

**SECTION 16150**  
**SPECIFICATION FOR**  
**LOW VOLTAGE INDUCTION MOTORS**

**PART 1 GENERAL**

**1.01 GENERAL REQUIREMENTS**

- A. Terms and Conditions of the Contract apply to Work of this Section.

**1.02 SUMMARY**

- A. Work Included:

1. This specification covers the general requirements for alternating current squirrel cage induction motors rated 260 KW and smaller for use with continuous duty driven equipment.
2. Ratings and detailed requirements for motors shall be provided in applicable specifications and datasheets.
3. This specification shall also apply to motors modified for the Supplier's standard equipment such as gear head motors, sealed motors, peristaltic pump motors, special duty motors with integral gear connection, etc.
  - a. Where deviations from this specification are required to accommodate such specially designed motors, such deviations shall be submitted to Owner/Engineer for approval.

- B. Work Not Included:

1. Not Applicable.

**1.03 RELATED DOCUMENTS**

- A. Reference Specifications:

1. 16000 – General Provisions for Electrical Work.
2. 16269 – Variable Frequency Controllers.

- B. References: Motors furnished under this specification shall comply with the applicable portions of the standards listed herein. Standards cited shall be the edition current at the time of purchase.

1. Refer to Section 16000 for general references.
2. IEC:
  - a. 60034 – Rotating Electrical Machines.

- b. 60072 – Dimensions & Output Ratings for Rotating Electric.
  - c. 60085 – Thermal Evaluation and Classification of Electrical Insulation.
- 3. Motors shall bear a CE label.

C. Attachments:

- 1. Not Applicable.

1.04 SUBMITTALS

A. Refer to Section 16000 for general submittal requirements.

B. Shop Drawings: Submit the following:

- 1. Dimensions.
- 2. Nameplate ratings (i.e. – horsepower, voltage, phase, frequency, full load amps, rpm's, frame type, service factor, etc.).
- 3. Connection data if more than three leads are brought out to the terminal box.
- 4. Auxiliary devices such as thermal switch, temperature sensor, space heater.
- 5. Bearings.
- 6. Lubrication recommendations.
- 7. Parts list.
- 8. Weight.
- 9. Motor mounting details.
- 10. Variable speed drive controls and active filters.

C. The following data shall be furnished for all motors 22 KW or larger and for all motors that have high inertia loads or acceleration times over 5 seconds at full voltage:

- 1. Motor speed versus torque curve at 100 percent ,90 percent , and 80 percent rated voltage.
- 2. Motor current versus speed curve at 100 percent ,90 percent , and 80 percent rated voltage.
- 3. Motor inertia and load inertia.
- 4. Motor stall time (hot and cold).
- 5. Open circuit time constant.
- 6. No-damage thermal limit curve.
- 7. Locked rotor power factor.
- 8. A statement certifying that routine tests (IEC, CE, CSA) were within standard performance limits.

D. Test Reports: Insulation resistance values.

E. Warranty.

- F. Installation, Operation, and Maintenance Manuals: Provide a minimum of 3 sets for each motor supplied.

#### 1.05 SOURCE QUALITY CONTROL

##### A. Inspections

1. Perform visual inspection.
2. Verify that motor has been installed and wired in accordance with manufacturer's instructions.
3. Verify that motor has been properly lubricated.
4. Rotate motor shaft by hand.

##### B. Tests

1. Prior to making connections to the motor, perform insulation resistance tests as stated below, record results, and submit an evaluation based upon measured results:
  - a. Dielectric Absorption Test – use a 1000V DC test voltage for 10 minutes taking a reading every 10 seconds for the first minute and one per minute for the next nine minutes. Record and graph the values to verify that the slope of the curve indicates good insulation.
  - b. Step Voltage Test – apply two test voltages with a ratio 1:5 in step for 60 seconds. Repeat the test for 60 seconds at different voltage levels and compare results. Verify that there is no excessive reduction in insulation values at the higher voltages.
  - c. Megger test values shall be a minimum of one megaohm.
2. Bump each motor to check rotation. Change wiring if necessary to get proper rotation.
3. Test run each motor coupled to load. Verify that the motor and driven equipment operate smoothly.
4. Check motor current under normal load conditions. Verify that current does not exceed motor nameplate FLA. Record no-load readings of current, power, and nominal speed at rated voltage and frequency.
5. Record winding resistance.

#### 1.06 DELIVERY, STORAGE, HANDLING

- A. Refer to Section 16000 for procedures.

## PART 2 PRODUCTS

### 2.01 ACCEPTABLE MANUFACTURERS

- A. Motors built by the following manufacturers are acceptable:

1. Asea Brown Boveri (ABB)
2. Reliance
3. Siemens

## 2.02 SERVICE CONDITIONS

- A. Motors below 0.37 KW shall be 220 Volts, single phase, 60 Hertz.
- B. Motors larger than 0.37 KW shall be 380 Volts, 3 Phase, 60 Hertz.
- C. All motors operated with a variable frequency controller (VFC) shall be 380 Volts, 3 Phase.
- D. Motors shall be designed for continuous operation with rated voltage  $\pm 10$  percent , rated frequency  $\pm 5$  percent , with the combined variation of voltage and frequency not more than  $\pm 10$  percent .
- E. Motors shall be capable of continuously delivering rated output power under the following conditions without injurious overheating:
  1. Ambient Temperature: -25 deg C to 40 deg C
  2. Maximum Humidity: less than 90 percent (non-condensing).
  3. Altitude: 1000 meters.
- F. The Supplier shall assume responsibility for satisfactory performance for at least one year of continuous full load heavy commercial and industrial service.

## 2.03 MOTOR TYPES

- B. Motors shall be squirrel cage induction motors designed for full voltage starting.
- C. Motor speed shall be 1800 RPM (60 Hz.) unless otherwise stated in specifications or datasheets or approved by the Owner.
- C. Two speed motors shall be single winding for 2:1 speed range and two windings for other speed ranges.

## 2.04 DUTY

- A. Motors shall have a continuous duty rating unless otherwise stated in the driven equipment specification. Motors shall have a service factor of 1.15.

## 2.05 INSULATION

- A. All motors shall be rated for a variable frequency controller application in accordance with IEC.

- B. When motor is operated at rated voltage and frequency, the average temperature rise shall not exceed 80 deg C by winding resistance.
- C. The insulation system shall resist moisture and contaminants and any special service conditions encountered in service.

## 2.06 OUTPUT POWER

- A. The rated output power of the motors shall exceed, by a minimum of fifteen percent (15 percent), the maximum input power required by the driven equipment under any conditions of normal continuous operation, without overloading, infringing on the service factor, or exceeding the temperature rating of the insulation.
- B. The guaranteed motor rating for pumps shall exceed the operating curve at any point, including runout, except for sanitary centrifugal pumps. The sanitary centrifugal pump curve used shall be based on the pump being equipped with an impeller capable of delivering rated flow at 110 percent head and the motor having a service factor of 1.15.
  - 1. The motor horsepower for pumps will be indicated in applicable specifications, datasheets, or drawing schedules.
- C. It shall be the Supplier's responsibility to match motor torques with driven equipment torques so that adequate starting, accelerating, pull-up, break-down, and full load torques are available for the intended service in accordance with the requirements of the driven equipment.

## 2.07 STARTING

- A. Motors shall be designed for full voltage, direct-on-line (DOL) starting.
- B. Motors shall be able to start and accelerate their connected loads to rated speed with only 80 percent of motor rated voltage at the terminals.
- C. Motors shall start under normal starting conditions with the driven equipment discharge valve open or closed as specified in the driven equipment specifications.
- D. Locked rotor (starting) currents shall not exceed IEC maximum values for the specified design and rating. In addition, the first cycle locked rotor transient current shall not exceed 12 times the full load current. The intent of this requirement is to eliminate nuisance tripping of the circuit breakers with instantaneous trips set in accordance with the IEC.

## 2.08 ADJUSTABLE SPEED OPERATION

- A. Motors used with a VFC shall be equipped with three thermostats for motor overtemperature and overload protection.

1. Thermostats shall be embedded in the windings (one per phase) with all leads brought out to a terminal box for connection by Owner.
  2. The thermostats shall have normally closed contacts and shall open at a maximum of 20 degrees C above the temperature rating of the insulation.
- B. Motors shall have epoxy encapsulated windings to minimize audible motor noise due to a VFC application.
- C. Motors shall be capable of continuous operation at reduced speeds without injurious overheating or nuisance tripping of the overtemperature thermostats. The Supplier shall assure the motor's heat dissipating capability meets this criteria while producing the full load torque required by the load over its entire speed range.
- D. If the driven equipment is to be used in a hazardous location, the motor and frequency controller in combination must comply with IEC and bear a CE label stating such compliance for the frequencies over which they operate.

#### 2.09 NOISE LEVEL

- A. Motors shall comply with the noise level requirements of IEC based on eight hours of exposure time per day, unless otherwise indicated.
- B. Where motors are purchased as an integral part of an equipment package, IEC requirements shall apply to the complete operating assembly.

#### 2.10 AREA CLASSIFICATION

- A. Motors shall be suitable for the IEC hazardous area classification specified. Motors intended for use in hazardous locations shall be approved by IEC and carry CE labels.
- B. Supplier shall submit proper paperwork and certificates that verify compliance of motor to operate in the stated hazardous environment.
- C. All motors located in hazardous areas shall be provided with a thermostat in each winding phase for connection to Owner's monitoring system for high temperatures.
- D. Fans shall be non-sparking construction suitable for the environment according to IEC.

#### 2.11 CONSTRUCTION

- A. General
1. Motor frames shall have provisions for earthing consistent with the requirements of the IEC.

2. Motors shall be provided with a drilled and tapped hole external to and on the same side as the terminal box for a ground lug.
3. Windings, leads, and rotor bar conductors shall be copper.
4. Fittings and hardware shall be corrosion resistant; stainless steel for cleanroom applications.
5. The use of plastic parts for motors is prohibited.
6. Motors weighing 20 kg or more shall be furnished with lifting eyes or lifting hooks.
7. Motor supporting elements including stator housing, bearing brackets, and mounting feet shall be cast iron; stainless steel for cleanroom applications.
8. Press fits for fans are not acceptable.
9. When requested, motors shall be painted with manufacturer's standard finish for severe chemical duty.

#### B. Enclosures

1. Motors shall have totally enclosed fan cooled (TEFC) enclosures, unless otherwise stated.
2. Motors in hazardous areas shall be explosion proof with a CE label.
3. The maximum surface temperature of motors in hazardous areas shall not exceed 80 percent of the ignition temperature of the hazardous materials encountered. Owner shall provide material ignition temperature or the "T" rating in applicable specifications and datasheets.
4. Motors located outdoor, wet/damp, or washdown areas must be sealed to prevent water entry.
5. TEFC motors shall be provided with a moisture trap, drain, or other anticondensation device. A drain hole is adequate for non-hazardous, non-washdown service.

#### C. Motor Terminal Boxes

1. Terminal boxes shall be one size larger than the required IEC standard size for installation of current transformers (CTs) by the Owner. Boxes shall be located on the right hand side viewed from the non-driving ends, rotatable in steps of 90 degrees. Furnish solderless lugs for incoming cable connections. All terminal boxes shall have a grounding lug mounted inside.
2. Terminal box shall be diagonally split with a threaded hole for cable gland.

#### D. Bearings

1. Bearings shall be electrically insulated to prevent shaft-to-bearing voltages and currents due to common mode currents from stray system capacitances.
2. Bearings shall be conveniently accessible for inspection, maintenance, lubrication, and replacement.
3. Motors shall have anti-friction ball or roller bearings.
4. Bearings will be designed such that no external cooling system is required.
5. Bearing life calculations for vertical motors and horizontal motors mounted in a vertical position shall consider applicable thrust loading.

6. Anti-friction bearings shall be rust-inhibiting grease lubricated and shall be designed to allow flushing through a plugged drain by the introduction of fresh grease via the appropriate fitting.

E. Couplings

1. Motors shall be directly connected or belt connected to the driven load as the application dictates.
2. Coupling or belt guards shall be provided as appropriate to insure against the accidental contact of moving parts by personnel.

F. Space Heaters

1. Space heaters shall be furnished on motors rated 37 KW and above located outdoors, and motors rated 170 KW and above located indoors.
2. Space heaters shall be designed for use at 220 volts with a maximum surface temperature of 200 degrees C, unless otherwise indicated. Hazardous areas shall have space heaters suitable and with a temperature rating for the environment.
3. The space heaters shall be of sufficient size to prevent condensation in the motor when the motor is idle.

G. Rotor

1. Fans may be part of the rotor. Fans shall force air from non-driving to driving end, and suitable for either direction of rotation.
2. Motor rotation shall be indicated with a permanent, legible directional arrow mounted on the motor. Directional arrow must be cast-in, screwed, or riveted to the motor, a self-adhesive marker is not acceptable.

2.12 MOTOR EFFICIENCY

- A. Motors 5 KW and above shall be premium efficiency type. Each motor shall have an efficiency range stamped on the nameplate.
- B. Motor efficiencies testing procedures shall be in strict accordance with IEC standards.

2.13 NAMEPLATES

- A. A stainless steel nameplate shall be permanently affixed to each motor and shall include, as a minimum, the following information:
  1. Rated KW/Voltage/Phase/Frequency.
  2. Full load amperes.
  3. Starting current in % of full load.
  4. Rated full load speed.



5. Starting torque in % of full load.
6. Insulation class.
7. Manufacturer name/model number/serial number.
8. Lube spec.
9. Heater watts/amps/volts.
10. Bearing numbers.
11. Service factor.
12. Enclosure type.
13. Frame size.
14. Winding arrangement (wye or delta).
15. Lead connection diagram(s) for each voltage and/or speed.
16. Hazardous area identification with applicable "T" number.
17. CE label.

### PART 3 EXECUTION

#### 3.01 INSTALLATION

- A. Install, mount, align, and lubricate motors in accordance with manufacturer's published instructions.
- B. Provide and install necessary couplings, belts, sheaves, pins and key. Provide personnel guards for belts and couplings.
- C. Make electrical connections, including ground, to motors.
  1. Make final connection to each motor using a length of liquid-tight flexible metal conduit (LFMC) minimum 300 mm to maximum 450 mm long. Use proper seals and conduit in hazardous areas.
- D. Verify drains function and installed properly.
- E. Perform applicable tests as specified in this specification. Provide a report for each motor that lists test performed, expected results, measured results, and applicable conclusions.

#### 3.02 COMMISSIONING

- A. Check operating motors for unusual conditions during normal operation. Coordinate with the commissioning of packaged equipment when applicable.
- B. Report unusual conditions to the construction manager and recommend corrective action.

**END OF SECTION**