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| Version | Date | Description of Revisions |
| 1 | August 30, 2006 | Approved final document. |
| 2 | February 19, 2010 | Modified ‘Related Sections’ and approved suppliers |
| 3 | June 4, 2013 | Final Draft – Consolidated Comments Spec Update Project |
| 4 | June 26, 2013 | Incorporation of new Commissioning Specification cross references. Incorporated several aspects of the NL building specifications. |
| 5 | July 29, 2014 | Changes to reflect renaming of commissioning specification and final review (AV) |
| **6** | **February 4, 2015** | **Updated, Finalized Specification – Reference eDOCS #5630492 v10 (AV) and update to standard (NEMA MG 1-2014)** |
| 7 | January 13, 2017 | Revised the Power Factor Correction Capacitor section. |
| 8 | February 10, 2017 | Applied changes related to reducing cited products contained in specification and addition of performance based parameters. (AV)  Updated Reference Standards (NEMA MG 1-2016, CSA C22.2 No. 145-11 (R 2015), CSA C390-10 (R2015), ISO/CD 21940-11:2016) (AAM) |

NOTE:

This is a CONTROLLED Document. Any documents appearing in paper form are not controlled and should be checked against the on-line file version prior to use.

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**The on-line copy is the current version of the document.**

# GEneral

## Summary

### Comply with Division 1 - General Requirements and Section 16010 – Electrical General Requirements.

### Products installed, but not supplied under work of this Section: Motors and power factor correction capacitors supplied together with driven equipment as package. Refer to driven equipment specifications.

### Power factor correction capacitors: When required to achieve 0.95 power factor, supplied as package with high efficiency motors.

#### Information pertaining to all motors supplied by the Contract shall be summarized by the Contractor in the format defined in Section 01425 - Computerized Maintenance Management System Data Requirements.

## Related Sections

### [Under "Related Sections", identify other Sections that are related to, and/or dependent on, the work results or information specified elsewhere. The list should be limited to Sections with specific information that the reader might expect to find in this Section, but is specified elsewhere. For example, if hardware for aluminum entrances is specified in the aluminum entrance Section, a cross-reference would be appropriate in the finish hardware Section. The purpose of this cross-referencing is for information only, to aid in finding those other requirements—not to define the scope of the Section.

### Cross-referencing here may also be used to coordinate assemblies or systems whose components may span multiple Sections and which must meet certain performance requirements as an assembly or system.

### Contractor is responsible for coordination of the Work. Contractor is responsible for being familiar with and incorporating all required elements of cross-referenced Specifications cited.

### This Section is to be completed/updated during the design development by the Consultant. If it is not applicable to the section for the specific project it may be deleted.]

### [List Sections specifying installation of products supplied but not installed under this Section and indicate specific items.]

### Section [\_\_\_\_\_\_ – \_\_\_\_\_\_\_\_\_\_\_\_]: Execution requirements for ...[item]... specified under this Section.

### [List Sections specifying products installed but not supplied under this Section and indicate specific items.]

### Section [\_\_\_\_\_\_ – \_\_\_\_\_\_\_\_\_\_\_\_]: Product requirements for ...[item]... for installation under this Section.

### [List Sections specifying related requirements.]

### Section [\_\_\_\_\_\_ – \_\_\_\_\_\_\_\_\_\_\_\_]: [Optional short phrase indicating relationship].

### Sections:

#### Section 01250 - Substitutions

#### Section 01300 – Submittals

#### Section 01430 – Operation and Maintenance Data.

#### Section 01425 - Computerized Maintenance Management System Data Requirements

#### Section 01810 – Equipment Testing and Facility Commissioning

#### [Division 13 –SCADA and Instrumentation - insert applicable specifications]

#### Section 16010 – Electrical General Requirements

#### Design Guidelines Section 12 – Electrical

#### Design Guidelines Section 21 – Development and Maintenance of Asset Inventory and Tagging

#### Product requirements for [item]... for installation under this Section.

## References

*[Delete .1 if Section 01060 – Regulatory Requirements is included in Contract Documents.]*

### Comply with the latest edition of the following statutes, codes, standards, and all amendments thereto:

#### Design motors in accordance with applicable sections of ANSI, IEEE, NEMA and CSA. [If EEMAC standards are to be applied, the Consultant will review the standards and approve any references to EEMAC standards in order to meet the Region’s energy efficiency objectives. If possible, the Consultant to replace any EEMAC reference with an equivalent NEMA standard]

#### NEMA MG 1-2016 Motors and Generators.

#### NEMA MG 2-2014, Safety Standard and Guide for Selection, Installation and Use of Electric Motors and Generators.

#### CSA C22.2 No. 100-14, Motors and Generators.

#### CSA C22.2 No. 145-11 (R 2015), Electric motors and generators for use in hazardous (classified) locations (Tri-national standard, with NMX-J-652-ANCE and UL 674).

#### CSA C390-10 (R2015), Test methods, marking requirements, and energy efficiency levels for three-phase induction motors.

#### CAN/CSA C838-13, Energy Efficiency Test Methods for Three-Phase Variable Frequency Drive Systems.

#### IEEE 112-2004, IEEE Standard Test Procedure for Polyphase Induction Motors and Generators.

#### ISO 3741:2010, Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Precision methods for reverberation test rooms.

#### ISO/CD 21940-11:2016, Mechanical Vibration – Part 11: Procedures and Tolerances for Rotors with Rigid Behaviour.

## Measurement and Payment

*[Choose one of the following payment language provisions that best suits the individual project.*

*If this Section is not specifically referenced by an item in the Bid Form, please use the following language:*

### The work of this Section will not be measured separately for payment. All costs associated with the work of this Section shall be included in the Contract Price.

*OR If this Section is specifically referenced in the Bid Form, use the following language and identify the relevant item in the Bid Form:*

### All costs associated with the work of this Section shall be included in the price(s) for Item No(s). \_\_\_ in the Bid Form.

*If the work of this Section is to be measured and paid for by several different methods, please amend the standard wording given above to reflect the different methods of measurement and payment.*]

## Quality Assurance

### Conduct tests using the methods detailed in IEEE 112-2004 for three phase motors.

### Unless noted otherwise in the Contract Documents, prior to shipment from motor manufacturer's factory, subject motors to routine tests as defined by NEMA/ANSI and IEEE.

### Perform tests at motor full speed.

### Statically and dynamically balance motors over 0 to 125% speed range in accordance with ISO/CD 21940-11:2016.

### Refer to related driven equipment specification for additional testing requirements in motor manufacturer's factory or driven equipment manufacturer's factory. Coordinate and include costs associated with additional testing.

### Submit two copies of certified test reports. Test reports are to be submitted to the Consultant and Region for approval in an electronic format suitable for upload to the Region’s CMMS (Maximo).

### Submit all other required information as detailed in the equipment information requirements of Design Guidelines Section 21 – Development and Maintenance of Asset Inventory and Tagging and in a format suitable for upload to the Region’s CMMS (Maximo) as defined by Section 01430 – Operation and Maintenance Data.

### All commissioning activities shall conform to the requirements of Section 01810 – Equipment Testing and Facility Commissioning.

## Submittals

### Submit the following shop drawings, information and data:

#### Refer to Section 01300 – Submittals.

#### Motor and nameplate and performance data.

#### Efficiency and power factor at 1/2, 3/4 and full load.

#### Approximate outline dimensions of each motor, showing sizes and location of terminal boxes and horizontal and vertical clearances necessary for maintenance purposes.

#### Speed-torque curve, speed-current curve, rotor WK2, starting time, and locked rotor time.

#### Maximum safe locked rotor time.

#### Total weight and heaviest shipping weight of motor.

#### Permissible number of fully loaded and unloaded starts over a defined time period (for example, starts per hour).

#### Design information regarding shaft and sheave sizes for coordination with driven equipment.

#### Diagrams of auxiliary systems, such as resistance temperature detectors, current transformers for differential protection. Auxiliary cooling water and leakage detection system. Space heaters to prevent moisture from condensing on the windings. RTD’s on major pumping units shall be wired to the motor protection relay for such pumps and shall be in accordance with the operational requirements set out in Division 13 - SCADA and Instrumentation and the Process Narrative/Process Control Narratives included in the SCADA appendices and Contract Documents. *[Project team/Consultant to ensure that the Process Narrative/Process Control Narratives are attached as appendix documents to the Contract]*

### Manuals

#### Submit bound and indexed copies of operating and maintenance manuals including, but not limited to, the following:

##### Storage instructions

##### Complete parts list

##### Spare parts list

##### Installation instructions

##### Operating instructions

##### Maintenance instructions

##### Routine factory test results

### Provide equipment and maintenance data in accordance with Section 01425 - Computerized Maintenance Management System Data Requirements.

## Design Requirements

### The design shall incorporate features and equipment types capable of efficient energy use and following the Region’s energy optimization objectives in accordance with Design Guidelines Section 12 – Electrical. The use of premium rated motors shall be standard. The design shall also incorporate energy monitoring capabilities in order to operationalize energy management initiatives.

### Water cooled motors may be considered and approved as an option by the Consultant.

### Supply severe duty fixed speed, three lead, single-voltage, squirrel-cage induction motors designed for full voltage

### Design motors and individual components thereof to perform at full nameplate rating in 40°C temperature and ambient conditions specified in the Contract Documents *[Consultant to amend subsection to reflect project specific details on ambient conditions].* Motor output power shall meet operating conditions without infringing upon motor service factor rating.

### Supply motors with 1.15 service factor.

### Comply with the applicable standards of ANSI, IEEE, NEMA and CSA.

### If the required kW (horsepower) falls between two listed kW (horsepower) design the motor for the required kW (horsepower). The larger listed horsepower motor will not be acceptable. Design the motor for this specific load rating.

### Minimum efficiency at full load shall be 95%. Minimum power factor requirement shall be achieved with the use of capacitors (if necessary).

### Utilize a design B squirrel cage induction motor, provided that this design meets the starting and operating requirements of the equipment. Minimum starting and breakdown torque shall be as indicated in NEMA MG 1-2016. If larger load torque or WK² requirements are encountered, other motor design type selection is acceptable subject to prior acceptance by the Consultant.

### Motors shall operate continuously at the rated load without exceeding the maximum temperature rise of 80°C above the ambient temperature of 40°C.

### Size pump and fan motors for duty point conditions without including service factor.

### Power supply variations: A combination of 10% voltage variation, 2% phase voltage imbalance and continuous operation at rated load in specified ambient is not to raise winding hot-spot temperature beyond insulation class rating.

### Do not exceed the maximum locked rotor current values as listed in NEMA Standard MG 1-2014 for the specified NEMA design and rating.

### Maximum overall sound pressure level: 80 dBA measure on "A" weighing network using an octave band frequency analyzer conforming to ISO 3741:2010. Measure the mean sound pressure level in accordance with ISO 3741:2010. Refer to *[insert applicable Contract section]* for additional noise level restrictions. *[Consultant to ensure that additional noise restrictions are detailed in the Contract Documents]*

### The Contractor must familiarize themselves with the facility power quality so any electrical components (including VFD’s) can fully function under typical levels of power quality as delivered by the Local Distribution Company (LDC) *[Consultant to insert actual name of the relevant LDC for the project].* The Contractor and supplier shall provide electrical devices to protect electrical components from sags and swells experienced from the LDC at no additional cost to the Region.

# PRODUCTS

## Acceptable Manufacturers

### Electric Motor (> 37kW (50 hp)):

#### U.S. Electrical Motors, division Emerson.

#### WEG Electric Motors Corp.

#### General Electric Company.

#### Approved Equivalent.

### Electric Motor (< 37 kW (50 hp)):

#### U.S. Electrical Motors, division Emerson.

#### WEG Electric Motors Corp.

#### General Electric Company.

#### TECO-Westinghouse Motors (Canada) Inc.

#### Brook Crompton (Canada) Inc.

#### Emerson Industrial Automation (Leroy-Somer).

#### Approved Equivalent.

## Power Factor Correction Capacitor

### Performance

#### The power factor shall be at least 0.95 at the rated load and not less than 0.85 under half-load conditions. If a motor has a power factor lower than these values under field test conditions, the necessary corrective equipment shall be provided and installed by the Contractor at no additional cost to the Region. This applies to both pre-selected and post-selected equipment.

## Enclosures

### Frames: NEMA standard [*Consultant to insert relevant NEMA standard]* regarding frame/kW (horsepower) relationships for single speed applications [see subsection 1.3.1.1 above].

### Frame Construction: The frame shall be constructed of cast or modular iron cast steel or welded steel plate. The end plates shall be detachable in order to facilitate the removal of the rotor and aid in the replacement of stator coils. Aluminum housing or end-bells are not acceptable.

### Corrosion prevention: Internal parts of the motor exposed to external cooling air, such as air deflectors and fans, shall be made of corrosion resistant material or corrosion resistant plating. Mounting hardware shall be made of corrosion resistant material and approved by Consultant.

### Mounting: Unless otherwise indicated in the Contract Documents, foot mounted suitable for horizontal installation.

### Bases: The motor mounts on the common pump base, as supplied by the manufacturer.

## Stator

### Windings and terminal leads: Copper conductors, with ends brought into terminal box.

### Insulating material: Epoxy based, VPI insulating system, all winding connections including leads, shall be placed prior to VPI. The insulation system shall meet the criteria for NEMA Class F insulation. Winding temperature rise shall be maximum of 80°C as measured by resistance at a 1.0 service factor. Minimum rating phase to phase is 5 kV and neutral to ground is 5 kV.

### End turn support system: Coil ends shall be braced in order to prevent fatigue and cracking of insulation during starting and extended operation. The bracing shall be suitable to withstand an external three phase short circuit at full load and 100% voltage.

### High humidity environment: use an anti-fungus treatment.

### Winding temperature detection: Where indicated in the Contract Documents, two temperature sensors per phase in the stator windings and one each motor bearing with leads brought out to a separate terminal box. Platinum three-wire RTD’s shall be provided with resistance of 100 ohms at 0°C. One RTD of each winding will be monitored.

### Space Heaters: Space heaters shall be low watt density silicon rubber wrap around or strip type.

### Treat insulation to render stator winding and leads moisture proof, it must pass a sealed winding conformance test in accordance with NEMA MG 1-2014.

## Bearings and Lubrication

### Sleeve: Sleeves shall be spherically seated, hydrodynamic babbit lined, self-angling type, with the following features:

#### The bearings shall be easily removable without disturbing any part of the pump other than the bearing caps.

#### Vibration transducers shall be incorporated in bearing housing design as per Contract Drawings and wired to the motor protection relay (for large motors only).

#### RTD devices to be installed on all bearing cited in the Drawings.

#### Sleeve bearing loading shall not exceed 1,200 kPa when calculated on projected shaft area.

#### The L/d ratio for the sleeve bearing shall not be less than 1.0; were “L” is the bearing length and “d” is the sleeve diameter at the bearing. Submit any request for variance from the above requirement to the Consultant for review and approval.

#### Provide bearings with a maximum surface finish roughness of 0.3 to 0.5 micron, rms.

#### Provide material with a maximum hardness that is at least 100 Brinnell points less than the hardness of the shaft.

#### The shaft surface finish inside the bearing shall have a maximum surface roughness of 0.15 to 0.3 micron, rms. The shaft shall have a minimum surface hardness of 350 bhn (Brinell Hardness Number).

#### Design the bearings for operation in reverse rotation at 135% of the maximum rated speed.

#### The bearings shall be pressure oil lubricated by a stand-alone system. The oil shall be fed under pressure to the bearings and flow by gravity back to the pressure lubricating system.

#### A redundant, two piece, brass oil ring shall be capable of picking up oil from the bottom of the bearing housing to allow equipment coast-down lubrication in the event of a power failure.

#### The bearings shall only rely on the oil for cooling.

#### Oil seals shall be floating labyrinth type.

#### The motor manufacturer shall furnish and install bearing oil piping, flow switches, gauges, flow control valves, and isolation valves, as necessary to connect the individual bearings to the oil lubrication system.

#### MSDS for each lubricant shall be submitted to the Consultant prior to delivery on Site.

### Non drive end bearing shall be electrically insulated.

## Rotor Assembly

### Rotation: For motors designed for single direction operation only, clearly indicate direction of rotation by means of arrow on non-driving end. Painted arrows are not acceptable.

### Shaft extensions: With keys.

### Keyway: NEMA standards for frame motors *[Consultant to insert relevant NEMA standard]* [see subsection 1.3.1.1 above].

### The rotor core shall be assembled with laminations of high grade fully processed and pre-coated silicon steel securely clamped between heavy end rings. The rotor bars and end rings shall be copper or copper alloy. Rectangular bars shall be placed in the slots without insulations or shims. End rings shall be induction brazed with silver brazing alloy.

## Ventilation System

### Totally enclosed water cooled motors: Integral fan, part of rotor, non-sparking, abrasion resistant, low noise level material. Air flow direction to be from non-driving end toward driving end.

## Terminal Boxes

### Terminal boxes: Waterproof, [oversized,] cast iron or heavy wall steel, split design, threaded conduit holes, field rotatable in 90 degree steps for bottom, side or top conduit entry.

### Terminal box location: On right hand side when viewed from the non-driving end, unless otherwise indicated in the Contract Documents.

### Motor lead terminations: Solderless type for incoming cable connections and clamp terminal for ground connections. Clearly and permanently mark motor leads.

### Frame to terminal box cable passage: Seal to prevent the entrance of moisture or foreign matter.

### Gaskets: Between cover and box mating surfaces.

### Window type: Provide current transformers for differential protection with 50/5 Amperes-ANSI accuracy cited in ANSI Standards, - one for each winding. Provide separate terminal box for the same. *[Note to Consultant: CT ratio is specific to the motor.]*

### For equipment not employing soft starters, provide surge capacitors and lightning arrestors, mounted and connected as close as possible to the motor leads. Their primary function is to attenuate the incoming very high, rates of current change that can cause damage to machine winding. Lightning arrestors shall serve as a limitation on the magnitude of the surges. These units will be accessible only after opening of main terminal box.

### Design all high voltage motor terminal boxes large enough for the installation of stress cones, current transformers and surge arrestors. *[Note to Consultant: stress cones no longer used on 5 kV applications]*

### Where ancillary devices are specified in the Contract Documents, provide a separate box for termination of sensor leads. Leads shall be clearly identified, provide nameplate data and connection diagram.

## Painting

### Finish: Non-machined metal surfaces, one coat, primer and one coat suitable corrosion and oil resistant paint. Colour, manufacturer standard, unless otherwise indicated.

### Highly corrosive areas: Chemical duty, epoxy finish.

### Shipping protection: Including machined surfaces, protect with suitable means to prevent corrosion or moisture accumulation and damage during shipment and installation.

## Lifting Provisions

### Lifting provisions: Motors weighing 23 kg minimum, one or more lifting eyebolts, rings, or lugs capable of supporting weight of motor. If lugs are concealed by enclosure, attach nameplates to both sides of motor warning against improper lifting.

## Nameplates

### Nameplates: Stainless steel or non-corrodible alloy, embossed lettering, fixed to non-removable part of frame, in easily readable location, nameplates gives.

#### Manufacturer’s type and frame designation

#### Horsepower/kilowatts output

#### Time rating

#### Temperature rise

#### RPM at rated load

#### Frequency

#### Number of phases

#### Voltage

#### Rated load amperes

#### Code letter and inrush current

#### Service factor

#### Enclosure

#### Manufacturer’s name, mark and logo

#### Manufacturer’s plant location

#### Serial number and date of manufacture

### Dual voltage and multi-speed motors: Nameplate information showing wiring diagram and connection for each voltage and/or speed.

## Capacitors

### Capacitors to be switched with motors unless otherwise indicated in the Contract Documents. Power factor corrected range, minimum to 0.95 lagging.

### Rating selection: By motor manufacturer, to prevent overvoltage and damaging transient torques.

### Liquid filled capacitors: With internal or external drip pans to contain liquid in the event of a rupture.

### Enclosure: Splash proof, steel construction with removable cover, suitable for floor mounting adjacent to motors. Mount motor capacitor within the MCC if possible or elsewhere with approval from the Consultant.

### Liquid impregnated polypropylene film for high voltage application.

### Internal discharge resistors: To discharge unit to 50 V maximum within one minute after disconnection from supply.

### Ancillaries: Solderless line connectors, NEMA *[Consultant to insert relevant NEMA standard]* [see subsection 1.3.1.1 above] conduit box [fuses, line terminals, fuse clips].

# EXECUTION

## Installation

### Protect the motor against physical damage and moisture until ready for energization.

### Dry out the motor in accordance with the manufacturer's recommendations if dampness is present.

### Install the motor on driven machinery, baseplate, structure, slide rails or concrete base (once fully cured), rigid plumb square, using only the lifting facilities provided.

### Make electrical connections as indicated in the Contract Documents. Install liquid-tight PVC jacketed flexible conduit section between rigid conduit feed and motor where applicable.

### Where applicable, make flexible conduit or armoured cable long enough to permit movement of the motor over entire length of slide rails.

### Check the direction of rotation with the motor uncoupled from driven equipment. Correct the rotation where required.

### Install the driven equipment with the correct alignment and proper coupling of motor to driven machinery. Comply with the manufacturers' instructions and use correct parts such as couplings, belts, sheaves, as provided by motor manufacturer.

### Where applicable, install power factor correction capacitors supplied with motor and make final connections.

## Tests

### Before connecting the feeder cable, measure winding insulation resistance between each phase and ground. Repeat tests after connecting the feeder cable at supply. Where applicable, disconnect power factor capacitors, surge arresters and solid state equipment during tests.

### Conduct megger test on motors following installation and submit the test result report to the Consultant.

### Verify the operation and settings of the motor protection system before energization.

### Check the motor lubrication, alignment and direction of rotation.

### For motors rated [200kW] minimum, employ the services of an independent test agency to test the variation in motor full load and peak current by means of an oscillograph as indicated by NEMA MG 1-2016.

### Test motor efficiency as required in Section 1.3.1.7 (CSA C390-10) and provide a report to the Consultant verifying compliance to minimum efficiency requirements in accordance with C390-10 (reference energy efficiency levels).

### Submit a report to the Consultant confirming that the motor efficiency meets the minimum motor efficiency standards and requirements in accordance with CSA C390-10, Energy Efficiency Test Methods for Three-Phase Induction Motors.

### Test reports shall be submitted to the Consultant and Region for approval in an electronic format suitable for upload to the Region’s CMMS (Maximo).

## Commissioning

### For all commissioning activities on systems where components of this Section are integral to functionality, refer to Section 01810 – Equipment Testing and Facility Commissioning. All inspection and testing activities shall be completed in accordance with the documentation required as part of the commissioning plan that shall be provided to the Consultant prior to the commencement of commissioning activities.

**END OF SECTION**