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**Engineering Discipline:** Electrical

**Specification Division:** 26 20 00.LLE  
**Date:** 6/12/09

**Specification Title & Description:** (List attached Specifications by Section number, revision, date, and number of pages for each Section Specification compiled under this cover page. Attached Specifications are to have sequentially numbered pages.)

Low Voltage AC Induction Motors

**Revision History:**

<table>
<thead>
<tr>
<th>Revision No.</th>
<th>Description</th>
<th>Date</th>
<th>Affected Pages</th>
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<tr>
<td>A</td>
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**Document Review & Approval:**

**Originator:**

NAME/POSITION  
SIGNATURE  
DATE

**Design Verification Complete:**

NAME/POSITION  
SIGNATURE  
DATE

**Approved:**

NAME/POSITION  
SIGNATURE  
DATE
PART 1  GENERAL

1.01  SCOPE

A. This section applies only when referenced by a motor-driven equipment specification. Application, horsepower, enclosure type, mounting, shaft type, synchronous speed, and deviations from this section shall be listed in the equipment specification. Where such deviations occur, they shall take precedence over this section.

1.02  REFERENCES

A. The following Specification sections are referenced in this section:

1. Section 01 43 33.LLE, Manufacturer’s Field Services.
2. Section 01 78 23.LLE, Operation and Maintenance Data.
3. Section 01 88 15, Seismic Anchoring and Bracing

B. The following is a list of referenced standards in this section:

1. American Bearing Manufacturers Association (ABMA):
   a. 9, Load Ratings and Fatigue Life for Ball Bearings.
   b. 11, Load Ratings and Fatigue Life for Roller Bearings.
2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. 85, Test Procedure for Airborne Sound Measurements on Rotating Electric Machinery.
   b. 112, Standard Test Procedures for Polyphase Induction Motors and Generators.
   d. 841, Standard for Petroleum and Chemical Industry—Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors—up to and Including 500 hp.
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. C50.41, Polyphase Induction Motors for Power Generating Stations.
   c. MG 1, Motors and Generators.
5. Underwriters Laboratories (UL):
   a. 1, Flexible Metal Conduit.
   b. 674, Standard for Safety Electric Motors and Generators for use in Division 1 Hazardous (Classified) Locations.
   c. 2111, Overheating Protection for Motors.
   d. 1004, Standard for Safety Electric Motors.

1.03 DEFINITIONS

A. CISD-TEFC: Chemical industry, severe-duty enclosure.

B. DIP: Dust-ignition-proof enclosure.

C. EXP: Explosion-proof enclosure.

D. Inverter Duty Motor: Motor meeting applicable requirements of NEMA MG 1, Section IV, Parts 30 and 31.

E. Motor Nameplate Horsepower: That rating after any derating required to allow for extra heating caused by the harmonic content in the voltage applied to the motor by its controller.

F. NRTL: Nationally Recognized Testing Laboratory.

G. ODP: Open drip-proof enclosure.

H. TEFC: Totally enclosed, fan cooled enclosure.

I. TENV: Totally enclosed, nonventilated enclosure.

J. WPI: Open weather protected enclosure, Type I.

K. WPII: Open weather protected enclosure, Type II.

1.04 SUBMITTALS

A. Approval Required Prior to Work (APW) Submittal:
   1. Descriptive information.
   2. Nameplate data in accordance with NEMA MG 1.
   3. Additional Rating Information:
      a. Service factor.
      b. Locked rotor current.
      c. No load current.
      d. Safe stall time for motors 50 hp and larger.
e. Adjustable frequency drive motor load classification (for example, variable torque) and minimum allowable motor speed for that load classification.

f. Guaranteed minimum full load efficiency and power factor.

4. Enclosure type and mounting (such as, horizontal, vertical).
5. Dimensions and total weight.
6. Conduit box dimensions and usable volume as defined in NEMA MG 1 and NFPA 70.
7. Bearing type.
8. Bearing lubrication.
10. Space heater voltage and watts.
11. Description, ratings, and wiring diagram of motor thermal protection.
12. Motor sound power level in accordance with NEMA MG 1.
13. Maximum brake horsepower required by the equipment driven by the motor.
14. Description and rating of submersible motor moisture sensing system.
15. Seismic anchorage and bracing data sheets and drawings as required by Section 01 88 15, Seismic Anchorage and Bracing.
16. NRTL Listing.

B. Vendor Information Submittal:

1. Factory test reports.
2. Seismic anchorage and bracing calculations as required by Section 01 88 15, Seismic Anchorage and Bracing.
3. Operation and Maintenance Data: As specified in Section 01 78 23.LLE, Operation and Maintenance Data.
4. Manufacturer’s Certificate of Proper Installation in accordance with 01 43 33.LLE, Manufacturer’s Field Services.

PART 2  PRODUCTS

2.01 MANUFACTURERS

A. General Electric.

B. Reliance Electric.

C. MagneTek.

D. Siemens Energy and Automation, Inc., Motors and Drives Division.

E. Baldor.

F. U.S. Electrical Motors.
2.02 GENERAL

A. For multiple units of the same type of equipment, furnish identical motors and accessories of a single manufacturer.

B. In order to obtain single source responsibility, utilize a single supplier to provide a drive motor, its driven equipment, and specified motor accessories.

C. Meet requirements of NEMA MG 1.

D. Frame assignments in accordance with NEMA MG 13.

E. Provide motors that have an appropriate Nationally Recognized Testing Laboratory (NRTL) listing mark applied listing mark such as UL 1004.

F. Provide motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark.

G. Motors shall be specifically designed for the use and conditions intended, and with a NEMA design letter classification to fit the application.

H. Lifting lugs on all motors weighing 100 pounds or more.

I. Operating Conditions:

1. Maximum ambient temperature not greater than 50 degrees C.
2. Motors shall be suitable for operating conditions without any reduction being required in the nameplate rated horsepower or exceeding the rated temperature rise.
3. Overspeed in either direction in accordance with NEMA MG 1.

2.03 HORSEPOWER RATING

A. As designated in motor-driven equipment specifications.

B. Constant Speed Applications: Brake horsepower of the driven equipment at any operating condition not to exceed motor nameplate horsepower rating, excluding any service factor.
C. Adjustable Frequency and Adjustable Speed Applications (Inverter Duty Motor): Driven equipment brake horsepower at any operating condition not to exceed motor nameplate horsepower rating, excluding any service factor.

2.04 SERVICE FACTOR

A. Inverter-duty Motors: 1.0 at rated ambient temperature, unless otherwise noted.

B. Other Motors: 1.15 minimum at rated ambient temperature, unless otherwise noted.

2.05 VOLTAGE AND FREQUENCY RATING

A. System Frequency: 60 Hz.

B. Voltage Rating: Unless otherwise indicated in motor-driven equipment specifications:

<table>
<thead>
<tr>
<th>Size</th>
<th>Voltage</th>
<th>Phases</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4 hp and smaller</td>
<td>115</td>
<td>1</td>
</tr>
<tr>
<td>1/2 hp through 400 hp</td>
<td>460</td>
<td>3</td>
</tr>
<tr>
<td>450 hp and larger</td>
<td>4,000</td>
<td>3</td>
</tr>
</tbody>
</table>

C. Suitable for full voltage starting.

D. 100 hp and larger also suitable for reduced voltage starting with 65 percent or 80 percent voltage tap settings on reduced inrush motor starters.

E. Suitable for accelerating the connected load with supply voltage at motor starter supply terminals dipping to 90 percent of motor rated voltage.

2.06 EFFICIENCY AND POWER FACTOR

A. For all motors except single-phase, under 1 hp, multispeed, short-time rated and submersible motors, or motors driving gates, valves, elevators, cranes, trolleys, and hoists:

1. Efficiency:
   a. Tested in accordance with NEMA MG 1, Paragraph 12.60.
   b. Guaranteed minimum at full load in accordance with NEMA MG 1 Table 12-12, Full-Load Efficiencies for 60-Hz NEMA Premium Efficiency Electric Motors, or as indicated in motor-driven equipment specifications.
2. Power Factor: Guaranteed minimum at full load shall be manufacturer’s standard or as indicated in motor-driven equipment Specification.

2.07 LOCKED ROTOR RATINGS

A. Locked rotor kVA Code G or lower, if motor horsepower not covered by NEMA MG 1 tables.

B. Safe stall time 12 seconds or greater.

2.08 INSULATION SYSTEMS

A. Single-Phase, Fractional Horsepower Motors: Manufacturer’s standard winding insulation system.

B. Motors Rated Over 600 Volts: Sealed windings in accordance with NEMA MG 1.

C. Three-Phase and Integral Horsepower Motors: Unless otherwise indicated in motor-driven equipment specifications, Class B or Class F at nameplate horsepower and designated operating conditions, except EXP and DIP motors which must be Class B with Class B rise.

D. Motors With Form-Wound Coils: Locked coil bracing system in accordance with NEMA C50.41.

2.09 ENCLOSURES

A. Enclosures to conform to NEMA MG 1.

B. TEFC and TENV: Furnish with a drain hole with porous drain/weather plug.

C. Explosion-Proof (EXP):

1. TEFC listed to meet UL 674 and NFPA 70 requirements for Class I, Division 1, Group C and D hazardous locations.
2. Drain holes with drain and breather fittings.
3. Integral thermostat opening on excessive motor temperature in accordance with UL 2111 and NFPA 70.
4. Thermal protection leads in a terminal box separate from main terminal box when required by Paragraph Special Features and Accessories.

D. Dust-Ignition-Proof (DIP):

1. TEFC listed to met UL 674 and NFPA 70 requirements for Class II, Division 1, Group E.
2. Integral thermostat opening on excessive motor temperature in accordance with UL 2111 and NFPA 70.
3. Terminate thermal protection leads in a terminal box separate from main terminal box when required by Paragraph Special Features and Accessories.

E. Submersible: In accordance with Article Special Motors.

F. Chemical Industry, Severe-Duty (CISD-TEFC): In accordance with Article Special Motors.

2.10 TERMINAL (CONDUIT) BOXES

A. Oversize main terminal boxes for all motors.

B. Diagonally split, rotatable to each of four 90-degree positions. Threaded hubs for conduit attachment.

C. Except ODP, furnish gaskets between box halves and between box and motor frame.

D. Minimum usable volume in percentage of that specified in NEMA MG 1, Section 1, Paragraph 4.19 and NFPA 70, Article 430:

<table>
<thead>
<tr>
<th>Terminal Box Usable Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
</tr>
<tr>
<td>Below 600</td>
</tr>
<tr>
<td>Below 600</td>
</tr>
<tr>
<td>Below 600</td>
</tr>
<tr>
<td>Above 600</td>
</tr>
</tbody>
</table>

E. Terminal for connection of equipment grounding wire in each terminal box.

2.11 BEARINGS AND LUBRICATION

A. Horizontal Motors:

1. 3/4 hp and Smaller: Permanently lubricated and sealed ball bearings, or regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.

2. 1 through 400 hp: Regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.
3. Above 400 hp: Regreasable antifriction bearings in labyrinth sealed end bells with removable grease relief plugs.
4. Minimum 100,000 hours L-10 bearing life for ball and roller bearings as defined in ABMA 9 and ABMA 11.

B. Vertical Motors:

1. Thrust Bearings:
   a. Antifriction bearing
   b. Manufacturer’s standard lubrication 100 hp and smaller.
   c. Oil lubricated 125 hp and larger.
   d. Minimum 50,000 hours L-10 bearing life.

2. Guide Bearings:
   a. Manufacturer’s standard bearing type.
   b. Manufacturer’s standard lubrication 200 hp and smaller.
   c. Oil lubricated 250 hp and larger.
   d. Minimum 100,000 hours L-10 bearing life.

C. Regreasable Antifriction Bearings:

1. Readily accessible, grease injection fittings.
2. Readily accessible, removable grease relief plugs.

D. Oil Lubrication Systems:

1. Oil reservoirs with sight level gauge.
2. Oil fill and drain openings with opening plugs.

E. Inverter Duty Rated Motors:

1. Bearing Isolation: Motors larger than 20 hp shall have electrically isolated bearings to prevent stray current damage.
2. Shaft Grounding Device: Motors larger than 1 hp shall be provided with a shaft grounding brush or conductive micro fiber shaft grounding ring. Shaft grounding device shall be solidly bonded to the grounded motor frame per manufacturer’s recommendations.
   a. Manufacturers:
      1) Grounding Brush: Sohre Turbomachinery, Inc.
      2) Grounding Ring: EST-Aegis.

2.12 NOISE

A. Measured in accordance with IEEE 85 and NEMA MG 1.
B. Motors controlled by adjustable frequency drive systems shall not exceed sound levels of 3 dBA higher than NEMA MG 1.

2.13 BALANCE AND VIBRATION CONTROL

A. In accordance with NEMA MG 1, Part 7.

2.14 EQUIPMENT FINISH

A. Protect Motor for Service Conditions:

1. ODP Enclosures: Indoor industrial atmospheres.
2. Other Enclosures: Outdoor industrial atmospheres, including moisture and direct sunlight exposure.

B. Internal Finish: Bore and end turns coated with clear polyester or epoxy varnish.

2.15 SPECIAL FEATURES AND ACCESSORIES

A. Screen Over Air Openings: Corrosion-resistant on motors with ODP, WPI, and WPII enclosures meeting requirements for Guarded Machine in NEMA MG 1, and attached with stainless steel screws.

B. Winding Thermal Protection:

1. Thermostats:
   a. Motors for constant speed application 50 hp through 75 hp.
   b. Bi-metal disk or rod type thermostats embedded in stator windings.
   c. Automatic reset contacts rated 24 volts dc, 5 amps minimum, opening on excessive temperature. (Provide manual reset at motor controller.)
   d. Leads extending to separate terminal box for motors 100 hp and larger.
2. Thermistors:
   a. Motors for constant speed application 100 hp and larger. Motors for adjustable speed application 100 hp and larger.
   b. Thermistor embedded in each stator phase winding before winding dip and bake process.
   c. In intimate contact with winding conductors.
   d. Epoxy-potted, solid-state thermistor control module mounted in NEMA 250 Type 4 box on motor, by motor manufacturer.
   e. Individual thermistor circuits factory-wired to control module.
f. Control module rated for 24 V dc power supply.
g. Control module automatically reset contact for external use rated 24 V dc, 5 amps minimum, opening on abnormally high winding temperature. Provide manual reset at motor controller.

C. Nameplates:
   1. Raised or stamped letters on stainless steel or aluminum.
   2. Display motor data required by NEMA MG 1, Paragraph 10.39 and Paragraph 10.40 in addition to bearing numbers for both bearings.
   3. Premium efficiency motor nameplates to display NEMA nominal efficiency, guaranteed minimum efficiency, full load power factor, and maximum allowable kVAR for power factor correction capacitors.

D. Anchor Bolts: Provide meeting manufacturer’s recommendations and of sufficient size and number for the specified seismic conditions.

2.16 SPECIAL MOTORS

A. Requirements in this article take precedence over conflicting features specified elsewhere in this section.

B. Chemical Industry, Severe-Duty (CISD-TEFC):
   1. In accordance with IEEE 841.
   2. TEFC in accordance with NEMA MG 1.
   3. Suitable for indoor or outdoor installation in severe-duty applications including high humidity, chemical (corrosive), dirty, or salty atmospheres.
   4. Motor Frame, End Shields, Terminal Box, and Fan Cover: Cast iron.
   5. Ventilating Fan: Corrosion-resistant, nonsparking, external.
   8. Gaskets between terminal box halves and terminal box and motor frame.
   9. Extra slinger on rotor shaft to prevent moisture seepage along shaft into motor.
10. Double shielded bearings.
11. 125,000 hours minimum L-10 bearing life for direct-connected loads.
13. Coated rotor and stator air gap surfaces.
14. Insulation System, Windings, and Connections:
    a. Class F insulation, Class B rise or better at 1.0 service factor.
    b. Multiple dips and bakes of nonhygroscopic polyester varnish.
15. Service Factor:
   a. At 40 Degrees C Ambient: 1.15.
   b. At 65 Degrees C Ambient: 1.00.

C. Severe-Duty Explosion-Proof: Meet requirements for EXP enclosures and CISD-TEFC motors.

D. Severe-Duty, Dust-Ignition-Proof: Meet requirements for DIP enclosures and CISD-TEFC motors.

E. Multispeed: Meet requirements for speeds, number of windings, and load torque classification indicated in the motor-driven equipment specifications.

F. Inverter Duty Motor:
   1. Motor supplied power by adjustable voltage and adjustable frequency drives shall be inverter duty rated.
   2. Motor shall be suitable for operation over entire speed range indicated.
   3. Provide forced ventilation where speed ratio is greater than published range for motor provided.
   4. Motor installed in Division 1 hazardous (classified) location shall be identified as acceptable for variable speed when used in a Division 1 location.

G. Submersible Pump Motor:
   1. Manufacturers: As provided by pump manufacturer.
   2. At 100 Percent Load:

<table>
<thead>
<tr>
<th>Horsepower</th>
<th>Guaranteed Minimum Efficiency</th>
<th>Guaranteed Minimum Power Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 through 10</td>
<td>80</td>
<td>82</td>
</tr>
<tr>
<td>10.1 through 50</td>
<td>85</td>
<td>82</td>
</tr>
<tr>
<td>50.1 through 100</td>
<td>87</td>
<td>82</td>
</tr>
<tr>
<td>Over 100</td>
<td>89</td>
<td>82</td>
</tr>
</tbody>
</table>

3. Insulation System: Manufacturer’s standard Class B or Class F.
4. Motor capable of running dry continuously.
5. **Enclosure:**
   a. Hermetically sealed, watertight, for continuous submergence up to 250-foot depth.
   b. Seals: Tandem mechanical.

6. **Bearing and Lubrication:**
   a. Permanently sealed and lubricated, replaceable antifriction guide and thrust bearings.
   b. Minimum 15,000 hours L-10 bearing life.

7. **Inrush kVA/horsepower no greater than NEMA MG 1 and NFPA 70, Code F.**

8. **Winding Thermal Protection:** Thermal sensor and temperature transmitter assembly, one each phase, embedded in stator windings and wired in series.

9. **Connecting Cables:**
   a. One cable containing power, control, and grounding conductors.
   b. Each cable suitable for hard service, submersible duty with watertight seal where cable enters motor.
   c. Length: 250 feet minimum.
   d. UL 1 listed and sized in accordance with NFPA 70.

H. **Inclined Motors:**

1. Motors suitable for operation only in horizontal position not acceptable.
2. Bearings designed for thrust imposed by driven equipment and by motor rotor when motor is in inclined position.
3. Lubrication system designed to provide adequate bearing lubrication when motor is in inclined position.

2.17 **FACTORY TESTING**

A. **Tests:**

1. In accordance with IEEE 112 for polyphase motors and IEEE 114 for single-phase motors.
2. Routine (production) tests on all motors in accordance with NEMA MG 1. Test multispeed motors at all speeds.
3. For energy efficient motors, test efficiency and power factor at 50 percent, 75 percent, and 100 percent of rated horsepower:
   a. In accordance with IEEE 112, Test Method B, and NEMA MG 1, Paragraph 12.60.
   b. For motors 500 hp and larger where facilities are not available to test by dynamometer (Test Method B), determine efficiency by IEEE 112, Test Method F.
   c. On motors of 100 hp and smaller, furnish a certified copy of a motor efficiency test report on an identical motor.
4. Provide test reports for polyphase motors 100 hp and larger.

B. Test Report Forms:

2. Efficiency and power factor by Test Method B, IEEE 112, Form A-2, and NEMA MG 1, Table 12-12.

PART 3  EXECUTION

3.01 INSTALLATION

A. In accordance with manufacturer’s instructions and recommendations.
B. Align motor carefully and properly with driven equipment.
C. Secure equipment to mounting surface with anchor bolts.

3.02 MANUFACTURER’S SERVICES

A. Furnish manufacturer’s representative at Site in accordance with Section 01 43 33.LLE, Manufacturer’s Field Services, for installation assistance, inspection, equipment testing, and startup assistance as required by the motor driven equipment specification.

END OF SECTION