-load current and slip
f) Determination of efficiency at 100%, 75%, and 50% of full load
g) Determination of power factor at 100%, 75%, and 50% of full load
h) Airborne sound power level

A.2 Frame paint corrosion resistance (external surface)

The manufacturer shall perform the corrosion resistance test specified in ASTM B117-97 for 96 h. At the end of the 96 h, the frame paint system shall exhibit continuous adhesion, without lifting, and no visible corrosion except at high points of castings.

A.3 Miscellaneous parts corrosion resistance

The manufacturer shall perform the corrosion resistance test specified in ASTM B117-97 for 96 h. At the end of the 96 h, miscellaneous parts shall have no visible signs of corrosion except at high points of castings.

A.4 Nameplate corrosion resistance

The manufacturer shall perform the corrosion resistance test specified in ASTM B117-97 for 720 h. At the end of the 720 h, the nameplate and its fastenings shall have no visible signs of corrosion.

A.5 Insulation system humidity resistance

The manufacturer shall perform the following test to determine the humidity resitance of the motor's insulation system: The stator shall be exposed for 168 h in a 40 °C closed chamber, in which an open water vessel is maintained at an elevated temperature, resulting in 100% relative humidity plus condensation on stator windings. Insulation resistance at the end of the test shall be not less than 5 MΩ (measured with a 500 V megohmmeter at 1 min), at or corrected to 40 °C. It may be necessary to provide some variation in water and air temperature to maintain visible condensation.

Annex B

(informative)

Motor data sheet

Figure B.1 shows a motor data sheet, which is included in this standard with the permission of Process Industry Practices (PIP); Construction Industry Institute; The University of Texas at Austin; Austin, Texas.

PIP ELSMT01D

IEEE 841 Data Sheet for AC Squirrel Cage Induction Motors [370 kW (500 hp) and below]

Client	Engineering Org.	Spec. No.
Project Title	Location	Date
Location	Contract No.	Equip. No.
Unit	Specifier Name	Tele. No.
		P.O. No.

Data provided by: ☐ Buyer with Request for Quotes ● Seller With Proposal ◆ Seller After Order

Site Conditions:

☐ Altitude: ____________________m

☐ Ambient Temperature: Max _________°C ☐ Min ________°C

☐ Area Class __________ Div _________ Group _______________

☐ Nonhazardous ☐ Auto Ignition Temp _________________°C

Data Supplied By User:

☐ Power: __________________kW __________________ hp

☐ Synchronous Speed: ___________________________________

☐ Voltage: ____

☐ Phase: 3

☐ Frequency: 60 Hz

☐ Insul. System: Random/Form Wound (See Note Below)

☐ Enclosure: TEFC/TENV

☐ Coupled Drive: Direct/Belt

☐ Mounting Position: Horizontal/Vertical

☐ Shaft Up or Down (Vertical Mtg. Only) ___________________

☐ Service Factor: (See Note Below) ________________________

☐ Motor Thrust Loads: _________________________________

☐ Special Load Conditions: _____________________________

☐ Space Heaters: _____________________________________

☐ Space Heater Maximum Surface Temperaure: ______________ °C

☐ Space Heater Leads Location: __________________________

☐ Rotation Direction: __________________________________

☐ Starting Method: ____________________________________

☐ Main Terminal Box Location: __________________________

____

☐ Other Data: (Bearing type, lubrication method, motor mounting information, unusual service conditions, etc.)

____

____

____

____

____

____

Notes:

1) Motor should be applied within its rating based on service factor of 1.0.

2) Motor insulation system:

- Random wound 600 V class for kW (hp) < 190 (250)
- Random/form wound 600 V class for kW (hp) > 150 (200)
- Form wound 2300 V and 4000 V

Data Supplied By Manufacturer:

● Frame Size: ________________________

● Full Load Speed: _______________ rpm

● Full Load Current: ______________________________

◆ Locked Rotor Current @ Full Voltage: _____________

◆ Locked Rotor Current @ 90% Voltage: _____________

● Allowable Stall Time @ Full Voltage: _____________ s

● Allowable Stall Time @ 90% Voltage: _____________ s

● Sound Power Level (No Load): 90 dBA (Max) _______

● Insulation System:

Class F Minimum: _______________________

Random/Form Wound: ___________________

● Temperature Rise at Rated Load: ___________°C Max.

● Service Factor: (See Note Below) _________________

● Motor Terminal Leads: _________________________

Bearing Information:

● Type: ____

● Lubrication Method: ____________________________

◆ Recommended Lubricant: ________________________

● Temp. Rise @ Full Load: ________________________

◆ Manufacturer & Number: ________________________

ODE _______________ DE ______________

● Motor Guaranteed Min. Eff. @ Full Load: __________

● Terminal Box(es) Materials of Construction: _________

____

● Fan Material: _____________________________________

● Space Heater Term. Box Location: ________________

● Space Heater Max. Sheath Temperature: ____________

● Other Data: ____________________________________

____

____

Shop Inspection & Tests:

☐ Shop Inspection Required: (Yes/No) ______________

☐ Final Tests Witnessed by Customer: (Yes/No) _______

☐ Other Special Tests: __________________________

____

____

____

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Figure B.1—Motor data sheet