SECTION 16221 - TEFC AC INDUCTION MOTORS

PART 1 - GENERAL

1.1 SUMMARY

A. This specification covers integral horsepower squirrel cage AC induction motors.

B. This specification is intended to specify superior quality motors that provide consistent performance, highest efficiency, improved life cycle and lowest maintenance cost. The motors shall be built to provide to provide the following:

1. Safe operation.

2. Highest efficiency.

3. Reliability in an application, which may be corrosive and wet.

4. Minimum maintenance requirement due to the design and quality of materials and workmanship.

5. Lowest noise pollution.

1.2 DEFINITIONS AND ABBREVIATIONS

A. Definition of terms used in this specification shall be in accordance with NEC Article 100, ANSI/IEEE Standard 100, and UL Standards Glossary.

B. DE: Drive End, motor side.

C. Megger - The electrical test of the insulation resistance of an electrical motor at 500, 1000, 2500, or 5000 volts DC. This test is performed to detect insulation breakdown. Also, the term Megger is used to describe the test equipment used to perform the test.

D. ODP: Open drip-proof, motor enclosure.

E. ODE: Opposite Drive End, motor side.

F. RPM: Revolutions per minute.

G. RTD: Resistance Temperature Detector.

H. TEAO: Totally Enclosed Air Over, air cooled motor enclosure.

I. TENV: Totally Enclosed Non Ventilated.

J. TEBC: Totally enclosed Blower Cooled, motor enclosure with separately powered blower.

K. TEFC: Totally Enclosed Fan Cooled, motor enclosure.

L. T'STAT: Thermostat, automatic reset high temperature thermal protector switch.

M. WP: Weather protected, motor enclosure.

1.3 STANDARDS AND CODES

A. Motor design and construction shall be in accordance with the latest applicable codes and standards of the following organizations:

1. ABMA American Bearing Manufacturers Association
2. ANSI American National Standard Institute
3. API American Petroleum Institute
4. ASTM American Society for Testing and Materials
5. CEE Consortium for Energy Efficiency
6. CSA Canadian Standards Association
7. IEC International Electrotechnical Commission
8. IEEE Institute of Electrical and Electronics Engineers
9. NEC National Electrical Code
10. NEMA National Electrical Manufacturers Association
11. NESC National Electrical Safety Code
12. NETA National Electrical Testing Association
13. NFPA National Fire Protection Agency - National Electrical Code
14. SAE Society of Automotive Engineers
15. UL Underwriters Laboratories

B. All motors shall be listed under UL recognized component file.

C. All motors shall be CSA certified.

D. All motors shall be suitable for installation according to the requirements of NEC.

1.4 SUBMITTALS

A. Product Data: For each type of motor, provide dimensions; mounting arrangements; location for conduit entries; shipping and operating weights; and manufacturer's technical data on features, performance, electrical ratings, and characteristics.

B. Motor performance submittals for special applications, upon Engineer's request, shall include the following manufacturer's data:

1. Torque vs. RPM curves at 80% and 100% nominal line voltage.

2. Motor performance - Percent Efficiency, Power Factor, Torque, RPM, Power (W) and Current (A) vs. Percent of rated power output (Horsepower) curves.

3. Motor performance percent change - Percent Efficiency, Power Factor, Torque, RPM, Power (W) and Current (A) vs. percent of line voltage variation curve.

4. Motor Derating Factor vs. voltage percent unbalance curve.

5. Motor thermal damage, logarithm inverse time vs. percent full load current curve.

6. Harmonic Derating Factor vs. Harmonic Voltage Factor curve, based on typical adjustable speed drive input line distortion.

   a. Adjustable speed drive and motor shall be of Matched Performance type.

   b. Adjustable speed drive and motor shall be manufactured by the same company.

7. Recommended power factor correction capacitor KVAR rating.

8. Motor equivalent circuit with parameters values.

9. Induction motor time constants:

   a. Open circuit time constant for power transfer switching surge analysis.

   b. Short circuit time constant and x/r ration for power system fault current analysis.

C. Shop Drawings: For each type and size motor,

1. Include dimensioned drawings with mountings details, including required clearances and service space around equipment. Include the following:

   a. Each installed motor type and details.

   b. UL, CSA or other applicable agency listing.

2. Wiring Diagrams to include power and auxiliary devices wiring.

D. Qualification Data: For testing agency and manufacturer.

E. Operation and Maintenance manual motor and all installed devices, and components to include the following:

1. Manufacturer's instruction sheets.

2. Manufacturer's installation instructions.

3. Manufacturer's operating manual.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Motor manufacturer shall be based and headquartered in the United States of America and shall design and manufacture motors in the United States.

2. Motor manufacturer shall have over 50 years experience in the motor industry and shall maintain active company wide quality assurance program.

3. Motor manufacturer shall have corporate quality policy based on the customer perceived value formula.

4. Motor manufacturer shall maintain an authorized service center capable of providing training, parts, and emergency maintenance and repairs. Distance between this center and the project site is specified elsewhere.

B. Motor design and performance shall comply with all applicable standards and the requirements of these specifications.

C. Motor performance shall be warranted against material and workmanship defects by manufacturers limited warranty and service policy for the period of at least of 18 months from the day of shipment from the factory or the manufacturer's warehouse.

1. Standard efficient motors shall be warranted for 24 month.

2. Premium efficient motors shall be warranted for 36 month.

3. Severe duty motors shall be warranted for 60 month.

4. Extended warranty shall be offered for certain products or as agreed by additional terms.

1.6 DELIVERY, STORAGE AND HANDLING

A. Depending on motor size and weight, motors shall be packed in a secure carton and/or securely fastened to a hardwood skid or pallet for fork truck handling and shall be covered for protection against dirt and moisture during transit and outdoor storage. The motor container shall be clearly identified with permanent ink.

B. Store motor indoors in clean, dry space with uniform temperature to prevent condensation. Protect motor from exposure to dirt, fumes, water, corrosive substances, and physical damage.

C. Periodically, during storage, "Megger", rotate the motor shaft and if available apply power to motor space heaters, according to manufacturer's instructions.

D. Handling shall be done with proper lifting equipment using lugs or eyebolts provided by the manufacturer.

1.7 COORDINATION

A. Coordinate layout and installation of motor with other equipment and machinery including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for motor cooling air, conduit box, lubrication spouts and coupling access.

B. Coordinate size and location of concrete bases for floor-mounted motors and make proper provisions for machinery-mounted motors.

C. Coordinate features of motor, installed units, and accessory devices with power and control circuits to which they connect.

D. Coordinate features, and accessories of each installed motor with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of controller and load.

PART 2 - PRODUCTS

2.1 MANUFACTURES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Baldor Electric Company

2.2 TOTALLY ENCLOSED FAN COOLED PREMIUM EFFICIENT AC INDUCTION MOTOR

A. Enclosures

1. In general, all motors shall be TEFC, NEMA T frame, NEMA F1 assembly for horizontal applications and designed for the environment where the motor will be used. This specification deals with motors built to comply with the Baldor Super-E™ motors (EM). Where special enclosures or assembly are required, it will be specified on the Motor Data Sheet.

2. Enclosures shall be rolled steel band or cast iron construction depending on horsepower. End brackets shall be die cast aluminum with steel bearing inserts or cast iron construction. Conduit box shall be die cast aluminum or cast iron construction.

3. Motors shall have drain openings suitably located for the type assembly being provided.

4. For frames 215 and above, shouldered lifting eyebolts or cast provisions within the frame shall be furnished for handling convenience.

5. Motor enclosures shall have a bi-directional, spark-proof, abrasion and corrosive resistant fan made of a material that is strong and durable. Fan will be keyed to shaft on frames 254 and above.

6. Motor nameplate shall be mounted on enclosure with stainless steel fastening pins. Nameplate shall have, as a minimum, all information as described in NEMA Standard MG-1-20.60.

7. Motor bearing numbers shall be included on nameplate. Motor connection diagram shall be attached to motor and easily readable.

B. Motor Terminal Boxes and Leads

1. Motor terminal boxes shall be sized larger than required by NEC or UL standards, pipe drilled for conduit and shall be attached to the motor frame with cadmium-plated hex head cap screws. Cover shall be installed with cadmium plated hex head cap screws. The conduit box shall come completely assembled to the motor.

2. Motor leads in the conduit box shall be sized in accordance with NEC suggested minimum ampacity values using a minimum of 125°C insulated lead wire. The wiring shall be clearly identified every inch or the lead shall have a metal band in accordance with ANSI C6.1, latest revision.

3. Motors shall be provided with a compression-type grounding lug mounted in the conduit box by drilling and tapping into the motor frame or by a double ended cap screw of silicon bronze.

C. Electrical and Mechanical Design Requirements

1. Motors shall be premium efficiency severe duty type, NEMA Design B (normal starting torque, full voltage starting), squirrel cage, induction type. Where other designs are required, they will be specified on the Motor Data Sheet.

2. Per NEMA MG 1 Part 12, Table 12-12, , nominal minimum efficiencies for TEFC motors shall be equal to or greater than those shown below:

HP	1200 RPM	1800 PM	3600 RPM
1	82.5	85.5	77.0
1.5	87.5	86.5	84.0
2	88.5	86.5	85.5
3	89.5	89.5	86.5
5	89.5	89.5	88.5
7.5	91.0	91.7	89.5
10	91.0	91.7	90.2
15	91.7	92.4	91.0
20	91.7	93.0	91.0
25	93.0	93.6	91.7
30	93.0	93.6	91.7
40	94.1	94.1	92.4
50	94.1	94.5	93.0
60	94.5	95.0	93.6
75	94.5	95.4	93.6
100	95.0	95.4	94.1
125	95.0	95.4	95.0
150	95.8	95.8	95.0
200	95.8	96.2	95.4
250	95.8	96.2	95.8
300	95.8	96.2	95.8
350	95.8	96.2	95.8
400	95.8	96.2	95.8
450	95.8	96.2	95.8
500	95.8	96.2	95.8

3. Motors shall be wound for 200, 230, 460, 230/460 or 575-volt, three-phase, 60-hertz, 1.15 service factor. 380 – 415 volt, 50-hertz designs are also available.

4. Windings shall be copper magnet wire rated at 200° C and moisture resistant. Magnet wire insulation varnish must be of a type designed to resist transient spikes (such as Inverter Spike Resistant™ ISR), high frequencies, and short time rise pulses produced by inverters. Motor insulation system shall comply with NEMA MG 1-2003 Part 31.4.4.2.

5. Insulation shall be a Class F, non-hygroscopic varnish. The maximum permissible temperature for the insulation is not exceeded when the motor operates at service factor load in a 40° C ambient. Magnet wire shall have a service coating equivalent in thickness to a commercial "heavy" coating. The combination of magnet wire and varnish when tested in accordance with IEEE No. 57, latest revision, shall show a thermal rating of not less than 150° C for a duration of 30,000 hours life. Normal temperature rise for 1.0 service factor operation shall not exceed a Class B rise.

6. Windings shall be firmly held in the stator slots to prevent coil shifts. Sharp edges and burs shall be removed from the stator core slots prior to inserting the winding. All coils shall be phase insulated using Nomex® paper or equal and laced down such that the windings will not move during repetitive starting. All stator connections will be securely made.

7. The insulation resistance of the sealed stator winding shall be greater than 100 megohms when measured at 25° C with a megohm bridge having 1000-volt direct current.

8. The motor design shall use the best available materials and methods to achieve premium efficiency, power factor and long life operation.

9. Motors shall be designed for operation in either direction of rotation without a physical change in the motor.

10. All motors shall have anti-friction, vacuum-degassed steel ball bearings electric motor quality. Grease fittings and reliefs are supplied for external lubrication while machine is in operation. Fittings and reliefs are plugged.

11. The bearings shall have a rated fatigue life of L-10 (B-10) of 150,000 hours for direct-coupled applications and 50,000 hours for belted applications minimum. Belted rating shall be based on radial loads and pulley sizes called out in NEMA MG 1-14.43. The calculation will be determined from the pulley centerline being at the end of the motor shaft.

12. The motor shall have tight mechanical bearing housing fits. Either the D.E. or O.D.E. bearing must be locked to limit axial shaft movement.

13. Bearing cavities and greasing passages shall be thoroughly cleaned of all debris before lubricating. Motors shall be lubricated at the factory with Exxon Mobil Polyrex™ EM grease or equal. Customer-specified grease may be supplied upon request as noted on the motor data sheet.

14. Motors 200-hp and smaller, unless otherwise noted, shall be furnished with standard NEMA T-frame shaft for V-belt drives even though motors are for direct connected drive duty. In general, motor shall be inter-changeable for horizontal, vertical or belt-driven mounting. For 3600-rpm motors 30 horsepower and up, short shaft (NEMA TS) will be acceptable and is suitable for coupled loads only.

15. Maximum vibration allowed shall be 0.15 inches per second velocity measured at the bearing housings.

16. Rotor assemblies shall be die cast aluminum for NEMA frames. Rotors shall be keyed and shrunk or pressed to the shaft. Welding will not be acceptable. Keyed rotors shall be press-fitted on a shoulder the full length of the rotor utilizing the full shaft surface diameter.

17. Rotor shaft extension run out shall not exceed:
0.002” TIR for shaft diameter 0.1875 - 1.625 inches
0.003" TIR for shaft diameter over 1.625 - 6.500 inches

18. All shafts shall be precision machined from high-strength carbon steel suitable for belt and pulley drives (except as limited by 3600 RPM motors).

D. Special Application Requirements

1. Severe Duty Use

2. For applications requiring a greater amount of weather protection than a standard TEFC motor, Baldor Severe Duty motors (ECP) may be specified. For motor built to closer tolerances and with certified test data supplied, Baldor motors built to IEEE Std. 841-2001 should be considered. These motors are supplied with Inpro/Seal® VBX bearing isolators on both the output and fan shafts. Motors will be supplied with premium efficiency windings that exceed minimum efficiencies of IEEE 841-2001.

3. Hazardous Location Use

4. Motors with UL and CSA listed enclosures are available for use in hazardous locations. Only the end user or a qualified underwriter is to identify and select the proper class, group, division and temperature code motor to meet the requirements of each installation.

5. Adjustable Speed Use

a. Adjustable speed motors controlled by variable frequency drives in general shall be of a Super-E® design called out in this specification. The manufacturer shall be notified on the requisition that the motor will be used in conjunction with a variable frequency drive. It shall be the responsibility of the motor manufacturer to ensure that this motor will be capable of operating under the torque requirements and speed range within temperature specifications.

b. If the duty cycle and speed range requires special design of the motor, it shall be brought to the owner's attention. Baldor Inverter-Duty™ or Vector-Duty™ motors may be quoted as required by the application.

c. It is recommended that the application be sized using a Matched-Performance™ curve showing the operating range of the particular motor and its matched control.

d. Any adjustable speed application required for a Division 1 or 2 hazardous location should use an Inverter-Duty™ Explosion Proof motor.

E. Testing & Final Inspection

1. Electrical Tests
Each motor design shall receive the testing called out for "Polyphase Induction Motors and Generators", IEEE 112, latest edition. The routine tests shall, as a minimum, conform to the NEMA MG 1 tests. In addition to the normal factory tests and those already covered in this specification, the following tests may be performed:

a. The completed insulation system shall be capable of withstanding continuously a phase-to-ground rms voltage of 1000 volts minimum for a period of 30 minutes minimum.

b. The winding shall also be capable of passing a 2500 volt AC minimum, phase-to-ground test for one second.

c. Surge comparison test shall be performed using 3000 volts AC minimum; phase-to-phase comparison waveforms on the test unit shall be supplied.

d. Full load amperes, watts, power factor and RPM.

e. Locked rotor current at rated voltage.

2. Mechanical Inspection

a. Shaft runout shall be checked after the motor is completely assembled and recorded.

b. Inches/second velocity vibration data.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to mount motor for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in for conduit systems to verify actual locations of motor conduit boxes for motor power and motor auxiliary device connections before motor installation.

C. Proceed with installation only if all conditions are satisfactory.

3.2 APPLICATIONS

A. Select features of each motor to coordinate with ratings and characteristics of electrical power supply circuit, motor operating ambient conditions, motor running duty cycle, load starting and

running torque demand, and if required for the application review and coordinate necessary equipment for proper acceleration, deceleration and speed control requirements.

3.3 INSTALLATION

A. Prepare rigid foundation or mounting surface to minimize vibration and maintain alignment between motor and load shaft.

B. Align the motor shaft with driven equipment according to manufacturers written instructions.

1. Flexible couplings for direct drive shall be accurately adjusted according to machine manufacturers guidelines, use dial indicators to check alignment to minimize vibrations. Coupling spacing shall be according to coupling manufacturer guidelines.

2. Belt drive sheaves shall be align according to belt drive manufacturers instructions to minimize belt ware and axial bearings loads. Belt tension shall be adjusted to prevent slippage at rated speed and rated load.

3. Adjust axial position of motor frame with respect to load shaft according to motor manufacturers endplay adjustment guidelines recommended to minimize extensive external axial thrust loads.

C. Anchor each motor base to load bearing surface by carriage grade 5 steel bolts arranged and sized according to manufacturer's written instructions.

3.4 IDENTIFICATION

A. Read the motor nameplate data. Verify that rated voltage and frequency and motor rated full load current matches drawings, specifications and application requirements.

B. Verify proper motor branch circuit and motor overload protection devices are installed in motor branch circuit as required by NEC article 430.

C. Identify motor, conduit, power and auxiliary wiring according to Engineer’s requirements and other applicable electrical systems and labor safety related requirements.

3.5 POWER CONNECTIONS

A. Install power cable conduits according to motor conduit box drawing and motor manufacturer’s instructions. Install motor power supply cables and connect to motor power. Motor lead cable sizes shall be selected based on NEC and local code requirements.

B. Properly ground all equipment according to manufacturer’s recommendations regarding equipment grounding and noise attenuation practices for electrical and electromagnetic interference.

C. Tighten electrical connectors and terminals according to cable and terminal manufacturer's published torque values.

3.6 AUXILAIRY CONTROL WIRING INSTALLATION

A. Install wiring between motor auxiliary devices and associated controllers and protective devices according to manufacturer's instructions and information on motor nameplate.

B. Connections of devices sensitive to electromagnetic interferes such as RTD's, thermistors, thermal protector switches, vibration sensors and other applicable instrumentation wiring shall be made per manufacturer's instructions. Shielded conductors shall be used and routed in dedicated conduits, all in separate conduit runs end to end.

C. Install wiring to motor auxiliaries such as motor space heaters, motor blowers motor brake coils according to NEC power wiring requirements and according to motor manufacturer's instructions.

D. Good wiring practices shall be followed at all times.

3.7 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Verify mechanical installation is secure and all mounting hardware is tight according to manufacturer's recommended torque specifications.

2. Inspect all electrical connections for proper termination, electrical clearances, mechanical strength and electrical continuity.

3. Verify all shipping materials and braces are removed from the shaft. Verify that the motor and the coupled load are properly aligned, rotate freely and are not binding.

4. Verify that maintenance information is posted. This information should include lubricants needed and preventive maintenance schedule.

5. Verify that proper lubricants are readily available at the site.

B. Testing: Perform the following field quality-control testing:

1. Test winding insulation integrity with a "Megger" or other insulation resistance tester.

2. Apply power and verify rotation direction of the motor. Change the rotation direction if necessary and retest.

C. Test Reports: Prepare a written report to record the following:

1. Test procedures used.

2. Test results that comply with requirements.

3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

3.8 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Verify that electrical wiring installation complies with manufacturer's submittal and Engineer’s requirements.

C. Complete installation and startup checks according to manufacturer's written instructions.

3.9 CLEANING

A. Clean motor externally, on completion of installation, according to manufacturer's written instructions. Vacuum dirt and debris; do not use blown compressed air to assist in cleaning.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to lubricate, clean and maintain motor in proper operation condition.

END OF SECTION 16221