SECTION 26 60 13

LOW-VOLTAGE MOTORS
07/07

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 11	(1990; R 1999) Load Ratings and Fatigue Life for Roller Bearings
ABMA 9	(1990; R 2000) Load Ratings and Fatigue Life for Ball Bearings

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 112	(2004) Standard Test Procedure for Polyphase Induction Motors and Generators

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2007) Acceptance Testing Specifications
NETA MTS	(2005) Maintenance Testing Specifications for Electric Power Distribution Equipment and Systems

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 1940-1	(2003; Corrigendum 2005) Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance Tolerance - International Restrictions

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2007) Standard for Motors and Generators
NEMA MG 10	(2001; R 2007) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors
NEMA MG 11	(1977; R 2007) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2007; AMD 1 2008) National Electrical

Code - 2008 Edition

UNDERWRITERS LABORATORIES (UL)

UL 984 (1996; Rev thru Sept 2005) Hermetic Refrigerant Motor-Compressors

1.2 DEFINITIONS

CISD-TEFC: Chemical industry, severe-duty enclosure.

DIP: Dust-ignition-proof enclosure.

EXP: Explosion-proof enclosure.

Inverter Duty Motor: Motor meeting applicable requirements of NEMA MG 1, Section IV, Parts 30 and 31.

Motor Nameplate Horsepower: That rating after any derating required to allow for extra heating caused by the harmonic content in the voltage applied to the motor by its controller.

ODP: Open drip-proof enclosure.

TEFC: Totally enclosed, fan cooled enclosure.

TENV: Totally enclosed, nonventilated enclosure.

WPI: Open weather protected enclosure, Type I.

WPII: Open weather protected enclosure, Type II.

1.3 GENERAL REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

This section applies only when referenced by a motor-driven equipment specification. Meet requirements of NEMA MG 1. Motors shall be specifically designed for the use and conditions intended, with a NEMA design letter classification to fit the application

Application, horsepower, enclosure type, mounting, shaft type, synchronous speed, and deviations from this section will be listed in the equipment specification. Where such deviations occur, they shall take precedence over this section.

In order to obtain single source responsibility, utilize a single supplier to provide a drive motor, its driven equipment, and specified motor accessories. For multiple units of the same type of equipment, furnish identical motors and accessories of a single manufacturer.

Maximum ambient temperature not greater than 50 degrees C outdoors and 40 degrees C indoors or outdoors protected from direct sunlight. Motors shall be suitable for operating conditions without any reduction being required in the nameplate rated horsepower or exceeding the rated temperature rise. Overspeed in either direction in accordance with NEMA MG 1.

Inverter Duty Rated Motors shall have bearing isolation for motors larger

than 20 hp to electrically isolate bearings to prevent stray current damage. Motors larger than 1 hp shall be provided with a shaft grounding brush or conductive micro fiber shaft grounding ring. Shaft grounding device shall be solidly bonded to the grounded motor frame per manufacturer's recommendations.

Motors controlled by adjustable frequency drive systems shall not exceed sound levels of 3 dBA higher than NEMA MG 1.

Include Lifting lugs on all motors weighing 100 pounds or more. Include terminal for connection of equipment grounding wire in each terminal box. Provide oversize main terminal boxes for all motors that are diagonally split, rotatable to each of four 90 degree positions and have threaded hubs for conduit attachment. Except ODP, furnish gaskets between box halves and between box and motor frame.

1.4 MOTORS

NEMA MG 1; hermetic-type sealed motor compressors shall also comply with UL 984. Provide the size in terms of HP, or kVA, or full-load current, or a combination of these characteristics, and other characteristics, of each motor as indicated or specified. Determine specific motor characteristics to ensure provision of correctly sized starters and overload heaters. Motors shall be designed to operate at full capacity with voltage variation of plus or minus 10 percent of motor voltage rating. Unless otherwise indicated, motors rated 1 HP and above shall be continuous duty type.

Where fuse protection is specifically recommended by the equipment manufacturer, provide fused switches in lieu of non-fused switches indicated.

Motor data shall be as indicated in equipment specifications or as scheduled on the Drawings.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings; G

Outline drawings for Motors shall indicate overall physical features, dimensions, ratings, service requirements, and weights of equipment.

SD-03 Product Data; G

1. Descriptive information.

2. Nameplate data in accordance with NEMA MG 1.

3. Additional Rating Information:
   a. Service factor.
   b. Locked rotor current.
   c. No load current.
   d. Safe stall time for motors 100 hp and larger.

e. Multispeed load classification (for example, variable torque).
f. Adjustable frequency drive motor load classification (for example, variable torque) and minimum allowable motor speed for that load classification.
g. Guaranteed minimum full load efficiency and power factor.

4. Enclosure type and mounting (such as, horizontal, vertical).

5. Dimensions and total weight.

6. Conduit box dimensions and usable volume as defined in NEMA MG 1 and NFPA 70.

7. Bearing type.

8. Bearing lubrication.

9. Bearing life.

10. Description, ratings, and wiring diagram of motor thermal protection.

11. Motor sound power level in accordance with NEMA MG 1.

12. Maximum brake horsepower required by the equipment driven by the motor.

Submit Manufacturer's Catalog Data in accordance with paragraph entitled, "Equipment," of this section

SD-07 Certificates; G

Certificates shall be submitted for the following tests showing conformance with the referenced standards contained in this section. Certified copies of previous test reports on identical motors may be submitted in lieu of factory test reports for motors less than 50hp. Submit actual test reports for all motors 50hp and above.

Factory Test Results
Efficiency
Power-Factor
Service Factor
Temperature Rating
Noise
Locked-Rotor
Insulation Resistance
Winding Resistance
High-Potential Tests

SD-08 Manufacturer's Instructions

Manufacturer's Instructions shall be submitted for Motors including special provisions required to receive, store and install equipment components and system packages. Special notices shall detail impedances, hazards and safety precautions.

PART 2 PRODUCTS

2.1 EQUIPMENT

Design, fabrication, testing, and performance of motors shall be in accordance with NEMA MG 1 and ISO 1940-1 and shall meet or exceed the requirements as specified herein.

Testing and performance of polyphase induction motors shall be in accordance with IEEE Std 112, Method B.

Efficiency labeling shall be in accordance with NEMA MG 1.

Allowable balance limits shall be in accordance with ISO 1940-1, Table 1

Locked rotor kVA Code G or lower, if motor horsepower not covered by NEMA MG 1 tables. Safe stall time of 12 seconds or greater.

2.1.1 Efficiency

2.1.1.1 High Efficiency Single-Phase Motors

Single-phase fractional-horsepower alternating-current motors shall be high efficiency types corresponding to the applications listed in NEMA MG 11. In exception, for motor-driven equipment with a minimum seasonal or overall efficiency rating, such as a SEER rating, provide equipment with motor to meet the overall system rating indicated.

2.1.1.2 Premium Efficiency Polyphase Motors

Polyphase motors shall be selected based on premium efficiency characteristics relative to typical characteristics and applications as listed in NEMA MG 1 and NEMA MG 10. In exception, for motor-driven equipment with a minimum seasonal or overall efficiency rating, such as a SEER rating, provide equipment with motor to meet the overall system rating indicated.

2.1.1.3 Motor Sizes

Provide size for duty to be performed, not exceeding the full-load nameplate current rating when driven equipment is operated at specified capacity under most severe conditions likely to be encountered. When motor size provided differs from size indicated or specified, make adjustments to wiring, disconnect devices, and branch circuit protection to accommodate equipment actually provided at no additional cost.

2.2 MOTOR TYPES

Motor shall be marked to show the index letter, which shall be the letter shown or a letter that indicates a higher efficiency.

Motors shall be of the following types:

1/3 HP and smaller, single phase - capacitor start

1/2 HP and larger, three-phase - induction squirrel-cage type, NEMA Design B, having normal starting torque and low starting current

Motors shall be designed for across-the-line starting and shall be designed

with torque characteristics to carry the specified rated starting load.

Motors shall have factory-sealed ball bearings with an L-10 rated life of not less than 50,000 hours in accordance with ABMA 9 or ABMA 11.

2.3 SIZES OF MOTORS

2.3.1 Motors

As designated in motor-driven equipment specifications.

Constant Speed Applications: Brake horsepower of the driven equipment, at any operating condition or at any head capacity point on the pump curve, not to exceed motor nameplate horsepower rating, excluding any service factor.

Adjustable Frequency and Adjustable Speed Applications (Inverter Duty Motor): Driven equipment brake horsepower, at any operating condition or at any head capacity point on the pump curve, not to exceed motor nameplate horsepower rating, excluding any service factor.

2.3.2 Electrically Driven Equipment

When electrically driven equipment differs from that indicated, adjustments shall be made to the motor size, wiring and conduit systems, disconnect devices, and circuit protection to accommodate the equipment actually installed, at no additional cost to the Government. Control and protective devices shall be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.4 VOLTAGE RATINGS

Motors shall have the following minimum voltage ratings:

MOTOR SIZE			MOTOR
MOTOR TYPE	HORSEPOWER	SERVICE	VOLTAGE RATING
Fractional horsepower, single-phase	1/3 and smaller	120-volt, 1-phase, 3-wire	115-volt, 60-hertz
Fractional and integral horsepower, 3-phase	1/3 and smaller	208-volt, 3-phase, 3-wire	200-volt, 3-phase 60-hertz
Fractional and integral horsepower, 3-phase	1/2 and larger	480-volt, 3-phase, 3-wire	460/230-volt, 3-phase, 60-hertz

2.5 TEMPERATURE RATING AND INSULATION

Motors shall be designed for continuous operation at the rated name plate hp full load speed in an ambient temperature as specified herein, without exceeding the rated temperature rise.

Single-Phase, Fractional Horsepower Motors: Manufacturer's standard winding insulation system.

Three-Phase and Integral Horsepower Motors: Unless otherwise indicated in motor-driven equipment specifications, Class F with Class B rise at nameplate horsepower and designated operating conditions. All motors shall have sealed windings.

2.6 MOTOR HOUSINGS

The motor housing shall have a smooth surface in the vertical, horizontal, and axial directions at each bearing housing for attaching a magnet mounted accelerometer in order to monitor the motor vibration. The surface shall be on the bearing housing. The axial surface will be as close to the motor centerline as possible. The surface will have a finish of 63 micro-inch minimum. Diameter of finished surface shall be 2 inch minimum and must be corrosion resistant. As an option sound disks can be used to meet the smooth surface requirement. Disk shall have a minimum thickness of 3/8 inch.

Surface shall be level within 1 degree or .001 inch.

The smooth surface shall be identified(using a label or plate) "Vibration data collection point - Do Not Paint"

2.7 MOTOR ENCLOSURES

Motors installed in indoor, clean, dry, nonhazardous locations shall have open-type drip-proof enclosures (ODP). Enclosures shall have a hinged access cover at each vibration collection point. Cover must be large enough to enable the placement of a magnet/accelerometer data collection instrument.

Motors installed in indoor, wet, nonhazardous locations shall be totally-enclosed, fan-cooled enclosures (TEFC). Enclosures shall have a hinged access cover at each vibration collection point. Cover must be large enough to enable the placement of a magnet/accelerometer data collection instrument.

Motors installed in indoor, nonhazardous locations where it is necessary to protect the motor from dirt, moisture, chemical fumes, or other harmful ingredients in the surrounding atmosphere shall be the totally enclosed type, with either of the following:

Totally enclosed, not fan-cooled, enclosures not equipped for cooling by means external to the enclosing parts Type TENV. Enclosures shall have a hinged access cover at each vibration collection point. Cover must be large enough to enable the placement of a magnet/accelerometer data collection instrument.

Totally enclosed fan-cooled enclosures for exterior cooling by means of a fan or fans integral with the machine but external to the enclosing parts, Type CISD - TEFC. Enclosures shall have a hinged access cover at each vibration collection point. Cover must be large enough to enable the placement of a magnet/accelerometer data collection instrument.

Motors installed in outdoor, nonhazardous locations shall have weatherproof enclosures, either TEFC or weather-protected Type I (WPI).

2.8 SERVICE FACTOR

Service factor of general purpose and other open ac motors shall be in accordance with NEMA MG 1.

Totally enclosed ac motors shall have a service factor of 1.15 at rated ambient temperature. Inverter duty motors shall have a service factor of 1.0 at rated ambient temperature.

2.9 SPECIAL FEATURES AND ACCESSORIES

Screen Over Air Openings: Stainless steel on motors with ODP, WPI, and WPII enclosures meeting requirements for Guarded Machine in NEMA MG 1, and attached with stainless steel screws.

Winding Thermal Protection:

Thermostats:

a. Motors for constant speed application 20 hp through 100 hp. Motors for adjustable speed application 20 hp through 100 hp.

b. Bi-metal disk or rod type thermostats embedded in stator windings.

c. Automatic reset contacts rated 120 volts ac, 5 amps minimum, opening on excessive temperature. (Provide manual reset at motor controller.)

d. Leads extending to separate terminal box for motors 75 hp and larger.

Resistance Temperature Detectors:

a. Motors for constant speed application 125 hp and larger, and motors for adjustable speed application 125 hp and larger.

b. 100 ohm platinum, three-wire, precision resistors with calibrated resistance-temperature characteristics.

c. Six (two each phase) positioned to detect highest winding temperature and located between coil sides in stator slots.

d. Compatible with monitoring instrumentation provided with motor controller and with adjustable speed control equipment.

e. Leads brought to separate motor terminal box.

2.10 FACTORY TESTS

Factory test all motors in accordance with the requirements of NEMA MG 1. Polyphase induction motors shall be factory-tested in accordance with IEEE Std 112, Method B. Tests shall consist of measurements of voltage, frequency, speed, and current under no-load conditions; voltage, frequency, and current under locked-rotor conditions; and efficiency, noise, power factor, and thermal protection. Electrical tests shall consist of winding resistance, insulation resistance, and high-potential tests. Submit certified copies of factory test results for approval prior to shipment from the factory as required in Article 1.3, SUBMITTALS.

PART 3 EXECUTION

3.1 INSTALLATION

Motors shall be installed, aligned, and connected in accordance with the equipment manufacturer's instructions.

Motors shall be bolt mounted. Motor feet shall be coplanar within 0.001 inch. Base mounting points shall be accessible and adjustable to enable machine alignment.

Alignment of motors shall be rechecked and adjusted as required after the motor has been in operation for not less than 48 hours.

3.2 ALIGNMENT

Before attempting alignment, the Contractor will demonstrate that the load does not have any load/force imposed by the piping system. Minimum alignment values (below) are for motor and load at normal running temperatures. Values must be compensated for thermal growth. Limited movement of the motor or load (commonly known as bolt-bound) must be corrected to ensure alignment capability. Hold down bolts shall not be undercut in order to perform adjustment.

Shims shall be commercially die-cut, without seams or folds, and be made of corrosion resistant stainless steel. No more than four shims shall be used at any single point.

Motor and load shall be aligned to the following minimum specifications:

Speed(RPM)	Close-Coupled Offset (mils)	Close-Coupled Angle(mils/in.)	Spool Piece Angle (mils/in. @ coupling pt.)
600	6.0	2.0	3.0
900	5.0	1.5	2.0
1200	4.0	1.0	1.5
1800	3.0	0.5	1.0
3600	1.5	0.4	0.5
7200	1.0	0.3	0.4

Motor/load alignment shall be performed under the direction of the manufacturer's representative.

Final alignment settings shall be provided as part of the final test data.

3.3 ELECTRICAL TESTS

Perform continuity test on all phases.

Perform insulation resistance and polarization index test on each phase of motor. Insulation tests on 480-volt motors shall be conducted using a 1000-volt insulation test set. Insulation tests on motors rated less than 480-volts shall be conducted using 500-volt insulation test set.

Test data shall include the location and identification of motors and megohm readings versus time. Test data shall be recorded at 15, 30, 45 seconds, and in 1 minute increments thereafter up to 10 minutes. Megohm readings shall not be less than 25 megohms for each phase and each phase

reading shall be within 10 percent of the other two.

Perform inspections and test procedures on all motors in accordance with NETA ATS and NETA MTS 7.15.1 for rotating machinery, AC motors.

Calculate the polarization index of each phase by dividing the 10 minute reading by the 1 minute reading. The polarization index shall be greater than 1.25. Any values lower shall be rejected and the motor returned to the factory.

3.4 VIBRATION TESTS

3.4.1 Vibration Analyzer

Contractor shall use an Fast Fourier Transformer (FFT) analyzer to measure vibration levels. It shall have the following characteristics: A dynamic range greater than 70 dB; a minimum of 400 line resolution; a frequency response range of 5 Hz-10 KHz(300-600000 cpm); the capacity to perform ensemble averaging, the capability to use a Hanning window; auto-ranging frequency amplitude; a minimum amplitude accuracy over the selected frequency range of plus or minus 20 percent or plus or minus 1.5 dB.

An accelerometer, either stud-mounted or mounted using a rare earth, low mass magnet and sound disk(or finished surface) shall be used with the FFT analyzer to collect data. The mass of the accelerometer and its mounting shall have minimal influence on the frequency response of the system over the selected measurement range.

3.4.2 Vibration Data

Vibration data shall be collected in the axial, vertical, and horizontal direction for each motor bearing.

Two narrowband spectra for each data collection point shall be obtained in the following manner: For all machines regardless of operating speed, a 5 to 500 Hz spectrum with a minimum of 400 lines of resolution shall be obtained. An additional spectrum of 5 to 2500 or 5 to 5000 Hz shall be acquired for machines operating at or below 1800 RPM or greater than 1800 RPM, respectively.

Vibration limits shall conform to the following:

Frequency Range(CPM)	Vibration limit(inch/sec)
0.3xRPM to 0.8xRPM	0.04
0.8xRPM to 1.2xRPM	0.75
1.2xRPM to 3.5xRPM	0.04
3.5xRPM to 120,000cpm	0.03

Final test reports shall be provided. Reports shall have a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports".

-- End of Section --