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USACE / NAVFAC / AFCEC / NASA	**UFGS-26 60 13.00 40 (May 2015)**

Preparing Activity: NASA	**Superseding**
	UFGS-26 60 13.00 40 (May 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021

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DIVISION 26 - ELECTRICAL

SECTION 26 60 13.00 40

LOW-VOLTAGE MOTORS

05/19

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SECTION 26 60 13.00 40

LOW-VOLTAGE MOTORS
05/19

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NOTE: This guide specification covers the requirements for alternating current wattage fractional and integral horsepower motors rated up to 38 kilowatt 50 hp.

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 item(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).

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PART 1 GENERAL

1.1 REFERENCES

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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 Reference Identifier (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 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 112	(2017) Standard Test Procedure for Polyphase Induction Motors and Generators
IEEE C2	(2017; Errata 1-2 2017; INT 1 2017) National Electrical Safety Code

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2017; Errata 2017) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems
NETA MTS	(2015) Standard for Maintenance Testing Specifications for Electrical Power Equipment and Systems

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 1940-1	(2003; R 2008) Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance Tolerances

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	(2018) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code

1.2 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified 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 Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters 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.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Low-Voltage Motors[; G[, [____]]]

SD-06 Test Reports

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

Field Test Report[; G[, [____]]]

SD-08 Manufacturer's Instructions

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

SD-10 Operation and Maintenance Data

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

SD-11 Closeout Submittals

Warranty[; G[, [____]]]

1.3 QUALITY CONTROL

1.3.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Ensure equipment, materials, installation, and workmanship are in accordance with the mandatory and advisory provisions of NFPA 70, IEEE C2 unless more stringent requirements are specified or indicated.

1.3.2 Qualifications

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Provide products which have been in satisfactory commercial or industrial use for 2 years prior to bid opening. Ensure the 2-year period includes applications of equipment and materials under similar circumstances and of similar size. Ensure the product has been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer.

1.3.3 Predictive Testing and Inspection Technology Requirements

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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 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.

1.3.4 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Provide products that have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period includes applications of equipment and materials under similar circumstances and of similar size. Provide products that have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, use items of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.3.4.1 Material and Equipment Manufacturing Date

Do not use products manufactured more than 3 years prior to date of delivery to site, unless specified otherwise.

1.4 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

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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.

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

2.1.1 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] [_____].

2.1.2 Motor Types

****
NOTE: The Department of Energy implemented the Integral Horsepower Motor Rule for three phase electric motors on June 1, 2016 superseding the Energy Independence and Security Act of 2007. Under the new rule three phase motors between 750W and 373KW1hp and 500hp and under 600 volts are required to be rated premium efficiency in accordance with NEMA MG-1.
****

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

a. [_____]

] Provide Low-Voltage Motors of the following types:

a. 750 watt rating[1 HP][_____] and smaller, single phase - capacitor start

b. 1125 watt[1-1/2 HP][_____] and larger, three-phase - induction squirrel-cage type, NEMA Design B, having normal starting torque and low starting current

2.1.3 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.

Ensure motors are premium efficiency in accordance with NEMA MG 1 Table 12-12.

Ensure efficiency labeling is in accordance with NEMA MG 1.

2.1.4 Electrically Driven Equipment

When electrically driven equipment differs from that indicated, make adjustments 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 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES] [and][Section 26 24 19.00 40 MOTOR CONTROL CENTERS].

2.1.5 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	1125 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	120-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	1.5 and larger	480-volt, 3-phase, 3 or 4-wire	230/460-volt, 3-phase, 60-hertz

2.1.6 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][H] [_____].

2.2 COMPONENTS

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

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2.2.1 Motor Housing

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NOTE: Health monitoring of electric motors is a useful predictive technology for maintenance and

operation of motors. The following paragraphs ensure motors are installed with provisions for installation of temporary accelerometers only. Installation of permanent accelerometers and health monitoring system is not included in this specification.
****

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.

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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: Ensure surface is level to prevent accelerometer magnet from rocking.
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Ensure surface is level within 1 degree or 0.0254 millimeters 0.001 inch.

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

2.2.2 Motor Enclosures

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

NOTE: Delete paragraphs below for enclosure types that are not applicable to the project.
****

2.2.2.1 Indoor Type Enclosures

[For motors installed in indoor, clean, dry, non-hazardous 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, non-hazardous 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, non-hazardous 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.

]2.2.2.2 Outdoor Type Enclosures

[For motors installed in outdoor, non-hazardous locations, provide waterproof enclosures.

]

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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 if required.

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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].

[2.2.2.3 Hazardous Type Enclosures

For motors installed in hazardous locations for Classification I, Division [1][2], meet or exceed the minimum requirements of NFPA 70, Article 501.8, using hazard type enclosure for the class and group of hazard in which the

motors are located. Ensure motor is approved by the Contracting Officer prior to fabrication.[

Provide all motors with hazard rated enclosures with permanent accelerometers installed in the horizontal, vertical, and axial directions. Ensure the enclosure has a sealed penetration installed to enable the accelerometer cables to be routed to outside of the enclosure.]

]2.3 TESTS, INSPECTIONS, AND VERIFICATIONS

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. Install alignment jack bolts for motors over [7.5][10][15][20][25] hp to enable alignment.

3.1.1 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

Speed(RPM)	Close-Coupled Offset (mils)	Close-Coupled Angle(mils/in.)	Spool Piece Angle (mils/in. @ coupling pt.)
1800	3.0	0.5	1.0
3600	1.5	0.4	0.5
7200	1.0	0.3	0.4

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

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

Provide written final alignment settings as part of the final test data.

3.2 FIELD QUALITY CONTROL

Submit Field Test Report containing results of all tests and checks contained in paragraphs entitled "Electrical Tests" and "Vibration Tests". Catalog and bind results. Submit to the Contracting Officer before Final Acceptance.

3.2.1 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 not to exceed 10 minutes. Ensure Megohm readings are not 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 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. Verify that the polarization index is less than 1.25[_____]. Reject any lower values and return the motor to the factory.

3.2.2 Vibration Tests

3.2.2.1 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.

3.2.2.2 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)
0.3 x RPM to 0.8 x RPM	0.04
0.8 x RPM to 1.2 x RPM	0.75
1.2 x RPM to 3.5 x RPM	0.04
3.5 x RPM to 120,000cpm	0.03

3.3 CLOSEOUT ACTIVITIES

3.3.1 Operation and Maintenance

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

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.

3.3.2 Warranty

Submit manufacturer's warranty to the Contracting Officer no later than

[10] [20] [30] [_____] days prior to final [inspections][acceptance].

-- End of Section --