SPECIAL SPECIFICATION

SECTION 15170S

MOTORS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Single phase electric motors.

B. Three phase electric motors.

1.02 REFERENCES/PROJECT REQUIREMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

C. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

D. IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators.

E. NEMA MG 1 - Motors and Generators.

F. NFPA 70 - National Electrical Code.

G. Regulatory Requirements : Conform to all applicable electrical codes and ANSI/NFPA 70.

1.03 DEFINITIONS

A. Not Used

1.04 SYSTEM DESCRIPTION

A. Not Used

1.05 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Submit manufacturer's installation instructions under provisions of Section 01300.

C. Submit operation and maintenance data under provisions of Section 13000.

D. Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.06 QUALITY ASSURANCE

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

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of associated Section.

B. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Vibration Sensitive Areas – Toshiba. Use Toshiba where motors are not mounted on an inertia base.

B. All other areas – use general electric, reliance, century..

2.02 EXISTING PRODUCTS

A. Not Used

2.03 MATERIALS

A. Not Used

2.04 MANUFACTURED UNITS

A. Not Used

2.05 EQUIPMENT

A. General Construction Requirements :

1. Motors Less Than 250 Watts, for Intermittent Service: Equipment manufacturer's standard and need not conform to these specifications.

2. Electrical Service: Refer to Section 16920 for required electrical characteristics, if fed by a starter, and to 16269-S if fed by a variable frequency controller.

3. Type:

   a. Tead except where specifically noted otherwise.

   b. Motors: Design for continuous operation in 40 degrees C environment.

   c. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type..

   d. Motors with frame sizes 245T and larger: Premium Efficiency Type, inverter duty motors, suitable for VFC's.

4. Explosion-Proof Motors: UL approved and labeled for hazard classification, with over temperature protection.

5. 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.

6. Wiring Terminations:

   a. 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.

   b. For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.

7. AC Induction Motors:

   a. Meet the rotor unbalance requirements outlined in NEMA MG 1-12.06. The balancing process shall meet or exceed ISO 1940 G 2.5.

   b. Additional requirements for AC induction motors equal or greater than 20 HP or those in a critical application:

(1) Vibration of uncoupled medium AC motors, when measured in accordance with MG 1-12.07, shall not exceed 0.10 in/sec (peak) overall vibration velocity as measure on bearing housing in any direction with axis of shaft in normal position with half a standard key in keyseat. The frequency range for motor certification will be from f_{min} = (0.4 x motor synchronous speed) to f_{max} = 120,000 cpm.

(2) Test AC motors at rated voltage and frequency, and no load.

8. Cooling Tower Motors: Provide space heaters to prevent condensation. Space heaters to be energized when motor is off. Motors to have non-hygroscopic insulation rated for severe duty with encapsulated copper windings, cast iron frames and drain hole.

B. Single Phase Power - Permanent - Split Capacitors :

1. Starting Torque: Exceeding one fourth of full load torque.

2. Starting Current: Up to six times full load current.

3. Multiple Speed: Through tapped windings.

4. Open Drip-proof of Enclosed Air Over Enclosure: Class B (40 degrees C temperature rise) insulation, minimum 1.15 Service Factor, pre-lubricated sleeve or ball bearings, automatic reset overload protector.

C. Single Phase Power - Capacitor Start Motors :

1. Starting Torque: Three times full load torque.

2. Starting Current: Less than five times full load current.

3. Pull-up torque: Up to 350 percent of full load torque.

4. Breakdown Torque: Approximately 250 percent of full load torque.

5. 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.

6. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, pre-lubricated sleeve or ball bearings.

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

D. Three Phase Power - Squirrel Cage Motors :

1. Starting Torque: Between 1 and 1-1/2 times full load torque.

2. Starting Current: Six times full load current.

3. Power Output, Locked Rotor Torque, Breakdown or Pull Out torque: NEMA Design B characteristics.

4. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors.

5. Insulation System: NEMA Class B or better. Also see requirements listed elsewhere for use with variable frequency controllers.

6. Testing Procedure: In accordance with IEEE 112, Test Method B. Load test motors to determine freedom from electrical or mechanical defects in compliance with performance data.

7. Motor Frames: NEMA Standard T-Frames of cast steel, cast aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts. Cast frames are required; rolled steel motor frames are not acceptable.

8. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for pre-lubrication, rated for minimum AFBMA 9, L-10 life of 200,000 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. Also see requirements listed elsewhere for use with variable frequency controllers.

9. Sound Power Levels: to NEMA MG 1.

10. Part Winding Start (Where Indicated): Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.

11. 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.

12. Nominal Efficiency: As scheduled at full load and rated voltage when tested in

accordance with IEEE 112.

13. Nominal Power Factor: As scheduled at full load and rated voltage when tested in accordance with IEEE 112.
14. Motors 50HP and larger are to have RTD motor winding temperature sensors, (two per phase) for overload protection. RTD's are to be interfaced with the starter or VFC suppling the motor. RTD resistance material shall be platinum, 100 ohm at 0 degrees C.

15. Vertical jackbolts are required for motors greater than 40 HP to allow shims to be added and removed in a safe manner.

16. VFC-driven motors shall meet the requirements of NEMA MG1, Part 31, Definite Purpose Inverter-Fed Motors. The motor shall be designed for use on insulated-gate-bipolar-transistor (IGBT) pulse-width-modulated (PWM) VFCs. The insulation system of the motor shall be capable of handling the VFC-generated voltages without deterioration or loss of life. Motor bearings shall be protected from shaft currents that may be induced in the motor from the non-linear, harmonic rich VFC output. An externally mounted grounding device is not an acceptable method of protecting motor bearings. Motor shaft may be insulated from the case or the motor shaft may be grounded.

17. Motor solos are required for motors greater than 20 HP prior to couple driven unit to motor after rotation has been verified. A motor solo is collection of vibration data on motor's bearings while it is uncoupled from driven equipment. Overall solo vibration readings shall not exceed 0.10 in/sec (peak) at the axial or radial directions at any motor bearing over frequency range f_{min} = (0.4 x motor synchronous speed) to f_{max} = 120,000 cpm.

18. Vertical In-Line pumps to have drive motors designed for application per NEMA MG 1-18.614 and 1-18.620. Vertically coupled motors (VC) shall use P-base In-Line Pump Motors per NEMA MG 1-18.620. Vertical Motor Shaft designed pumps (VM) shall use NEMA JM or JP solid shaft design motors per NEMA MG 1-18.614. Vertical Bearing Housing design pumps (VB) shall use NEMA C-face motors.

2.06 - 2.11

A. Not Used

PART 3 - EXECUTION

3.01 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.

3.02 - 3.05

A. Not Used

3.05 APPLICATION

A. Motors shall be open-drip proof type, except where specifically noted otherwise.

B. Motors shall be Premium efficiency type per guidelines below.

C. Single phase motors for shaft mounted fans or blowers: Permanent split capacitor type.

D. Single phase motors for fans, pumps, blowers: Capacitor start, capacitor run type.

E. Motors located in wet air streams, downstream of sprayed coil dehumidifiers, air cooled condensers, humidifiers, direct drive axial fans, roll filters, explosion proof environments, dust collection systems: Totally enclosed type.

F. Motors located outdoors: Totally enclosed weatherproof epoxy-sealed type.

G. Motors shall be suitable for variable frequency controller (VFC) applications. Line termination kits shall be installed at the motor if the VFC is more than 50 feet from the motor. Submit for approval prior to installation.

H. Motor lead splicing:

1. The conductors shall be first spliced or joined as to be mechanically and electrically secure.

2. Apply two half-lapped layers of varnished cambric tape (3M 2510 or 2520) over the connection.

3. Apply rubber insulation tape (3M 23 or 130c) over the varnished cambric tape in stretched lapped layers over the connection and at least one inch onto the cable jacket.

4. Apply half-lapped layers vinyl tape (3M 23 or 88) over the rubber insulation tape to provide mechanical and abrasion protection to the splice.

5. This application should build up the tape insulation to a minimum thickness of the existing cable insulation.

3.7 - 3.15

A. Not Used

3.16 NEMA OPEN MOTOR SERVICE FACTOR SCHEDULE

Horsepower (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
1.5-150	1.15	1.15	1.15	1.15

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

HP	RPM(Syn)	NEMA Frame	Min % Efficiency	Min. % Power Factor
~~1~~	~~1200~~	~~145T~~	~~82.5~~	~~72~~
~~1-1/2~~	~~1200~~	~~182T~~	~~86.5~~	~~73~~
~~2~~	~~1200~~	~~184T~~	~~87.5~~	~~75~~
~~3~~	~~1200~~	~~213T~~	~~88.5~~	~~60~~
~~5~~	~~1200~~	~~215T~~	~~89.5~~	~~65~~
~~7-1/2~~	~~1200~~	~~254T~~	~~90.2~~	~~73~~
~~10~~	~~1200~~	~~256T~~	~~91.7~~	~~74~~
~~15~~	~~1200~~	~~284T~~	~~91.7~~	~~77~~
~~20~~	~~1200~~	~~286T~~	~~92.4~~	~~78~~
~~25~~	~~1200~~	~~324T~~	~~93.0~~	~~74~~
~~30~~	~~1200~~	~~326T~~	~~93.6~~	~~78~~
~~40~~	~~1200~~	~~364T~~	~~94.1~~	~~77~~
~~50~~	~~1200~~	~~365T~~	~~94.1~~	~~79~~
~~60~~	~~1200~~	~~404T~~	~~94.5~~	~~82~~
~~75~~	~~1200~~	~~405T~~	~~94.5~~	~~80~~
~~100~~	~~1200~~	~~444T~~	~~95~~	~~80~~
~~125~~	~~1200~~	~~444T~~	~~95~~	~~84~~
1	1200	145T	82.5	72

1-1/2	1200	182T	86.5	73
2	1200	184T	87.5	75
3	1200	213T	88.5	60
5	1200	215T	89.5	65
7-1/2	1200	254T	90.2	73
10	1200	256T	91.7	74
15	1200	284T	91.7	77
20	1200	286T	92.4	78
25	1200	324T	93.0	74
30	1200	326T	93.6	78
40	1200	364T	94.1	77
50	1200	365T	94.1	79
60	1200	404T	94.5	82
75	1200	405T	94.5	80
100	1200	444T	95	80
125	1200	444T	95	84

HP	RPM(Syn)	NEMA Frame	Min % Efficiency	Min. % Power Factor
~~1~~	~~1800~~	~~143T~~	~~88.5~~	~~84~~
~~1-1/2~~	~~1800~~	~~145T~~	~~86.5~~	~~85~~
~~2~~	~~1800~~	~~145T~~	~~86.5~~	~~85~~
~~3~~	~~1800~~	~~182T~~	~~89.5~~	~~86~~
~~5~~	~~1800~~	~~184T~~	~~89.5~~	~~87~~
~~7-1/2~~	~~1800~~	~~213T~~	~~91~~	~~86~~
~~10~~	~~1800~~	~~215T~~	~~91.7~~	~~85~~
~~15~~	~~1800~~	~~256T~~	~~93.0~~	~~85~~
~~20~~	~~1800~~	~~256T~~	~~93.0~~	~~86~~
~~25~~	~~1800~~	~~284T~~	~~93.6~~	~~85~~
~~30~~	~~1800~~	~~286T~~	~~94.1~~	~~88~~
~~40~~	~~1800~~	~~324T~~	~~94.1~~	~~83~~
~~50~~	~~1800~~	~~326T~~	~~94.5~~	~~85~~
~~60~~	~~1800~~	~~364T~~	~~95~~	~~88~~
~~75~~	~~1800~~	~~365T~~	~~95~~	~~88~~
~~100~~	~~1800~~	~~404T~~	~~95.4~~	~~83~~
~~125~~	~~1800~~	~~405T~~	~~95.4~~	~~86~~
~~150~~	~~1800~~	~~444T~~	~~95.8~~	~~85~~
~~200~~	~~1800~~	~~445T~~	~~95.8~~	~~85~~

~~HP~~	~~RPM(Syn)~~	~~NEMA Frame~~	~~Min % Efficiency~~	~~Min. % Power Factor~~
~~1-1/2~~	~~3600~~	~~143T~~	~~84~~	~~85~~
~~2~~	~~3600~~	~~145T~~	~~85.5~~	~~87~~

~~3~~	~~3600~~	~~145T~~	~~85.5~~	~~85~~
~~5~~	~~3600~~	~~182T~~	~~86.5~~	~~86~~
~~7-1/2~~	~~3600~~	~~184T~~	~~88.5~~	~~88~~
~~10~~	~~3600~~	~~213T~~	~~89.5~~	~~86~~
~~15~~	~~3600~~	~~215T~~	~~90.2~~	~~89~~
~~20~~	~~3600~~	~~254T~~	~~91.0~~	~~89~~
~~25~~	~~3600~~	~~256T~~	~~91.7~~	~~92~~
~~30~~	~~3600~~	~~284T~~	~~91.7~~	~~91~~
~~40~~	~~3600~~	~~286T~~	~~92.4~~	~~92~~
~~50~~	~~3600~~	~~324T~~	~~93~~	~~89~~
~~60~~	~~3600~~	~~326T~~	~~93.6~~	~~91~~
~~75~~	~~3600~~	~~364T~~	~~93.6~~	~~88~~
~~100~~	~~3600~~	~~365T~~	~~93.6~~	~~88~~
1	1800	143T	88.5	84
1-1/2	1800	145T	86.5	85
2	1800	145T	86.5	85
3	1800	182T	89.5	86
5	1800	184T	89.5	87
7-1/2	1800	213T	91	86
10	1800	215T	91.7	85
15	1800	256T	93.0	85
20	1800	256T	93.0	86
25	1800	284T	93.6	85
30	1800	286T	94.1	88
40	1800	324T	94.1	83
50	1800	326T	94.5	85
60	1800	364T	95	88
75	1800	365T	95	88
100	1800	404T	95.4	83
125	1800	405T	95.4	86
150	1800	444T	95.8	85
200	1800	445T	95.8	85

HP	RPM(Syn)	NEMA Frame	Min % Efficiency	Min. % Power Factor
1-1/2	3600	143T	84	85
2	3600	145T	85.5	87
3	3600	145T	85.5	85
5	3600	182T	86.5	86
7-1/2	3600	184T	88.5	88
10	3600	213T	89.5	86
15	3600	215T	90.2	89
20	3600	254T	91.0	89

25	3600	256T	91.7	92
30	3600	284T	91.7	91
40	3600	286T	92.4	92
50	3600	324T	93	89
60	3600	326T	93.6	91
75	3600	364T	93.6	88
100	3600	365T	93.6	88

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

HP	RPM(Syn)	NEMA Frame	Min % Efficiency	Min. % Power Factor
~~1~~	~~1200~~	~~145T~~	~~82.5~~	~~72~~
~~1-1/2~~	~~1200~~	~~182T~~	~~87.5~~	~~65~~
~~2~~	~~1200~~	~~184T~~	~~88.5~~	~~68~~
~~3~~	~~1200~~	~~213T~~	~~89.5~~	~~63~~
~~5~~	~~1200~~	~~215T~~	~~89.5~~	~~66~~
~~7-1/2~~	~~1200~~	~~254T~~	~~91.0~~	~~68~~
~~10~~	~~1200~~	~~256T~~	~~91.0~~	~~75~~
~~15~~	~~1200~~	~~284T~~	~~91.7~~	~~72~~
~~20~~	~~1200~~	~~286T~~	~~91.7~~	~~76~~
~~25~~	~~1200~~	~~324T~~	~~93~~	~~71~~
~~30~~	~~1200~~	~~326T~~	~~93~~	~~79~~
~~40~~	~~1200~~	~~364T~~	~~94.1~~	~~78~~
~~50~~	~~1200~~	~~365T~~	~~94.1~~	~~81~~
~~60~~	~~1200~~	~~404T~~	~~94.5~~	~~83~~
~~75~~	~~1200~~	~~405T~~	~~94.5~~	~~80~~
~~100~~	~~1200~~	~~444T~~	~~95~~	~~83~~
~~125~~	~~1200~~	~~445T~~	~~95~~	~~85~~
1	1200	145T	82.5	72
1-1/2	1200	182T	87.5	65
2	1200	184T	88.5	68
3	1200	213T	89.5	63
5	1200	215T	89.5	66
7-1/2	1200	254T	91.0	68
10	1200	256T	91.0	75
15	1200	284T	91.7	72
20	1200	286T	91.7	76
25	1200	324T	93	71
30	1200	326T	93	79
40	1200	364T	94.1	78
50	1200	365T	94.1	81
60	1200	404T	94.5	83

75	1200	405T	94.5	80
100	1200	444T	95	83
125	1200	445T	95	85

HP	RPM(Syn)	NEMA Frame	Min % Efficiency	Min. % Power Factor
~~1~~	~~1800~~	~~143T~~	~~85.5~~	~~84~~
~~1-1/2~~	~~1800~~	~~145T~~	~~86.5~~	~~85~~
~~2~~	~~1800~~	~~145T~~	~~86.5~~	~~85~~
~~3~~	~~1800~~	~~182T~~	~~89.5~~	~~83~~
~~5~~	~~1800~~	~~184T~~	~~89.5~~	~~83~~
~~7-1/2~~	~~1800~~	~~213T~~	~~91.7~~	~~85~~
~~10~~	~~1800~~	~~215T~~	~~91.7~~	~~84~~
~~15~~	~~1800~~	~~254T~~	~~92.4~~	~~86~~
~~20~~	~~1800~~	~~256T~~	~~93.0~~	~~85~~
~~25~~	~~1800~~	~~284T~~	~~93.6~~	~~84~~
~~30~~	~~1800~~	~~286T~~	~~93.6~~	~~86~~
~~40~~	~~1800~~	~~324T~~	~~94.1~~	~~83~~
~~50~~	~~1800~~	~~326T~~	~~94.5~~	~~85~~
~~60~~	~~1800~~	~~364T~~	~~95~~	~~87~~
~~75~~	~~1800~~	~~365T~~	~~95.4~~	~~87~~
~~100~~	~~1800~~	~~405T~~	~~95.4~~	~~86~~
~~125~~	~~1800~~	~~444T~~	~~95.4~~	~~87~~
~~150~~	~~1800~~	~~445T~~	~~95.8~~	~~88~~
~~200~~	~~1800~~	~~447T~~	~~96.2~~	~~87~~
1	1800	143T	85.5	84
1-1/2	1800	145T	86.5	85
2	1800	145T	86.5	85
3	1800	182T	89.5	83
5	1800	184T	89.5	83
7-1/2	1800	213T	91.7	85
10	1800	215T	91.7	84
15	1800	254T	92.4	86
20	1800	256T	93.0	85
25	1800	284T	93.6	84
30	1800	286T	93.6	86
40	1800	324T	94.1	83
50	1800	326T	94.5	85
60	1800	364T	95	87
75	1800	365T	95.4	87
100	1800	405T	95.4	86
125	1800	444T	95.4	87
150	1800	445T	95.8	88

200	1800	447T	96.2	87

HP	RPM(Syn)	NEMA Frame	Min % Efficiency	Min. % Power Factor
~~1-1/2~~	~~3600~~	~~143T~~	~~84~~	~~85~~
~~2~~	~~3600~~	~~145T~~	~~85.5~~	~~87~~
~~3~~	~~3600~~	~~182T~~	~~86.5~~	~~87~~
~~5~~	~~3600~~	~~184T~~	~~88.5~~	~~88~~
~~7-1/2~~	~~3600~~	~~213T~~	~~89.5~~	~~86~~
~~10~~	~~3600~~	~~215T~~	~~90.2~~	~~86~~
~~15~~	~~3600~~	~~254T~~	~~91~~	~~91~~
~~20~~	~~3600~~	~~256T~~	~~91~~	~~89~~
~~25~~	~~3600~~	~~284T~~	~~91.7~~	~~92~~
~~30~~	~~3600~~	~~286T~~	~~91.7~~	~~92~~
~~40~~	~~3600~~	~~324T~~	~~92.4~~	~~91~~
~~50~~	~~3600~~	~~326T~~	~~93~~	~~92~~
~~60~~	~~3600~~	~~364T~~	~~93.6~~	~~93~~
~~75~~	~~3600~~	~~365T~~	~~93.6~~	~~91~~
~~100~~	~~3600~~	~~405T~~	~~94.1~~	~~92~~
1-1/2	3600	143T	84	85
2	3600	145T	85.5	87
3	3600	182T	86.5	87
5	3600	184T	88.5	88
7-1/2	3600	213T	89.5	86
10	3600	215T	90.2	86
15	3600	254T	91	91
20	3600	256T	91	89
25	3600	284T	91.7	92
30	3600	286T	91.7	92
40	3600	324T	92.4	91
50	3600	326T	93	92
60	3600	364T	93.6	93
75	3600	365T	93.6	91
100	3600	405T	94.1	92

END OF SECTION