

SECTION 15170
MOTORS

PART 1 GENERAL

1.1 SECTION INCLUDES:

- A. Single phase electric motors.
- B. Three phase electric motors.

1.2 REFERENCES

- A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- C. IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators.
- D. NEMA MG 1 - Motors and Generators.
- E. NFPA 70 - National Electrical Code.
- F. Motor Starters – Refer to Section 16480.

1.3 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
- C. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 5 HP.
- D. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.

1.4 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 01700.
- B. Operation Data: Include instructions for safe operating procedures.
- C. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacture of electric motors and their accessories, with minimum five years documented product development, testing, and manufacturing experience.

1.6 REGULATORY REQUIREMENTS

- A. Conform to NFPA 70 - National Electrical Code
- B. Provide certificate of compliance indicating approval of high efficiency motors.
- C. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc., as suitable for the purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Section 01600.

- B. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering.

1.8 WARRANTY

- A. For 10 HP and larger motors provide five-year warranty under provisions of Section 01700.
- B. For 7 ½ HP and smaller motors provide minimum one-year or standard manufacturer's warranty, whichever is better.

PART 2 PRODUCTS

2.1 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Motors Less Than 250 Watts, for Intermittent Service: Equipment manufacturer's standard and need not conform to these specifications.
- B. Electrical Service:
 - 1. Refer to Section 16180 for required electrical characteristics.
 - 2. Motors ½ HP and smaller: 115 Volts, single-phase, 60 Hz.
 - 3. Motors ¾ to 2 HP: 208 Volts, single-phase, 60 Hz.
 - 4. Motors 3 HP and larger: 480 Volts, three-phase, 60 Hz.
- C. Type:
 - 1. Open drip-proof except where specifically noted otherwise.
 - 2. Motors: Design for continuous operation in 40°C environment.
 - 3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
 - 4. Motors with frame sizes 254T and larger: Energy Efficient Type.
- D. Explosion-Proof Motors: UL approved and labeled for hazard classification, with over temperature protection.
- E. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.
- F. Wiring Terminations:
 - 1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
 - 2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.
- G. Motor Starters
 - 1. Provide motor starters with under-voltage, phase loss, phase unbalance and phase reversal relay protection with automatic reset between 3 to 5 minutes after motor shut down.
 - 2. Provide motor starters with overload heaters sized from motor nameplate full load amperage for each phase. Overload heaters shall be manual reset. Refer to Sections 16480, "Motor Control", 16483 "Motor Starters" and electrical design.

2.2 SINGLE PHASE POWER - SPLIT PHASE MOTORS

- A. Starting Torque: Less than 150% of full load torque.
- B. Starting Current: Up to seven times full load current.
- C. Breakdown Torque: Approximately 200% of full load torque.
- D. Drip-proof Enclosure: Class A (50°C temperature rise) insulation, 1.0 Service Factor, pre-lubricated ball bearings.

- E. Enclosed Motors: Class A (50°C temperature rise) insulation, 1.0 Service Factor, pre-lubricated ball bearings.

2.3 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

- A. Starting Torque: Exceeding one fourth of full load torque.
- B. Starting Current: Up to six times full load current.
- C. Multiple Speed: Through tapped windings.
- D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50°C temperature rise) insulation, minimum 1.0 Service Factor, pre-lubricated sleeve or ball bearings, automatic reset overload protector.

2.4 SINGLE PHASE POWER - CAPACITOR START MOTORS

- A. Starting Torque: Three times full load torque.
- B. Starting Current: Less than five times full load current.
- C. Pull-up Torque: Up to 350% of full load torque.
- D. Breakdown Torque: Approximately 250% of full load torque.
- E. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
- F. Drip-proof Enclosure: Class A (50°C temperature rise) insulation, NEMA Service Factor, pre-lubricated ball bearings.
- G. Enclosed Motors: Class A (50°C temperature rise) insulation, 1.0 Service Factor, pre-lubricated ball bearings.

2.5 THREE PHASE POWER - SQUIRREL CAGE MOTORS

- A. Starting Torque: Between one and one and one-half times full load torque.
- B. Starting Current: Six times full load current.
- C. Power Output, Locked Rotor Torque, Breakdown or Pullout Torque: NEMA Design B characteristics.
- D. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors.
- E. Insulation System: NEMA Class B or better.
- F. Testing Procedure: In accordance with IEEE 112, load test motors to determine freedom from electrical or mechanical defects and compliance with performance data.
- G. Motor Frames: NEMA standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
- H. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter; refer to Section 16483 - Motor Starters.
- I. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
- J. Sound Power Levels: To NEMA MG 1.
- K. Part Winding Start Above 254T Frame Size: Use part of winding to reduce locked rotor starting current to approximately 60% of full winding locked rotor current while providing approximately 50% of full winding locked rotor torque.

- L. Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.
- M. Nominal Efficiency: As scheduled at full load and rated voltage when tested in accordance with IEEE 112.
- N. Nominal Power Factor: As scheduled at full load and rated voltage when tested in accordance with IEEE 112.

PART 3 EXECUTION

3.1 APPLICATION

- A. Single-phase motors for shaft mounted fans: Split phase type.
- B. Single-phase motors for shaft mounted fans or blowers: Permanent split capacitor type.
- C. Single-phase motors for fans, pumps, blowers, and air compressors: Capacitor start type.
- D. Single-phase motors for fans, blowers, and pumps: Capacitor start, capacitor run type.
- E. Motors located in exterior locations, wet air streams, air cooled condensers, direct drive axial fans, dust collection systems: Totally enclosed type.
- F. Motors located in outdoors: Totally enclosed weatherproof, factory epoxy-treated type.
- G. Motors located in draw thru cooling towers: Totally enclosed weatherproof, factory epoxy-sealed type.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- C. Check line voltage and phase and ensure agreement with nameplate.

3.3 NEMA OPEN MOTOR SERVICE FACTORS SCHEDULE

| HP | 3600 RPM | 1800 RPM | 1200 RPM | 900 RPM |
|-------------|----------|----------|----------|---------|
| 1/6 - 1/3 | 1.35 | 1.35 | 1.35 | 1.35 |
| 1/2 | 1.25 | 1.25 | 1.25 | 1.15 |
| 3/4 | 1.25 | 1.25 | 1.15 | 1.15 |
| 1 | 1.25 | 1.15 | 1.15 | 1.15 |
| 1 1/2 - 150 | 1.15 | 1.15 | 1.15 | 1.15 |

3.4 PERFORMANCE SCHEDULE: THREE- PHASE, ENERGY EFFICIENT, OPEN DRIP-PROOF

| HP | RPM (Syn) | NEMA Frame | Minimum Percent Efficiency | Minimum Percent Power Factor |
|-------|--------------|---------------|----------------------------------|------------------------------------|
| 3 | 1200 | 213T | 86 | 60 |
| 5 | 1200 | 215T | 87 | 65 |
| 7 1/2 | 1200 | 254T | 89 | 73 |
| 10 | 1200 | 256T | 89 | 74 |
| 15 | 1200 | 284T | 90 | 77 |
| 20 | 1200 | 286T | 90 | 78 |
| 25 | 1200 | 324T | 91 | 74 |
| 30 | 1200 | 326T | 91 | 78 |

| | | | | |
|-----|------|------|----|----|
| 40 | 1200 | 364T | 93 | 77 |
| 50 | 1200 | 365T | 93 | 79 |
| 60 | 1200 | 404T | 93 | 82 |
| 75 | 1200 | 405T | 93 | 80 |
| 100 | 1200 | 444T | 93 | 80 |
| 125 | 1200 | 444T | 93 | 84 |
| | | | | |
| 3 | 1800 | 182T | 86 | 86 |
| 5 | 1800 | 184T | 87 | 87 |
| 7½ | 1800 | 213T | 88 | 86 |
| 10 | 1800 | 215T | 89 | 85 |
| 15 | 1800 | 256T | 91 | 85 |
| 20 | 1800 | 256T | 91 | 86 |
| 25 | 1800 | 284T | 91 | 85 |
| 30 | 1800 | 286T | 92 | 88 |
| 40 | 1800 | 324T | 92 | 83 |
| 50 | 1800 | 326T | 93 | 85 |
| 60 | 1800 | 364T | 93 | 88 |
| 75 | 1800 | 365T | 93 | 88 |
| 100 | 1800 | 404T | 93 | 83 |
| 125 | 1800 | 405T | 93 | 86 |
| 150 | 1800 | 444T | 93 | 85 |
| 200 | 1800 | 445T | 94 | 85 |
| | | | | |
| 3 | 3600 | 145T | 84 | 85 |
| 5 | 3600 | 182T | 85 | 86 |
| 7½ | 3600 | 184T | 86 | 88 |
| 10 | 3600 | 213T | 87 | 86 |
| 15 | 3600 | 215T | 89 | 89 |
| 20 | 3600 | 254T | 90 | 89 |
| 25 | 3600 | 256T | 90 | 92 |
| 30 | 3600 | 284T | 91 | 91 |
| 40 | 3600 | 286T | 92 | 92 |
| 50 | 3600 | 324T | 93 | 89 |
| 60 | 3600 | 326T | 93 | 91 |
| 75 | 3600 | 324T | 93 | 88 |
| 100 | 3600 | 365T | 92 | 88 |

3.5 PERFORMANCE SCHEDULE: THREE- PHASE, ENERGY EFFICIENT, TOTALLY ENCLOSED, FAN COOLED

| HP | RPM (Syn) | NEMA Frame | Minimum Percent Efficiency | Minimum Percent Power Factor |
|----|--------------|---------------|----------------------------------|------------------------------------|
| 3 | 1200 | 213T | 85 | 63 |
| 5 | 1200 | 215T | 86 | 66 |
| 7½ | 1200 | 254T | 89 | 68 |
| 10 | 1200 | 256T | 89 | 75 |
| 15 | 1200 | 284T | 90 | 72 |
| 20 | 1200 | 286T | 90 | 76 |
| 25 | 1200 | 324T | 90 | 71 |

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Design and Construction Standards

| | | | | |
|-----|------|------|----|----|
| 30 | 1200 | 326T | 91 | 79 |
| 40 | 1200 | 364T | 92 | 78 |
| 50 | 1200 | 365T | 92 | 81 |
| 60 | 1200 | 404T | 92 | 83 |
| 75 | 1200 | 405T | 92 | 80 |
| 100 | 1200 | 444T | 93 | 83 |
| 125 | 1200 | 445T | 93 | 85 |
| 3 | 1800 | 182T | 87 | 83 |
| 5 | 1800 | 184T | 88 | 83 |
| 7½ | 1800 | 213T | 89 | 85 |
| 10 | 1800 | 215T | 90 | 84 |
| 15 | 1800 | 254T | 91 | 86 |
| 20 | 1800 | 256T | 91 | 85 |
| 25 | 1800 | 284T | 92 | 84 |
| 30 | 1800 | 286T | 93 | 86 |
| 40 | 1800 | 324T | 93 | 83 |
| 50 | 1800 | 326T | 93 | 85 |
| 60 | 1800 | 364T | 93 | 87 |
| 75 | 1800 | 365T | 93 | 87 |
| 100 | 1800 | 405T | 94 | 86 |
| 125 | 1800 | 444T | 94 | 87 |
| 150 | 1800 | 445T | 94 | 88 |
| 200 | 1800 | 447T | 95 | 87 |
| 3 | 3600 | 182T | 82 | 87 |
| 5 | 3600 | 184T | 85 | 88 |
| 7½ | 3600 | 213T | 86 | 86 |
| 10 | 3600 | 215T | 86 | 86 |
| 15 | 3600 | 254T | 88 | 91 |
| 20 | 3600 | 256T | 89 | 89 |
| 25 | 3600 | 284T | 90 | 92 |
| 30 | 3600 | 286T | 91 | 92 |
| 40 | 3600 | 324T | 91 | 91 |
| 50 | 3600 | 326T | 90 | 92 |
| 60 | 3600 | 326T | 91 | 93 |
| 75 | 3600 | 364T | 91 | 91 |
| 100 | 3600 | 365T | 92 | 92 |

END OF SECTION