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USACE / NAVFAC / AFCESA / NASA | **NASA-16225S (December 2005)**

Preparing Activity: NASA | **MasterFormat™ 2004 - 25 18 39.00 40**
Superseding
NASA-16225 (April 2005)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are NOT in agreement with UMRL
References will be in agreement at next scheduled update of UMRL
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SECTION 16225S

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12/05

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SECTION 16225S

MOTORS
12/05

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NOTE: Delete, revise, or add to the text in this section to cover project requirements. Notes are for designer information and will not appear in the final project specification.

This section covers alternating current wattage fractional and integral horsepower motors rated up to 190 kilowatt 250 hp when used on a 120-, 208- or 240-volt, single-or three-phase, 60-hertz power source and up to 225 kilowatt 300 hp when used on a 480-volt and 600-volt, three-phase, 60-hertz power source.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.
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PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically

be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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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 2000) 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	(1996) Standard Test Procedure for Polyphase Induction Motors and Generators

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2003) Acceptance Testing Specifications for Electrical Power Distribution Equipment Systems

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

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

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2003) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2005) National Electrical Code 2005 Edition

U.S. DEPARTMENT OF ENERGY (DOE)

DOE CI-1	(2001) How to Buy a Premium Energy-Efficient Electric Motor

1.2 GENERAL REQUIREMENTS

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NOTE: If Section 16003S GENERAL ELECTRICAL PROVISIONS is not included in the project specification, applicable requirements therefore should be inserted and the following paragraph deleted.

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Section 16003S GENERAL ELECTRICAL PROVISIONS applies to work specified in this section.

1.3 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01330 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

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Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

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

SD-03 Product Data

Equipment and performance data shall be submitted for Motors consisting of use life, system functional flows, safety features, and mechanical automated details. Curves indicating tested and certified equipment response and performance characteristics shall

also be submitted.

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

For Electric Motors rated over [7.5] [10] [15] [20 hp] [25] and those specified to meet a special vibration class in accordance with NEMA MG 1 indicate number of:

Rotor Bars
Stator Slots
Rotational Speed
Cooling Fan Blades
Bearing Manufacturer
Bearing Style
Bearing Type
Balls/Elements
Commutator Bars
Commutator Brushes
SCR Firing Frequencies (for variable speed motors)

SD-07 Certificates

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.

Factory Test Results
Efficiency
Power-Factor
Service Factor
Temperature Rating
Noise
Full-Load
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 install equipment components and system packages. Special notices shall detail impedances, hazards and safety precautions.

1.4 DESIGN REQUIREMENTS

The following motor design data shall be provided prior to final turnover-number of motor rotor bars, Stator slots, rotational speed; number of cooling fan blades; RPM of motor; bearing manufacturer, bearing type, bearing style and number of balls/elements; number of commutator bars and commutator brushes; and SCR firing frequencies.

PART 2 PRODUCTS

2.1 EQUIPMENT

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NOTE: For most general purpose motors the vibration levels listed in NEMA MG 1 and ISO 1940-1, Grade G6.3 are acceptable, however, industry has shown a marked increase in bearing life when initial vibration levels are reduced to under .10 in/sec peak-to-peak. This is 30 percent less than NEMA MG 1 and ISO 19401 G6.3 allows. ISO 1940-1, G2.5 would be appropriate on critical motors, high cost motors, and special application motors.
****

Submit manufacturer's catalog data for motors and enclosures.

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

2.1.1 Efficiency

Metric motor sizes shall be converted to English units by multiplying the kilowatt rating by 1.34 to determine the horsepower equivalent. The result shall be compared to the motor sizes listed in DOE CI-1 and the closest size listed to the horsepower equivalent shall be used for determining efficiencies.

Motors shall have efficiencies in accordance with the recommended levels specified in DOE CI-1.

2.2 MOTOR TYPES

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NOTE: Energy efficient induction motors are required when the projected annual operating hours are greater than 2,000 and motors are rated 3.7 to 185 kilowatt 5 to 250 hp.
****

[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:

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

375 watt 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 [30,000] [50,000] [80,000][_____] hours in accordance with ABMA 9 or ABMA 11.

2.3 SIZES OF MOTORS

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NOTE: When part load operation is required, specify efficiency and power factor at 1/2 and 3/4 as well as full load.

Wattage Horsepower ratings indicated are minimum sizes for guidance only and do not limit the motor size.

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2.3.1 Motors

Motors shall be of a sufficient size for the duty to be performed and shall not exceed the full-load rating when the driven equipment is operating at specified capacity under the most severe loading conditions.

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 16286S OVERCURRENT PROTECTIVE DEVICES.

2.4 VOLTAGE RATINGS

Motors shall have the following minimum voltage ratings:

MOTOR TYPE	MOTOR SIZE WATTAGE RATING	SERVICE	MOTOR VOLTAGE RATING
Single-phase	250 and smaller	120/208-volt, 3-phase, 4-wire	115-volt, 60-hertz
3-phase	375 and larger	120/208-volt, 3-phase, 4-wire	200-volt, 3-phase 60-hertz
3-phase	375 and larger	480-volt, 3-phase, 3-wire	230/460-volt, 3-phase, 60-hertz

MOTOR TYPE	MOTOR SIZE HORSEPOWER	SERVICE	MOTOR VOLTAGE RATING
Fractional horsepower, single-phase	1/3 and smaller	120/208-volt, 3-phase, 4-wire	115-volt, 60-hertz

MOTOR SIZE			MOTOR
MOTOR TYPE	HORSEPOWER	SERVICE	VOLTAGE RATING
Fractional and integral horsepower, 3-phase	1/2 and larger	120/208-volt, 3-phase, 4-wire	200-volt, 3-phase 60-hertz
Fractional and integral horsepower, 3-phase	1/2 and larger	480-volt, 3-phase, 3-wire	230/460-volt, 3-phase, 60-hertz

2.5 TEMPERATURE RATING AND INSULATION

Motors shall be designed for continuous operation at the rated full load in an ambient temperature of [40 degrees C] [104 degrees F] [_____].

Insulation level shall be at least Class [B] [F] [_].

2.6 MOTOR HOUSINGS

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NOTE: For motors in outdoor applications and indoor applications in a harsh environment refer to Section 09960 HIGH-PERFORMANCE COATINGS.
****

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 50 millimeter 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 9 millimeters 3/8 inch.

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NOTE: Good frequency response (required for accurate vibration data) is more related to placing the accelerometer magnet on a clean surface with a lubricant between the magnet and the surface than a highly polished surface. When using a stud mounted accelerometer, mounted directly to the disk or finished surface, minimum surface finish is 32 micro-inch.
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NOTE: When using stud mounted accelerometers specify the hole size per the accelerometer's manufacturers instructions. Most threaded accelerometers use 1/4-28 or 10-32 thread size.
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NOTE: Surface must be level to prevent

accelerometer magnet from rocking.

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Surface shall be level within 1 degree or 0.0254 millimeters .001 inch.

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

2.7 MOTOR ENCLOSURES

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NOTE: Motors with full enclosures require a way to effectively collect vibration data.

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[Motors installed in indoor, clean, dry, nonhazardous locations shall have open-type drip-proof enclosures. 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 have open splash-proof enclosures. 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. 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. 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 waterproof enclosures.]

[Motors installed in hazardous locations for Classification I, [Division 1] or [Division 2] shall meet or exceed the minimum requirements of NFPA 70, Article 501.8. Type of enclosure shall be approved by the Contracting Officer prior to fabrication for the class and group of hazard in which the motors are located.]

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NOTE: For motors installed in locations where weatherproof/waterproof enclosures are required specify accelerometers and data collection boxes consistent with other accelerometers and data collectors used at the facility.

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Motors with weatherproof/waterproof enclosures shall have permanent accelerometers installed in the horizontal, vertical, and axial directions. The enclosure shall have a penetration installed to enable the accelerometer cables to be routed to outside the enclosure. A data collection box shall be mounted to the outside of the motor enclosure in a location that is easily accessible. Data collection box shall be rated NEMA 4R.

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] [_____].

2.9 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. Routine tests on wound-rotor induction motors shall include the measurement of wound-rotor open-circuit voltage across the slip rings under locked-rotor conditions. 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. Previous test reports on identical motors are not acceptable for these tests.

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 0.0254 millimeters0.001 inch. Base mounting points shall be accessible and adjustable to enable machine alignment. Motors over [7.5] [10] [15] [20] [25] hp shall have alignment jack bolts installed to enable 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 and 600-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 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 to the Contracting Officer. Reports shall have a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

-- End of Section --