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USACE / NAVFAC / AFCEC **UFGS-26 29 02.00 10 (November 2022)**

Preparing Activity: USACE **Superseding**
UFGS-26 29 02.00 10 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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ELECTRIC MOTORS, 3-PHASE VERTICAL SYNCHRONOUS TYPE

11/22

PART 3   EXECUTION

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SECTION 26 29 02.00 10

ELECTRIC MOTORS, 3-PHASE VERTICAL SYNCHRONOUS TYPE
11/22

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NOTE: This guide specification covers the requirements for the procurement of three-phase vertical synchronous motors, 1118 kW 1500 horsepower and above, for driving storm-water pumps for local flood-control pumping stations. This section was originally developed for USACE Civil Works projects.

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

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NOTE: This Section covers motors with special features of construction which are considered necessary to provide maximum insurance against failures where the motors are to be operated only for short periods of time, at infrequent intervals, and at locations where the average relative humidity of the air is high. Where operating characteristics or features of motor construction are different from those normally specified, this specification must be modified accordingly. The designer must also

consider unusual service conditions such as direct exposure to the sun, vermin infestation, or high altitude.

In adapting this specification to any project, the form and phraseology will be changed as necessary to properly specify the work contemplated. When deviations from this specification are considered, necessary prior approval from HQUSACE will be obtained.

Instructions for Section 35 45 01 VERTICAL PUMPS, AXIAL-FLOW AND MIXED-FLOW IMPELLER-TYPE, specify that Section 4 of Part IV, Technical Provisions, be reserved for insertion of the technical provisions of this guide specification.

The following should be included in section "L" of standard form 36, Information to Bidders.

"It is preferred that the field poles be secured to the rotor structure by means of dovetails, but an alternate method of construction will be acceptable, provided that evidence of its adequacy, satisfactory to the Contracting Officer, is submitted with the bid."

The designer should consider prequalifying the bidders based on past experience with this type and size of motor. Criteria for qualifying should be included in section "L" of standard form 36.
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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.

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM B344	(2020) Standard Specification for Drawn or Rolled Nickel-Chromium and Nickel-Chromium-Iron Alloys for Electrical Heating Elements

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 43	(2013) Recommended Practice for Testing Insulation Resistance of Rotating Machinery
IEEE 115	(2019) Guide for Test Procedures for Synchronous Machines: Part I Acceptance and Performance Testing; Part II Test Procedures and Parameter Determination for Dynamic Analysis
IEEE C37.96	(2012) Guide for AC Motor Protection
IEEE C57.13	(2016) Standard Requirements for Instrument Transformers

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 4	(2015) Application Guideline for Terminal Blocks
NEMA MG 1	(2021) Motors and Generators

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 and Air Force 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.
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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. Submittals not having a "G" or "S" classification are 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-02 Shop Drawings

Motors; G, [_____]

SD-03 Product Data

Insulated Windings; G, [_____]

Witness Test; G, [_____]

Motors; G, [_____]
Government Study

Spare Parts

Antireverse Device; G, [_____]

SD-06 Test Reports

Factory Tests

Acceptance Checks And Tests; G, [_____]

SD-07 Certificates

Power Factor and Efficiency

Factory Tests

Complete Test

Check Tests

SD-10 Operation and Maintenance Data

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

[Long Term Storage; G, [_____]]

1.3 QUALITY ASSURANCE

1.3.1 Corrosion Prevention and Finish Painting

The equipment provided under these specifications will be subjected to severe moisture conditions. Design and construct the equipment to render it resistant to corrosion from such exposure. The general requirements to be followed to mitigate corrosion are specified below. Any additional special treatment or requirement considered necessary for any individual items is specified under the respective item. However, other corrosion-resisting treatments that are the equivalent of those specified herein may, with the approval of the Contracting Officer, be used.

1.3.1.1 Corrosion-Resisting Materials

Corrosion-resisting steel, copper, brass, bronze, copper-nickel, and nickel-copper alloys are acceptable corrosion-resisting materials.

1.3.1.2 Corrosion-Resisting Treatments

Hot-dip galvanizing must be in accordance with ASTM A123/A123M or ASTM A153/A153M as applicable. Other corrosion-resisting treatments may be used if approved by the Contracting Officer.

1.3.1.3 Frames

Clean rust, grease, millscale, and dirt from motor frames, end bells, covers, conduit boxes, and any other parts, if of steel, and if they will be coated during the process of insulating the windings. Then treat and rinse in accordance with manufacturers' standard process. If any of the above-listed parts are not coated during the process of insulating the windings then, in addition to the above, give them two coats of primer and then two coats of manufacturers' standard moisture-resistant coating, processed as required.

1.3.1.4 Cores

Thoroughly clean and then immediately prime the assembled motor core by applying a minimum of two coats of a moisture-resisting and oil-resisting insulating compound. Give air gap surfaces a minimum of one coat.

1.3.1.5 Shafts

Clean rust, grease, and dirt from exposed surfaces of motor shafts. Except for bearing surfaces, give one coat of a zinc molybdate or equivalent primer and two coats of a moisture-proof coating, each cured as required. Shafts of a corrosion-resisting steel may be used in lieu of the above-mentioned treatment.

1.3.1.6   Finish Painting

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NOTE: If severely moist conditions exist, a separate paint system should be specified using Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES, system 21, epoxy finish or equivalent. When such painting is specified, care must be taken to specify a paint that will adhere to and not be injurious to the protective painting provided under these specifications.
****

Finish painting of all equipment in accordance with the standard practice or recommendation of the manufacturer for the installed conditions, as approved by the Contracting Officer.

1.3.1.7   Fastenings and Fittings

Where practicable, all screws, bolts, nuts, pins, studs, springs, washers, and other similar fittings must be of corrosion-resisting material or must be treated in an approved manner to render them resistant to corrosion.

1.3.2   Government Study

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NOTE: Item d. may be used only when the pump and motor are furnished under the same procurement.
****

Submit the specified data. Supply to the Government, for completion of its Motor Torque and Accelerating Time Studies (MTATS), the following data:

a. Complete equivalent circuit data referred to the stator with friction, windage, and stray load losses.

b. Current, power factor, and torque versus speed (0-100 percent, inclusive, in 1 percent increments up to 95 percent and 0.1 percent increments above 95 percent) and load (0-125 percent, inclusive, in 25 percent increments) as a function of line voltage (from 80 percent to 110 percent, inclusive, in 5 percent increments), for rated and 90 percent of rated voltage at starter. Only tabulated data will be required.

c. Load inertia, Wk2 of motor rotating parts, pound-foot2.

[d. Load inertia, Wk2 of pump rotating parts (wet), pound-foot2.]

1.4   DELIVERY, STORAGE, AND HANDLING

Ship each motor in the vertical position with the rotor blocked inside the stator to prevent damage to the bearings. Securely mount the motor on a skid or pallet of ample size. Box all small parts or elements. Perform the skid mounting and boxing in a manner which will prevent damage or distortion to the motor during loading, shipment, unloading, indoor storage, and subsequent handling. Provide weatherproof covers as necessary to protect the motor and appurtenances during shipment. [Furnish for unloading and handling at the destination any eyebolts, special slings, strongbacks, or other devices used in loading the equipment at the manufacturer's plant. Devices must become the property of the Government.]

1.4.1 Impact Recorder

Ship each motor with a three-way temporary impact recorder to measure magnitude and direction of longitudinal (Y), lateral (X), and vertical (Z) impacts suffered during shipment. If the recorder indicates impacts equal to or greater than those determined by the Contractor prior to shipment for any of the three directions specified herein, inspect and test motor to determine extent of damage, if any, and repair or replace any damaged equipment.

[1.4.2 Long Term Storage

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NOTE: The designer will include this paragraph only when there is no available Government storage. The designer should also investigate storage to be used by the installation Contractor and the possibility of making this a requirement under the installation contract.

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Store all equipment provided under this contract for [_____] [days] [months]. The storage site must meet the manufacturer's recommendations for indoor storage. The equipment will be subject to periodic inspection by the Government to ensure that proper storage conditions are maintained. Submit the storage site description, location, description of environmental controls, and means of access.

]1.5 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies.

1.6 EXTRA MATERIALS

Furnish the following spare parts for each type and rating in addition to the assembled motors:

a. Two complete stator coils but not less than the number of coils to span one coil pitch with necessary wedges and material for installation for one motor.

b. Two complete field coils, including necessary materials for installation.

c. One complete exciter field coil, including necessary materials for installation.

d. One complete set of bearing parts for pump motors. Each set to include:

    (1) Stationary thrust bearing plate.

    (2) Rotating thrust bearing plate.

    (3) Upper guide bearing lining.

(4) Lower guide bearing lining.

(5) Two sets of oil rings for pump motors.

[(6) One complete set of parts necessary for replacement of antireverse device.]

[(7) Spare lubricant in sufficient quantity to purge and refill the system.]

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

The work under this section includes furnishing all labor, equipment, and material and performing all operations required to design, manufacture, assemble, factory test, prepare for shipment and storage, and to deliver the vertical synchronous motors required to drive the flood-control pumps specified under Section 35 45 01 VERTICAL PUMPS, AXIAL-FLOW AND MIXED-FLOW IMPELLER-TYPE. Supply these motors complete with all accessories, spare parts, tools, and manufacturer's data and instructions as specified herein.

a. With the instruction manuals, submit a complete list of renewal parts for the motor.

b. Submit instructions manual for the proper installation, erection, inspection, and maintenance of the machines furnished under this contract not later than the date the equipment is shipped from the manufacturer's plant. Manuals must include complete installation, maintenance, and service instructions for the motors, lube oil system, thrust bearings (including cooling water requirements), and other accessories.

c. The instructions must include a cross-sectional drawing indicating the major component parts of the motor and procedure for disassembly. [Coordinate the description in the manual for the motor with the installation erection instructions specified in Section 35 45 01 VERTICAL PUMPS, AXIAL-FLOW AND MIXED-FLOW IMPELLER-TYPE for the pump and integrated with same for a complete motor and pump assembly.]

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NOTE: Include contract specification number where service conditions are described.
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d. Insulation for the stator, rotor field, and exciter windings must be full class "F" insulation as defined in NEMA MG 1 paragraph 1.66 and as described herein. The insulation system must be a combination of materials and processes which provides high resistance to moisture, fungus, and other contaminants as experienced by a motor in the service conditions specified herein.

e. The insulation system must also be of a type designed and constructed to withstand severe humidity conditions and to function properly after long periods of idleness without first drying out. All windings and connections must be of the sealed type as defined in NEMA MG 1 paragraph 1.27.2. Completely assemble insulated windings in the motor core before impregnating with the insulating compound. The compound must consist of 100 percent solid resin. Submit a detailed description of and specification for the manufacturing process, the materials and the insulating compound used in insulating the windings for approval before manufacture of the motors is commenced. If, in the opinion of the Contracting Officer, the insulation proposed is not of the quality specified and if the methods of manufacture are not considered to be in accordance with best modern practice, the motors will not be accepted. Impregnation of the windings with the insulating compound must be by vacuum impregnation method followed by baking. Repeat the procedure as often as necessary to fill in and seal over the interstices of the winding, but in no case must the number of dips and bakes be less than two dips and bakes when the vacuum method of impregnation is used.

f. Process insulation to ground on the coil. Slot tubes or cells are not acceptable. The insulation must be of adequate thickness and breakdown strength throughout the length of the coil. Use mica in the slot portion of adequate thickness to withstand the dielectric tests specified in paragraph FACTORY TESTS.

2.2 NAMEPLATES

Include rated voltage, rated full-load amperes, rated horsepower, service factor, number of phases, RPM at rated load, frequency, code letter, locked-rotor amperes, duty rating, insulation system designation, and maximum ambient design temperature in the nameplate data. On each motor, provide a nameplate listing motor characteristics in accordance with NEMA MG 1 paragraph 21.25. Furnish a separate starting information nameplate as specified in paragraph OPERATING CHARACTERISTICS. On each motor, provide a starting information nameplate setting forth the starting capabilities in accordance with NEMA MG 1 paragraph 21.25. This nameplate must also include the minimum time at standstill and the minimum running time prior to an additional start.

2.3 GUARDS AND PROTECTIVE ENCLOSURES

All moving, energized, or other parts where accidental contact might be hazardous to personnel must be equipped with adequate guards, rails, or other suitable enclosures to prevent accidental contact. Pipe all lubrication fittings to convenient locations where they can be serviced from regularly utilized access ways without removal of the guards or enclosures. All guards and protective enclosures must comply with NEMA MG 1 Part 5.

2.4 MOTORS

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NOTE: For weak source (high thevenin source impedance), the electric utility should be contacted to determine starting restrictions, maximum inrush, or voltage dip limits. This is especially critical for motors over 75 kW 100 hp. The designer must then perform a motor torque and accelerating time study (MTATS) to evaluate the motor starting torque and voltage dip requirement. The selection of a reduced voltage starter will be based on the electric utility requirements and the motor pump arrangement.

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The motors to be supplied under these specifications must be of the vertical [solid] [hollow] shaft type as required by the pump manufacturer, with direct-connected brushless exciter, designed for full voltage starting, of drip-proof construction, [complete with antireversing ratchet or backstop device], and must conform to the applicable requirements of NEMA MG 1, except as hereinafter specified.

a. Submit equipment foundation dimensions; outline drawings for motor and rotor set-down fixture and jacking provisions with weights, nameplate data, and details showing method of mounting and anchoring the motor. Obtain Contracting Officer's approval in writing prior to the commencement of manufacture of motors.

b. Submit complete descriptive specification for each type and size motor furnished, with necessary cuts, photographs, and drawings to clearly indicate the construction of the motor, specifications for the materials and treatments used to prevent corrosion of parts, and of bearing construction.

c. Submit a complete listing of motor performance data in the form provided in NEMA MG 1 paragraph 21.50. Include with the submittal all information required for the selection of protective and control equipment and for operational settings. Information such as, but not limited to, normal and maximum operating temperatures for windings and bearings, V-curves, field control and protective equipment to be mounted on the motor controller cubicle, locked-rotor current, permissible locked-rotor time, starting times for each type of start as indicated above, and subtransient, transient, and synchronous reactance.

d. If duplicate equipment has not been manufactured previously, perform and confirm calculations or tests as required by paragraph FACTORY TESTS. Obtain Contracting Officer's approval in writing prior to the commencement of manufacture of motors.

2.4.1 Rating

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NOTE: The local electric utility should be consulted for the expected average and maximum values of percentage voltage unbalance, as defined in NEMA MG 1 paragraph 21.81.2, that will be present at the pumping station. If either value exceeds 1 percent as recommended in NEMA MG 1 paragraph 21.81, the utility should be requested to furnish their plans to improve the voltage unbalance. If they are unable to do so, then the motor should be derated where the voltage unbalance exceeds 1-2 percent. Voltage unbalance should never exceed 5 percent. Motor manufacturers should be consulted for voltage unbalance limits whenever motors have specified limits on locked-rotor currents, particularly the 500 percent limit.

****

Wind each motor for three-phase, 60 Hz, alternating current, and for the respective operating voltage listed below:

PLANT	PUMP	PUMP SERVICE	MOTOR OPERATING VOLTAGE
[_____]	[_____]	[_____]	[_____]
[_____]	[_____]	[_____]	[_____]

Design the motor for operation in a 40 degrees C 104 degrees F ambient temperature, and all temperature risers must be above this ambient temperature. The rated horsepower of the motor must be not less than 110 percent of the determined maximum load requirement of the pump. [Supply voltage unbalance will be [_____] percent. The motor rated horsepower will be further derated according to NEMA MG 1 paragraph 21.29 for a voltage unbalance above [1.5 percent] [2 percent].] Motors must have a power factor and service factor of 1.0. The temperature rise above the ambient temperature for continuous rated full load conditions and for the class of insulation specified must not exceed the values given in NEMA MG 1 paragraph 21.40.

2.4.2 Operating Characteristics

2.4.2.1 Torques

****

NOTE: This guide specification identifies closed transition autotransformer-type reduced voltage starters. These starters provide the most flexibility during installation, when exact load and line characteristics are not determined, since both input voltage and inrush current may be adjusted. This specification is not meant to limit the selection of reduced voltage starter to only autotransformer type. The use of wye-delta type starter may be appropriate in certain situations. The reduced starter cost must be weighed against the increase cost in motor designs; however each design should be evaluated for the most suitable type starter. All reduced voltage starters will reduce the motor starting torque, so the designer should evaluate the load characteristics to ensure that motor torque will be sufficient under all starting conditions. If reduced-kVA starters are required, EM 1110-2-3105 should be consulted for further guidance.

****

Starting and accelerating torque must be sufficient to start the pump and accelerate it against all torques experienced in passing to the pull-in speed under maximum head conditions and with rated excitation current and a terminal voltage equal to [90 percent of rated value] [the output of a closed-transition autotransformer type reduced-voltage starter supplied at 90 percent of rated voltage and connected on its [80] [65] percent tap]. The pull-in torque must exceed that required by the load under maximum load conditions but must not be less than 100 percent of motor full-load torque, with a terminal voltage equal to 90 percent of rated value. Pull-out torque must not be less than 150 percent of motor full-load torque for one minute minimum and with a terminal voltage equal to 90 percent of rated value.

2.4.2.2   Locked-Rotor Current

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NOTE: The objective of this specification is to limit the locked-rotor current to a value sufficiently low to permit full-voltage starting. The motor horsepower rating is to be a minimum of 110 percent of the maximum pump load at a service factor of 1.0. Manufacturer's standard is to limit locked-rotor current to 600 percent of full load current. However, local utilities may have additional limitations on inrush currents and should be consulted. Motor design will permit some reduction in inrush current in which case 500 percent should be used. If this is not sufficient, reduced-voltage starting should be used. The inrush current limit should be specified whenever possible.
****

The locked-rotor current must not exceed [600] [500] percent of rated nameplate full load running current. [The locked-rotor current must not exceed [_____] amperes at 90 percent of rated voltage during any point in the starting cycle under worst case starting conditions. For autotransformer reduced voltage starting, the above criteria apply to the primary side and at any prescribed tap.]

2.4.2.3   Starting Capability

Each motor, when operating at rated voltage and frequency and on the basis of the connected pump load inertia, Wk2, and the speed-torque characteristics of the maximum load during starting conditions as furnished by the pump manufacturer, must be capable of making the starts required in NEMA MG 1 paragraph 21.43.

2.4.2.4   Balance

The balance for each motor must be in accordance with NEMA MG 1 Part 7. [Each motor's characteristics must be such that the maximum vibration requirements of Section 35 45 01 VERTICAL PUMPS, AXIAL-FLOW AND MIXED-FLOW IMPELLER-TYPE are met.]

2.4.2.5   Noise

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NOTE: The Department of Defense considers hazardous noise exposure of personnel as equivalent to 85 dB or greater: A-weighted sound pressure level for eight hours in any one 24-hour period. On the assumption that pumping plant operating personnel may be exposed to noise levels approaching or exceeding that defined by the DOD as hazardous, the motor noise limit should be specified not to exceed 85 dBA. The additional cost of providing motors meeting this requirement should be investigated and weighed against an alternate of providing a room to isolate these personnel from the noise exposure.
****

All motors must operate at a noise level less than 85 decibels A-weighted mean sound pressure level (dBA). Determine noise in accordance with NEMA MG 1 Part 9.

2.4.2.6 Overspeed Option

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NOTE: NEMA MG 1 paragraphs 12.48 and 21.45 specify that overspeeds are for emergencies lasting no longer than one minute. Using this option will increase costs due to requirements well beyond standard limits. Designer must do a cost analysis before selection of this option.
****

Design each motor to withstand indefinitely, without injury, the maximum overspeed to which the motor will be subjected when the pump to which it is connected is acting as hydraulic turbine under the maximum head with the pump discharge pipe open.

2.4.2.7 [Antireverse Device

Install a self-actuated backstop device or antireversing ratchet, to prevent reverse rotation of the pump due to loss of power or failure of the electric prime mover, as an integral part of the motor. Submit the design of the antireverse device for approval by the Contracting Officer, such that its action is without intentional delay or excessive backlash. It must have sufficient capacity to prevent reverse rotation with a back flow through the pump due to a [_____]-foot differential head. The device must be precision machined and be complete with support housing and oil collector as required. Provide an oil reservoir, independent of the one used for the thrust bearing, complete with oil-level gauge and 120-volt ac rated high and low level contacts for the backstop device. The lubricant for the antireverse device must contain a corrosion inhibitor. Show the type and grade of the lubricant on a special nameplate attached to the frame of the motor adjacent to the lubricating filling device.]

2.4.2.8 [Power Factor and Efficiency

****
NOTE: List power factor and efficiency for each size only if high efficiency motors are required. Generally manufacturers' standards will be used.
****

The power factor and efficiency at full load, 3/4 full load, and 1/2 full load must be not less than [_____], [_____], [_____] and [_____], [_____], [_____], respectively. Submit certification guaranteeing value of power factor and efficiency for full load, 3/4 full load, and 1/2 full load. Motors will be rejected if factory tests specified in paragraph FACTORY TESTS do not demonstrate that these values will be met or exceeded.]

2.4.3 Frames and Brackets

Frames and end brackets must be of cast iron, cast steel, or welded steel. The mounting ring, unless otherwise approved, must be built integral with the frame or lower end bracket. Coordinate the motor installation with the mounting arrangement specified in Section 35 45 01 VERTICAL PUMPS: AXIAL-FLOW AND MIXED-FLOW IMPELLER-TYPE, paragraph BASE

PLATE AND SUPPORTS. Furnish all equipment and materials required to mount the motor, such as a base or pedestal, sole plates, and bolts or dowels. Install sufficient bolts and dowels to prevent any possible movement of the motor assembly when the motor is subjected to stresses resulting from the most severe short-circuit conditions. Treatment against corrosion must be as specified in paragraph QUALITY ASSURANCE.

2.4.3.1 Stator Frame

The stator frame must be rigid and sufficiently strong to support the weight of the upper bearing bracket load, the weight of the stator core and windings, and to sustain the operating torques without perceptible distortion.

2.4.3.2 Supporting Brackets

The upper bracket supporting the thrust bearing and upper guide bearings must have sufficient strength and rigidity to support the weight of the entire rotating element of the motor, together with the pump impeller and shaft, and the unbalanced hydraulic thrust of the pump impeller. If feasible, design and construct the lower bracket supporting the lower guide bearing so the entire rotor can be lifted out as a unit without disturbing the bearing alignment. If it is not feasible to construct the rotor so that it can be lifted out as a unit, support the lower bracket on separate base plates or structure and design so that it can be removed through the stator. The maximum deflection of the thrust bearing support system at any point must not exceed the limits set by the pump manufacturer to maintain proper clearances for any operating condition.

2.4.3.3 Eyebolts

Provide eyebolts, lugs, or other approved means for assembling, dismantling, and removing the motors from above, utilizing the overhead pumping station building crane. Furnish with the motor all lifting devices for use in conjunction with the building crane.

2.4.3.4 Platforms and Stairways

Furnish each motor with a platform and stairway complete with railing. Provide an easily removed section of railing so that the rotor shaft does not have to be hoisted above the railing when the rotor is removed. The platform must also provide maintenance access as required by the motor furnished. Locate the stairway [_____] degrees [counter-] clockwise from the discharge elbow of the pump, when looking down on the motor/pump assembly.

2.4.4 Insulation Against Stray Currents

The motor must be adequately insulated against stray currents which may be set up by the field of the motor and which might cause injury to the motor or pump bearings. Arrange this insulation to break the possible path of such currents in not less than two places in series.

2.4.5 Motor Cooling

Provide the motor with an open-type system of ventilation, taking cooling air from above the operating floor level and discharging the heated air into the operating room through upper openings in the stator frame. Induce the circulation of air by means of the fan action of the rotor. No openings to the air space below the operating level are to be used in the motor design for ventilation or other uses that are not reasonably airtight.

2.4.6 Stator

2.4.6.1 Stator Core

The cores must be built up of separately punched thin laminations of low-hysteresis loss, nonaging, annealed, electrical silicon steel; assembled under heavy pressure; and clamped in such a manner as to ensure that the assembled core is tight at the top of the teeth of the laminated core. Laminations must be properly insulated from each other. Use only laminations free from burrs, and remove all burrs or projecting laminations from the slots of the assembled cores. Cores must be keyed, dovetailed, or otherwise secured to the shaft or frame in an approved manner. Treatment against corrosion must be as specified in paragraph QUALITY ASSURANCE.

2.4.6.2 Stator Coils

Thoroughly insulate and treat the coils with a moisture and fungus-resisting compound in such a way that air will be excluded and the insulation will be protected from the absorption of moisture. Provide additional insulation for those portions of each coil which are within the slots. The coils must fit the slots accurately and they must be form wound and interchangeable. Design and construct the end turns that they will not be distorted under the most severe short-circuit conditions to which the motor may be subjected.

2.4.6.3 Insulated Stator Windings

Insulate the stator windings as specified in paragraph QUALITY ASSURANCE. Coils must be of such uniformity that the stator windings of all similarly rated motors will be alike, in shape and size, and interchangeable. Fully brace the stator winding and end turn connections to withstand repeated full voltage starts. The bracing system must essentially eliminate coil vibration under these high current conditions as well as during normal operation. A tieless bracing system will be acceptable. If a tied system is used it must be such that no tie depends upon the integrity of any other tie within the system.

2.4.6.4 Temperature Detectors

Provide in the stator six standard copper resistance-type temperature detectors, with a resistance of 10 ohms at 25 degrees C 75 degrees F, in accordance with NEMA MG 1 paragraph 20.27. Detectors must be wired in accordance with paragraph ACCESSORY WIRING AND BOXES.

2.4.6.5 Grounding

The stator frame must have provisions for solidly grounding to the station ground system which will be furnished and installed by others.

2.4.7 Rotor

Build the rotor in accordance with the best modern practice and in such a manner as to secure adequate strength for the operating conditions described herein. Build up the pole pieces of thin steel laminations accurately aligned and securely riveted or bolted together.

2.4.7.1 Field Windings

Insulate the field windings as specified in paragraph QUALITY ASSURANCE. Adequately insulate the field coils between turns and from the pole pieces. Thoroughly brace to withstand the stresses which could be imposed under maximum pump speed.

2.4.7.2 Starting Windings

Design the starting windings for full-voltage starting, securely built into the field poles and designed to ensure conservative stresses when the unit is operating at maximum pump speed. The bars must be silver soldered or brazed to heavy end segments to form a low-resistance joint of high mechanical strength. Design the starting windings to permit any pole or group of poles to be removed.

2.4.8 Exciter

Provide each synchronous motor with a direct connected exciter without brushes, commutators, or additional bearings. The exciter must be capable of supplying continuously, and without overheating, the excitation for the motor to which it is connected when the latter is operating at rated power factor, voltage, frequency, and horsepower. Accomplish the field-protective function and the field switching and application function by semiconductor elements mounted on suitable heat sinks supported on the motor rotor and ventilated by rotation of the rotor. The exciter must be either built into or so arranged that it is ventilated from the main motor enclosure. The enclosure of the exciter must be of drip-proof construction comparable to that of the motor. The control system must apply excitation to the motor field at the speed and phase angle required to obtain maximum pull-in torque. Insulate the exciter windings as specified in paragraph QUALITY ASSURANCE. The field coils must be adequately insulated between turns and from the pole pieces and must be thoroughly braced to withstand the stresses which could be imposed under maximum pump speed.

2.4.9 Shaft

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NOTE: Use hollow shaft pumps whenever possible, since they are more readily adjusted. Pumps requiring large motors (above 746 kW 1,000 hp) are limited by the available motors. Investigate the exact motor capabilities and sources of supply when using hollow shafts with motors above 746 kW 1,000 hp. Solid shafts will be used only when the available motor designs require their use.

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Make the motor shaft of high grade steel, finished all over, and of ample size to drive the pump under maximum load conditions. The shaft must be of the [solid type and must be connected to the pump shaft with a rigid adjustable coupling.] [hollow type and must be connected to the pump shaft above the thrust bearing in a manner that will permit the pump impeller to be adjusted vertically]. Coordinate the connection with the pump shaft and furnish a motor shaft with all provisions, fittings, and devices required to conform to the shafting arrangement specified in Section

35 45 01 VERTICAL PUMPS, AXIAL-FLOW AND MIXED-FLOW IMPELLER-TYPE, paragraph SHAFTS. See paragraph QUALITY ASSURANCE for treatment against corrosion.

2.4.10 Bearings

2.4.10.1 Thrust Bearings

Provide thrust bearings of the spring type located above the rotor. A design in which each pivot shoe rests upon a support of metal which may take a permanent deformation in order to equalize the load on the bearing shoes, or in which individual shoe pivots are supported on spring plates or spring disks, is not considered to be of the self-equalizing type and will not be acceptable. The stationary shoes must be babbitt-lined. The thrust bearing must have ample capacity to support the maximum pump hydraulic thrust load plus the static load while operating under maximum rated pump conditions. [The thrust bearing must be capable of withstanding without injury the pump being started normally without prior jacking of the rotor.] The thrust bearing must have a removable runner and must be arranged to permit adjustments, dismantling, and assembly of the runner and shoes without disturbing the stator or rotor, other than jacking the load from the bearing. A spacer plate between the thrust bearing runner plate and the thrust block will not be permitted.

2.4.10.2 Guide Bearings

Except as permitted below, provide the motor with two guide bearings, one located above the rotor and the other below the rotor. The guide bearings must be capable of withstanding all stresses incident to the normal operation of the unit [and to the maximum runaway speed]. Both guide bearings must be self-cooled, of the oil-immersed, self-oiling type. Prevent oil or oil vapor from entering the motor cooling system. The guide bearings must be of the split-sleeve type. Design and construct the guide bearing so that they can be dismantled without disturbing the thrust bearing or the motor rotor. The Contractor may combine the thrust bearing and the upper guide bearing into a combination integral guide and thrust bearing assembly in a common housing. In such a combination bearing, use the vertical side of the thrust-bearing block, but not the runner plate, as the journal surface.

2.4.10.3 Lubrication

Use lubricating oil containing a corrosion inhibitor. Show the type and grade of lubricant on a special nameplate and attach to the frame of the motor adjacent to the bearing filling device. Each lubrication system must include oil reservoirs, oil-level sight gauge, oil piping, valves, and necessary appurtenances.

2.4.10.4 Bearing Housing

Bearing housing must be of a design and method of assembly that will permit ready removal of the bearings, and prevent escape of lubricant and entrance of foreign matter. Protect the bearings with the lubricant when the motor is idle. Provide suitable means to apply and drain the lubricant. Provide oil-level indicator gauges for oil-lubricated bearing housings.

2.4.10.5   Cooling

Each thrust bearing must be self-cooling whenever possible. When required by motor speed or load, provide an oil cooler with suitable coils of corrosion-resisting metal in the oil reservoir of sufficient capacity to maintain the oil at the proper temperature with [30 percent glycol] cooling water entering the coils at a temperature of [30] [_____] degrees C and with a minimum pressure of 40 pounds per square inch. Design the cooler for safe operation at a maximum working pressure of 345 kPa 50 psi. At the factory, subjected the cooler to a hydrostatic test pressure of 517 kPa 75 psi for a period of one hour without leakage. Cooling water will be supplied by a central system, furnished by others, consisting of a radiator, circulating water pump, and piping system terminating at the exterior of each motor. If required an auxiliary-motor-driven circulating oil pump, rated at 480 volts, three-phase, with electrical leads terminated in a special terminal box on the motor, include an oil pressure sensing device in the bearing oil cooler system. Construct the cooler system so that the thrust bearing can be readily inspected or removed for repairs. Include a water flow indicator with adjustable alarm contacts in the water supply line. The oil reservoir must have an oil-level gauge with high and low level normally open contacts rated 120 volts ac.

2.4.10.6   Temperature Detectors

Provide a standard copper resistance-type temperature detector, with a resistance of 10 ohms at 25 degrees C 75 degrees F, for each bearing. Casings must be made of copper. Wire detectors in accordance with paragraph ACCESSORY WIRING AND BOXES.

2.5   INSTRUMENTS AND GAUGES

Furnish the following instruments and gauges.

2.5.1   Thermometers

Provide indicating thermometers, 150 mm 6 inch vapor-tension [dial-type] [digital], with adjustable ungrounded alarm contacts suitable for 120 volts ac for (a) the thrust bearing, (b) the thrust bearing oil reservoir, and (c) each guide bearing. Locate the bulbs to indicate the temperatures of the hottest parts. Mount the thermometers on a thermometer panel and locate on the motor housing at a location approved by the Contracting Officer. Provide adequate length of tubing with each thermometer. Insulate the bulb and tubing where necessary to prevent bearing currents. [The dial-type thermometers must be of the [round][square] semiflush type with black cases, white dials, and black figures and pointers.] [The digital thermometers must be square, semiflush type with black cases and minimum 25 mm 1 inch high display.]

2.5.2   Temperature Relay

Provide a pneumatic bearing temperature relay having two sets of electrically independent contacts, located close to the babbitt of the thrust bearing [and each guide bearing]. Each relay must close its contacts when the bearing temperature reaches approximately 105 degrees C 220 degrees F. The contacts must have a current-carrying capacity of not less than 10 amperes, must be ungrounded, and must be suitable for 120 volts ac. Mount the relays in an approved accessible location. Bring the leads to a terminal block mounted on the stator frames in an approved location. The bulbs for the temperature relays must be easily accessible and constructed for removal and testing without disturbing the bearing or bearing housing. Insulate the tubing where necessary to prevent bearing currents.

2.5.3 Oil-Level Gauge

Provide an oil-level gauge for each oil reservoir, with scale of sufficient length to indicate the oil level at all room and operating temperatures. Locate the gauges near the reservoirs in an approved, accessible location where they can be easily read. Each oil-level gauge must have adjustable high and low oil-level ungrounded alarm contacts suitable for 120 volts ac.

2.6 PIPING

Design and furnish all piping systems within the motor for bearings, including valves and fittings. Bring these connections out to approved positions at the bottom of the stator frame. Clean all piping inside and cap for protection where ending in open connections for other work. Valves and other operating devices must be easily accessible, and mount gauges and indicating devices on a control panel as approved by the Contracting Officer. Piping and fittings must be of copper or brass as required. Valves must have bronze seats and stems and must be suitable for the service intended. At all points where the piping system must be disconnected for dismantling operations, provide bolted flange connections or unions. Arrange piping and location of valves and joints to minimize disturbance to piping or interference with other service when the motor is dismantled or parts are removed for inspection or repairs.

2.7 WINDING SPACE HEATERS

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NOTE: The inclusion or omission of "Winding Space Heaters" will depend upon the decision reached after giving due consideration to the problem of prevention of moisture condensation on the station equipment.

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Install heaters in the lower section of the frame or wrap them around the winding end turns. Design heaters for operation on 120 volts, single-phase, 60-Hz, alternating current and with sufficient capacity or wattage that, when energized, they will hold the temperature of the motor windings approximately 10 degrees C above the ambient temperature. Heaters must be de-energized when motor is operating.

2.7.1 Construction

The heaters, except for wrap-around type, must be of the tubular type, constructed with a chrome-nickel heating element embedded in a refractory insulating material, and encased in an approved watertight metal sheath. Design heaters for continuous operation with a maximum watt density of 20 watts per square inch. The rate of heat dissipation must be uniform throughout the effective length of the heater. Cartridge-type heaters of equivalent construction, as approved by the Contracting Officer, will be acceptable. Heaters installed around the winding end turns must consist of the required turns of heating cable wrapped around the end turns and secured in place before the winding is impregnated.

2.7.2 Element

Heating element must conform to the requirements of ASTM B344 for an 80 percent nickel and 20 percent chromium alloy.

2.7.3 Sheath

Sheath must be of a corrosion-resisting, nonoxidizing metal and must have a wall thickness not less than 0.625 mm 0.025 inch.

2.7.4 Insulation

Insulation must be a granular mineral refractory material, highly resistant to heat, and must have a minimum specific resistance of 1,000 megohms per inch cubed at 585 degrees C 1,000 degrees F. Insulation for the heating cable (winding wrap-around type heaters) must be suitable for a conductor temperature of 180 degrees C 356 degrees F.

2.7.5 Terminals

Terminals of the heater, including the leads, must be watertight. Provide heater terminals with leads suitable for making connections to a separate drip-proof terminal box located on the motor frame. The terminal box must be readily accessible through the crating, so that winding heaters can be energized while motors are in storage.

2.8 MAIN LEADS AND TERMINAL BOX

2.8.1 Stator Terminals

Insulated terminal leads must receive a treatment equal to that of the motor winding. Bring six leads out of the stator frame and make connections for the current transformers in paragraph ACCESSORY WIRING AND BOXES. Provide terminal lugs for connection to the motor shielded single-conductor supply wiring.

2.8.2 Stator Terminal Box

Provide drip-proof cast iron or steel terminal boxes, treated in the same manner specified for frames to resist corrosion, for housing the stator lead connections, surge capacitors, surge arresters, and current transformers. Boxes must have adequate space to facilitate the installation and maintenance of cables and equipment. Boxes must have a [bolted] [hinged lockable] cover providing unrestricted access, be mounted on the motor frame, and have an auxiliary floor supporting structure, when required, supplied by the motor manufacturer. Conduit entrance must be from the bottom. Design the boxes to permit removal of the motor supply leads when the motor is removed. Provide a "HIGH VOLTAGE [_____] VOLTS" warning sign on the cover of the box. When looking down on the motor/pump assembly, locate the terminal box between [_____] degrees and [_____] degrees [counter-] clockwise from the discharge elbow of the pump. Provided in the stator terminal box a ground bus and means for external connection to the station grounding system.

2.9 SURGE PROTECTION

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NOTE: To obtain the most reliable protection for 2,300- and 4000-volt motors, surge capacitors and

arresters, mounted at the motor terminals, should be specified. In addition, it is recommended that station-type arresters be installed on the line side of the supply transformers.
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2.9.1 Surge Capacitors

Furnish and install, in the main terminal box, a three-pole capacitor unit equipped with built-in discharge resistors and using a non-polychlorinated biphenyl (non-PCB) insulating medium. Each pole must be rated 0.5 microfarad and [2,400] [4,160] volts line-to-line. Provide removable bus links for motor testing. These links must be treated to resist corrosion, designed to maintain a positive contact, and have low contact resistance.

2.9.2 Surge Arresters

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NOTE: Use 3,000 MCOV arresters for 2,400-volt systems or effectively grounded 4,160-volt systems. Use 4,500-MCOV for ungrounded or resistance grounded 4,160-volt systems.
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In the main terminal box, furnish and install surge arresters of the station type with porcelain tops. The arresters must be of the metal-oxide type rated [3,000] [4,500] [_____] maximum continuous operating voltage line-to-ground. Provide removable bus links for motor testing. These links must be treated to resist corrosion, designed to maintain a positive contact, and have low contact resistance.

2.9.3 Space Heater

If recommended by the surge protection manufacturer, furnish a space heater of adequate capacity, rated 120 volts and install it in the terminal box. Space heater maximum watt density must not exceed 20 watts per square inch.

2.10 CURRENT TRANSFORMERS

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NOTE: For motor differential protection, the "Flux-Balancing Current Differential" scheme, as shown in Fig. 16 of IEEE C37.96, is preferred and will generally be applicable. In this case, the window-type current transformers should be used. However, when the KVA rating of a motor is approximately one-half the supply transformer KVA rating, or greater, it may be necessary to use the differential scheme shown in Fig. 15 of IEEE C37.96, in which case the "Differential Protection" scheme should be used.
****

Current transformer must meet the applicable requirements of IEEE C57.13 and IEEE C37.96. [Do not ground][Ground] secondary circuits at the motor. Bring out to terminal blocks all leads from each individual transformer. Terminal blocks must be of the dry or compound-insulated type. Provide terminal blocks with a suitable means of mounting and for grounding the frame. Connect each current transformer secondary lead to a terminal block of the short-circuiting type. Locate terminal blocks to permit short-circuiting the secondary windings without requiring access to the primary bus compartments. Plainly mark the polarity of the current transformers. [Provide each motor with three indoor dry-type window transformers with single secondary and rated [50/5 amperes, 600 volts] [_____]. Current transformers must have minimum full-wave insulation level of 10 kV and, when installed, must meet the requirements for a [60 kV] [_____] basic impulse level (BIL). Mount the transformers in the main terminal box and arrange in the "flux-balancing" connection.] [Provide each motor with three current transformers of rated [4,160] [_____] and [60 kV] [_____] basic impulse level (BIL). Mount the transformers in the main terminal box and connect in the wye point of the winding for use with differential relays.] All current transformers must be suitable for continuous operation at the full-rated voltage and current at a frequency of 60 Hz. Design all current transformers to withstand, without damage, the thermal and mechanical stresses resulting from short-circuit currents corresponding to ratings of the breakers in the circuits to which they are connected.

2.11 ACCESSORY WIRING AND BOXES

Except for current transformer leads and field control leads, terminate all accessory wiring in an accessory terminal box. Boxes must be drip-proof and treated in the same manner specified for frames to resist corrosion. Furnish the accessory terminal box with a door hinged full length and mounted on the motor in a location approved by the Contracting Officer. Use rigid galvanized steel conduit wherever practicable and arrange to make removal unnecessary when the motor is dismantled. Provide a wiring diagram within the enclosure for all circuits. Identify each conductor with the designation shown on the diagram. Terminate all wiring on terminal blocks as specified below.

2.11.1 Wiring

Except as otherwise approved, all wiring must be 125 degrees C rated flexible copper conductors, No. 14 AWG minimum, with 600-volt insulation. The size and type of temperature detector leads may be in accordance with the manufacturer's standard practice and, where required, must be suitable for contact with lubricating oil. Connect each detector by three leads to terminal blocks, with one wire connected to a common point on the blocks. Separate the common point for the stator detectors from that for the bearing detectors.

2.11.2 Terminal Blocks

All terminal blocks must be molded closed-back type as defined in NEMA ICS 4, rated not less than 600 volts, and provided with covers. The terminals must be screw-clamp type or stud-and-nut type. For circuit designation, provide white or other light-colored marking strips, fastened by screws to the molded sections at each block. Permanently mark on a strip the circuit designation or wire number for each connected terminal of each block. Furnish with each block reversible or spare marking strips and at least 10 percent spare terminals.

2.12 JACKING PROVISIONS

Provide suitable means for hydraulic jacking of the rotor to permit inspection, adjustment, or removal of the thrust bearing. Make provisions for blocking the rotor in the fully raised position. The blocking device must not require maintenance of hydraulic pressure on the jacks while the assembly is in the raised position.

2.13 SPECIAL TOOLS AND EQUIPMENT

Provide special tools, jigs, fixtures, lifting tackle, and instruments which may be necessary in assembly, erection, operation, maintenance, and repair of equipment. Special tools and equipment are those the design, purpose, and use of which are peculiar to equipment furnished and which are not available from normal wholesale or retail outlets. The motor manufacturer must provide hydraulic jacking devices as required in order to pull the thrust bearing thrust collar from the upper end of the shaft. The motor manufacturer must furnish one complete set of lifting attachments such as detachable eyebolts or special slings for handling various parts with a hoist.

2.14 SET-DOWN FIXTURES

Furnish one separate motor set-down fixture for each motor rating supplied. This fixture, when installed on the operating floor, must provide sufficient clearance above the floor for the motor shaft and coupling extending below the motor frame. The fixture must be suitable for holding the motor during assembly and disassembly. Furnish one separate rotor set-down fixture for each motor rating supplied. The fixture must hold the rotor in the horizontal position above the floor without unduly stressing the rotor pole pieces or laminations. Ship the motor and rotor fixtures to the destination prior to the shipment of any motor.

2.15 FACTORY TESTS

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NOTE: The designer should carefully consider whether to allow the Contracting Officer to waive these tests. Decision should be based on expertise in the field within the Division or District.

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Give one motor of each rating and type, selected at random by the Contracting Officer, a complete test. Check test the remainder of the motors. Submit test reports recording all data, calculations, and curves for each motor used. All complete tests will be [witnessed by the Contracting Officer][unless waived in writing].

2.15.1 Witness Test

When the Contractor is satisfied that a motor selected for a "Complete Test" performs in accordance with the requirements of the specifications, notify the Contracting Officer and submit the tabulated data, calculations, and curves required by paragraph COMPLETE TEST below.

a. Submit motor design (characteristic) curves or tabulated data indicating the efficiency, current, and kilowatt input at rated voltage and 110 and 90 percent rated voltage, all plotted or tabulated against torque or percent load as abscissas. Where values are given in percentages all base values will be indicated.

b. Three weeks will be required, after receipt, to review the foregoing information. Should the witness test indicate that a motor does not perform in accordance with the requirements of the specifications, make changes or corrections and run new complete witness tests, at no additional cost to the Government.

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NOTE: Use final sentence only when the pump and motor are furnished under the same procurement.
****

c. Submit the motor torque curves plotted for the following values of voltage at the motor terminals: [rated and 90 percent of rated voltage] [the output of a closed-transition autotransformer type reduced-voltage starter supplied at rated and 90 percent of rated motor voltage and connected on its [80] [65] percent tap]. [Plot the pump torque curve for starting, accelerating, and synchronizing against maximum head. Furnish computations to demonstrate that the motor will pull into synchronism under all of the foregoing conditions.]

2.15.2 Complete Test

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NOTE: For the large motors (1118 kW 1,500 hp and above), the efficiency is high, i.e. 95 percent at 1/2 to full load, however, efficiency varies with motor design. In general, high efficiency motors are not cost effective in the large size motors covered by this specification. If other than manufacturer's standard efficiency is required, the designer should list those values in paragraph FACTORY TEST.
****

Submit certified results of a "Complete Test" for duplicate equipment of the respective rating and type. Test will be accepted in lieu of the "Complete Test" specified for equipment of the respective rating and type. No substitute will be accepted for the "Check Test". Include the following in the complete test of a synchronous motor:

a. Resistance of armature and field windings.

b. Polarity of field coils.

c. High-potential tests of armature and field windings in accordance with NEMA MG 1 paragraph 21.52.

d. Air gap measurement.

e. V-curves (for zero, 1/2, 3/4, and full load).

f. Determination of the subtransient, transient, and synchronous reactance.

g. Conventional efficiency tests, in accordance with NEMA MG 1paragraph 21.44. Motor must meet manufacturer's published efficiency criteria for 1/2, 3/4, and full rated loads. Calculation of efficiency must include [that portion of the thrust bearing loss produced by the motor itself] [bearing loss due to external thrust load].

h. Tests to determine temperature rise in accordance with NEMA MG 1 paragraph 21.40.

i. Insulation resistance-temperature test, in accordance with IEEE 43. Plot test result values on semilogarithmic graphs, the insulation resistance values as logarithmic ordinates and the temperature values as uniform abscissas. Take readings at approximately 10 degrees C intervals. Determine temperature by the resistance method. Also, for comparison purposes, plot on the same sheet a curve indicating the safe operating value of insulation resistance.

j. Noise level tests in accordance with NEMA MG 1 paragraph 20-50.

k. Motor balance in accordance with NEMA MG 1 paragraph 20.54.

l. Conformance test in accordance with NEMA MG 1 paragraph 20.49.

m. Torques. Perform torque tests in accordance with IEEE 115 to demonstrate that the values specified in paragraph "Torques," will be met or exceeded.

2.15.3 Check Tests

Include the following in the check test of a synchronous motor and exciter:

a. Routine test in accordance with NEMA MG 1 paragraph 21.51.

b. Cold resistance measurement.

c. Insulation resistance and winding temperature at time the insulation resistance was measured.

d. Conformance test in accordance with NEMA MG 1 paragraph 20.49.

e. Motor balance in accordance with NEMA MG 1 paragraph 20.54.

2.15.4 Stator Winding Coil Tests

Test all coils, either before or after they are placed in the slots, for short circuits between turns of the individual coils by applying a high frequency voltage of not less than 75 percent of the voltage for which the machine is insulated, or by applying a surge test voltage of equivalent value to the terminals of each coil. Equivalent surge voltage must be a wave whose peak value is equal to 1.06 times the voltage for which the motor is insulated.

2.15.5 Space Heater Tests

Test at the factory each winding space heater unit for successful operation and dielectric strength.

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL

Perform the following acceptance checks and tests in accordance with NETA ATS section 7.15.2.

3.1.1   Visual and Mechanical Inspection

(1) Compare equipment nameplate data with drawings and specifications.

(2) Inspect physical and mechanical condition.

(3) Inspect anchorage, alignment, and grounding.

(4) Inspect air baffles, filter media, stator windings, stator core, rotor, cooling fans, slip rings, brushes, brush rigging, and bearings.

(5) Inspect bolted electrical connections for high resistance using a low-resistance ohmmeter. Correct values which deviate by more than 50 percent of the lowest value.

(6) Perform special tests such as air-gap spacing and machine alignment.

(7) Manually rotate the rotor and check for problems with the bearings or shaft.

(8) Rotate the shaft and measure and record the shaft extension runout.

(9) Verify the application of appropriate lubrication and lubrication systems.

(10) Verify that resistance temperature detector (RTD) circuits conform to drawings.

3.1.2   Electrical Tests

(1) Perform insulation-resistance tests in accordance with IEEE 43. Test duration must be [10 minutes][one minute]. The [polarization index][dielectric-absorption ratio] must be at least [2.0][1.4].

(2) Perform insulation-resistance test on insulated bearings in accordance with manufacturer’s published data.

(3) Test surge protection devices.

(4) Test motor starter.

(5) Perform resistance tests on resistance temperature detector (RTD) circuits.

(6) Verify operation of machine space heater.

(7) Perform insulation-resistance tests on the main rotating field winding, the exciter-field winding, and the exciter-armature winding in accordance with IEEE 43.

(8) Measure resistance of machine-field winding, exciter-stator winding, exciter-rotor windings, and field discharge resistors.

(9) Prior to re-energizing, apply voltage to the exciter supply and adjust exciter-field current to nameplate value.

(10) Verify that the field application timer and the enable timer for the power-factor relay have been tested and set to the motor drive manufacturer’s recommended values.

(11) Measure bearing temperatures while machine is running under load.

-- End of Section --