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USACE / NAVFAC / AFCESA / NASA **UFGS-26 60 13.00 40 (November 2011)**
Change 1 - 08/12

Preparing Activity: NASA **Superseding**
UFGS-26 60 13.00 40 (May 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2013
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SECTION 26 60 13.00 40

LOW-VOLTAGE MOTORS
11/11

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NOTE: This guide specification covers the requirements for 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.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

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 2008) Load Ratings and Fatigue Life for Roller Bearings
ABMA 9	(1990; R 2008) Load Ratings and Fatigue Life for Ball Bearings

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

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

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems
NETA MAINT	(2011) Standard for Maintenance Testing Specifications for Electric Power Distribution Equipment and Systems

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

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

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

RCBEA GUIDE	(2004) NASA Reliability Centered Building and Equipment Acceptance Guide

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2011; Errata 2012) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011; Errata 2 2012) National Electrical Code

U.S. DEPARTMENT OF ENERGY (DOE)

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

1.2 ADMINISTRATIVE REQUIREMENTS

****
NOTE: If Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS is not included in the project specification, applicable requirements therefore should be inserted and the following paragraph deleted.
****

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

]1.2.1 Pre-Installation Meeting

The Contracting Officer will schedule a pre-installation meeting within [30] [_____] days of Contract Award. Provide the following for review and approval:

a. Submit informational drawings for Low-Voltage Motors indicating the overall physical features, dimensions, ratings, service requirements, and weights of equipment.

b. Submit equipment and performance data for Low-Voltage Motors consisting of:

(1) Use life

(2) System functional flows

(3) Safety features

(4) Mechanical automated details

(5) Data curves indicating tested and certified equipment response and performance characteristics

(6) Sample warranty with submittal for review and approval by the Contracting Officer

c. 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:

(1) Rotor bars

(2) Stator slots

(3) Rotational speed

(4) Cooling fan blades

(5) Bearing manufacturer

(6) Bearing style

(7) Bearing type

(8) Balls/Elements

(9) Commutator bars

(10) Commutator brushes

(11) SCR firing frequencies (for variable speed motors)

d. Submit manufacturer's instructions for Low-Voltage Motors including special provisions required to install equipment components and system packages. Include all special notices regarding detail impedances, hazards and safety precautions.

e. Submit certificates for the following tests showing conformance with the referenced standards contained in this section. Certified copies of previous test reports on identical Low-Voltage Motors may be submitted in lieu of factory test reports.

(1) Factory test results

(2) Efficiency

(3) Power-Factor

(4) Service factor

(5) Temperature rating

(6) Noise

(7) Full-Load

(8) Locked-Rotor

(9) Insulation resistance

(10) Winding resistance

(11) High-Potential tests

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project.

The Guide Specification technical editors have designated those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, 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 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Sample Warranty[; G][; G, [_____]]

Equipment and Performance Data[; G][; G, [_____]]

Manufacturer's Instructions[; G][; G, [_____]]

SD-02 Shop Drawings

Informational Drawings[; G][; G, [_____]]

SD-03 Product Data

Motor Enclosures[; G][; G, [_____]]

Rotor Bars[; G][; G, [_____]]

Stator Slots[; G][; G, [_____]]

Rotational Speed[; G][; G, [_____]]

Cooling Fan Blades[; G][; G, [_____]]

Bearing Manufacturer[; G][; G, [_____]]

Bearing Style[; G][; G, [_____]]

Bearing Type[; G][; G, [_____]]

Balls/Elements[; G][; G, [_____]]

Commutator Bars[; G][; G, [_____]]

Commutator Brushes[; G][; G, [_____]]

SCR Firing Frequencies[; G][; G, [_____]]

SD-07 Certificates

Factory Test Results[; G][; G, [_____]]

Efficiency[; G][; G, [_____]]

Power-Factor[; G][; G, [_____]]

Service Factor[; G][; G, [_____]]

Temperature Rating[; G][; G, [_____]]

Noise[; G][; G, [_____]]

Full-Load[; G][; G, [_____]]

Locked-Rotor[; G][; G, [_____]]

Insulation Resistance[; G][; G, [_____]]

Winding Resistance[; G][; G, [_____]]

High-Potential Tests[; G][; G, [_____]]

SD-08 Manufacturer's Instructions

Motors[; G][; G, [_____]]

SD-10 Operation and Maintenance Data

Operating and Maintenance Manual[; G][; G, [_____]]

SD-11 Closeout Submittals

Warranty[; G][; G, [_____]]

1.4 QUALITY ASSURANCE

****

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.

****

1.4.1 Predictive Testing And Inspection Technology Requirements

****

NOTE: The Predictive Testing and Inspection (PT&I) tests prescribed in Section 01 86 12.07 40 RELIABILITY CENTERED ACCEPTANCE FOR MECHANICAL SYSTEMS are MANDATORY for all [NASA] [_____] assets and systems identified as Critical, Configured, or Mission Essential. If the system is non-critical, non-configured, and not mission essential, use sound engineering discretion to assess the value of adding these additional test and acceptance requirements. See Section 01 86 12.07 40 RELIABILITY CENTERED ACCEPTANCE FOR MECHANICAL SYSTEMS for additional information regarding cost feasibility of PT&I.

****

This section contains systems and/or equipment components regulated by NASA's Reliability Centered Building and Equipment Acceptance Program. This program requires the use of Predictive Testing and Inspection (PT&I) technologies in conformance with RCBEA GUIDE to ensure building equipment and systems installed by the Contractor have been installed properly and contain no identifiable defects that shorten the design life of a system and/or its components. Satisfactory completion of all acceptance requirements is required to obtain Government approval and acceptance of the Contractor's work.

Perform PT&I tests and provide submittals as specified in Section 01 86 12.07 40 RELIABILITY CENTERED ACCEPTANCE FOR MECHANICAL SYSTEMS.

1.5 DELIVERY, STORAGE, AND HANDLING

Ensure all motors and related equipment are packaged and protected to prevent any damage during shipping, after acceptance of delivery, storage, and handling at the project site. Include manufacturer's instructions for proper handling and uncrating with the shipment of the Low-Voltage Motor(s).

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

****

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.

****

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

2.1.1 Motor Types

****
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.
****

[Mark Low-Voltage Motor with an index letter, from the letters shown below or a letter that indicates a higher efficiency.]

Provide Low-Voltage Motors of the following types:

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

b. 375 watt 1/2 HP and larger, three-phase - induction squirrel-cage type, NEMA Design B, having normal starting torque and low starting current

2.1.2 Design Requirements

Provide Low-Voltage Motors (LVM) designed for across-the-line starting with torque characteristics to carry the specified rated starting load. Ensure LVM 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.

Ensure design, fabrication, testing, allowable balance limits and performance of polyphase induction motors are in accordance with NEMA MG 1 and ISO 1940-1 and meets or exceeds the requirements as specified herein.

Provide the following motor design data prior to final turnover:

a. Number of motor rotor bars

b. Stator slots

c. Rotational speed

d. Number of cooling fan blades

e. RPM of motor

f. Bearing manufacturer

g. Bearing type

h. Bearing style

i. Number of balls/elements

j. Number of commutator bars

k. Commutator brushes

l. SCR firing frequencies

2.1.2.1 Sizes Of Motors

****

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

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

****

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

2.1.2.2 Efficiency

Convert metric motor sizes to English units by multiplying the kilowatt rating by 1.34 to determine the horsepower equivalent. Compare the result to the motor sizes listed in DOE CI-1 and use the closest size listed to the horsepower equivalent for determining efficiencies Ensure motors have efficiencies in accordance with the recommended levels specified in DOE CI-1.

Ensure efficiency labeling is in accordance with NEMA MG 1.

2.1.3 Electrically Driven Equipment

When electrically driven equipment differs from that indicated, ensure adjustments have been 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. Provide control and protective devices in accordance with Section 26 05 70.00 40 HIGH VOLTAGE OVERCURRENT PROTECTIVE DEVICES and Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

2.2 VOLTAGE RATINGS

Provide motors with the following minimum voltage ratings:

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

2.3 TEMPERATURE RATING AND INSULATION

Provide motors designed for continuous operation at the rated full load in an ambient temperature of 40 degrees C 104 degrees F [_____], with an insulation level of at least Class [B] [F] [_____].

2.4 MOTOR HOUSINGS

****
NOTE: For motors in outdoor applications and indoor applications in a harsh environment refer to Section 09 96 00 HIGH-PERFORMANCE COATINGS.
****

Provide a smooth surface motor housing in the vertical, horizontal, and axial directions at each bearing housing for attaching a magnet mounted accelerometer in order to monitor the motor vibration. Ensure the smooth surface is on the bearing housing, with the axial surface as close to the motor centerline as possible. Provide a motor housing with a surface finish of 63 micro-inch minimum, corrosion resistant, with a minimum diameter finished surface of 50 millimeter 2 inch. As an option sound disks with a minimum thickness of 9 millimeters 3/8 inch can be used to meet the smooth surface requirement.

****
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.
****

****
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.

****

****
NOTE: Ensure surface is level to prevent accelerometer magnet from rocking.
****

Ensure surface is level within 1 degree or 0.0254 millimeters .001 inch.

Identify the smooth surface using a printed label or embossed plate stating "Vibration data collection point - Do Not Paint".

2.5 MOTOR ENCLOSURES

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

2.5.1 Indoor Type Enclosures

[For motors installed in indoor, clean, dry, nonhazardous locations, provide the following:

a. Open-type drip-proof enclosures

b. Hinged access cover, large enough to enable the placement of a magnet/accelerometer data collection instrument, at each vibration collection point

][For motors installed in indoor, wet, nonhazardous locations, provide the following:

a. Open splash-proof enclosures

b. Hinged access cover, large enough to enable the placement of a magnet/accelerometer data collection instrument, at each vibration collection point

][For 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, provide either of the following type of enclosure:

[a. Totally enclosed, not fan-cooled, enclosures not equipped for cooling by means external to the enclosing parts, with a hinged access cover at each vibration collection point, large enough to enable the placement of a magnet/accelerometer data collection instrument.

] [b. 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, with a hinged access cover at each vibration collection point, large enough to enable the placement of a magnet/accelerometer data collection instrument.

]]

2.5.2 Outdoor Type Enclosures

[For motors installed in outdoor, nonhazardous locations, provide waterproof enclosures.

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

Provide all motors with weatherproof/waterproof enclosures with permanent accelerometers installed in the horizontal, vertical, and axial directions. Ensure the enclosure has a penetration installed to enable the accelerometer cables to be routed to outside the enclosure. Include a NEMA 4R rated data collection box mounted to the outside of the motor enclosure in a location that is easily accessible.

2.6 SERVICE FACTOR

Ensure service factor of general purpose and other open ac motors is in accordance with NEMA MG 1.

Provide totally enclosed ac motors with a service factor of [1.15] [_____].

2.7 FACTORY TESTS

Factory test all motors in accordance with the requirements of NEMA MG 1. Ensure polyphase induction motors are factory-tested in accordance with IEEE 112, Method B, consisting 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. Verify routine tests on wound-rotor induction motors include the measurement of wound-rotor open-circuit voltage across the slip rings under locked-rotor conditions. Provide written documentation of electrical tests including 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

Install, align, and connect motors in accordance with the equipment manufacturer's instructions.

Mount motors with bolts. Ensure motor feet are coplanar within 0.0254 millimeters 0.001 inch, and base mounting points are accessible and adjustable to enable machine alignment. For motors over [7.5] [10] [15] [20] [25] hp, provide alignment jack bolts installed to enable alignment.

Recheck alignment of motors and adjust as required after the motor has been in operation for not less than [48] [_____] hours.

3.2 ALIGNMENT

Before attempting alignment, 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. Ensure values are compensated for thermal growth. Correct limited movement of the motor or load (commonly known as bolt-bound) to ensure alignment capability. Do not undercut hold down bolts in order to perform adjustment.

Provide commercially die-cut shims, without seams or folds, made of corrosion resistant stainless steel. Use no more than four shims at any single point.

Align motor and load 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

[Perform motor/load alignment under the direction of the manufacturer's representative.

] Provide written final alignment settings 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. Conduct insulation tests on 480-volt and 600-volt motors using a 1000-volt insulation test set. For insulation tests on motors rated less than 480-volts, use a 500-volt insulation test set.

Include in test data the location and identification of motors and megohm readings versus time. Record test data at 15, 30, 45 seconds, and in 1 minute increments thereafter up to 10 minutes. Ensure Megohm readings are not be less than 25 megohms for each phase; and each phase reading is within 10 percent of the other two.

Perform inspections and test procedures on all motors in accordance with NETA ATS and NETA MAINT 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. Verify that the polarization index is than 1.25. Reject any lower values and return the motor to the factory.

3.4 VIBRATION TESTS

3.4.1 Vibration Analyzer

To measure vibration levels, use a Fast Fourier Transformer (FFT) analyzer having the following characteristics:

a. A dynamic range greater than 70 dB; a minimum of 400 line resolution

b. A frequency response range of 5 Hz-10 KHz(300-600000 cpm)

c. The capacity to perform ensemble averaging

d. The capability to use a Hanning window

e. Auto-ranging frequency amplitude

f. A minimum amplitude accuracy over the selected frequency range of plus or minus 20 percent or plus or minus 1.5 dB

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

3.4.2 Vibration Data

Collect vibration data in the axial, vertical, and horizontal direction for each motor bearing.

Obtain two narrowband spectra for each data collection point in the following manner:

a. For all machines regardless of operating speed, obtain a 5 to 500 Hz spectrum with a minimum of 400 lines of resolution.

b. Acquire an additional spectrum of 5 to 2500 or 5 to 5000 Hz for machines operating at or below 1800 RPM or greater than 1800 RPM, respectively.

Ensure vibration limits 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

Provide final test reports to the Contracting Officer. Include with reports 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."

3.5 OPERATION AND MAINTENANCE DATA

No later than [10] [20] [30] [_____] days prior to final acceptance, submit manufacturer's operating and maintenance manual to the Contracting Officer.

3.6 WARRANTY

No later than [10] [20] [30] [_____] days prior to final [inspections][acceptance], submit manufacturer's warranty to the Contracting Officer.

-- End of Section --