SECTION 16221

ELECTRIC MOTORS, 3-PHASE VERTICAL INDUCTION TYPE

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PART 1 GENERAL

1.1 SCOPE. This section covers the requirements of 3-phase vertical induction motors for driving storm-water pumps for the pumping stations. The motors and pumps are required to be furnished and delivered together. The work under this section includes providing all labor, equipment, and material and performing all operations required to design, manufacture, assemble, test, and package and deliver the vertical induction motors. These motors shall be supplied complete with all accessories, spare parts, tools, and manufacturer's data and instructions as specified herein.

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123	(2001) Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153	(1982; R 1987) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM B 344	(1992) Drawn or Rolled Nickel-Chromium and Nickel-Chromium Iron Alloys for Electrical Heating Elements

ANTI-FRICTION BEARING MANUFACTURER'S ASSOCIATION (AFBMA)

AFBMA 9	(1990) Load Ratings and Fatigue Life for Ball Bearings
AFBMA 11	(1990) Load Ratings and Fatigue Life for Roller Bearings

INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS (IEEE)

IEEE Std 85	(1973; R 1986) Airborne Sound Measurements on Rotating Electric Machinery

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(1998) Motors and Generators
NEMA WC 7	(1998) Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

1.3 GENERAL REQUIREMENTS

1.3.1 Corrosion Prevention and Finish Painting. The equipment provided under these specifications will be subjected to severe moisture conditions and shall be designed 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 Fastenings and Fittings

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

1.3.1.2 Corrosion-Resisting Materials

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

1.3.1.3 Corrosion-Resisting Treatments

Hot-dip galvanizing shall be in accordance with ASTM A 123 or ASTM A 153 as applicable. Other corrosion-resisting treatments may be used if approved by the Contracting Officer.

1.3.1.4 Frames

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, shall be cleaned of rust, grease, mill-scale, and dirt, and then treated and rinsed per manufacturer's 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, they shall be given one coat of primer and then two coats of manufacturer's standard moisture-resistant coating, processed as required.

1.3.1.5 Cores

The assembled motor core shall be thoroughly cleaned and then immediately primed by applying a minimum of two coats of a moisture-resisting and oil-resisting insulating compound. Air gap surfaces shall be given a minimum of one coat.

1.3.1.6 Shafts

Exposed surfaces of motor shafts shall be cleaned of rust, grease, and dirt and, except for bearing surfaces, given one coat of a zinc primer and two coats of a moisture-proof coating, each cured as required. Shafts of corrosion-resisting steel may be used in lieu of the above treatment.

1.3.1.7 Finish Painting

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

1.3.2 Nameplates

Nameplate data shall 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.

1.4 SUBMITTALS. Government approval is required for submittals with "GA" designation; submittals having an "FIO" designation are for information only.

1.4.1 Data

1.4.1.1 Insulated Windings; GA.

Contractor shall submit a detailed description and specification for the manufacturing process. The materials and the insulating varnish or compound used in insulating the windings shall be submitted to the Contracting Officer 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.

1.4.1.2 Duty Cycle; GA.

An analysis to verify that the motor, when operated in accordance with the duty cycle specified, will not undergo injurious temperature rise. If the duty cycle cannot be met with a standard NEMA design motor, the motor manufacturer shall provide a description of proposed modifications to provide such compliance.

1.4.1.3 Motor Design Curves; GA.

Motor design (characteristic) curves or tabulated data (test or calculated), indicating the speed, power factor, efficiency, current, and kilowatt input, all plotted or tabulated against torque or percent load as abscissa. The base value shall be given whether ANSI or IEEE standard system is used. The maximum allowable reverse rotation speed for the motor shall also be provided.

Pump and motor speed-torque curves for the pump starting operation shall be submitted. The motor speed-torque curves shall be plotted for the ramp up values of voltage at the motor terminals: The output of the solid state reduced voltage starter shall be indicated. The pump torque curve shall be plotted for starting and accelerating against maximum head. Computations shall be furnished to demonstrate that the motor furnished will carry the pump load under all the specified conditions.

1.4.1.4 Motors; GA.

Complete descriptive specification of each type and size motor provided, with necessary cuts, photographs, and drawings to clearly indicate the construction of the motor. The materials and treatments used to prevent corrosion of parts, bearing construction, and type of insulation used on all windings shall be indicated. Submittal shall include all information required for selection of protective and control equipment and for operational setting, such as, but not limited to, normal and maximum operation temperature for windings and bearings, overload trip setting for motor at pump maximum head condition and starting times for starting at rated and reduced percent starter voltage. Contracting Officer's approval shall be obtained in writing prior to the commencement of manufacture of motors.

A complete list of renewal parts with prices for each different rating of motor. This list shall accompany the instruction manual.

1.4.2 Drawings

1.5.2.1 Motors; GA.

Equipment foundation dimension outline drawings with weights, nameplate data, and details showing method of mounting and anchoring the motor. Contracting Officer's approval shall be obtained in writing prior to the commencement of manufacture of motors.

1.4.3 Reports

1.4.3.1 Starting Capabilities; FIO.

Certified test reports, when available, of tests previously performed on motors of each type and size specified or calculated data to substantiate the motor's capability to conform to the requirements of paragraph STARTING CAPABILITIES.

1.4.3.2 Factory Tests; GA.

Test reports recording all data obtained during the tests specified in paragraph FACTORY TESTS shall be provided to the Contracting Officer for each motor used. Test reports shall include performance curves indicating the results of paragraph COMPLETE TEST as follows. The base value shall be given whether ANSI or IEEE standard system is used:

a. Excitation Tests. Volts as abscissa versus amperes and watts as ordinates.

b. Impedance Tests. Volts as abscissa versus amperes and watts as ordinates.

c. Performance Test. Torque or percent load as abscissa versus efficiency, power factor, amperes, watts, and RPM or percent slip as ordinates.

d. Speed-Torque Test. Torque in foot-pounds as abscissa versus speed in RPM as ordinate.

e. Insulation Resistance-Temperature Test. Test result values shall be plotted on semilogarithmic graphs, the insulation resistance values as logarithmic ordinates and the temperature values as uniform abscissas. For comparison purposes, a curve indicating the safe operating value of insulation resistance shall be plotted on the same sheet with the insulation resistance-temperature test curve.

1.4.4 Certificates

1.4.4.1 Power Factor and Efficiency; GA.

Certification of guaranteed value of power factor and efficiency for full load, 3/4 full load, and 1/2 full load.

1.4.5 Operation and Maintenance Manuals

Instruction Manuals; FIO.

Six copies of complete instructions for the proper installation, inspection, and maintenance of the machines provided for this particular service. Instruction manuals shall be submitted to the Contracting Officer not later than the date the equipment is shipped from the manufacturer's plant. The instructions shall include a cross-sectional drawing indicating the major component parts of the motor and the procedure for disassembly.

PART 2 PRODUCTS

2.1 MOTORS

A total of 6 motors are required. The motors to be supplied under these specifications shall be of the vertical shaft type as required by the pump manufacturer. The required motors shall be furnished and provided by the pump manufacturer. Motors shall be normal or low starting torque, low starting current, squirrel-cage induction type, designed for full voltage starting, and Totally Enclosed Fan Cooled (TEFC) for motors outdoors at the two existing stations, and Weather Proof Type 1 (WP1) for the new stations. Motors shall conform to the applicable requirements of NEMA MG 1, except as hereinafter specified. Motors shall be high efficiency type. Motors shall be minimum 93% efficient. Motors will be rejected if factory tests do not demonstrate an efficiency of 93% or greater.

2.1.1 Rating

Motors shall be rated at 75 horsepower, minimum. Each motor shall be wound for 3-phase, 60-Hz, alternating current, and for the respective operating voltage listed below:

SPEED RPM	MOTOR OPERATING VOLTAGE
1200	460

The motor shall be designed for operation in a 40 degrees C ambient temperature and all temperature rises shall be above this ambient temperature. The rated horsepower of the motor shall be not less than 110 percent of the determined maximum load requirement of the pump. Motors shall have a service factor of 1.10. The temperature rise above the ambient temperature for continuous rated full-load conditions and for the class of insulation used shall not exceed the values given in NEMA MG 1, paragraph 12.42 or paragraph 20.40.

2.1.2 Operating Characteristics

2.1.2.1 Torques

Starting torque shall be sufficient to start the pump to which the motor will be connected under the maximum conditions specified, but in no case shall the starting torque be less than 60 percent of full-load torque. Breakdown torque shall be not less than 200 percent of full-load torque.

2.1.2.2 Locked-Rotor Current

The locked-rotor current shall not exceed 600 percent of normal full-load running current.

2.1.2.3 Starting Capabilities

Motors, on the basis of the load torque characteristics and the load inertia Wk2 listed in NEMA MG 1, paragraphs 20.41 and 20.42, shall as a minimum be capable of making the starts required in NEMA MG 1,paragraph 20.43.

2.1.2.4 Duty Cycle

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 load during starting conditions as furnished by the pump manufacturer, shall be capable of performing on a continuous basis the following motor duty cycle without injurious temperature rise: (1) operation at rated load over a period of approximately 14 days; (2) capable of 3 complete, evenly spaced, cycles of starting and stopping over a 1 hour period. A starting information nameplate specifying the starting capabilities shall be provided on each motor. This nameplate shall also include the minimum time at standstill and the minimum running time prior to an additional start.

2.1.2.5 Balance

The balance for each motor when measured in accordance with NEMA MG 1, paragraph 12.06 or paragraph 20.53, shall not exceed the values specified.

2.1.2.6 Noise

All motors shall operate at a noise level less than 85 decibels A-weighted mean sound pressure level (dBA). Noise shall be determined in accordance with IEEE 85. The specified noise limit applies for a reference distance of one meter for free-field conditions.

2.1.2.7 Power Factor and Efficiency

The power factor and efficiency at full load, 3/4 full load, and 1/2 full load shall be not less than 83, 80, 70 and 95, 93, 90, respectively. Motors will be rejected if factory tests specified in paragraph FACTORY TESTS do not demonstrate that these values will be met or exceeded.

2.1.3 Frames and Brackets

Frames and end brackets shall be of cast iron, cast steel, or welded steel. The mounting ring, unless otherwise approved, shall be built integral with the frame or lower end bracket and arranged for direct mounting on the pump, or station floor, or as required by the installation conditions. Treatment against corrosion shall be as specified in paragraph GENERAL REQUIREMENTS.

2.1.3.1 Stator Frame

The stator frame shall 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. The stator frame, if not direct mounted on the pump, shall be supported on a motor base or drive pedestal which in turn will be supported on sole plates or other suitable structure installed in the concrete foundation constructed as part of the pumping station structure. The motor base or drive pedestal shall be provided with bolts and dowels for fastening to the sole plates or supporting structure for preserving the alignment.

2.1.3.2 Supporting Bracket

The upper bracket supporting the thrust bearing and upper guide bearings shall 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 hydraulic thrust of the pump impeller.

2.1.3.3 Anti-reverse Device

A self-actuated backstop device or anti-reversing ratchet, to prevent reverse rotation of the pump due to loss of power, shall be installed as an integral part of the motor. The design of the device shall be submitted to and approved by the Contracting Officer. It shall have sufficient capacity to prevent reverse rotation with a back-flow through the pump due to a 30 foot differential head. If the device requires a lubrication system, an oil reservoir independent of the one used for the thrust bearing and complete with visible oil level gauge and 120-volt a.c. rated high and low level contacts shall be provided. All electrical leads shall be terminated in the accessory terminal box specified in paragraph MOTOR TERMINALS AND BOXES. The lubricant for the anti-reverse device shall contain a corrosion inhibitor whose type and grade shall be shown on a special nameplate attached to the frame adjacent to the lubricating filling device.

2.1.3.3.1 Overspeed

In the event of failure of the anti-reverse device, each motor shall be designed to withstand (for up to three minutes), without injury, the maximum over-speed to which the motor will be subjected to. This condition shall occur when the pump to which the motor is connected is acting as a hydraulic turbine under the maximum head specified above.

2.1.3.4 Eyebolts

Eyebolts, lugs, or other approved means shall be provided for assembling, dismantling, and removing the motor, if required, from above using an overhead crane. All lifting devices required for use in conjunction with the crane shall be provided with the motor.

2.1.4 Cores

The cores for the stators and rotors shall be built up of separately punched thin laminations of low-hysteresis loss, non-aging, annealed, electrical silicon steel, assembled under heavy pressure, and clamped in such a manner as to insure that the assembled core is tight at the top of the teeth of the laminated core. Laminations shall be properly insulated from each other. Only laminations free from burrs shall be used, and care shall be taken to remove all burrs or projecting laminations from the slots of the assembled cores. Cores shall be keyed, dovetailed, or otherwise secured to the shaft or frame in an approved manner. Treatment against corrosion shall be as specified in paragraph GENERAL REQUIREMENTS.

2.1.5 Insulated Windings

All motors shall have a non-hygroscopic, sealed, fungus-resisting insulation of a type designed and constructed to withstand severe moisture conditions, and insofar as practicable, to operate after long periods of idleness without previous drying out. All windings and connections shall be of the sealed type as defined in NEMA MG 1 paragraph 1.27.2. Insulated windings, unless otherwise approved, shall be completely assembled in the motor core before impregnating with the insulating compound. The compound shall consist of 100 percent solid resin. Impregnation of the windings with the insulating compound shall be by vacuum impregnation method followed by baking. The procedure shall be repeated as often as necessary to fill in and seal over the interstices of the winding, but in no case shall the number of dips and bakes be less than two dips and bakes when the vacuum method of impregnation is used. Insulation to ground shall be processed on the coil. The completed stator shall be of a type that is capable of passing the submerged or sprayed water test, as applicable, required by NEMA MG 1 paragraph 20.49.

2.1.5.1   Random Wound Machines

Random wound coils may be used on motors supplied in NEMA frame size 445 TP and smaller. The components of the insulation system and the conductor insulation of the coils shall be Class F insulation with a 110 percent continuous overload factor as defined in NEMA MG 1 paragraph 1.66. After winding, the completely wound stator shall be encapsulated with an insulating resin as defined in NEMA MG 1 paragraph 1.27.1.

2.1.5.2   Form Wound Machines

Form wound coils shall be used on motors supplied in NEMA frames larger than 445 TP. The components of the insulation system and the coil insulation of the rectangular conductors shall conform to Class F insulation with a 110 percent continuous overload factor as defined in NEMA MG 1, paragraph 1.66. The completed stator windings and connections shall be of the sealed type as defined in NEMA MG 1 paragraph 1.27.2. Insulation to ground shall be processed on the coil. Slot tubes or cells are not acceptable. The insulation shall be of adequate thickness and breakdown strength throughout the length of the coil. Mica shall be used in the slot portion and shall be of adequate thickness to withstand the dielectric tests specified in paragraph FACTORY TESTS. Form wound coils shall be of such uniformity that the stator windings on motors of equal ratings shall be alike, in shape and size, and be interchangeable.

2.1.5.3   Bracing

Coils of all windings shall be fully braced so that vibration is virtually eliminated during repeated starts as required by the duty cycle specified as well as during normal operation. If a tied system is used it shall be such that no tie depends upon the integrity of any other tie within the system.

2.1.6   Thermal Protection

Positive-temperature-coefficient thermistors (one per phase) shall be embedded in the windings. The thermistors with all necessary additional equipment, as required, shall open a normally closed contact when the critical temperature is reached. All outgoing wiring shall terminate on the terminal blocks specified in paragraph MOTOR TERMINALS AND BOXES.

2.1.7 Winding Heaters

Heaters shall be wrapped around the winding end turns. They shall be designated for operation on 120 volts, 1-phase, 60 Hz, alternating current and of sufficient capacity or wattage that, when energized, they will hold the temperature of the motor windings approximately 10 degrees C above the ambient temperature. They shall be designed for continuous operation and to withstand at least 10 percent overvoltage continuously. The rate of heat dissipation shall be uniform throughout the effective length of the heater. Heaters installed around the winding end turns shall consist of the required turns of heating cable wrapped around the end turns and secured in place before the winding is impregnated.

2.1.7.1 Heating Element

Heating element shall conform to the requirements of ASTM B 344 for an 80 percent nickel and 20 percent chromium alloy.

2.1.7.2 Sheath

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

2.1.7.3 Insulation

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

2.1.7.4 Terminals

Terminals of the heater, including the leads, shall be watertight and shall be provided with leads suitable for making connections to the drip-proof terminal box provided in paragraph MOTOR TERMINALS AND BOXES. The terminal box shall be readily accessible through the crating so that winding heaters can be energized while motors are in storage.

2.1.8 Shafts

Shafts shall be made of high grade steel, finished all over, and of ample size to drive the pumps under maximum load conditions. Shafts shall be of hollow types as required by the pump manufacturer. See paragraph GENERAL REQUIREMENTS for treatment against corrosion.

2.1.9 Bearings

2.1.9.1 Loading

Bearings shall be capable of withstanding all stresses incidental to the normal operation of the unit [and the maximum speed of the pumping unit when operating in the reverse direction].

2.1.9.2 Thrust Bearings

Thrust bearings shall be of the antifriction type of either the ball or roller type. Tandem or series bearing assemblies shall not be used. Antifriction bearings shall conform to the requirements of AFBMA 9 and AFBMA 11.

2.1.9.3 Guide Bearings

Guide bearings shall be of the sleeve or antifriction type of either the ball or roller type or a combination of sleeve and antifriction bearings.

2.1.9.4 Lubrication

Bearings shall be grease lubricated and the lubricant used shall contain a corrosion inhibitor. Type and grade of lubricant used shall be shown on a special nameplate which shall be attached to the frame of the motor adjacent to the bearing lubricant filling device. In addition to the quantity of lubricant required to fill the system initially, spare lubricant shall be provided in sufficient quantity to purge and refill the system.

2.1.9.5 Housings

Bearing housings shall be of a design and method of assembly that will permit ready removal of the bearings, prevent escape of lubricant and entrance of foreign matter, and protected by the lubricant when the motor is idle. Except for prelubricated antifriction bearings of an approved type, suitable means shall be provided to apply and drain the lubricant.

2.1.9.6 Cooling

All bearings shall be self-cooling unless otherwise specifically approved by the Contracting Officer.

2.1.9.7 Rating

Antifriction bearings shall be rated on the basis of a minimum life factor of 8,800 hours, based on the life expectancy of 90 percent of the group, unless otherwise approved by the Contracting Officer.

2.1.9.8 Shaft Currents

Bearings shall be insulated or otherwise protected against the damaging effects of shaft currents.

2.2 MOTOR TERMINALS AND BOXES

2.2.1 Stator Terminal Box

Drip-proof cast iron or steel conduit terminal boxes, treated as specified for frames in paragraph GENERAL REQUIREMENTS, shall be supplied for housing the stator lead connections and shall have adequate space to facilitate the installation and maintenance of cables and equipment. Boxes shall have a bolted cover providing unrestricted access, be mounted on the motor frame, and shall have an auxiliary floor supporting structure, when required, supplied by the motor manufacturer. Conduit entrance shall be from the bottom. The boxes shall be designed to permit removal of motor supply leads when the motor is removed. A 480 VOLTS" warning sign shall be provided on the cover of the box. When looking down on the motor/pump assembly, the terminal box shall be located 90 degrees clockwise from the discharge elbow of the pump. The location of the terminal box shall be coordinated with the location of the grease lubrication system for the pump. These two items shall be installed at least 90 degrees apart.

2.2.2 Stator Terminals

Insulated terminal leads shall receive a treatment equal to that of the motor winding. Leads shall be brought out of the stator frame and shall be provided with terminal lugs for connection to the motor supply wiring.

2.2.3 Grounding

A ground bus and means for external connection to the station grounding system shall be provided.

2.2.4 Accessory Leads and Boxes

Terminal leads for motor winding space heaters, resistance temperature detectors, thermistors, and any other auxiliary equipment shall be brought into conveniently located terminal boxes provided with terminal blocks for extension by others. The terminal boxes shall be drip-proof and treated as specified for frames in paragraph GENERAL REQUIREMENTS. All auxiliary wiring shall be stranded copper conductors with 600-volt flame-retardant insulation conforming to NEMA WC 7, except temperature detector leads may be in accordance with the manufacturer's standard practice. All wiring and terminals shall be properly identified.

2.3 WRENCHES, TOOLS, AND SPECIAL EQUIPMENT

The Contractor shall provide all nonstandard and special equipment required for dismantling, reassembly, and general maintenance of the motor units. The Contractor shall also provide one complete set of lifting attachments such as detachable eyebolts or special slings for handling various parts with a hoist.

2.4 FACTORY TESTS

One motor, selected at random by the Contracting Officer, shall be given a complete test. The remainder of the motors shall be given a check test. All complete tests shall be witnessed by the Contracting Officer and the Government, unless waived in writing by the Contracting Officer.

2.4.1 Complete Test

A complete test of a motor shall include the following:

a. Excitation Test.

b. Impedance Test.

c. Performance and Speed-Torque Test. (Prony brake or other equivalent method.)

d. Temperature Test. Made on completion of paragraph c above. (If screens are provided over openings, test will be made with screens removed and by thermometer).

e. Insulation Resistance-Temperature Test. Shall be taken following heat run, readings being taken at approximately 10 degrees C intervals. Temperature shall be determined by the resistance method.

f. Cold and Hot Resistance Measurement.

g. Dielectric Test.

h. Sound Level Test. In accordance with IEEE 85.

i. Vibration Measurement. In accordance with NEMA MG 1 paragraph 20.54.

j. Conformance Tests. In accordance with NEMA MG 1 paragraph 20.47.

2.4.2 Check Test

A check test of a motor shall include the following:

a. Routine test per NEMA MG 1 paragraph 12.51 or NEMA MG 1 paragraph 20.47.

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 20.47.

e. Vibration measurement in accordance with NEMA MG 1 paragraph 12.07 or NEMA MG 1 paragraph 20.54.

2.4.3 Form Wound Coil Test

All form wound coils, either before or after they are placed in the slots, shall be tested 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 shall be a wave whose peak value is equal to 1.06 times the voltage for which the motor is insulated.

2.4.4 Winding Space Heater Test

Each winding space heater unit shall be tested at the factory for successful operation and dielectric strength.

-- End of Section --