SECTION E1

ELECTRIC MOTORS

1. GENERAL: This Specification details the requirements for motors supplied by AC voltage sources. All motors shall be designed for direct across the line starting. If requirements herein conflict with those specified elsewhere within these specifications, the order of precedent stated in Section GR-A – General Description and Scope shall be observed. The types of motors covered by this Specification include the following:

1.1 Motor Types:

a. fractional horsepower motors,
b. integral horsepower motors, 1/2HP through 250 HP,
c. integral horsepower motors, greater than 250 HP,

1.2 Applicable Standards: The latest revisions of the following publications shall be considered a part of this Specification:

1.2.1 National Electrical Manufacturers Association

NEMA MG 1	"Motors and Generators"
NEMA Premium	"General Specification for Consultants, Industrial and Municipal: NEMA Premium® Efficiency Electric Motors"

1.2.2 American National Standards Institute/The Institute of Electrical and Electronic Engineers.

ANSI/IEEE C50.41	"Polyphase Induction Motors for Power Generating Stations"
ANSI/IEEE Std. 112	"Standard Test Procedure for Polyphase Induction Motors and Generators"
IEEE 43	"Recommended Practice for Testing Insulation Resistance of Rotating Machinery"

1.2.3 American Bearing Manufacturers Association ABMA Standards.

1.2.4 International Organization for Standardization

ISO 1680	"Acoustics — Test code for the measurement of airborne noise emitted by rotating electrical machines"

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1.3 Motor Selection: The equipment supplier shall provide motors to start and operate the driven loads at the most severe condition of loading. Motor types, horsepower, drive arrangement, and enclosure shall be suitable for the operating conditions and environment of the driven load. Motors shall be UL listed in accordance with their application.

1.3.1 Motor Duty: Unless otherwise specified, the following types of motors shall be designed for operation in the ambient temperature and altitude specified in Section GR-A.

1.3.1.1 Continuous Duty: Motors shall be rated for continuous service at normal operating load.

1.3.1.2 Inverter Duty: Motors furnished for use with variable frequency drive (VFD) equipment shall be compatible with the VFD output characteristics and shall be de-rated if necessary to prevent overheating at any of the specified speed ranges. Motors shall meet all other requirements specified herein. Seller shall be responsible for supplying VFD equipment, line side filtering equipment, and any required special cable types between the VFD and the motor for all VFD motors. Motors shall be VFD rated, per NEMA MG-1 requirements, if applicable.

1.3.1.3 Intermittent Duty: Intermittent duty motors shall be selected and sized based on the anticipated service conditions and operating ambient temperatures where recognized and defined as standard by the equipment codes and standards.

1.3.2 Special Service Motors: Special purpose motors provided with a Seller's package equipment design shall be the Seller's standard proven motor furnished completely assembled, mounted, lubricated and ready for operation. Special purpose motors shall be suitable for the location, atmosphere, ambient temperature, duty cycle, and operating conditions of the package equipment. Continuous running motors shall meet the “Premium efficiency,” starting requirements, service factor, and duty requirements as specified herein. Special service motors may include but not be limited to the following:

a. Crane motors
b. Elevator motors
c. Hoist motors
d. Door operators
e. Gate operators
f. Motor operated valves (see Section E3 – Valve Motor Operators)
g. Submersible sump pumps
h. D.C. motor drives (from AC rectifiers)
i. Submersible motors
j. Hermetic Refrigerant Motors

1.3.3 Two Speed Motors: Equipment specified for two speed operation shall utilize two speed single winding or dual winding constant horsepower, constant torque, or variable torque motors as required by the driven load. Motors shall meet all other requirements as specified herein.

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1.3.3.1 Two Speed Motor Wiring Diagram(s): For two speed motors, a specific motor wiring diagram for the application and motor being provided must be supplied by the Seller as part of the drawing deliverable(s) package.

1.3.4 Vertical Motors: Vertical motors shall have the same general requirements as horizontal motors except as follows: for low voltage motors, shafts may be solid or hollow as suitable for the application; for medium voltage motors, bearings shall be thrust-type locked for thrust in both directions; and motors shall be provided with reverse direction ratchets for pumping applications where fluid can turbine through the pump backwards.

1.3.5 Hazardous Location Motors: Motors located in areas defined by the National Electrical Code as classified hazardous areas shall be UL listed and identified for the class and group of the hazardous area and shall have an appropriate enclosure, terminal box, instruments, accessory boxes, and conduits with seal-off fittings. Hazardous enclosures shall have a cast iron frame, bearing supports and end housing. Hazardous rated motors shall have a combination breather/drain UL listed for the class and group of the hazardous area. Nameplates must include the location class and group design and the maximum operating temperature value or operation temperature code number.

1.4 General Motor Design Criteria:

1.4.1 Voltage Range:

1.4.1.1 Normal Operating Voltage Range: Motors shall operate normally within a voltage range of 90% to 110% of the system rated voltage.

1.4.1.2 Starting Voltage Range: Motors shall start and accelerate the driven load to full speed without damage to the motor or driven load within a voltage range of 80% to 110% of the system rated voltage.

1.4.2 Motor Starting Characteristics: Unless otherwise specified, all motors shall be designed for full voltage, across-the-line starting and frequent starting where required. Unless specific design conditions dictate otherwise, motors shall meet or exceed values of the torque at locked rotor, pull-up and breakdown in accordance with NEMA MG 1 and exhibit the starting characteristics as shown in Table 1. The thermal limit curves of the motor shall be coordinated with the starting time of the load.

Table 1 - Motor Starting Characteristics	
Locked rotor current	Not to exceed 650% at full load.

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Locked rotor (starting) torque at rated voltage and frequency:	Not less than 80% of full-load torque.
Speed torque characteristics	Motors 250 HP and less – NEMA Design B
	Motors greater than 250 HP – As specified herein or NEMA Design B, whichever is more stringent

1.4.2.1 Motors shall be able to accelerate the driven load to full speed in less time than the allowable locked rotor time limit within the starting voltage range as specified above and at normal operating temperature.

1.4.2.2 All motors rated 125HP and larger, provide motor starting characteristics (current vs. time) at 100% and 85% rated voltage, as well as motor hot and cold thermal limits plotted on the same sheet as starting characteristics. Motors rated lower than 125HP employed in applications with starting times exceeding 15 seconds shall be provided with a clear time vs. current starting curve at rated voltage, 90% of rated voltage, and 80% of rated voltage.

1.4.2.3 All low voltage motors shall be designed to be protected by a class 20 overload relay for protection provided by Buyer. If a different class overload relay is required for a different acceleration time, this requirement for the motor starter overload shall be clearly specified by the Seller in the proposal. If the motor starter is provided by the Seller, vendor standard design is acceptable.

1.4.3 Service Factor and Motor Sizing Requirements: Service factor and motor sizing requirements are detailed in Table 2. Motor service factor shall not be used in selecting motor for operating or rated conditions, even for short duration loads. Pump motors shall not exceed a 1.0 service factor when operating at any point of the head capacity curve.

Table 2 - Service Factor Requirements	
Motor Nameplate Horsepower	Service Factor Requirement
Low voltage motors	Service Factor 1.15 - The nameplate horsepower rating (not including service factor) shall be 115% or greater than, the requirements of the driven equipment when operating at design conditions and motors shall be able to handle the maximum capability of the driven equipment within its service factor rating. This requirement shall be met for all operating speeds and conditions.

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Table 2 - Service Factor Requirements	
Motor Nameplate Horsepower	Service Factor Requirement
Medium voltage motors	Service Factor 1.15 The nameplate horsepower rating (not including the service factor) shall not be less than 115% of the requirements of the driven equipment when operating under design requirements and not less than 100 % of the horsepower required to operate the driven equipment at its maximum capabilities.

1.4.4 Motor Efficiency: In general, motors shall be of the highest efficiency readily available for the specified application. Motors shall be of premium efficiency design. The motor efficiency shall be measured in accordance with NEMA MG-1 and IEEE Std. 112. Additional requirements, as applicable, are shown in Table 3 below.

Table 3 - Efficiency Requirements	
Motors less than 500HP	Per NEMA MG 1 and IEEE Std. 112
Motors 500HP to 1000 HP	95%
Motors greater than 1000 HP	96%

1.4.5 Windings: All stator windings and rotor squirrel cage shall be copper. The winding temperature rise for all motors shall not exceed a Class B insulation system temperature rise as defined by ANSI C50.41.

1.4.6 Terminal Box Cable and Bracing: All motor power lead terminal boxes shall be sized and designed to accept and brace the cables and terminations as defined in the tables below. Ground cable termination provisions shall be supplied for each set of phase conductors. All motor terminal studs shall be designed in standard imperial units. Compression type, double indent, NEMA two-hole copper lugs will be used for all power cables rated greater than 600V and for all power cables #6 AWG and larger. All power cables 600V and less and smaller than #6 AWG will use one hole lugs for termination.

1.4.6.1 13.8 kV Cable Termination Requirements:

Motor Service Factor Amps	QTY of Terminations per Phase	Cable Size per Phase	KAIC Rating
≤ 100	1	#2/0 AWG	50kAIC
>100-130	1	#2/0 AWG	
>130-150	1	#2/0 AWG	
>150-190	1	#4/0 AWG	
>190-240	1	350 kCMIL	
>240-290	1	500 kCMIL	
> 290	2	Subject to Engineer's approval during shop drawing reviews	

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1.4.6.2 6.9 kV Cable Termination Requirements:

Motor Service Factor Amps	QTY of Terminations per Phase	Cable Size per Phase	KAIC Rating
≤ 100	1	#2 AWG	40kAIC
>100-130	1	#2/0 AWG	
>130-150	1	#2/0 AWG	
>150-190	1	#4/0 AWG	
>190-240	1	350 kCMIL	
>240-290	1	500 kCMIL	
> 290	2	Subject to Engineer's approval during shop drawing reviews	

1.4.6.3 480V Cable Termination Requirements:

Motor FLA * 125% per NEC Article 430	QTY of Terminations per Phase	Cable Size per Phase	KAIC Rating
≤ 20	1	#10 AWG	85kAIC-480VAC 22kAIC – 120VAC 42kAIC – 125VDC
> 20-30	1	#8 AWG	
> 30-45	1	#4 AWG	
> 45-60	1	#2 AWG	
> 60-70	1	#2/0 AWG	
> 70-100	1	#2/0 AWG	
> 100-125	1	#2/0 AWG	
> 125-190	1	350 kCMIL	
> 190-250	1	350 kCMIL	
> 250-300	1	500 kCMIL	
> 300	2	Subject to Engineer's approval during shop drawing reviews	

1.4.7 Motor Space Heaters: Heaters shall be included for all medium voltage motors. Heaters shall be derated for extended life and shall be sized to prevent condensation at the lowest Project Site design temperature. Low voltage motors 25 hp or greater shall be supplied with heaters. The heaters shall be rated 240VAC for operation at 120V AC. Heaters rated above 1200W shall by 480VAC, 3 phase. Heaters shall be located and insulated so they do not damage motor components or finish. Heaters shall not cause winding temperatures to exceed rated limiting values, nor cause thermal protective device "over temperature" indication when the motor is not energized. Leads shall be stranded copper cable with 600V insulation and shall include terminal connectors or be wired to a terminal block rated 600V and capable of accepting at least #10 AWG copper wire. Heaters shall be readily accessible for maintenance and replacement. If the heaters are not easily accessible, an additional spare set of heaters shall be furnished and the leads of the spare set shall be clearly labeled in the terminal housing. Voltage requirements for space heaters are shown in Table 4.

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Table 4 – Medium Voltage Motor Heater Voltage Requirements		
Heater Output in Watts at Heater Operating Voltage	Heater Rated Voltage	Heater Operating Voltage
≤ 800W	240 VAC single-phase	120 VAC single-phase
> 800W	480 VAC three phase	120 VAC three phase

1.4.7.1 Motor space heaters with an output less than or equal to 1200W shall have internal terminal blocks rated for 600V, 20A capable of accepting at least #10 AWG wire. Wiring leads between the heater and terminal box shall be routed in rigid galvanized steel raceway and UL listed liquid tight flexible metallic conduit.

1.4.7.2 Motor space heaters with an output greater than 1200 W shall be provided with a 3-pole contactor rated for the operating amperage of the heater, but not less than 20 A. All contactors for controlling the heaters shall be rated 600V with 120 VAC coil and shall be mounted in a NEMA 4 enclosure mounted to the motor or the equipment skid. Power wiring between the contactor and the space heater shall be provided and installed by the Seller. The contactor shall be setup for a single point power connection and a single point control connection directly on the contactor by the Buyer.

1.4.8 Motor Bearings: All low-voltage motors shall be provided with Anti-friction type bearings. Bearings shall have hydraulic pressure grease fitting and reliefs, ABMA L10 life of not less than 80,000 hours for direct coupled service and 45,500 hours for belt or chain connected service. Bearing life shall be based on continuous duty at rated load and speed, calculated in accordance with ABMA 9 for ball bearing and ABMA 11 for roller bearings. Vertical mounted motors shall be provided with thrust bearings. Thrust bearings connected to equipment producing axial loads shall be designed to carry 200% of the maximum net thrust (up and down). Thrust bearings shall be at the non-driven end. Both driven and non-driven end bearings shall be insulated.

1.4.8.1 Anti-friction Bearings: Bearings shall be either oil filled or regreasable in service. Bearings shall have suitable seals to prevent lubricant leakage along the shaft and to prevent dirt or moisture from entering the bearing.

1.4.8.2 Sleeve Bearings: Bearings shall be oil filled. Bearings shall be provided with doweling or other suitable means in all end bells for alignment and to prevent rotation of split bearing caps. Bearings shall be designed to prevent rotor axial thrust from being continuously applied against either end bearing. The motor and bearings shall be capable of withstanding the axial thrust developed when the motor is energized. The Seller shall provide any special tools required for bearing removal with the motor in place.

1.4.8.3 Ball Bearings: Bearings shall be oil filled. Motors shall be equipped with minimum pressure relief fittings for in service lubricating.

1.4.8.4 Roller Bearings: Bearings shall be oil filled. Motors shall be equipped with minimum pressure relief fittings for in service lubricating. Bearings shall be spherical roller thrust type with deep groove guide bearings. One (1) guide bearing shall be locked to the shaft to take

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upward thrust and to assure the guide bearing is always loaded. Spring loaded guide bearings shall not be preloaded during normal operation.

1.4.8.5 Motors 250 HP and above: Horizontal motors shall have split sleeve bearings of the oil ring type. A sample drain line shall be provided for obtaining bearing oil samples. Oil rings shall be provided on all motors and the lubrication systems shall be in accordance with ANSI C50.41-2000, Paragraph 26. Vertical motors shall be sleeve guide and thrust. Thrust bearings shall be sized to accommodate all temporary and intermittent loading they may be exposed to without detrimental effect to the life of the bearing. Sight glasses shall be furnished in place of oil cups on all oil filled bearings. Motors shall be prepared for extended outdoor storage by protecting the motor bearings with either a protective grease covering or liquid preservative. The motors shall be tagged to show that a preservative has been used and to list the procedure to be followed before motors are placed in operation. All low-voltage motors shall be provided with Anti-friction type bearings. Bearings shall have hydraulic pressure grease fittings and reliefs. Bearing life shall be based on continuous duty at rated load and speed, calculated in accordance with ABMA 9 for ball bearing and ABMA 11 for roller bearings. Vertical mounted motors shall be provided with thrust bearings. Thrust bearings connected to equipment producing axial loads shall be designed to carry 200% of the maximum net thrust (up and down). Thrust bearings shall be at the non-driven end. Both driven and non-driven end bearings shall be insulated.

1.4.8.6 Bearing Lubrication: Bearing lubricants shall contain a corrosion inhibitor. The type and grade of lubricant shall be indicated on a nameplate attachment to the motor frame or end shield adjacent to the lubricant-filling device. Self-cooled bearing lubrication systems shall have oil reservoir capacities and ventilation of the bearing housings as required to maintain proper cooling of the oil and bearings under the maximum ambient temperature conditions specified. Seller shall supply lube oil and cooling requirements with proposal.

1.4.8.7 Forced Feed Lube Oil Systems: If the driven equipment has a forced-feed lube oil system, the motor shall also use this lube oil system. Oil reservoirs shall have sufficient capacity to hold all oil in the system and have a metal protected glass sight gauge marked for proper oil level. Oil heaters and coolers shall be provided as necessary to maintain the minimum required oil temperature when the equipment is off and to limit the maximum required oil temperature with the equipment at normal operation. The lube oil system shall be supplied with a pressure transmitter in lieu of multiple pressure switches. Lubricating oil supply piping shall be stainless steel and shall not be less than 1/2-inch size.

1.4.8.8 Water Cooled Bearings: Bearings requiring water as the cooling medium must be reviewed and approved by the Engineer during the proposal stage. The number and size of connection points along with all flow and temperature requirements shall be submitted.

2. FRACTIONAL HORSEPOWER MOTORS:

2.1 General: Fractional horsepower motors shall be provided as required to drive the specified equipment. Motors shall conform to the applicable standards as specified herein. Motor selection in regards to sizing, service factor, and starting conditions shall be as specified herein. Motors may be of either a general purpose or special purpose design as specified herein. Motors

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shall be single speed, squirrel-cage induction, energy efficient, and mill type as specified herein. All motors shall be completely assembled with the driven equipment, lubricated, and ready for operation.

2.2 Motor Voltage Ratings: Unless otherwise specified, typical voltage ratings for motors shall be as follows:

2.2.1 Less than 1/2 HP: 115 VAC, single-phase, 60 Hz rated for service on a 120 VAC, single-phase, 60 Hz, solidly grounded system except as follows:

2.2.1.1 Damper operators shall be 460 VAC, three-phase, 60Hz, rated for service on a 480 VAC, three-phase, 60 Hz, resistance grounded system.

2.2.2 1/2 HP through 250 HP plus larger HP fire pump motors: 460 VAC, three-phase, 60 Hz, rated for service on a 480 VAC, three-phase, 60 Hz, resistance grounded system.

2.3 Enclosures: Motors shall be provided with enclosures suitable for the location, atmosphere, ambient temperature, and operating condition of the driven load. All motors shall be self-cooled and shall have a cast iron frame. Fully guarded enclosures shall be furnished on all motor enclosure types having accessible moving parts other than shafts. All motors shall be TEFC totally enclosed, ventilation, and cooling or explosion proof as applicable to the environment. Each TEFC or TENV motor shall be provided with a condensation drain hole and a breather/drain plug. Motor enclosures shall have all exposed metal surfaces protected with a moisture and corrosion-resistant polyester paint or coating. Assembly hardware shall be zinc plated or stainless steel. Mounting shall be foot mounted base or C-face mounting as required by the equipment.

2.3.1 Totally enclosed motors with NEMA waterproof features shall have enclosure interior surfaces and the stator and rotor air gap surfaces protected with corrosion-resistant alkyd enamel or with polyester or epoxy paint or coating. Bolts, nuts, screws, and other hardware items shall be corrosion-resistant or heavy cadmium-plated metal.

2.4 Power Lead Terminal Box: Motors shall have power leads brought into a frame mounted terminal box. The terminal box shall be oversized to allow termination of 600V power cable with the quantity and size of cables listed as specified herein. All motor power lead terminal boxes shall be at least one (1) size larger than normally furnished per NEMA MG 1. Terminal boxes shall be consistent with the motor enclosure type; (e.g., ODP, TEFC, TENV, hazardous rated,.). A grounding means shall be provided in the motor terminal box for terminating a dedicated equipment ground conductor. Terminal boxes for motors shall be cast iron, pressed steel, or fabricated steel. Terminal boxes shall be diagonally split with a gasket between the split halves of the housing. Each terminal box shall have a threaded opening to provide a watertight, rigid connection with the conduit. Approved trade sizes for conduit openings shall be: ½”, ¾”, 1”, 1-1/2”, 2”, 3”, 4” and 6”. Terminal boxes shall be designed for rotation in 90° increments or have provisions to receive conduit from any of the four sides of the terminal box.

2.4.1 Power Leads: Winding leads shall be terminated using conductor size and material matched single-conductor, compression type lugs. Leads between the motor and the power lead

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terminal box shall be non-hygroscopic 600V insulated copper. Leads entering the terminal box shall have motor lead positioners and be sealed or gasketed between the terminal box and the motor. Leads shall be permanently identified. All leads shall be permanently wired in accordance with the requirements of NEMA MG 1, Part 2.

2.4.2 Submersible Motor Power Cords: Special purpose submersible motors shall be provided with a 50 foot SJO power cord (2 conductors with ground for single-phase motors and 3 conductors with ground for three-phase motors) with a bushed cable protector at the entrance into the motor. Any SJO cords required for thermal overload signals or water detection signals shall be provided by the Seller and shall be the same length as the power cord. Submersible motors shall have all SJO cord installed, terminated, and sealed in the motor from the factory.

2.5 Insulation: All motors shall have Class F non-hygroscopic insulation with Class B temperature rise limits per NEMA MG 1. Insulation shall be treated to prevent deterioration due to high humidity, corrosive vapors, or abrasive dust.

2.6 Rotor and Stator: Rotors shall be solid cast squirrel cage type adequately sized to avoid overheating of the motor during acceleration. Rotor and shaft shall be dynamically balanced with vibration limits not exceeding peak-to-peak amplitude values per NEMA MG 1. Stator core shall be constructed from high grade electrical steel to reduce hysteresis and eddy-current losses.

2.7 Shaft: The shaft shall be furnished with corrosion-resistant treatment or shall be of corrosion-resistant metal. A rotating labyrinth shaft seal shall be furnished on the shaft extension end of the motor.

2.8 Integral Thermal Overloads: All single-phase motors shall be provided with integral thermal overload protection. Thermal overloads shall typically be automatic reset type unless the Seller's package equipment design using special purpose motors requires manual reset thermal overloads. If manual reset overloads are used with package equipment, the reset means shall be easily externally accessible without disassembly of the equipment.

2.9 Capacitors: All single-phase motors shall be capacitor start type unless the special purpose motor requirements of the packaged equipment do not require capacitor start motors. Capacitor enclosures and mounting hardware shall be compatible with the motor enclosure type. Capacitors shall be furnished in removable metal enclosures mounted on the motor frame. Lock washers shall be provided under the heads of the enclosure hold-down bolts.

2.10 Nameplates: All motors shall be provided with a permanent stainless steel or aluminum nameplate firmly attached to the motor frame with corrosion-resistant metal attachment pins. Nameplates shall be either embossed raised letter or engraved and enamel filled. Nameplate information shall be in English units, with minimum data according to NEMA MG 1, ANSI C50.41, and as follows:

a. Motor manufacturer
b. Horsepower (at plant altitude), NEMA design letter
c. Speed in RPM

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d. Voltage/phase/hertz
e. Service factor
f. Running load amps/locked rotor amps or locked rotor KVA code letter
g. Duty rating and ambient temperature
h. Insulation class
i. Enclosure type

2.10.1 Separate permanent nameplates shall be provided identifying the following: space heater wattage and voltage, bearing lubrication requirements, connection diagram, and direction of rotation for the supply voltage sequence T1-T2-T3.

2.11 Tests: Routine factory tests in accordance with NEMA MG 1 shall be performed to determine that there are no mechanical or electrical defects associated with the motors.

2.12 Motor Submittal Data: The attached Motor Data Sheet shall be completed and submitted for each motor furnished. Motor Data sheets shall be completed in full per the SDS requirements and submitted for each motor furnished.

3. INTEGRAL HORSEPOWER MOTORS, 1/2 HP THROUGH 250 HP:

3.1 General: Integral horsepower motors, rated 1/2 HP through 250 HP, shall be provided as required to drive the specified equipment. Motors shall conform to the applicable standards referenced within the specification. Motor selection in regards to sizing, service factor, efficiency, and starting conditions shall be as specified herein. Horizontal or vertical as required, single-speed, squirrel-cage induction, energy efficient, mill and chemical dry type. Cast iron frames and copper windings as specified herein.

3.2 Motor Voltage Ratings: Unless otherwise specified, typical voltage ratings for motors shall be as follows:

3.2.1 460 VAC, three-phase 60 Hz, rated for service on a 480 VAC, three-phase, 60 Hz, resistance grounded system.

3.2.2 Motors may be dual rated 230/460 VAC, but shall be connected for 460 VAC, three-phase, 60 Hz operation.

3.3 Enclosure: Motors shall be provided with enclosures suitable for the location, atmosphere, ambient temperature, and operating condition of the driven load. Motors shall be TEFC totally-enclosed, ventilation, and cooling or explosion proof as applicable to the environment and the fan covers shall meet NEMA MG 1 requirements for a fully guarded machine. TEFC and hazardous rated enclosures shall have cast iron frame, bearing supports and end housing. Aluminum enclosure parts are not acceptable. All motors in hazardous location(s) shall be listed and labeled. Motors located in classified areas according to the NEC shall be UL listed and identified for use for the required classification. All TEFC motors shall be provided with condensation drain holes and rotating shaft seals. Drain holes shall be provided with Crouse-Hinds Type ECD “Universal” combination water drain-breather plugs, or approved equal. Foot mounted

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motors shall have feet integrally cast with the frame. "C" face motors shall be provided where required for the driven equipment. Motor enclosures shall have all exposed metal surfaces protected with a moisture and corrosion-resistant polyester paint or coating. Assembly hardware shall be zinc plated or stainless steel. Lubricating oil, seal oil, and transformer accessory motors shall be totally enclosed.

3.3.1 Totally enclosed motors with NEMA waterproof features shall have enclosure interior surfaces and the stator and rotor air gap surfaces protected with corrosion-resistant alkyd enamel or with polyester or epoxy paint or coating. Bolts, nuts, screws, and other hardware items shall be corrosion-resistant or heavy cadmium-plated metal.

3.4 Mountings: Unless mounted on a common frame with the driven equipment, horizontal motors shall be furnished with a matching soleplate such that the motor can be removed without disturbing the alignment or position of the driven equipment, and be installed and realigned with the use of shims on the motor. Vertical jacking bolts shall be provided on the motor base for motor alignment. For horizontal sleeve motors, the rotor end float and coupling end-play shall be in accordance with NEMA MG 1. Vertical mounted pump motors shall be NEMA "P" face type. Motors greater than 50 lbs shall be provided with lifting eyebolts or lifting lugs for hoisting motors during installation, maintenance, and alignment.

3.5 Frame Ground Lug: All motors rated 100 HP and larger shall be provided with a copper ground pad or ground bolt tapped (1/4", 3/8" or ½") and welded on the motor frame in addition to the terminal box mounted ground lug. Frame ground pad shall be located within 1' of the motor termination box. For medium voltage motors, provide two copper ground pads, one on each side of the motor with drilled and tapped holes suitable for attaching two-hole NEMA grounding lugs.

3.6 Bonding Jumper: All motors 100 HP and larger shall be connected to the equipment skid via a #4/0 AWG cable minimum in addition to the equipment grounding conductor. Motors less than 100HP shall be grounded where a ground pad is provided on the motor. When a motor's starter and disconnect switch are separate devices, the grounding conductor shall be bonded to the starter and disconnect device enclosures and motor inclusive.

3.7 Power Lead Terminal Box: Motors shall have power leads brought into a frame mounted terminal box. The terminal box shall be oversized to allow termination of 600V power cable with the quantity and size of cables listed as specified herein. All motor power lead terminal boxes shall be at least one (1) size larger than normally furnished per NEMA MG 1. Terminal boxes shall be consistent with the motor enclosure type; (e.g., WPII, TEFC, hazardous rated,). A ground clamp or ground pad shall be provided in the motor terminal box for terminating two (2) dedicated equipment ground conductors. Terminal boxes for motors shall be cast iron, pressed steel, or fabricated steel. Terminal boxes shall be diagonally split with a gasket between the split halves of the housing. Each terminal box shall have a threaded opening to provide a watertight, rigid connection with the conduit. Acceptable trade sizes for threaded openings shall be: ½", ¾", 1", 1-1/2", 2", 3", 4", and 6". Terminal boxes shall be designed for rotation in 90° increments or have provisions to receive conduit from any of the four sides of the terminal box.

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3.7.1 Terminal Box General Arrangement: For motors 100 HP and greater, drawings shall be submitted with terminal box dimensions and locations as part of the GA submittal requirements of the Seller's Deliverable Schedule (SDS) included with this documentation.

3.7.2 Power Leads: Winding leads shall be terminated using conductor size and material matched single-conductor, compression type, double indent NEMA lugs. Leads between the motor and the power lead terminal box shall be non-hygroscopic 600V insulated copper. Leads entering the terminal box shall have motor lead positioners and be sealed or gasketed between the terminal box and the motor. Leads shall be permanently identified. All leads shall be permanently wired in accordance with the requirements of NEMA MG 1, Part 2.

3.7.3 Submersible Motor Power Cords: Special purpose submersible motors shall be provided with a 50 foot SJO power cord (3 conductors with ground) with a bushed cable protector at the entrance into the motor. Any SJO cords required for thermal overload signals or water detection signals shall be provided by the Seller and be the same length as the power cord. Submersible motors shall have all SJO cord installed, terminated, and sealed in the motor from the factory.

3.8 Insulation: Motors shall have Class F non-hygroscopic insulation with Class B temperature rise limits per NEMA MG 1. Insulation shall be treated to prevent deterioration due to humidity, abrasive dust, or corrosive vapors. Motors for cooling tower fan drive service shall be vacuum pressure impregnated (VPI) with an epoxy resin thermal setting compound. The insulation resistance of the entire winding shall meet the requirements of IEEE 43.

3.9 Rotor and Stator: Rotors shall be solid cast squirrel cage type adequately sized to avoid overheating of the motor during acceleration. Rotor and shaft shall be dynamically balanced with vibration limits not exceeding peak-to-peak amplitude values per NEMA MG 1. Stator windings shall be constructed with copper magnet wire, random wound. Stator core shall be constructed from high grade electrical steel to reduce hysteresis and eddy-current losses.

3.10 Shaft: The shaft shall be furnished with corrosion-resistant treatment or shall be of corrosion-resistant material. A rotating labyrinth shaft seal shall be furnished on the shaft extension end of the motor.

3.10.1 Shaft Couplings: Direct connected motors shall be connected to driven equipment through a flexible coupling. Motor shafts shall be keyed. Maximum end float shall be limited to motor manufacturer's recommendations to prevent axial thrust from being transmitted to the motor bearings. The shaft shall be furnished with corrosion-resistant treatment or shall be of corrosion-resistant material.

3.10.2 Noise: Noise requirements as defined in Section GR-A.

3.11 Nameplates: All motors shall be provided with a permanent stainless steel or aluminum nameplate firmly attached to the motor frame with corrosion-resistant metal attachment pins. Nameplates shall be either embossed raised letter or engraved and enamel filled. Nameplate

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information shall be in English units, with minimum data according to NEMA MG1, ANSI C50.41, and as follows:

a. Motor manufacturer, model number or serial number
b. Horsepower (at plant altitude), NEMA design letter, speed in RPM, service factor
c. Voltage, phase, hertz
d. Running amps, locked rotor amps or locked rotor KVA code letter, full load amps
e. Duty rating, ambient temperature
f. Insulation class
g. Efficiency data
h. Bearing data including ABMA bearing identification number for motors furnished with rolling element bearings.
i. Voltage or speed connection diagram
j. Frame size and enclosure type
k. Starting limitations, if any

3.11.1 Separate permanent nameplates shall be provided identifying the following: space heater wattage and voltage, bearing lubrication requirements, the motors shall have the direction of rotation marked on a nameplate for the supply voltage sequence of T_1-T_2-T_3. The magnetic center at rated load shall be marked on all motors.

3.12 Tests: Motors shall undergo routine factory testing in accordance with NEMA and IEEE 112 standards to verify freedom from mechanical and electrical defects. Motor tests shall be performed with the motor terminal housing installed on motor. As a minimum motors shall be factory tested for the following:

a. No load running current
b. Insulation resistance (hi-pot)
c. Winding resistance
d. Mechanical balance
e. Locked rotor current
f. No load speed
g. Motor efficiency

3.12.1 Test reports shall be furnished for all motors 100 HP and larger. The test report shall include complete nameplate information, and shall be patterned after IEEE Std. 112.

3.13 Motor Data Submittal: The attached Motor Data Sheet shall be completed and submitted for each motor furnished. Seller shall submit motor outline drawings showing motor dimensions, terminal box locations, wiring termination details on winding leads and accessories, approximate rotor weight, and the total motor weight.

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3.13.1 In addition to the Motor Data Sheet and requirements submittal drawings listed above, the following Seller's information shall be submitted for review for all large LV motors (>50kW). Motor thermal limit and performance curves (>100 kW Motors only).

a. Motor thermal damage curve including each of the following curves plotted on one graph:
   1. Thermal limit curve at cold (ambient temperature) condition for locked rotor
   2. Thermal limit curve at hot (operating temperature) condition for locked rotor
   3. Thermal limit curve at cold (ambient temperature) condition for running overload
   4. Thermal limit curve at hot (operating temperature) condition for running overload
   5. Time-current motor acceleration curve at 110% of rated voltage
   6. Time-current motor acceleration curve at rated voltage
   7. Time-current motor acceleration curve at 90% of rated voltage
   8. Time-current motor acceleration curve at 80% of rated voltage

b. Motor speed versus torque and current curves indicated at rated voltage, 90% of rated voltage, and 80% of rated voltage.

c. Motor outline drawings showing detailed motor dimensions, shaft dimensions, mounting dimension clearances, and rotor and coupling end float limits.

4. INTEGRAL HORSEPOWER MOTORS, GREATER THAN 250 HP:

4.1 General: Integral horsepower motors, greater than 250 HP shall be provided as required to drive the specified equipment. Motor selection in regards to sizing, service factor, efficiency, and starting conditions shall be as specified herein. Motors shall be single-speed, squirrel-cage, and induction. Motors may be of the horizontal direct coupled, horizontal belt driven, or vertical type as specified herein.

4.2 Voltage Ratings: Unless otherwise specified, typical voltage ratings for motors shall be as follows:

4.2.1 Motors greater than 250 HP shall be 6600 VAC, three-phase, 60 Hz, rated for service on a 6900 VAC, three-phase, 60 Hz, resistance grounded system.

4.3 Enclosures: Motors shall be provided with enclosures suitable for the location atmosphere, ambient temperature, and operating conditions of the driven load. Motors shall be weather protected Type II (WPII). Enclosures for hazardous or classified areas shall be appropriately designed by the Seller. Enclosures shall be provided with removable dry type filters and stainless steel screens. Assembly hardware for all motors shall be zinc-plated corrosion resistant steel or stainless steel. Enclosures shall be of cast iron or formed steel not less than 0.125 inches thick and shall be suitably treated to resist corrosion and braced to prevent distortion and

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vibration. Aluminum enclosure parts are not acceptable. Motor enclosures shall have all exposed metal surfaces protected with a moisture and corrosion-resistant polyester paint or coating. Assembly hardware shall be zinc plated or stainless steel. Soleplates shall be provided if required by design.

4.3.1 Totally enclosed motors with NEMA waterproof features shall have enclosure interior surfaces and the stator and rotor air gap surfaces protected with corrosion-resistant alkyd enamel or with polyester or epoxy paint or coating. Bolts, nuts, screws, and other hardware items shall be corrosion-resistant or heavy cadmium-plated metal.

4.4 Mountings: Unless mounted on a common frame with the driven equipment, horizontal motors shall be furnished with a matching soleplate such that the motor can be removed without disturbing the alignment or position of the driven equipment, and be installed and realigned with the use of shims on the motor. Vertical jacking bolts shall be provided on the motor base for motor alignment. For horizontal sleeve motors, the rotor end float and coupling end-play shall be in accordance with NEMA MG 1. Vertical mounted pump motors shall be NEMA "P" face type. Motors shall be provided with lifting eyebolts or lifting lugs for hoisting motors during installation, maintenance purposes, and alignment.

4.5 Frame Ground Lugs: In addition to the terminal box ground clamp or ground pad, motors shall be provided with two (2) diagonally opposite frame grounding pads. Pads shall be copper with drilled and tapped holes suitable for attaching NEMA two-hole grounding lugs. One frame ground pad shall be located within 1’ of motor terminal box.

4.6 Bonding Jumper: All motors 100HP and larger shall be connected to the equipment skid via a #4/0 AWG cable minimum in addition to the equipment grounding conductor. When a motor’s starter and disconnect switch are separate devices, the grounding conductor shall be bonded to the starter and disconnect device enclosures and motor inclusive.

4.7 Power Lead Terminal Box: Motors shall have power leads brought into a frame mounted terminal box. The terminal box shall be oversized to allow termination of medium voltage shielded cable, quantity and size of cables listed as specified herein, with stress cones. Terminal box size and configuration furnished shall provide insulator supported copper bus bar for terminations consistent with NEMA MG 1 Standard requirements for "Type II" Terminal Housings. All motor power lead terminal boxes shall be at least one (1) size larger than normally furnished per NEMA MG 1. Terminal boxes shall be consistent with the motor enclosure type (WPII, TEFC, hazardous rated,). A ground clamp or ground pad shall be provided in the motor terminal box for terminating two (2) dedicated equipment ground conductors. Terminal boxes shall be provided with a gasketed bolt-on cover with lifting handles for easy removal. The terminal box shall be designed for rotation in 90° increments or have provisions to receive conduit from any of the four sides of the terminal box. Terminal boxes shall be provided with a breather/drain fitting.

4.7.1 Power Leads: Winding leads shall be terminated using conductor size and material matched single-conductor, compression type, double indent, NEMA two-hole lugs. Leads between the motor and the power lead terminal box shall be non-hygroscopic EPR insulated copper with a voltage rating equal to the line-to-line voltage of the electrical system feeding the motor.

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Terminations shall be landed on insulator supported copper bus bar configuration consistent with NEMA MG 1 standard requirements for "Type II" Terminal Housings. Copper busses shall be drilled and tapped for attaching NEMA two-hole lugs. Medium voltage power cables shall be terminated with prefabricated terminal kits. Lugs will be long barrel, double indent NEMA two-hole copper compression type. Leads entering the terminal box shall have motor lead positioners and shall be sealed or gasketed between the terminal box and the motor. Leads shall be permanently identified. Provisions shall be made for connecting medium voltage shielded cables to the bus bars using NEMA two-hole lugs. All leads shall be permanently wired in accordance with the requirements of NEMA MG 1, Part 2.

4.7.2 Differential Protection: Core balance current transformers (CTs) for motor differential protection shall be provided for all motors larger than 1500 HP. CTs shall be provided as follows: Both ends of each motor winding shall be brought out to the power lead terminal box and shall pass through the core balance CTs for application of differential relay protection. One (1) CT shall be installed per winding for a total of three (3) CTs. Final connections shall be provided and installed for the common side windings as specified above. The CT secondary leads shall be #10 AWG SIS copper wire, terminated on shorting-type terminal blocks with ring lugs in an accessory terminal box mounted externally to the power lead terminal box. The CTs shall be 50:5A ANSI relaying class C20 or higher. Seller shall be solely responsible for ensuring adequate space in the power lead terminal box for installation of the CTs.

4.7.3 Surge Protection: Motors greater than 4000 HP shall be provided with a station class surge arrester sized per the Seller's standard. The motor will be connected to a resistance grounded system, which will present line-to-line voltage between two (2) of the phases and ground during a line-to-ground event on the electrical system. Seller shall provide a surge arrester that will not be damaged due to line-to-ground overvoltage caused by a line-to-ground event on the electrical system.

4.8 Insulation: Class F non-hygroscopic insulation shall be furnished with a Class B temperature rise per NEMA MG 1. Windings on motors shall be form wound and vacuum pressure impregnated (VPI) with an epoxy resin thermal setting compound to prevent deterioration due to humidity, abrasive dust, or corrosive vapors. The insulation resistance of the entire winding shall meet the requirements of IEEE 43.

4.9 Rotor and Stator: The rotor shaft assembly shall be fabricated copper bar construction. Rotor and shaft shall be dynamically balanced with vibration limits not exceeding peak-to-peak amplitude values per NEMA MG 1. Rotors shall be adequately sized to avoid overheating during acceleration of the driven load. Stators shall be constructed from high grade electrical steel with copper windings to reduce load and magnetic losses.

4.10 Shaft: All shafts shall be solid. The shaft shall be furnished with corrosion-resistant treatment or shall be of corrosion-resistant material. A rotating labyrinth shaft seal shall be furnished on the shaft extension end of the motor.

4.10.1 Shaft Couplings: Direct connected motors shall be connected to driven equipment through a flexible coupling. Motor shafts shall be keyed. Maximum end float shall be limited to

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motor manufacturer's recommendations to prevent axial thrust from being transmitted to the motor bearings.

4.11 Critical Speeds: Motors shall be designed to keep torsional and rotational natural frequencies of vibration at least 25% above the motor rated speed ranges to avoid vibration over the operational speed range of the equipment-motor unit.

4.12 Torque Characteristics: Unless specified otherwise, motor torques in percent of full load torque at rated voltage and frequency, shall not be less than 200% breakdown, 85% pull-up, and 100% locked-rotor. At 85% rated voltage the torque of the motor shall be a minimum of 15% above the load torque requirement throughout the entire speed range. Torques for normal torque (NT) motors shall not be less than 80% of full load torque at rated voltage and frequency for locked rotor and pull-up torque and 200% for breakdown torque. High torque (HT) motor torques will be in accordance with Table 2 of NEMA C50.41 as a minimum and higher if required for proper operation.

4.13 Noise: Noise requirements as defined in Section GR-A. Warranted maximum A-weighted sound level shall not exceed 85 dBA (dB, re: 0.0002 microbar) at any point one meter from motor when tested as per NEMA MG 1, Part 9.

4.14 Accessory Terminal Boxes: Accessory terminal boxes shall be mounted on the motor frame and be consistent with the motor enclosure type; (e.g., WPII, TEFC, hazardous rated,). Accessories shall be wired to terminal blocks mounted in the respective auxiliary terminal box. Drawings shall be submitted with terminal box dimensions and locations and shall be subject to approval by the Engineer. Wiring leads between the accessories and the terminal box shall be routed in rigid galvanized steel raceway and liquid tight flexible metallic conduit. Connections shall be indicated on the terminal box nameplate. An accessory terminal box shall be provided for each of the following:

a.	Motor Space Heater Terminal Box
b.	Differential Protection CT Leads Terminal Box
c.	Stator Winding RTDs, Bearing RTDs and Vibration Switch Terminal Box

4.15 All RTD elements shall be duplex, with class A accuracy.

4.16 Thermocouples and RTDs elements shall be spring-loaded to provide good thermal contact with its associated thermowell. All connection heads shall be rated NEMA 4 as a minimum with appropriate hazardous area rating as required, made of cast iron, steel, or aluminum with screwed covers and retaining chain, and supported from the well by a nipple-union-nipple extension. Connection heads shall be furnished with insulated brass terminal blocks for extension wiring. Connection head conduit connections shall
be 'A" NPT.

4.17 Stator Winding RTDs: Stator winding RTDs shall be furnished, installed, and completely wired for all motors with two (2) RTDs installed per phase. RTDs shall be 100 ohm

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platinum, ungrounded, three-wire type. RTD and lead insulation class shall be the same as the stator coil insulation class. RTD wiring shall not be less than #16 AWG. Leads shall be provided with an abrasion-resistant covering or sleeve external to the slot. Stator RTDs shall be embedded in the stator windings at locations of highest probable temperature. All RTDs shall be ungrounded with leads wired to terminal blocks rated for 300V capable of accepting at least #16 AWG wire furnished in the accessory terminal box. A separate ungrounded terminal for each RTD shall be included with the lead terminals for connection of the cable shield drain wire.

4.18 Bearing RTDs: Bearing RTDs shall be furnished, installed, and completely wired for all motors with two (2) RTDs installed per bearing as a minimum. RTDs shall be 100 ohm platinum 90 degree Celsius, ungrounded, three-wire type. RTD wiring shall not be less than #16 AWG. RTDs for bearings shall be insulated with magnesium oxide packed in a stainless steel protective sheath. Insulation shall be provided on the RTDs and on oil piping connections when required to prevent circulation of shaft current through bearings. Where sleeve type bearings are furnished, each RTD tip shall be held within 1/16 inch of the Babbitt material, but not extending into the Babbitt material. All RTDs shall be ungrounded with leads wired to terminal blocks rated for 300 V capable of accepting at least #16 AWG wire furnished in the accessory terminal box. A separate ungrounded terminal for each RTD shall be included with the lead terminals for connection of the cable shield drain wire.

4.19 Bearing Temperature Detectors: Type K (chromel-alumel) thermocouple type bearing temperature detectors, one dual element unit per bearing, complete with thermowell and detector head and holder assemblies, as required, shall be furnished for all motors. Thermocouples shall be ungrounded. Thermocouple type detectors for bearings shall be insulated with magnesium oxide packed in a stainless steel protective sheath. Thermocouple wire insulation shall be color coded with standard colors to represent the thermocouple metals. Insulation shall be provided on bearing temperature detectors and on oil piping connections when required to prevent circulation of shaft current through bearings. Where sleeve type bearings are furnished, each detector tip shall be held within 1/16 inch of the Babbitt material, but not extending into the Babbitt material. The thermocouples shall be factory wired in rigid galvanized steel raceway and liquid tight flexible metallic conduit from the thermowell housings to the stator RTD terminal box, and terminated on dedicated terminal blocks listed for type “K” thermocouple use. Hazardous rated designs shall utilize conduit seals as required for the hazardous location.

4.20 Vibration Monitoring: All motors shall have provisions for mounting vibration monitoring probes. Vibration monitoring shall be supplied for major plant and auxiliary equipment with motors above 250 HP with the exception of air compressor and fire pump motors. The system shall meet API 670 standards. Vibration probes shall be compatible with Bently Nevada Orbit 60 System. A vibration switch shall be provided by the Seller for all motors unless vibration monitoring equipment is specified below for specific applications. Vibration switches shall be of the mechanical type with manual reset pushbutton accessible from the outside of the switch. Vibration switches shall be capable of sensing and alarming on vibration in any plane of motion. If electronic type switches are required for proper protection of the motor, they shall be electrically shielded and subject to the Engineer’s approval. Each vibration switch shall be preset at the factory to alarm on vibration limits specified by the motor manufacturer. Two (2) form C contacts rated 5A at 120 VAC, 0.5A at 125 VDC, shall be provided for each vibration switch. All contacts shall

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be wired to a terminal block rated for 600V, 20A capable of accepting at least #10 AWG wire. A separate ungrounded terminal for each contact shall be included with the lead terminals for connection of the cable shield drain wire.

4.21 Nameplates: All motors shall be provided with a permanent stainless steel or aluminum nameplate firmly attached to the motor frame with corrosion-resistant metal attachment pins. Nameplates shall be either embossed raised letter or engraved and enamel filled. Nameplate information shall be in English units, with minimum data according to NEMA MG 1, ANSI C50.41, and as follows:

a. Motor manufacturer, model number, and serial number
b. Horsepower (at plant altitude), NEMA design letter, speed in RPM, and service factor
c. Voltage, phase, and hertz
d. Running amps, locked rotor amps or starting KVA code letter, and full load amps
e. Duty rating and ambient temperature
f. Insulation class
g. Efficiency data
h. Bearing data including ABMA bearing identification number for motors furnished with rolling element bearings
i. Voltage or speed connection diagram
j. Frame size and enclosure type
k. Maximum permissible number of starts and the required cooling period when motor is started under conditions of (a) cold rotor and (b) warm rotor (after running continuously at full load for a period of one hour or after a number of failed starts specified by the Seller)

4.21.1 Separate permanent nameplates shall be provided identifying the following: Space heater wattage and voltage, bearing lubrication requirements, direction of rotation for the supply voltage sequence T1-T2-T3, connection diagram, and the magnetic center at rated load.

4.22 Tests: Motors shall undergo factory testing in accordance with NEMA and IEEE standards to verify freedom from mechanical and electrical defects. Motor tests shall be performed with the motor terminal housing installed. As a minimum, motors shall be factory tested for the following:

a. No load running current, power, and speed at rated voltage and frequency
b. Insulation resistance (hi-pot)
c. Winding resistance
d. Mechanical balance
e. Locked rotor current
f. No load speed, percent slip at full load
g. Efficiency at 100%, 75%, and 50% load
h. Power factor at locked rotor, 100%, 75%, and 50% load
i. Full load, locked rotor, breakdown torque

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j. Speed torque, voltage, and current curves
k. Rotation verification

4.22.1 Test reports shall be furnished for all motors. The test report shall include complete nameplate information, and shall be patterned after IEEE Std. 112.

4.23 Motor Data Submittal: The attached Motor Data Sheet shall be completed and submitted for each motor furnished. In addition to the Motor Data sheet, the following Seller's information shall also be submitted for review for all motors:

a. Motor thermal damage curve including each of the following curves plotted on one graph:
   1. Thermal limit curve at cold (ambient temperature) condition for locked rotor
   2. Thermal limit curve at hot (operating temperature) condition for locked rotor
   3. Thermal limit curve at cold (ambient temperature) condition for running overload
   4. Thermal limit curve at hot (operating temperature) condition for running overload
   5. Time-current motor acceleration curve at 110% of rated voltage
   6. Time-current motor acceleration curve at rated voltage
   7. Time-current motor acceleration curve at 90% of rated voltage
   8. Time-current motor acceleration curve at 80% of rated voltage
b. Motor speed versus torque and current curves indicated at rated voltage, 90% of rated voltage, and 80% of rated voltage.
c. Consecutive number of starts with the motor at ambient temperature and at operating temperature. Cool down time between starts with the motor at ambient temperature and at operating temperature.
d. Superimposed speed-torque curves for each motor driven equipment match. Speed-torque curves shall include the motor speed-torque curves at 80% of rated voltage and at 110% of rated voltage, superimposed on the driven equipment speed-torque curve during acceleration.
e. Parameters for relay settings including voltage imbalance limits and current imbalance limits
f. Winding temperature alarm and trip setpoints
g. Bearing temperature alarm and trip setpoints

END OF SECTION

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