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A-C MOTORS

(PROJECT STANDARDS AND SPECIFICATIONS)

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SCOPE

This Project Standard and Specification covers requirements governing design and inspection of A-C motors.

REFERENCES

Throughout this Standard the following dated and undated standards/codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this standard. For dated references, the edition cited applies. The applicability of changes in dated references that occur after the cited date shall be mutually agreed upon by the Company and the Vendor. For undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

1. ANSI/ASME Standard

B4.1	Preferred Limits and Fits for Cylindrical Parts

2. IEC

34-1	Recommendation for Rotating Electrical Machines
85	Recommendations for the Classification of Materials for the Insulation of Electrical Machinery and Apparatus in Relation to their Thermal Stability in Service

3. ANSI/AFBMA Standards

9	Load Rating and Fatigue Life for Ball Bearings
11	Load Rating and Fatigue Life for Roller Bearings

4. AGMA Standard

460	Gear Motors Using Spur, Helical, Herringbone and Spiral Bevel Gears

5. ANSI Standard

C50.10	General Requirements for Synchronous Machines

6. API Standard

541	Form Wound Squirrel Cage Induction Motors - 250 Horsepower and Larger

7. IEEE Standard

43	Test Insulation Resistance of Rotating Machinery
112	Test Procedures for Polyphase Induction Motors and Generators

115 Test Procedures for Synchronous Machines

8. ANSI/NEMA Standard

MG1 Motors and Generators

9. NEMA Standard

MG2 Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators

DEFINITIONS AND TERMINOLOGY

A totally-enclosed fan-cooled guarded machine - a totally-enclosed fan-cooled machine in which all openings giving direct access to the fan are limited in size by the design of the structural parts or by screens, grilles, expanded metal, etc., to prevent accidental contact with the fan. Such openings shall not permit the passage of a cylindrical rod 3/4 in. (20 mm) in diameter, and a 1/2 in. (12 mm) diameter probe when penetrated 4 in. (100 mm) shall not contact the blades, spokes, or other irregular surfaces of the fan.

A totally-enclosed fan-cooled machine - a totally-enclosed machine equipped for exterior cooling by means of a fan or fans integral with the machine but external to the enclosing parts.

A totally-enclosed machine - a machine so enclosed as to prevent the free exchange of air between the inside and the outside of the case but not efficiently enclosed to be termed air-tight.

A totally-enclosed non-ventilated machine - a totally enclosed-machine which is not equipped for cooling by means external to the enclosing parts.

A totally-enclosed pipe-ventilated machine - totally-enclosed machine except for openings so arranged that inlet and outlet ducts or pipes may be connected to them for the admission and discharge of the ventilating air. This air may be circulated by means integral with the machine or by means external to and not a part of the machine. In the latter case, these machines shall be known as separately- or forced-ventilated machines.

A totally-enclosed water air-cooled machine - a totally-enclosed machine which is cooled by circulating air which, in turn, is cooled by circulating water. It is provided with a water-cooled heat exchanger for cooling the ventilating air and a fan or fans, integral with the rotor shaft or separate, for circulating the ventilating air.

A watertight enclosure - one into which there shall be no leakage after 5 minutes under test with a water hose from a distance of 10 ft (3 m) in any direction.

A weather-protected machine - an open machine with its ventilating passages at both intake and discharge so arranged that high-velocity air and air-borne particles blown into the machine by storms or high winds can be discharged without entering the internal ventilating passages leading directly to the electric parts of the machine itself. The normal path of the ventilating air which enters the electric parts of the machine shall be so arranged by baffling or separate housings as to provide at least three abrupt changes in direction, none of which shall be less than 90 degrees. In addition, an area of low velocity not exceeding 600 fpm (3 m/s) shall be provided in the intake air path to minimize the possibility of moisture or dirt being carried into the electric parts of the machine. Its ventilation openings shall be so constructed as to prevent the passage of cylindrical rod 3/4 in. (20 mm) in diameter.

An explosion-proof machine - a totally-enclosed machine whose structure is designed and constructed to withstand an explosion of a specified gas or vapor which may occur within it, and to prevent the ignition of the specified gas or vapor surrounding the machine by sparks, flashes, or explosions of the specified gas or vapor which may occur within the machine casing.

Determination of - a calculated determination of the quantity at rated conditions, based on tests of that or other quantities at other than design conditions (usually reduced voltage).

Frame size 445 - the frame of a motor which, in its horizontal foot mounted configuration, has a height of
11 in. (280 mm) from the bottom of the feet to the center of the shaft and an axial length of 16-1/2 in. (420 mm) between center lines of the mounting holes.

Measurement of - measuring the actual quantity, at design voltage, load, and the like, as applicable.

Motor continuous overload capability/service factor - a multiplier which, when applied to the rated horsepower, indicates horsepower loading which may be carried continuously without exceeding, by more than $10^{o}C$ at continuous overload/service factor loading, rated temperature rise per ANSI/NEMA MG1 or IEC 34-1, if rated voltage and frequency are maintained.

When the motor is operated at any service factor greater than 1.0, it may have efficiency, power factor and speed different from those rated horsepower, but the locked rotor torque and current and breakdown torque will remain unchanged.

DOCUMENTATION

1. Motor data, including the following, shall be furnished by vendor with all proposals. All the same data shall be furnished with final drawings and data corrected to apply to the actual motor furnished. Guaranteed or published values are acceptable for motors that do not require certified test reports.

   a. Rated horsepower (or kW)
   b. Rated full-load speed
   c. Rated voltage
   d. Full load current at rated voltage
   e. Efficiency and power factor at 1/2, 3/4, and full load
   f. Rated temperature rise
   g. Continuous overload capability/service factor (may be omitted if standards of manufacture do not provide for continuous overload capability/service factor)
   h. Locked rotor current at rated voltage
   i. Allowable time at locked rotor with rated voltage applied for the following conditions:
      - Motor starting cold (at design maximum ambient temperature)
      - Motor starting hot (motor having attained allowable full load temperature rise at design maximum ambient temperature)

      Note:

      Design maximum ambient temperature is 40^{o}C unless otherwise specified.
   j. Bearing type and lubrication system type
   k. For integral hp horizontal sleeve bearing motors, calculated value of the maximum axial force to constrain the motor rotor at either limit of its endfloat with motor operating at rated voltage.

      Note:

      This data is required to permit purchaser to check capacity of driven equipment thrust bearing. This data shall be furnished immediately after order placement.
   l. "L_{10}" rating life for vertical motor anti-friction bearings (other than in-line pump motors) and the thrust load on which rating life is based.
   m. Locked rotor power factor for motors 150 hp (110 kW) and larger
   n. Locked rotor torque at rated voltage
   o. 100 hp and larger – rotor weight and inertia (Wk^2)
   p. Motor type – (horizontal/vertical)

q. Enclosure type – (WP, TEFC, EX-P, etc.)
r. Rotation, viewed from coupling end – (cw / ccw)
s. Rotor end float – mils
t. Thrust bearing mounting – (face-to-face, back-to-back, tandem)
u. Vertical motors – maximum allowable thrust up/down

Note:

Efficiency of NEMA Frame motors shall be determined by direct measurement using IEEE Standard 112. Test Method B. For other frame sizes, direct measurement of efficiency using Test Method B is preferred where motor size and test facilities permit. When use of Test Method B is not feasible, efficiency shall be determined indirectly, using IEEE Standard 112, segregated- loss Test Methods E & F, calculating motor losses from data obtained through load or no-load testing.

2. Test reports shall be submitted to the purchaser for each motor for which inspection is specified.
3. Outline drawings showing principal dimensions, and mounting and shaft dimensions shall be submitted to purchaser for each motor.
4. Motor and driven equipment data referenced by Section 6 of this standard shall be submitted to purchaser at the time motor proposal is submitted. Typical data for identical or similar proven motor designs may be submitted at proposal time. If this is the case, however, it must be clearly stated in the bid proposal, and data for the specific design required shall be furnished as soon as it is available.
5. At time of bid, motor and/or driven equipment vendor must provide the following for antifriction bearings:
   a. Motor bearing housing drawings showing details of lubrication system proposed.
   b. True axial loading on motor bearings at rated motor load.
   c. Maximum allowable axial loading on bearings consistent with the specification "L_{10}" life.
6. Drawings and Performance Data Marking - The following information is required on all copies of drawings and performance data:
   a. Requisition, purchase order and specification numbers.
   b. Manufacturer's serial number.
   c. Driven equipment identification number.

GENERAL REQUIREMENTS

Voltage and Frequency Tolerance

1. All motors shall operate successfully at rated load and at rated frequency with a voltage variation of 5% or less above or below rated voltage.
2. All motors shall operate successfully at rated load and at rated voltage with a frequency variation of 5% or less above or below rated frequency.
3. All motors shall operate successfully at rated load with a combined variation in voltage and frequency not more than 5%.

Insulation, Conductors and Leads

1. Insulation classes shall be selected per the following. Proposals to use other classes shall be submitted to purchaser for approval by Owner's Engineer:

DRIVER APPLICATION	INSULATION CLASS	APPLICABLE STANDARD OR PUBLICATION
a. Drivers for solids handling equipment in dusty locations (or drivers within the proximity of grinding equipment and conveyors) and Refinery & Chemical plant drivers operating under dusty, hot, humid, outdoor conditions	Class F, but rated for a Class B temperature rise	ANSI/NEMA MG1 or IEC 85
b. Motor Actuators for Type C RBVs	Class B or F	
c. Motor Actuators for Type D RBVs	Class H	
d. All drivers for other equipment	Class B or F or Class E	ANSI/NEMA MG1/IEC 85 or EC 85

2. Insulation system shall be designed and constructed to prevent penetration of any moisture, oil mist or contaminants, i.e., to obtain a "sealed" insulation system. In particular, Manufacturer shall provide special insulation materials and treatments, as necessary, to make the winding suitable for outdoor refinery or chemical plant service in a seacoast area.
3. Copper conductors shall be used for stator windings and terminal leads and for field windings (if any).
4. The following additional requirements apply to all motors rated 2300 volts and above:
   a. Stator coils shall be form wound.
   b. Weather protected motors shall have a "sealed" insulation system that will withstand an immersion test in accordance with NEMA MG1.

c. Unless otherwise specified, the stator insulation of weather-protected motors shall consist of a vacuum pressure impregnated (VPI) system.

5. Motor leads shall be insulated with heat-resistant, thermosetting insulation. If the motor is to be oil mist lubricated, lead insulation shall be Teflon or Teflon jacketed.

Bearings and Lubrication

1. For motors rated 1500 hp (1100 kw) and smaller, grease lubrication for anti-friction bearings is acceptable. In addition, when specified by purchaser, such grease lubrication system shall be suitable for future conversion oil mist dry sump ("pure" mist) operation.
2. For all motors, the following lubrication systems are acceptable:
   a. Non-forced-feed oil lubrication for anti-friction and sleeve bearings, which when specified by purchaser, shall be suitable for, or future conversion to, oil mist wet sump ("purge" mist) operation.
   b. Forced-feed oil lubrication.
3. Motors with regreasable bearings shall meet the following:
   a. Be capable of being regreased in service.
   b. Be capable of operating for at least 8000 hours without requiring addition of grease or a complete change of grease.
   c. Be equipped with external relief or drain plugs. Alternative arrangements for expelling or collecting used grease may be proposed for Owner's Engineer approval.
   d. Seals shall be provided to prevent loss of lubricant.
   e. If grease fitting are to be furnished, the type will be specified. Otherwise motors are to be furnished pipe plugs in the tapped holes normally provided for such fittings.
4. Motors suitable for oil mist lubrication or for future conversion to oil mist lubrication shall also be able to access the vendor's standard lubrication system. In addition, the following minimum requirements shall be met:
   a. An oil mist connection, 1/4 in. NPS (8 mm) shall be provided in the top half of the bearing housing and shall connect to a drilled or cored passage which directs the oil mist into the bearing chamber. For motors with anti-friction bearings, the passage shall be arranged to direct the oil mist through the bearing rolling elements. A separate inlet connection and passage is not required for grease lubricated motors if the grease inlet connection and passage meets these requirements.
   b. A 1/4 in. NPT (8mm) tapped and plugged vent connection shall be provided in the bearing housing. The vent connection shall be in the top of