MIL-M-17059A(SHIPS)
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SUPERSEDING
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(See 6.3)

MILITARY SPECIFICATION

MOTORS, 60-CYCLE, ALTERNATING-CURRENT, FRACTIONAL H..P. (SHIPBOARD USE)

1. SCOPE

1.1 Scope. - This specification covers 60 cycle, fractional horsepower (hp.), alternating-current, motors for board use.

1.2 Classification. - The motors shall be of the following services, as specified (see 6.1):

Service A - For applications where motors are essential to the Military effectiveness of a ship.
Service C - For applications where motors are not essential to the Military effectiveness of a ship.

2. APPLICABLE DOCUMENTS

2.1 The following documents of the issue in effect on date of invitation for bids or request for proposal, form a part of the specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

FF-B-171	- Bearings, Ball Annular (General Purpose).
QQ-A-591	- Aluminum Alloy Die Castings.
QQ-A-601	- Aluminum Alloy Sand Castings.
QQ-B-650	- Brazing Alloy, Copper, Copper-Zinc, and Copper-Phosphorous.
QQ-I-666	- Iron Castings, Malleable.
GGG-P-781	- Puller and Puller Kit, Mechanical, and Mechanical Puller Attachment.

SPECIFICATIONS

MILITARY

MIL-M-14	- Molding Plastics and Molded Plastic Parts, Thermosetting.
MIL-S-901	- Shock Tests, H. I. (High-Impact) Shipboard Machinery, Equipment and Systems, Requirements For.
MIL-E-917	- Electric Power Equipment, Basic Requirements for (Naval Shipboard Use).
MIL-D-963	- Drawings, Electrical, Hull and Mechanical Equipment for Naval Shipboard Use.
MIL-E-2036	- Enclosures for Electric and Electronic Equipment, Naval Shipboard.
MIL-B-3743	- Brushes, Electrical, Contact and Carbon Stock, Electrical Contact Brush.
MIL-S-15083	- Steel Castings.
MIL-P-15137	- Provisioning Technical Documentation for Repair Parts for Electrical and Mechanical Equipment (Naval Shipboard Use).
MIL-B-15395	- Brazing Alloys, Silver.
MIL-L-15719	- Lubricating Grease, High-Temperature, Electric Motor, Ball and Roller Bearings.
MIL-B- 16261	- Bronze, Bearing, Castings.
MIL-E-16298	- Electric Machines Having Rotating Parts and Associated Repair Parts, Packaging of.
MIL-L- 17331	- Lubricating Oil, Steam Turbine, Noncorrosive.
MIL-P-17840	- Pumps, Centrifugal, Close- Coupled, Navy Standard For Use on Naval Ships.
MIL-G-18709	- Grease, Ball and Roller Bearing.
MIL-I-24092	- Insulating Varnish, Electrical, Impregnating.
MIL-I-24137	- Iron Castings, Nodular Graphitic (Ductile Iron) and Nodular Graphitic (Corrosion Resisting, Austenitic, Low Magnetic Permeability) (For Shipboard Application).

STANDARDS

MILITARY

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-108 - Definitions of and Basic Requirements For Enclosures for Electric and Electronic Equipment.
MIL-STD-414 - Sampling Procedures and Tables for Inspection by Variables for Percent Defective.

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring agency or as directed by the contracting officer.)

3.1 General design. -

3.1.1 Ambient temperatures. - Motors shall be designed for the following ambient temperatures, as specified (see 6. 1):

40°C., 50°C., 65°C., 80°C. and special.

3.1.2 Airborne noise. - Motors shall operate without objectionable airborne noise at all loads and speeds within the service range (see 4.3.4.4).

3. 1.3 Voltage. - Motors shall be designed for the following voltages, as specified (see 6.1):

Single phase:	Three-phase:
115	115
Special.	440.
	Special.

3.1.4 Voltage limitations. - All motors shall be designed to operate continuously at rated horsepower output and frequency with the voltage not more than 10 percent above or below rated voltage, but not necessarily in accordance with the requirements for operation at rated conditions.

3.1.5 Frequency limitations. - All motors shall be designed to operate continuously at rated horsepower output and voltage, with frequencies not more than 5 percent above or below the rated frequency but not necessarily in accordance with the requirements for operation at rated conditions.

3.1.6 Combined variation of voltage and frequency. - Alternating-current motors shall operate successfully at rated load with a combined variation in the voltage and frequency up to 10 percent above or below the rated voltage and the rated frequency, provided that the frequency variation does not exceed 5 percent. In determining compliance with this requirement, the signs of both percent variation of voltage and percent variation of frequency shall be considered positive. Under this condition of operation the performance need not necessarily be in accordance with the requirements for operation at rated conditions.

3.1.7 Duty. - The duty of motors shall be continuous, intermittent, varying, or short-time as specified (see 6.1).

3.1.7.1 Continuous duty. - Motors rated for continuous duty shall carry rated load continuously at the ambient temperature specified (see 6.1) without exceeding allowable temperature rises (see table IX and 6.2.1).

3.1.7.2 Intermittent duty. - Motors rated for intermittent duty shall carry rated load for the time duration which will permit operation of the motor indefinitely at the ambient temperature and the cycle of load, no- load, and rest specified (see 6.1) without exceeding the allowable temperature rises (see table IX and 6.2. 2). Where intermittent operation is involved and no definite operating cycle can be given, a short-time duty motor of sufficient rating to meet the estimated load requirements will be required.

3.1.7.3 Varying duty. - Motors rated for varying duty shall carry rated load for the time duration which will permit operation of the motor indefinitely at the ambient temperature and the cycle of varying loads specified (see 6.1) without exceeding allowable temperature rises (see table IX and 6.2.3).

3.1.7.4 Short-time duty. - Motors rated for short-time duty shall carry rated load which, starting at the ambient temperature, can be carried constantly for the period specified (see 6.1) without exceeding allowable temperature rises (see table IX and 6.2.4).

3.1.8 Enclosure. - Enclosures shall conform to MIL-E-2036 and MIL-STD-108. Motors shall be of the following enclosures, as specified (see 6.1). (For submarine applications, see 3.5.1.17.1.)

open 1/	Watertight fan-cooled.
Protected 1/	Totally enclosed.
Dripproof.	Totally enclosed fan-cooled.
Dripproof protected.	Explosionproof.
Spraytight	Explosionproof fan-cooled.
Spraytight fan-cooled	Submersible (15 foot).
Watertight.	Submersible (50 foot).

3.1.9 Standard horsepower sizes and speed ratings of induction motors. - The horsepower and speed ratings for fractional horsepower, single-phase induction motors rated 115 volts shall be as specified in 6.1 and shall be furnished in accordance with table I.

Table I - Horsepower and speed ratings (induction motors).

	60-cycle synchronous r.p.m.	All motors except shaded pole and permanent-split capacitor	Shaded-pole motors	Permanent-split capacitor motors
		Approximate full-load r.p.m.		
1, 1.5, 2, 3, 5, 7.5, 10, 15, 25, and 35 milli-horsepower	3600 1800 1200 900	3450 1725 1140	3000 1550 1050 800	3000 1550 1050 800
1/20, 1/12, and 1/8 horsepower	3600 1800 1200 900	3450 1725 1140 850	3000 1550 1050 800	3250 1625 1075 825
1/6, 1/4, and 1/3 horsepower	3600 1800 1200 900	3450 1725 1140 850	---- ---- ---- ----	3250 1625 1075 825
1/2 horsepower	3600 1800 1200	3450 1725 1140	---- ---- ----	3250 1625 1075
3/4 horsepower	3600 1800	3450 1725	---- ----	3250 1625
1 horsepower	3600	3450	----	3250

3.1.9.1 Universal motors. - Horsepower ratings shall be 10, 15, 25 and 35 millihorsepower and 1/20, 1/12, 1/8, 1/6, 1/4, 1/3, 1/2, 3/4 and 1 horsepower at a rated speed of 5,000 revolutions per minute (r. p.m.) or above.

3.1.10 Speed variations. - The rated speed in r. p. m. or rated speed range in r.p.m. shall be as specified (see 6.1). The speed shall be constant, multi, varying, or adjustable varying, as specified (see 6.1 and 6.2.5 through 6.2.8).

1/ Permitted only when motor is to be located within a larger enclosure.

3.1.11 Types. - The motors shall be designed for the following types, as specified (see 6.1 and 6.2.11 through 6.2.18):

Single-Phase.-

Capacitor-start.
Permanent-split capacitor.
Two-value capacitor.
Shaded pole.
Split-phase.
Universal.
Synchronous.

Three-phase. -

Squirrel-cage induction.
Synchronous.

3.1.12 Torque and current limitations. -

3. 1.12.1 Basis of horsepower rating. - When the breakdown torque of single-phase motors other than the universal type is specified, the horsepower rating shall be in accordance with tables II and III.

Table II- Induction motors, except shaded-pole and permanent-split capacitor motors.

3600	1800	1200	900	Synchronous r. p. m.
Breakdown torque, oz. -in.				Standard Hp. rating, Millihorsepower
0. 35 - 0. 55	0. 7 - 1. 1	1. 1 - 1. 65	------	1
0. 55 - 0. 7	1. 1 - 1. 45	1. 65 - 2. 2	------	1. 5
0. 7 - 1. 1	1. 45 - 2. 2	2. 2 - 3. 3	------	2
1. 1 - 1. 8	2. 2 - 3. 6	3. 3 - 5. 4	------	3
1. 8 - 2. 7	3. 6 - 5. 4	5. 4 - 8. 1	------	5
2. 7 - 3. 6	5. 4 - 7. 2	8. 1 - 11. 0	------	7. 5
3. 6 - 5. 5	7. 2 - 11. 0	11. 0 - 17. 0	------	10
5. 5 - 9. 5	11. 0 - 19. 0	17. 0 - 29. 0	------	15
9. 5 - 15. 0	19. 0 - 30. 0	29. 0 - 46. 0	------	25
15. 0 - 24. 0	30. 0 - 48. 0	46. 0 - 72. 0	------	35
Breakdown torque, oz. -ft.				Hp.
2. 0 - 3. 7	4. 0 - 7. 1	6. 0 - 10. 4	8. 0-13. 5	1/20
3. 7 - 6. 0	7. 1 - 11. 5	10. 4 - 16. 5	13. 5-21. 5	1/12
6. 0 - 8. 7	11. 5 - 16. 5	16. 5 - 24. 1	21. 5-31. 5	1/8
8. 7 - 11. 5	16. 5 - 21. 5	24. 1 - 31. 5	31. 5-40. 5	1/6
11. 5 - 16. 5	21. 5 - 31. 5	31. 5 - 44. 0	40. 5-58. 0	1/4
16. 5 - 21. 5	31. 5 - 40. 5	44. 0 - 58. 0	58. 0-77. 0	1/3
21. 5 - 31. 5	40. 5 - 58. 0	58. 0 - 82. 5	------	1/2
31. 5 - 44. 0	58. 0 - 82. 5	------	------	3/4
44. 0 - 58. 0	------	------	------	1
Breakdown torque, lb. -ft.				Hp.
------	------	5. 16- 6. 9	------	3/4
------	5. 16 - 6. 8	6. 9 - 9. 2	------	1
3. 6 - 4. 6	6. 8 - 10. 1	9. 2 - 13. 8	------	1 1/2
4. 6 - 6. 0	10. 1 - 13. 0	13. 8 - 18. 0	------	2
6. 0 - 8. 6	13. 0 - 19. 0	18. 0 - 25. 8	------	3
8. 6 - 13. 5	19. 0 - 30. 0	25. 8 - 40. 5	------	5
13. 5 - 20. 0	30. 0 - 45. 0	40. 5 - 60. 0	------	7 1/2
20. 0 - 27. 0	45. 0 - 60. 0	------	------	10

Note 1. - Breakdown-torque range includes the higher figure down to, but not including, the lower figure
Note 2. - The horsepower rating of motors designed to operate on two or more frequencies shall be determined by the torque at the highest rated frequency.

Table III - Shaded-pole and permanent-split capacitor motors,

Synchronous speeds, r.p.m.			Standard horsepower rating
1800	1200	900	
Breakdown torque, oz.-in.			
			Millihp.
0.89 - 1.1	1.3 - 1.6	1.7 - 2.1	1
1.1 - 1.4	1.6 - 2.1	2.1 - 2.7	1.25
1.4 - 1.7	2.1 - 2.5	2.7 - 3.3	1.5
1.7 - 2.1	2.5 - 3.1	3.3 - 4.1	2
2.1 - 2.6	3.1 - 3.8	4.1 - 5.0	2.5
2.6 - 3.2	3.8 - 4.7	5.0 - 6.2	3
3.2 - 4.0	4.7 - 5.9	6.2 - 7.8	4
4.0 - 4.9	5.9 - 7.2	7.8 - 9.5	5
4.9 - 6.2	7.2 - 9.2	9.5 - 12.0	6
6.2 - 7.7	9.2 - 11.4	12.0 - 14.9	8
7.7 - 9.6	11.4 - 14.2	14.9 - 18.6	10
9.6 - 12.3	14.2 - 18.2	18.6 - 23.8	12.5
12.3 - 15.3	18.2 - 22.6	23.8 - 29.6	16
15.3 - 19.1	22.6 - 28.2	29.6 - 37.0	20
19.1 - 23.9	28.2 - 35.3	37.0 - 46.3	25
23.9 - 30.4	35.3 - 44.9	46.3 - 58.9	30
30.4 - 38.3	44.9 - 56.4	58.9 - 74.4	40
Breakdown torque, oz.-ft.			
3.20 - 4.13	4.70 - 6.09	6.20 - 8.00	1/20
4.13 - 5.23	6.09 - 7.72	8.00 - 10.1	1/15
5.23 - 6.39	7.72 - 9.42	10.1 - 12.4	1/12
6.39 - 8.00	9.42 - 11.8	12.4 - 15.5	1/10
8.00 - 10.4	11.8 - 15.3	15.5 - 20.1	1/8
10.4 - 12.7	15.3 - 18.8	20.1 - 24.6	1/6
12.7 - 16.0	18.8 - 23.6	24.6 - 31.0	1/5
16.0 - 21.0	23.6 - 31.5	31.0 - 41.0	1/4
21.0 - 31.5	31.5 - 47.0	41.0 - 61.0	1/3
31.5 - 47.5	47.0 - 70.8	------	1/2
47.5 - 63.5	------	------	3/4
Breakdown torque, lb.-ft.			
------	------	3.81 - 5.81	1/2
------	4.42 - 5.88	5.81 - 7.62	3/4
3.97 - 5.94	5.88 - 8.88	7.62 - 11.6	1
5.94 - 7.88	8.88 - 11.8	11.6 - 15.2	1 1/2

Note 1. - The breakdown torque range includes the higher figure down to, but not including, the lower figure.

Note 2. - The horsepower rating of motors designed to operate on two or more frequencies shall be determined by the torque at the highest rated frequency.

3.1.12.2 Locked-rotor current. - With the rotor locked and rated voltage and frequency applied, the locked- rotor current of single-phase motors, other than universal motors shall not exceed the values given in table IV (see 3. 52.3 for service C requirements).

Table IV - Locked-rotor currents.

3.1.12.3 Torque characteristics of general purpose motors. - Motors of the type specified in 3.1.12.2 shall have breakdown and locked rotor torques not less than the values shown in table V.

Table V - Torque characteristics of general purpose motors.

Single-phase motors breakdown torque, oz. - ft.				
Synchronous approx. F. L.	RPM			
	3600 3450	1800 1725	1200 1140	900 850
Hp.				
1/20	3.7	7.1	10.4	13.5
1/12	6.0	11.5	16.5	21.5
1/8	8.7	16.5	24.1	31.5
1/6	11.5	21.5	31.5	40.5
1/4	16.5	31.5	44.0	58.0
1/3	21.5	40.5	58.0	77.0
1/2	31.5	58.0	82.5	----
3/4	44.0	82.5	----	----
1	58.0	----	----	----

Single-phase motors locked-rotor torque, oz. - ft.			
Synchronous approx. F. L.	RPM		
	3600 3450	1800 1725	1200 1140
Hp.			
1/8	----	24	32
1/6	15	33	43
1/4	21	46	59
1/3	26	57	73
1/2	37	85	100
3/4	50	119	---
1	61	---	---

Polyphase motors breakdown torque, oz. - ft.				
Synchronous approx F. L.	RPM			
	3600 3450	1800 1725	1200 1140	900 850
Hp.				
1/20	5.2	9.9	14.6	18.9
1/12	8.4	16.1	23.1	30.1
1/8	12.2	23.1	33.8	44.2
1/6	16.1	30.1	44.2	56.7
1/4	23.1	44.2	61.6	81.2
1/3	30.1	56.7	81.2	107.8
1/2	44.2	81.2	115.6	-----
3/4	61.6	115.6	-----	-----
1	81.2	-----	-----	-----

3.1.13 Electrical balance (three-phase only). - The amperes in any line of three-phase motors at rated load shall not differ from the arithmetic average of the maximum and minimum line amperes by more than 10 percent.

3.1.14 Dielectric strength. - Motors shall withstand dielectric test voltages in accordance with table VI.

Table VI - Dielectric test voltages.

Part	Test voltage	Minimum duration
Secondary windings of wound rotors:		
Nonreversing	1,000 plus twice normal induced voltage on open circuit.	1 minute
Reversing, while running at approximately normal speed by reversing the primary connections	1,000 plus four times normal induced voltage on open circuit.	1 minute
Motors rated 1/2 H. p. and larger	1,000 plus twice rated voltage	1 minute
Motors rated less than 1/2 H. P.		
(a) Motors rated 250 volts or less	900 volts	1 minute
(b) Motors rated over 250 volts	1,000 plus twice normal induced voltage on open circuit	1 minute

3.1.14.1 Alternate test. - An alternating-current test voltage of 1.2 times the one-minute test voltage specified above may be applied for 1 second as an alternative to the l-minute test.

3.1.15 Mechanical balance. - Motors shall be balanced at any load and speed in the operating range. Windings not in mechanical symmetry shall have dummy coils. In general, the proper mechanical balance shall be effected by the use of balance weights securely attached, (if bolts are used, corrosion-resistant bolts and locknuts shall be used), removal of material, securely welded steel weights, or by metal carried in a receiver in such a manner as to preclude its breaking loose. Balancing by the use of solder on the banding wire is permissible subject to the following limitations:

(a) Peripheral speed not to exceed 6,500 feet per minute at rated load.
(b) All armatures to be balanced before the windings are inserted.
(c) Only tinned banding wire is to be used.
(d) The solder not to cover an arc of more than 25 percent of the circumference of the armature measured on the banding wire unless satisfactory to the bureau or agency concerned. Where the manufacturer prebalances the armature and takes care in placing the windings in the slots to reduce unbalance due to axial misalignment of the coils, this value may be increased to 33 percent if satisfactory to the bureau or agency concerned.

(See 3.5.1.5 for service A and 3.5.1.17.5 for submarine requirements.)

3.1.16 Frame and feet. - The frame shall be of rigid construction. The feet shall be machined and the holes for holding-down bolts may be either drilled or slotted.

3.1.17 End shields (explosionproof and explosionproof, fan-cooled excluded). - An accurate shoulder joint shall be provided between the frame and end shields. When so specified (see 6. 1), the design of the end shields shall provide for the rotation of the shields through 90 degrees or 180 degrees in either direction to allow for bulkhead or underside suspension of the motor. Resilient-gaskets shall not be placed between any bearing support member and the frame in such a manner as to affect the alignment of the bearing. In the case of spraytight, watertight and submersible motors, the contact surfaces between the enclosing covers and the motor frame or end shields shall be free from fins, burrs, or other imperfections detrimental to watertightness, and shall be provided with “O” rings or gaskets suitably secured and treated with graphite on the contact surface to prevent sticking. All sheet packing shall be securely attached to the covers.

3.1.17.1 General. - The end shields shall be secured by not less than two machine screws or through bolts of suitable size and strength. These machine screws or through bolts may be furnished with either screw-driver slots or hexagon-head screws.

3.1.17.1.1 Vertical fan-cooled motor covers. - Vertical fan-cooled motors shall be furnished with a solid cover over the fan assembly to prevent personnel injury and to prevent foreign particles from falling into the fan.

3.1.17.2 Aluminum end shields. - Aluminum end shields (see table VIII) shall not support the total weight of the motor or driven auxiliary unless approved by the bureau or agency concerned. Steel inserts shall be provided for all threaded portions and bearing housings.

3.1.18 Shafts. - A shaft extension shall be provided to suit the driven apparatus. Unless otherwise specified in the contract or order, the shaft extension shall be in accordance with figure 1.

3.1.19 Bearings. -

3.1.19.1 Types of bearings. - Bearings shall be of the ball or sleeve type, as specified (see 6.1).

3.1.19.2 Ball bearings. - Ball bearings shall be in accordance with FF-B-171 and shall be of the following types, as specified (see 6.1):

(a) Type III, classes 3 and 8.
(b) Type 120.
(c) The use of other types for special application requirements shall be approved by the bureau or agency concerned.

3.1.19.2.1 Grease lubricant seals. - A close clearance running seal shall be provided on both sides of the bearings to prevent the leakage of grease along the shaft.

3.1.19.2.2 Housing construction. - The bearing housing shall be so constructed as to permit ready removal of the end shield preferably without the necessity of removing the bearings.

3.1.19.2.3 Removal of bearing. - The design shall be such as to permit removal of the ball bearing by pulling on the inner race of the bearing with one of the tools contained in a “complete” Naval shipboard set of tools specified in GGG-P-781.

3.1.19.2.4 A plate bearing the warning ‘WARNING DO NOT LUBRICATE” shall be permanently attached to the motor.

3.1.19.3 Sleeve bearings. -

3.1.19.3.1 Lubrication of sleeve bearings. - Sleeve bearings shall be lubricated by means of an oil wick or wool yarn or shall be of the self lubricated type.

3.1.19.3.2 End play (sleeve bearings only). - To insure floating of the shaft in horizontal sleeve-bearing motors, there shall be at least 1/64 inch end play in either direction.

3.1.20 Rotor and stator core. -

3.1.20.1 Securing core to shaft. - Provisions shall be made to prevent rotation of the core on the shaft and axial displacement of the core along the shaft. Keys knurling of the shaft or keys in conjunction with press or shrink fits shall be provided to prevent rotation of the core around the shaft. Press or shrink fits without keys to secure the core on the shaft to prevent axial or rotational movement of the core shall be as approved by the bureau of agency concerned. Tack welding in conjunction with other means (press or shrink interference fits) will be permissible to prevent axial displacement of the core along the shaft.

3.1.20.2 Securing stator core to frame. - Provisions shall be made to prevent rotation of the core in the frame and axial displacement of the core along the frame.

3.1.21 Commutators (where used). -

3.1.21.1 General. - The commutator shall be secured rigidly to the shaft by means of a shrink or press fit or other method satisfactory to the bureau or agency concerned which will positively secure the commutator in such a manner as to prevent either rotational or axial motion of the commutator relative to its support under operating conditions.

3.1.21.2 Copper segments. - The copper segments shall be securely retained in such manner as will prevent their relative displacement as a result of centrifugal forces and the stresses imposed by repeated expansion and contraction in service. The segments shall be of ample section to operate satisfactorily when worn to a depth of a minimum of 1/16 inch on the diameter.

3.1.21.3 Connections. - The connections to the windings shall be effectively soldered, brazed, or hot or cold welded.

3.1.21.4 Sealing. - After the assembly of the commutator, all crevices or joints at each end between the bars and the retaining flanges shall be completely filled up and sealed over with high-grade, flexible, baking insulating varnish in such manner as to prevent the entrance of moisture, oil, carbon, or copper dust, or other deleterious substances at these points, likewise, the creepage paths from the ends of the copper bars to the metal flanges shall be given a heavy, durable coating of flexible, baking insulating varnish as a protection against short circuits and ground at these points. This sealing may be accomplished as part of the varnishing procedure of the armature.

3.1.21.5 Mica undercutting. - The mica insulation between bars shall be undercut on all motors. The undercutting shall be accomplished by removing all mica between bars to form a groove not to exceed 3/64 inch in depth.

3.1.21.6 Curing. - All commutators with non-thermosetting materials shall be cured at higher than operating temperatures and shall be of such thoroughly solid construction throughout as will insure that they will hold their shape in service and obviate the necessity of frequently dressing the commutators on account of high bars or flat spots.

3.1.22 Terminal boxes and terminal box covers. - Terminal boxes and covers shall be provided and shall be either securely bolted or welded to the frame or shall be an integral part of the motor frame or end shield. The use of pipe nipples where they are necessary or where motors are to be used in inaccessible locations shall be satisfactory to the bureau or agency concerned.

3.1.23 Connections and terminals. -

3.1.23.1 Securing connections. - All connections, mechanical and electrical, shall be provided with locking devices in accordance with MIL-E-917. Connections and leads shall be secured in a reliable manner to prevent their coming in contact with moving parts or being chafed by contact with stationary parts. All excess solder shall be removed from soldered connections.

3.1.23.2 Terminal connections. - The terminal leads shall be brought out of the end shield at the end opposite the drive end and at the right-hand side when viewing this end or out of the frame at the right-hand side when viewing the end opposite the drive and as close to this end as is practicable.

3.1.23.3 Securing terminal leads. - The leads shall be secured by anchoring them to the motor windings so that no strain is put on the end connections, or by a lead clamp. Where a lead clamp is provided, the terminal leads shall be attached to the frame and not to the end shields.

3.1.23.4 Flexible leads. - All terminal leads shall be made of flexible, stranded insulated wire. Means shall be provided to prevent abrasion of the lead insulation by metallic edges of the motor frame, terminal box, piping, or cable clamp.

3.1.24 Lead wire identification. - All lead wires shall be permanently marked in accordance with MIL-E-917.

3.1.25 Radio noise. - The design of the motors shall be such as to insure a minimum amount of radio interference.

3.1.26 Painting. - Painting shall be in accordance with MIL-E-917.

3.1.27 Class of insulation. All insulation shall be in accordance with MIL-E-917 and shall be class A, B, F, H or N as specified (see 6.1).

3.1.28 Encapsulated motors. - Motors encapsulated for severe environmental service conditions such as exposure to condensate, steam leaks, flooding, salt spray, splashing or temporary submergence (see 6.1) shall conform to the following:

3.1.28.1 Design. - All design requirements of this specification shall apply except as follows:

(a) The enclosure shall be as specified in contract or order (see 6.1) except test motors shall be dripproof protected.
(b) Type. - The motor shall be squirrel-cage induction of a type as specified in contract or order.
(c) Temperature limits. - The motors shall not exceed the temperature values specified in table IX by more than 5 ‘C. when operating in air or when tested submerged for dripproof protected and for non-fan cooled, enclosed types of motors. Fan cooled, enclosed types of motors shall not exceed the temperature value specified in table IX when operated in air only.
(d) Insulation resistance. - Insulation resistance of production motors (dry) shall be not less than 2000 megohms when measured in accordance with 40.4.1 of appendix II. For the suitability test motors the insulation resistance shall be not less than 10 megohms (corrected to 25°C) during any of the tests when measured in accordance with 40.4.1 of appendix If. For the routine submergence test a minimum of 100 megohms shall be maintained.
(e) Corrosion. - The metal frame, end shields, terminal box assembly, rotor core, rotor ends and exposed stator, iron parts shall be suitably protected to withstand the corrosive effects of salt water. All hardware and shafts shall be made from corrosion resistant materials. A design goal for corrosion protection shall be 40,000 hours life without retreatment.
(f) Insulation. - Class of insulation-shall be class B. The minimum material requirements of table VIII need not apply to the insulating materials used in encapsulated motors.
(g) Submerged operation. - When specified in the contract or order, the motors shall be designed to operate when submerged under the conditions specified.

3.1.28.2 Encapsulation. - By encapsulation is meant that the motor windings are completely sealed from the terminal box connection end through the slots and return loop.

3.1.28.3 Random wound motors. - Stator windings shall be encapsulated after all winding is completed. As a guide, the following points should be considered for encapsulated system:

(a) The resin or elastomer should be compatible with the insulation materials used.
(b) Bonding of the resin to the stator core should not be relied upon to give adequate sealing from water. The encapsulated winding should float free in the slots and core.
(c) The core punchings should be sealed between laminations by use of a 100 percent solid resin.
(d) The winding should be so positioned during the encapsulation process that a minimum of 1/8 inch thickness of material should encapsulate all end turn parts. Slot material shall be of the moisture barrier type and approximately 0.015 thick.
(e) The leads should be of the non-wicking type and should not be braided. All connections at the winding end should be embedded in the encapsulating material. Where the leads enter the terminal box they should be sealed and encapsulated. The terminal box shall be watertight.
(f) The slot liners should be extended beyond the slot and should be folded over and bonded prior to encapsulating.

3.1.28.4 Form wound motors. - Stator coils shall be bonded and sealed prior to winding in the stator. All connections after winding shall be bonded and sealed. As a guide, the following points should be considered for form wound motors:

(a) Coils should be preformed and preinsulated with a heat sealable or vulcanizing flexible plastic or elastomeric material.
(b) Each coil should be insulated for full voltage to ground and be watertight.
(c) Leads should be of the non-wicking type and should not be braided. All connections and joints should be sealed and watertight.

3.1.28.5 Repair of encapsulated motors. - Encapsulated motors shall be designed so that the motor may be repaired (rewound) using encapsulating materials and methods suitable for normal repair shop usage and also shall be designed for rewinding by using conventional rewinding materials and methods.

3.1.29 Class H and N insulation suitability tests. - Where class H or N insulation is used, insulation suitability tests in accordance with the procedures detailed in MIL-E-917 shall be conducted and submitted to the Bureau of Ships for approval. Bureau of Ships approval shall be obtained prior to manufacturing class H or N insulated motors.

3.1.30 Encapsulated motor suitability tests. - Where encapsulated motors are used, encapsulated motor suitability tests in accordance with the procedures of appendix II shall be conducted and Bureau of Ships approval shall be obtained prior to acceptance of any motor for shipment under a contract or order.

3.1.31 Life. - Except for the bearings and brushes, the motor and the insulation system shall be designed for a minimum of 40, 000 hours of operation over a period of 20 years. Brushes shall be selected for a minimum of 8, 000 hours of operation. Bearings shall be selected to insure a minimum B-10 life of 10,000 hours.

3.1.32 Interchangeability. - All similar parts, including repair parts supplied for replacement purpose, furnished to the same drawings or sets of drawings shall be strictly interchangeable without the necessity of further machining, selective assembly or hand fitting.

3.2 Identification plates. -

3.2.1 General. - The identification plates (and information plates where required) shall be attached to the part of the machinery or equipment which will not ordinarily be renewed during its normal service life. These plates shall be located where they can be read at all times without danger to personnel. Identification plates and information plates shall be made of brass, nickel-copper-alloy or corrosion resistant steel. The markings shall be either etched, stamped, engraved, metal-photo on anodized aluminum or cast in such a manner as to produce permanent and durable markings to last the anticipated life of the equipment, All etchings, engravings or stampings shall not be less than .003 inch deep. The characters on cast plates shall be raised to at least 0.03 inch. All engraved stamped or direct etched markings shall be filled with black paint enamel or lacquer.

3.2.2 Identification plate markings. - The minimum data to be marked on the identification plate for motors shall include the following items:

3.2.2.1 Motors rated less than 1/20 hp. -

(a) Manufacturer's name.
(b) Type designation.
(c) Power output (millihorsepower-mhp).
(d) Full-load speed. 1/
(e) Voltage rating.
(f) Frequency.
(g) Number of phases–polyphase only (this may be designated by a number showing the number of phases following the frequency).
(h) The words "thermal protection" for motors equipped with inherent overheating protective devices. 2/
(i) Federal stock number.
(j) Government contract number.
(k) Year of manufacture.
(1) Blank space for Government inspector's official stamp.

1/ This speed is the approximate full-load speed.
2/ These words may be shown on a separate plate.

3.2.2.2 Alternating-current single-phase and polyphase squirrel-cage motors larger than 1/20 horsepower. -

(a) Manufacturer's name.
(b) Manufacturer's type and frame designation.
(c) Horsepower output.
(d) Time rating.
(e) Maximum ambient temperature for which motor is designed.
(f) Insulation system designation.
(g) R.p.m. at rated load.
(h) Frequency.
(i) Number of phases.
(j) Rated-load amperes.

(k) Voltage.
(l) The words "thermal protection" for motors equipped with thermal protectors. 1/
(m) Federal stock number.
(n) Government contract number.
(o) Year of manufacture.
(P) Blank space for Government inspector's official stamp.

These words may be shown on a separate plate if desired.

3.2.2.3 Universal motors. -

(a) Manufacturer's name.
(b) Manufacturer's type and frame designation.
(c) Horsepower output.
(d) Time rating.
(e) R. p. m. at full load.
(f) Voltage.
(g) Full-load amperes (on 60 cycles).
(h) Frequency (60/DC is recommended form).
(i) Federal stock number.
(j) Government contract number.
(k) Blank space for Government inspector's official stamp.

3.3 Repair parts. - Each repair part shall be suitable for immediate use in replacing originally installed parts in any identical motor, and the operation of the motor in which such repair parts are installed shall be equal to that of the original machine. The design shall be such that no special tools are required for maintaining the motors. Special tools are defined as those tools not listed in the Federal Supply Catalog. (Copies of this catalog may be-consulted in the office of the Government inspector.) The requirements of MIL-R-15137 shall apply.

3.3.1 Onboard repair parts. -

3.3.1.1 Quantity. - Repair parts, based upon the total number of motors or parts furnished for each ship (see 6. 1) on a contract or order, shall be supplied as specified in table VII.

Table VII - Onboard repair parts.

Name of part	Factor code	Quantity per set							
		Number of components							
		1	2	3	4	5-8	9-20	21-50	51-100
Motors, complete	K	1	1	1	1	1	1	1	2
Rotors complete with shafts for close coupled pumps (surface ships only)	K	1	1	1	1	1	1	1	2
Bearings, or bearing linings, sets	G	1	1	1	1	2	3	4	5
Brushes, sets	C	2	3	4	4	5	6	8	12
Brush-rigging insulation sets	K	1	1	1	1	1	1	1	1
Brush holders, sets (complete with springs)	K	1	1	1	1	1	1	1	2
Brush holder springs 1/	C	2	3	4	4	5	6	8	12
Bearing lubricant seals, sets	G	1	1	1	1	2	3	4	5
Capacitors, sets	K	1	1	1	1	1	1	1	2
Additional repair parts required for gear motors (gear end only):									
(a) Bearings, sets	K	1	1	1	1	1	1	1	2
(b) Friction type (rubbing) seals, sets, where permitted	G	1	1	1	1	2	3	4	5
(c) Sets of gears 2/	G	1	1	1	1	2	3	4	5

1/ When brushes are supplied with springs as a component part of each brush it is not necessary to furnish springs as a separate item.
2/ If any gear is not readily removable from its shaft, the shaft shall be furnished as a repair part.

3.3.1.2 Shipping onboard repair parts. - Unless otherwise specified in the contract or order, repair parts shall be inspected and shipped at the same time as the motors. Separate inspection and shipment will be satisfactory only when an acceptable schedule of shipment of onboard repair parts has been arranged between the manufacturer and the ordering activity.

3.3.2 Stock repair parts. - Quantities of stock repair parts (that is parts required to replace onboard repair parts or those required for repair of a motor but not specified as onboard) and their stock numbers shall be determined in accordance with MIL-P-15137.

3.4 Drawings. -

3.4.1 General requirement. - Drawings shall be class A in accordance with MIL-D-963 and as specified herein.

3.4.2 Service A motor drawings. - Service A drawings shall contain the data required by 3.5.1.18.

3.4.3 Service C motor drawings. - Service C drawings shall contain the data required by 3.5.2.4.

3.4.4 Two drawing system for service A motors. - Where practical, a two drawing system may be used. This system shall consist of a family design drawing plus a specific application drawing.

3.4.4.1 Family design drawing. - This drawing may cover various lengths of motors for a particular frame diameter, various frame diameters for motors of similar mechanical construction or enclosure or other natural groupings as may lend itself to an individual manufacturer's line.

3.4.4.2 Application drawing. - For specific applications, an application drawing shall be submitted for approval along with a copy of the approved family drawing.

3.4.4.3 Drawing content. -

3.4.4.3.1 Family design drawing. - This drawing shall contain all construction details required by 3.5.1.18 which can be applied to a drawing of this nature. Tables may be included on the drawing to cover such variations within a family as bearings, fits and tolerances, insulation materials, and so forth. The list of material should include all material applicable to the family. Part numbers shall be omitted where they will change for different units within the family (these numbers will be picked up on the application drawing) unless they can be easily represented in tabular form.

3.4.4.3.2 Application drawing. - This drawing shall contain the data required by 3. 5.2.4 plus all information required-by 3.5.1.18 and not included on the family drawing. The family drawing shall be referenced on the application drawing.

3.4.4.4 Drawing approval. -

3. 4.4.4.1 Family design drawing. - The approval authority for the original submission and any subsequent modifications shall be the Bureau of Ships.

3.4.4.4.2 Application drawing. - The approval authority shall be the Bureau of Ships or its field representative delegated such approval authority.

3.5 Requirements applicable to individual services. -

3.5.1 Service A. -

3.5.1.1 General. - Service A motors shall conform to MIL-E-917 and shall be a class HI shockproof motor meeting the requirements specified in 3.1 to 3.5.1 inclusive, as applicable.

3.5.1.1.1 Standardization. - Motors shall be in conformance with the standardization requirements shown on figure 1 for general purpose motors, and MIL-P-17840 for close-coupled pump motors. For applications where the use of standard motors is not practical, nonstandard motors may be used subject to approval of the procuring activity. Where nonstandard motors are procured, the requirements of figure 1 herein and MIL-P-17840 shall be used as a guide.

3.5.1.1.2 Materials. -

3.5.1.1.3 Material restrictions. - The minimum requirements for materials to be used shall be as specified in table VIII.

Table VIII - Minimum material requirements for service A motors.

Item	Limitations	Material	Remarks
Ball bearings	All sizes	----------	Spec. FF-B-171
Ball bearings caps and cartridges	All sizes	Steel[1/]	----------
		Malleable iron[2/]	Grade I of QQ-I-666
		Nodular graphitic iron[2/]	MIL-I-24137
	Use with aluminum end brackets only provided with steel inserts	Aluminum	Commercial treated for corrosion resistance
Brushes	All sizes		MIL-B-3743
Brush holder studs	All sizes	Steel[1/]	Commercial treated for corrosion resistance
End shields	All sizes	Steel[1/]	----------
		Malleable iron[2/]	Grade I, QQ-I-666
		Nodular graphitic iron[2/]	MIL-I-24137
		Aluminum	QQ-A-591 or QQ-A-601
Oil, lubrication	Maximum oil sump temperature 82°C.		MIL-L-17331, Navy symbol 2190 TEP
Fans - external and internal (not integral with rotor)	All sizes	Steel[1/]	----------
		Aluminum	QQ-A-601
	----------	Malleable iron[2/]	Grade I, QQ-I-666
	----------	Nodular graphitic iron[2/]	MIL-I-24137
External	External fan on totally enclosed fan cooled motors	Plastic, molded	MIL-M-14 (as permitted in MIL-E-917) reinforced material of nominal impact strength of 1.0 foot-pounds per inch notch or greater
	Insulation class A, B, F, H or N (class A or B limits)		
Frames	All sizes	Steel[1/]	----------
	----------	Malleable iron[2/]	Grade I, QQ-I-666
		Nodular graphitic iron[2/]	MIL-I-24137
Grease	Bearings total temperature of 110°C. and below	Petroleum	MIL-G-18709
	Bearings total temperature above 110°C.	Silicone	MIL-L-15719
Insulation - ground and phase, lead and connection, lead wire, spacers, separators, washers, bushings, tubes, wedges and lead clamp.	Class A, B, F, H or N	All types and classes	MIL-E-917
Part covers for totally enclosed type machines where the cover acts as a shield only, and not as a support for another part such as an auxiliary or brake	All sizes	Steel[1/]	----------
	----------	Malleable iron[2/]	Grade I, QQ-I-666
	----------	Nodular graphitic iron[2/]	MIL-I-24137

See next page for footnotes.

Table VIII - Minimum material requirements for service A motors (cont'd.).

Item	Limitations	Material	Remarks
Shafts	Close-coupled pumps	----------	Corrosion resistant material
	All other motors	Steel	Tensile strength not less than 75,000 p.s.i. and elongation not less than 20 percent in 2 inches
Sleeve bearings	All sizes	Bronze babbitt	Grade III, MIL-B-16261
Terminal boxes and terminal box covers	All sizes	Steel 1/ Malleable iron 2/ Nodular graphitic iron 2/	---------- Grade I, QQ-I-666 MIL-I-24137
Varnish, insulating	All classes		MIL-I-24092
Wire, electric	All types	Copper	MIL-E-917

1/ Unless otherwise indicated in table VIII steel parts may be cast, fabricated, wrought, or forged. Cast steel shall be in accordance with class B of ML-S-15083, or equivalent, except that radiographic and magnetic particle inspection will not be required.

2/ For Bureau of Naval Weapons contracts or equipment, specific approval from the Bureau of Naval Weapons shall be obtained prior to use of these materials.

3.5.1.1.4 AH insulated electrical windings shall receive at least one of the required impregnations before assembly on machine parts except that impregnation before assembly on machine parts will not be required for windings which are to be inserted in semienclosed slots or other windings where the method of installation is such as to make this preliminary impregnation impractical. In such cases, all required impregnations shall be made after the windings are installed on the machine parts.

3.5.1.1.5 Solder for squirrel-cage windings. - Solder, where required, for electrical connections shall be silver-base brazing alloy or brazing conforming to MIL-B-15395 or QQ-B-650, respectively,

3.5.1.2 Temperature limits. - The motors shall be so designed as not to exceed the values of maximum permissible temperature rises specified in table IX when tested as specified in 4.3.4.11. The methods of temperature measurements specified in table IX shall apply.

Table IX - Maximum permissible temperature rises.

	specified in item 3																	
	(a) Open, protected, dripproof, dripproof protected																	
	Method 2	60	80	105	125	145	50	70	95	115	135	35	55	80	100	120	95	105
	(b) Others																	
	Method 2	65	85	110	135	150	55	75	100	125	140	40	60	85	110	125	95	105
	(c) Any motoring frame smaller than 42 frame																	
	Method 2	65	85	110	135	150	55	75	100	125	140	40	60	85	110	125	95	105

Table IX - Maximum permissible temperature rises (cont'd.).

Item	Part	40°C. ambient					50°C. ambient					65°C. ambient					80 C. ambient	
		A	B	F	H	N	A	B	F	H	N	A	B	F	H	N	H	N
2	Commutators																	
	(a) Open, protected, dripproof, dripproof protected																	
	Method 1	55	75	100	125	145	45	65	90	115	135	30	50	75	100	120	85	105
	(b) All others including motors in frames smaller than 42 frame																	
	Method 1	65	85	110	135	150	55	75	100	125	140	40	60	85	110	125	95	105
3	Bare copper windings and single-layer field windings with exposed uninsulated surfaces																	
	(a) Open, protected, dripproof, dripproof protected																	
	Method 1	60	80	105	130	150	50	70	95	120	160	35	55	80	105	125	90	110
	(b) All others including motors in frames smaller than 42 frame																	
	Method 1	65	85	110	135	150	55	75	100	125	165	40	60	85	110	130	95	115
4	Bearing, ball	70	70	70	110	110	60	60	60	100	100	45	45	45	85	85	70	70
	Bearing sleeve, imbedded thermocouple	53	53	53	53	53	43	43	43	43	43							
	Bearing oil (sump)	42	42	42	42	42	32	32	32	32	32							

NOTE: Squirrel-cage and mechanical parts (such as brush holders, brushes, pole tips), may attain such temperatures as will not injure the motor in any respect.

3.5.1.3 Shock resistance. - The motors shall be capable of withstanding the high-impact shock test specified in MIL-S-901 and 4.3.4.16.

3.5.1.4 Ball bearings. -

3.5.1.4.1 Mounting. - The bearings shall be mounted as follows:

(a) Opposed shoulder method. - Where this method is employed, the end play of the shaft. shall be adjusted to compensate for any relative movement that may occur between the shaft and the housing due to temperature differential between these parts. In no case shall this end play exceed .045 inches.

(b) Fixed-free method. - When this method is employed, the bearing shall be secured on the shaft by means of locknuts and lockwashers or by a locknut utilizing a nylon insert to effect locking. The pulley end or back end bearing shall be clamped axially in the housing by suitable housing and end cap shoulders. End caps shall be secured by screws or bolts in such a manner that the screws or bolts shall be capable of being removed without dismantling the motor. For gear motors the front end bearing shall be clamped in the housing.

3.5.1.4.2 Bearing pre-load washers or springs. - Bearing pre-load washers or springs or both may be used to attain required end-play.

3.5.1.5 Mechanical balance. - When tested as specified in 4.3.4.5, the maximum allowable amplitude in inches shall be as specified in table X. Unless otherwise specified (see 6.1), the degree of balance shall be standard in accordance with table X. (For submarine applications, see 3.5.1.17.5.)

Table X - Mechanical balance.

Maximum allowable total amplitude		
Standard balance	Precision balance	Super-precision balance
Inch	Inch	Inch
0.001	0.0005	0.0002

3.5.1.6 Inclination. - Motors shall be designed to operate satisfactory under the following conditions:

(a) Horizontal motors:
  (1) For sleeve bearing motors:
    a. Shaft inclined 15 degrees, front end low.
    b. Shaft inclined 15 degrees, rear end low.
    c. Shaft horizontal, motor base tilted 15 degrees to right.
    d. Shaft horizontal, motor base tilted 15 degrees to left.
  (2) For ball bearing motors:
    a. Shaft inclined 15 degrees, front end low.
    b. Shaft inclined 15 degrees, rear end low.
(b) Vertical motors:
  (1) For sleeve or ball bearing motors:
    a. Fifteen degrees from their normal position in any direction.
(c) All motors shall be suitable for operation where a ship is rolling 45 degrees to either side.
(d) Sleeve bearing motors shall be tested as specified in 4.3.4.15.

3.5.1.7 Methods of attaching fans to shaft. - Fans not an integral part of the shaft shall be secured in such a manner as to preclude their becoming loose when the motor is subjected to high-impact shock test.

3.5.1.8 Frame and rotor marking. - The manufacturer's name or symbol and identification numbers shall be stamped or otherwise permanently marked in the solid metal of the frame underneath (covered by) the main identification plate. For universal motors the part number, or other information sufficient to completely identify one rotor, shall be stamped or otherwise permanently marked on the shaft or rotor core. The marking of armatures shall identify the manufacturer and the style and type of motor.

3.5.1.9 Thread cutting screws. - Thread cutting screws (self-tapping screw) shall not be used to secure any part of the motor.

3.5.1.10 Securing brush holder support. - The support shall be secured in such a manner as to prevent loosening of the support under shock or vibration.

3.5.1.11 Securing terminal leads. - A lead clamp shall be provided on all motors. The method of fastening shall be such that no strain from the outside can come upon the connections within the motor frame. The use of friction rubber bushings, unclamped, is not a suitable method of securing such leads. Sealing compounds for anchoring leads shall not be used (see 3.1.23. 3).

3.5.1.12 Brush holders. - Brush holders shall be readily accessible for adjustment and renewal of brushes and springs. The construction shall also provide for maintaining the spacing of the various holders and means shall be provided to prevent loosening and shifting of brush holders under vibration and spring pressure.

3.5.1.13 Capacitors. - For capacitor-start motors, the capacitor shall be interchangeable with a Military type if practical.

3.5.1.14 Direction of rotation. - Nonreversible motors shall be marked in a permanent manner to indicate the direction-of rotation.

3.5.1.15 Seals. - The housing shall provide for a close-clearance metallic (nonrubbing) seal on both sides of the bearings to prevent the leakage of oil or grease along the shaft. This is in addition to bearing shields or slingers required on the shaft. Friction type seals may be used to supplement the close-clearance metallic seal on motors for certain applications; for example, watertight and submersible motors. Such sealing arrangements shall however, be satisfactory to the bureau or agency concerned (see 3.1.21. 4). Friction type seals shall be secured in their housing and on the shaft to prevent rotational or axial movement in the housing or on the shaft.

3.5.1.16 Pump motors. - The following additional requirements shall apply to all pump motors as applicable:

(a) For dripproof protected pump motors, the air intake at the pump end of the motor is permitted subject to the air intake being at right angles to the shaft (no openings in the end shields parallel to the shaft shall be permitted).
(b) For all motors (except motors supplied with friction type seals as used in submersible and watertight motor enclosures) a slinger with guard shall be provided on the motor shaft immediately outside the end bracket to prevent entrance of water into the bearing housing. The slinger shall have an external diameter of not less than 1.5 times the shaft diameter and an axial clearance between the end shield and frame not greater than 30 roils. Where the slinger-end shield or the pump design or both is such that no injury to personnel would result and no entrance of water into the bearing housing would take place without the guard, the guard need not be furnished. Omission of the guard shall be approved by the approval activity.

3.5.1.17 Motors for submarine service. - In addition to the requirements of 3.1 through and including 3.5.1.16, the following requirements apply:

3.5.1.17.1 Enclosure. - The enclosure shall be one of those listed under 3.1.8 or shall be special as specified (see 6.1), except that dripproof protected motor shall meet the requirements of MIL-STD-108 at 45 degrees from the vertical in lieu of 15 degrees.

3.5.1.17.2 Mounting. - Horizontal motors shall be suitable for either deck or underside suspension. Dual ended ventilated (air inlets in both end shields and air outlets in frame) dripproof protected horizontal motors shall be considered suitable provided a shield is designed to meet the necessary dripproofness requirements when the motor is suspended underside. This shield shall be provided when required by the contract or order; however, it shall be shown on the motor drawing, whether the shield is or is not furnished, in sufficient detail to permit fabrication by a Government activity. To ascertain that the motor will operate satisfactorily all tests on dual ended dripproof protected horizontal motors shall be conducted with the shield on the motor.

3.5.1.17.3 Ball bearings. - Unless otherwise specified in the contract or order, the bearings shall be in accordance with 3.1.19.

3.5.1.17.4 Center of gravity and radii of gyration. - The center of gravity of the motor and the radii of gyration of the motor" about its "three principal axes shall be indicated on the drawing.

3.5.1.17.5 Dynamic balance. - The degree of balance shall be "Precision" in accordance with table X unless otherwise specified in the contract or order.

3.5.1.17.6 Inclination. - Motors shall be designed to operate satisfactorily under the following conditions:

(a) Horizontal motors:
  (1) For sleeve bearing motors:
    a. Shaft inclined 45 degrees, front end low.
    b. Shaft inclined 45 degrees, rear end low.
    c. Shaft horizontal, motor base tilted 45 degrees to right.
    d. Shaft horizontal, motor base tilted 45 degrees to left.
  (2) For ball or roller bearing motors:
    a. Shaft inclined 45 degrees, front end low.
    b. Shaft inclined 45 degrees, rear end low.

(b) Vertical motors - sleeve, ball or roller bearing:
(1) 45 degrees from their normal position in any direction.
(c) All motors shall be suitable for operation when a submarine is rolling 60 degrees to either side.
‘(d) Sleeve and oil lubricated bearing motors shall be tested as specified in 4.3.4.15.

3.5.1.18 Drawings. - In addition-to the requirements of 3.4, master drawings shall conform to figure 2 in form, and general arrangement, and shall contain the following minimum data:

(a) An assembly end and side view showing all parts of the motor identified with piece numbers in the list of materials and direction of mounting. The assembly side view shall show a longitudinal section of the motor above the centerline. The assembly end view shall show a transverse quarter section above the centerline. These assembly views shall show the following information:
(1) Bearings housing construction and bearing fits and tolerances. Bearing fits and tolerances may be shown as a note on the drawing or on other assembly views.
(2) Sectional view of commutator (where used), brush rigging and brushes, design and materials of all brush rigging and brush holder stud insulation, and methods of supporting brush rigging, brush holder studs and brushes against excessive deflection due to high-impact shock. If necessary for clarity, a separate detail shall be included on the drawing. Brush information shall include manufacturer’s grade, Government grade and Government form number.
(3) Method of retaining commutator and rotor core to shaft. Where a press fit is used to secure the cores to the shaft the interference fit and minimum pressure to force the cores on the shaft shall be shown. Where a shrink fit is used to secure the cores to the shaft, the interference fit and the minimum pressure to remove the cores from the shaft shall be shown.
(4) Baffles and screen guards and the method used to attach them to the end shields or frames.
(5) Method of attaching terminal box to frame.
(6) Method of bringing cables out of frame into terminal box and the method of protecting these cables against chafing at sharp metallic corners.
(7) Method of clamping motor leads in the terminal box to prevent strain on internal connections and method of protecting lead insulation against abrasion by the clamp.
(8) Method of attaching fan to shaft and detail of fan showing constructions and number of blades.
(9) All overall dimensions including mounting, shaft extensions and key.
(10) Method of securing stator core to frame to prevent axial and rotational movement and the minimum pressure to force the core in the frame shall be shown if a press fit is used in conjunction with other means. Where a shrink fit is used, the pressure required to force the stator core out of the frame shall be shown.
(11) Direction of air flow.
(12) Total axial movement of the shaft to include bearing end play.
(13) All details required by this specification and not covered in the foregoing enumeration.

(b) A detailed working drawing of the shaft including bearing mounting dimensions.
(c) A schematic wiring diagram of the motor windings.
(d) Drawing of wiring arrangement and stator connection diagram. A connection table of motor leads for two or more speed and/or dual voltage motors.
(e) Guaranteed performance including locked-rotor current, torque and power factor; pull-up torque, breakdown torque, and efficiency and power factor at 2/4, 3/4 and 4/4 load.
(f) Stator inside diameter, and core length.
(g) Rotor outside diameter, number of bars, and bar material. Indicate reference line and dimension for locating rotor axially on shaft in connection with replacement of shaft or rotor,
(h) Size of end ring and end ring material.
(i) Winding data of stator, including:
Number of poles.
Type of connection.
Number of slots.
Number of coils.
Winding pitch in slots.
Turns in series per coil.
Conductor circular roils or size.

Conductor insulation and Government specification.
Resistance between terminals in ohms.
Weight of copper in pounds.

(j) Insulation materials and their dimensions and applicable specification of the following:
Slot cell.
Spacer.
Top wedge.
"U" wedge (where used).
Insulation between phases.
Insulation on coil extension.
Insulation on coil leads and connections.
Complete stator. Government specification and grade of varnish.
Lead wire.
For universal motors, data as specified in (r) (2) shall be shown.

(k) Slot sections, showing details of slot wedges, slot armor, coil spacers, slot tubes.

(l) Where rubbing seals are used, a sketch showing construction of seal and method used to secure seal in its housing and shaft to prevent axial or rotational movement.

(m) Sketches for each type of winding showing a cross-section of the winding with relative location and identification of insulating materials shown.

(n) Test data, In the case of multispeed motors, the specified data shall be included for each definite speed:

(1) Table of temperature conditions containing the following:

a. Time and hp. load and amperes.

b. Temperature readings of items listed in table IX and ambient temperature at shutdown with readings at one hour before shutdown (in case of short-time duty motors this column need not be completed), final while running (prior to shutdown) and after shutdown.

(2) The resistance in ohms and rise by resistance in degrees centigrade including the following:
Cold temperature in degrees centigrade.
Hot temperature at end of full-load heat run.
Rise calculated by resistance.

(3) Performance at rated voltage and frequency including the following at 4/4, 3/4, 2/4 and 0 load:
Actual load, amperes, watts, r.p.m., efficiency, power factor and torque.

(4) Torque data for locked rotor, pull-up and breakdown, listing volts, amperes, r.p.m. and foot-pounds as applicable.

(5) Weight of the complete motor.

(6) A space for Government inspector's signature, office and date.

(o) Detail of the identification plate and identification plate data (and other information plate detail and data where required). Where an identification plate drawing has been approved by the Bureau of Ships, it will not be necessary to show a detail of the identification plate on the motor master plan. However, it will be necessary to identify the plate in the List of Material and show the manufacturer's drawing number of the approved identification plate drawing and file number and date of the Bureau of Ships approval letter.

(p) A note identifying bearings by Government type or class or both.

(q) A note identifying the type and class of the applicable Government standard bearing puller (see GGG-P-781).

(r) Additional insulation data:

(1) The following additional insulation data shall be included on each master drawing or on a separate insulation master drawing previously approved by the bureau or agency concerned. If the data are shown on a separate insulation master drawing covering insulation practice for a number of motors, the bureau or agency concerned drawing of the insulation master drawing can be referred to on each applicable motor master drawing subject to the following:

a. A manual is being supplied for the driven equipment and a copy of both the motor and insulation master drawings are included in the manual.

b, When a manual is not being supplied for the driven equipment, reference to the insulation master drawing on the motor master drawing will be permitted provided the insulation drawing is furnished with the master drawing.

(2) These additional data, together with the information required by (j) and (k) shall completely describe all insulation used, indicating the materials, dimensions, forms, sequence of

winding and insulating operations, numbers of layers and amount of overlapping of tape applications, treatment schedules prebake period and temperature, number of dips and class of varnish used, varnish manufacturers identification number or symbol, temperature and duration of baking treatments, vacuum and pressure employed during impregnation (where used) as applicable for each type of wound assembly including:

a. Conductor strand and turn insulation.
b. Coil insulation including slot and end turn insulation of each armature coil, ground insulation, coil turn separators, coil end turn banding insulation, and support pads between coils and armature.
c. Other sketches and data as necessary to show method of manufacture (insulation and forming) of each winding. These sketches shall show such details as the direction and overlap of the various tape windings on strands, conductors, turns and coils, the distance that coil slot insulation and slot wedge extend beyond the iron, and the original and final shape of form wound conductors and coils.
d. Each sketch shall be identified as to the design of motor and the type of winding.

(s) Title block in size, form and arrangement in accordance with MIL-D-963.
(t) Classification block directly above title block including manufacturer's type and class, frame size, duty, enclosure, speed class, synchronous and full-load r.pm., bp., volts, cycles, phases, type of rotor, design, class of insulation, type of mounting, service classification, ambient temperature and nominal (calculated) full-load amperes with the following notation. (Note: This calculated value of full-load amperes can be used as a basis for selecting the distribution system components and overload heaters or relays.)
(u) Government specification, size, and quantity applicable to motor terminal lugs.
(v) On master drawings covering equipment shock-tested, which have been found satisfactory, there shall be indicated the following:
(1) The file number and date of the shock-test report and the file number and date of the bureau or agency concerned letter of approval.
(w) On class H or N insulated motors, the file number and date of the Bureau of Ships letter approving the insulation suitability test.
(x) On encapsulated motors, the file number and date of the Bureau of Ships letter approving the encapsulation suitability test.
(y) In the List of Material identify onboard repair parts by an asterisk and add the following note under the List of Materials: "Piece numbers identified by an asterisk are normally supplied as onboard repair parts. For onboard repair parts actually furnished refer to the contract or order."

NOTE; Figure 2 is indicative of the general arrangement and information desired by the bureau or agency concerned for a class A drawing for a two-speed integral hp. alternating-current motor. The bureau or agency concerned recognizes that the information required on other designs of motors; such as single speed, will not be the same as shown hereon. In such cases it will be permissible to add or subtract the necessary column, and information so as to fit the particular motor.

3.5.2 Service C. - Service C motors shall be a marine type commercial motor meeting the requirements specified in 3.1 to 3. 4.3 and the following:

3.5.2.1 General. - Protection against corrosion shall conform to MIL-E-917, Temperature limits shall conform to table IX.

3.5.2.2 Magnet wire. - The magnet wire shall be of such size as to permit rewinding with one of the types specified in MIL-E-917.

3.5.2.3 Locked rotor current. - The locked rotor current of single phase motors shall be in accordance with table IV; however, where the number of starts of split-phase motors does not exceed 4 starts per hour, the limits of table XI are permitted.

Table XI - Split-phase locked-rotor currents.

Rated horsepower	Locked rotor currents in amperes at 115 volts. Speed 900 to 3600 r.p.m., inclusive
1/6 and smaller	50
1/4	50
1/3	50
1/2	50

3.5.2.4 Drawings. - In addition to the requirements of 3.4 master drawings shall conform to figure 3 in form and general arrangement and shall contain the following minimum data:

(a) An outline drawing giving all dimensions, clearance holes, tapped holes, holes for mounting and position of mounting.
(b) Stator data including inside diameter, core length and winding data. Winding data to include:
Number of poles.
Type of connection.
Number of slots.
Number of coils.
Winding pitch in slots.
Turns in series per coil.
Conductor diameter.
Conductor insulation and Government specification.
Resistance between terminals in ohms.
Weight of copper in pounds.
(c) Treatment of wound stator. Number of dips and bakes including baking temperatures and period of baking.
(d) Rotor data including outside diameter, number of bars, bar material, size of end ring, and material of end ring.
(e) Insulation materials and applicable specification for the following:
Slot cell.
Spacer.
Top wedge.
U wedge (where used).
Insulation between phases.
Insulation on coil extension.
Insulation on coil leads and connections.
Insulation on completed windings.
Lead wire.
(f) Detail of slot section, showing details of slot wedges, slot armor, coil spacers and slot tubes.
(g) A detailed working drawing of the shaft.
(h) Schematic wiring diagram of motor windings and stator connection diagram.
(i) Weight of complete motor in pounds.
(j) Guaranteed performance including locked-rotor current, locked-rotor torque, locked-rotor power factor, pull-up torque, breakdown torque, and efficiency and power factor at 2/4, 3/4, and 4/4 load.
(k) Title and classification block as required in 3.5.1.18(s) and (t)
(l) List of repair parts and tools with manufacturer's part numbers.
(m) A connection table of motor leads for two or more speed or dual voltage motors or both. Terminal markings shall be shown on all connection and wiring diagrams.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. - Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Factory inspection during manufacture for service A motors. - The motor manufacturer's in-process inspection shall include the applicable items of inspection contained in appendix I herein, selected in accordance with the design, manufacturing methods and sequence of operations.

4.2.1 Performance test. - Tests requiring assembly with the driven auxiliary for which the motor is designed may be conductcd at either the plant of the auxiliary machinery supplier or the motor supplier. If the contract or order requires tests other than the tests specified herein, the motor supplier shall prepare a list of these tests and submit it to the Government for approval prior to conducting the test.

4.2.2 Records. - Records of the results of in-process inspection and performance tests shall be complete and available to the Government inspector.

4.3 Service A. -

4.3.1 Sampling. -

4.3.1.1 Sampling procedures for in-process inspection. - All processes, parts, subassemblies, assemblies and complete motors shall be inspected to determine compliance with the approved drawings (see appendix I) and with the requirements of this specification. Sampling and other statistical methods, when used, shall be appropriate to the item inspected, to the manufacturing method involved and to the previous inspection experience for that item and for that manufacturing method. Statistical and engineering analysis shall be used to evaluate the results of the sampling and statistical methods. The following are authorized for use:

Sampling Procedures and Tables for Inspection by Attributes - MIL-STD-105.

Sampling Procedures and Tables for Inspection by variables for Percent Defective - MIL-STD-414.

4.3.1.2 Sampling procedures for periodic performance tests. - Motors shall be selected for periodic performance tests in accordance with table XII and shall be subjected to the applicable periodic tests in accordance with table XIV. However, only one periodic shock and explosionproof enclosure test need be run unless there has been a change in design which affects the shockproof or explosionproof characteristics. A complete set of periodic tests is required after any change in design which affects the performance characteristics. If routine test data reveal variations beyond normal manufacturing tolerances, the Government may require that any or all of the periodic tests be made on a particular motor to demonstrate that it conforms to this specification. If a motor sample does not meet performance requirements under periodic tests, that motor and those of the same design and lot shall be cause for rejection. After the design has been modified and the revisions incorporated into the sample, the sample may be resubmitted for tests. Upon successful completion of the periodic tests on the sample specified herein and acceptance by the Government, production motors of identical designs produced in the same 12 month period shall be accepted on the basis of routine tests.

Table XII - Sampling for periodic tests.

Number of motors offered for delivery each 12 months	Number of motors to be tested
First motor of a particular design and rating	1
10 to 25 additional	1
26 to 63	2
64 to 160	3
161 to 400	5
401 to 1000	8
1001 to 2500	13

4.3.1.3 Sampling procedure for routine performance tests. - Motors shall be selected from the lot accordance with table XIII and shall be subjected to the applicable routine tests in accordance with table XIV.

Table XIII-Sampling for routine tests.

Lot size number of motors	Sample size number to be tested	Acceptance number (defective)	Rejection number (defective)
1 to 32	All	--	--
33 to 63	32	1	2
64 to 160	50	2	3
161 to 400	80	3	4
401 to 1000	125	5	6
1001 to 2500	200	7	8

4.3.2 Inspection of repair parts. - All motor repair parts shall be subjected to the in-process inspection required by 4.3.1.1 to ascertain that the materials and workmanship are in accordance with the applicable specification and that they conform fully to the approved drawings (see appendix I). This inspection shall determine if the repair parts are exact duplicates of those used in the motor.

4.3.3 Tests. - Routine and periodic tests shall be in accordance with the applicable tests specified in table XIV. Vertical motors with sleeve or oil lubricated ball bearings shall be tested in the vertical position.

4.3.3.1 Tests reports and records. - Records of periodic tests, verified and attested by the government inspector, shall be included on and made a part of the finished drawings of the motor.

Table XIV - Routine and periodic tests.

Description of test	Applicable test paragraph	
	Routine tests	Periodic tests
Material	4.3.4.1	4.3.4.1
Resistance (cold)	4.3.4.2	4.3.4.2
Lubrication	4.3.4.3	4.3.4.3
Airborne noise	4.3.4.4	4.3.4.4
Dynamic balance	4.3.4.5.2	4.3.4.5.1
End play:		
Sleeve bearing motors	4.3.4.6.1	4.3.4.6.1
Ball bearing motors	4.3.4.6.2	4.3.4.6.2
No-load input (induction motors)	4.3.4.7	- - - - -
Pull-up, breakdown and locked-rotor torque	-----	4.3.4.8
Dielectric strength	4.3.4.9	4.3.4.9
Effectiveness of enclosure:		
Submersible and watertight where submergence test option is used	4.3.4.10	4.3.4.10
Explosionproof (subsequent test waived)	- - - - -	4.3.4.10
All others	- - - - -	4.3.4.10
Heat run	- - - - -	4.3.4.11
Electrical balance	- - - - -	4.3.4.12
Weight	- - - - -	4.3.4.13
Load test (induction motors)	- - - - -	4.3.4.14
Inclined operation (sleeve bearing motors only)	- - - - -	4.3.4.15
Shock (subsequent tests waived)	- - - - -	4.3.4.16
Encapulation	4.3.4.17	4.3.4.17

4.3.4 Test procedures. -

4.3.4.1 Material tests. - While it is not the intention of this specification, in general, to require that all the material used in the construction of motors be tested in accordance with the requirements of specifications referred to in each individual case, the Government shall require such material tests whenever it considers it necessary to ascertain that. the quality of a material used is at least equal to the material specified herein and covered by the referenced specifications, or as shown on the manufacturer's approved drawings.

4.3.4.2 Resistance. - The resistance of the windings and the temperature at which they are measured shall be taken and recorded.

4.3.4.3 Lubrication. - The effectiveness of the lubricating system with the motor in its normal position shall be observed during the progress of the other tests, or by special test, as the circumstances may warrant. Navy approved lubricants similar to those required for service operation shall be used. It shall be demonstrated that the motor lubrication is satisfactory, that the specified limitations of the bearing temperatures have not been exceeded, and there is no suction of lubricant into the electrical windings under any operating condition, The test report shall indicate that such tests have been made.

4.3.4.4 Airborne noise. - Observance shall be made of motor noise during the progress of testing to determine that the motor is free from any degree of noise comparably greater than that inherent in the given type and size of motor.

4.3.4.5 Dynamic balance. -

4.3.4.5.1 By instrument. - The mechanical balance of the completely assembled motor (and any special attachments such as brakes or overspeed switches) shall be measured. Motors having a varying speed but no definite no-load speed shall be tested at twice their rated speed. The method of test shall be as follows:

(a) Place the motor on an elastic mounting so proportioned that the up and down natural frequency shall be at least as low as one-quarter of the operating speed of the motor. To accomplish this, it is required that the elastic mounting be deflected downwards at least by the following amounts due to the weight of the motor. The deformation of the mounting should in no case be more than 1/2 the original height of the elastic element:

Revolutions per minute	Compression (inch)
900	1
1,800	1/4
3,600	1/16
7,200	1/64

(b) A reliable vibration indicator shall be employed.

(c) The amplitude of vibration shall be measured on the bearing housing in the direction giving the maximum amplitude, with the motor running, the axis of the shaft in normal position and at normal voltage. The motor shall be balanced with 1/2 a standard key in the keyway; that is, a key of full length, flush with the top of the keyway (where applicable).

4.3.4.5.2 By hand. - The balance shall be checked by "Touch" without the necessity of mounting on an elastic base. If the motor feels to vibrate excessively it shall be retested in accordance with 4.3.4. 5.1 to determine whether or not the dynamic balance is within the acceptable limit.

4.3.4.6 End play. -

4.3.4.6.1 Horizontal sleeve-bearing motors shall be tested for "end-play" while at standstill by alternately pressing and releasing the rotor shaft at each end. The requirements of 3. 1.19.3.2 shall apply.

4.3.4.6.2 AU ball bearing motors shall be tested for end play at standstill. The requirements of 3.5.1.4 as applicable and MIL-P-17840 apply.

4.3.4.7 No-load input data. - The no-load input data test shall consist of taking a no-load input reading with rated voltage and frequency applied at the motor terminals. Where the rotor of the motor is supported by the

bearings of the driven auxiliary, this test may be conducted with the motor driving the unloaded auxiliary. Readings of line volts and amperes, watts input and r.p.m. shall be taken and recorded. The motor shall be run for a sufficient period of time to allow bearing losses to become constant before any readings are taken.

4.3.4.8 Pull-up, breakdown, and locked-rotor torque. - Readings of line volts and torque (plus amperes and watts for locked-rotor) shall be taken and recorded for each of the above torques.

4.3.4.9 Dielectric tests. -

4.3.4.9.1 General. - The dielectric test shall be made after all other tests have been complete. The frequency of the testing voltage shall be not less than 60 cycles and shall approximate a sine wave. If the insulation resistance of the windings is known to be lower than specified, due to dirt or moisture or damage to windings, this shall be remedied before the application of the dielectric test voltage. The dielectric test shall be made on the completely assembled machine and not upon individual parts. An exception is made in the case of repair parts which require dielectric tests; for example, repair coils and repair rotating elements with insulated windings. In the case of motors using capacitors, the dielectric test on the motor may be made with the capacitor disconnected. The capacitor shall be given a separate dielectric test according to the rating of the capacitor used.

4.3.4.9.2 Measurement of test voltage. - The measurement of the voltage used in dielectric tests shall be made by the voltmeter method whereby the instrument derives its voltage from the high-volt circuit either directly or by means of a voltmeter coil placed in the testing transformer, or through an auxiliary ratio transformer. In any case, if the capacitance of the machine to be tested is such as to cause wave distortion, the testing voltage shall be checked by a crest-voltage meter. If the crest-voltage meter is calibrated in crest volts, its reading shall be reduced to the corresponding root-mean-square sinusoidal value by multiplying by 0.707.

4.3.4.9.3 Points of application. - The test voltage shall be successively applied between each electric circuit and all other electric circuits and metal parts grounded. The test voltage shall be applied in such a manner as to preclude the possibility of pitting the bearings in case of insulation failure. Voltage need not be applied between stationary and rotating windings.

4.3.4.10 Effectiveness of enclosure. - Motors shall be tested as specified in MIL-E-2036 except that hose test of dripproof enclosures is waived.

4.3.4.11 Heat-run test. -

4.3.4.11.1 General. - The heat-run test shall be made on continuous duty motors in accordance with the following:

Rated motor load - 100 percent.
Voltage - rated.
Time - until all temperatures are constant.

Motor load may be obtained by maintaining the current, torque or watts input corresponding to rated motor hp. output.

4.3.4.11.2 Details of temperature test. -

4.3.4.11.2.1 Normal load heat runs on continuous-duty motors shall be continued until constant temperatures have been attained in all parts of the motor. For motors having several continuous ratings, the heat run shall be conducted using the rating giving the highest temperature rises. In cases where the highest temperature rises cannot be determined prior to the test, the motor shall be tested separately for each rating. Temperature measurements by thermocouple shall be taken and recorded during the progress of the heat run to determine when the constant operating temperature has been reached. It shall be considered that constant temperatures have been reached when at least four consecutive readings taken at 15-minute intervals show no increase in the temperature in any part of the motor. The resistance rise shall then be determined in accordance with the procedures for method 2 of MIL-E-917.

4.3.4.11.2.2 The duration of temperature test of a motor with a short-time or overload requirement shall be the time specified for that rating. Intermittent and varying duty motors shall be tested at the specified

duty cycle. In lieu thereof, the motors may be tested as short time duty motors of sufficient rating to meet the actual load requirements. The manufacturer shall submit to the bureau or agency concerned evidence that the short-time duty rating used for test purposes is equivalent to the required duty cycle.

4.3.4.12 Electrical balance. - Line currents measured during the heat run cycle test may be used to indicate electrical balance. Requirements of 3.1.13 apply.

4.3.4.13 Weight. - The weight of motor shall be taken and recorded.

4.3.4.14 Load tests. - With the motor operating at rated voltage and frequency, simultaneous reading of the voltage, frequency, amperes in each phase, speed in r.p.m. and watts shall be taken at 0, 1/4, 1/2, 3/4 and 4/4, of rated hp. , where hp. load may be maintained by current or watt input or by torque. The motor shall be approximately at its normal operating temperature during these tests.

4.3.4.15 Inclined operation. - Sleeve bearing motors only.

4.3.4.15.1 The inclination tests for horizontal motors shall, in general, cover the following test positions:

(a) Surface vessels motors:
Shaft inclined 15 degrees, front end low.
Shaft inclined 15 degrees, rear end low.
Shaft horizontal, motor base tilted 15 degrees to the right.
Shaft horizontal, motor base tilted 15 degrees to the left.
(b) Submarine motors same as 4.3.4.15. l(a) except that inclination shall be at 45 degrees.

4.3.4.15.2 Under each of the positions of inclination specified in 4.3.4.15.1, the motor shall be run for a period of not less than 30 minutes for surface ship motors and 1 hour for submarine motors. This test may be made on the combined motor driven auxiliary. The combined motor-driven auxiliary shall be run at not less than its maximum service speed, and the driven auxiliary need not be loaded. During the progress of these tests it shall be ascertained that the mechanical balance is as good as it was in the normal horizontal position, that there is no pounding or grinding at the bearings, and that the lubrication is satisfactory. For submarine motors the bearing temperature at the completion of test shall be recorded and shown on the drawing.

4.3.4.15.3 Vertical motors shall be tested by inclining them to an angle of 15 degrees for surface motors and 45 degrees for submarine motors from their normal position, in any direction (that direction which imposes the most severe condition, if there be any dissymmetry) and for a period of 30 minutes for surface ship motors and 1 hour for submarine motors. If desired, this test may be made on the combined unit used for the special operating test. (Vertical motor-driven auxiliaries shall be tested by inclining them to an angle of 15 degrees for surface ship units and 30 degrees for submarine units from their normal horizontal position, in each of four different directions; namely, (a) forward, (b) backward, (c) to the right, and (d) to the left, Observations shall be made as specified in 4.3.4.15.2 for horizontal motors and combined motor-driven auxiliaries.)

4.3.4.15.4 The suitability of motor-driven auxiliaries for operation when a ship is rolling 45 degrees for surface ships and 60 degrees for submarine motors to either side shall be determined by inspection of design.

4.3.4.16 High-impact shock test. - The tests shall be as specified in MIL-S-901. The features of the test shall be as follows:

(a) The required type of shock test. - Type A.
(b) The weight designation of the shock test. - Lightweight. If the motor shaft in application will be required to support a heavy weight such as a clutch-type coupling or pump impeller, the shock tests shall be conducted with the motor shaft so loaded.
(c) Required class of equipment. - Class I unless otherwise specified in the contract or order.
(d) Required grade of equipment. - Grade A.
(e) A definition of "failure to perform principal functions". -
(1) Breakage of any parts, including mounting bolts.
(2) Appreciable distortion or dislocation of any parts such as mounting feet, poles, coils, brushes, and bearings.

(3) Values of full load current, speed and watts differing by more than one percent of the preshock test values.
(4) A mechanical unbalance of more than two times the value of unbalance specified in 3.5.1.5.
(5) Either a bearing or oil temperature rise or both in excess of that permitted in table IX.
(6) Objectionable noise. - Any noticeable increase or decrease in noise of the motor when operating at rated speed should be investigated and its cause determined. However, if disassembly is required for this check, it should be made during the test specified in 4.3.4.16(e)(8).
(7) Low dielectric strength. - The motor shall be operated to obtain approximately rated temperature rise of iron and windings, then disconnected from its load or from its source of power and a dielectric strength test made to check the condition of the insulation. This dielectric strength test shall be made in accordance with 4.3.4.9 except that it shall be made with an applied voltage equal to 65 percent Under these conditions, insulation failures shall be cause for rejection.
(8) Failure to pass inspection. - The motor shall be disassembled following checks 4.3.4.16(e)(1) to 4.3.4.16(e)(7) inclusive, and inspected thoroughly for damage. The extent of disassembly need be only to the point where the condition of the motor can be easily observed. The effects of the shocks and subsequent check tests on the structure, bearings, and insulation shall be carefully observed and recorded.

(f) Acceptable method of mounting on shock-testing machine. - The mounting adapters shown on the following figure of MIL-S-901 shall be used:
(1) Fixture 4C for motors to be tested on the shock-testing machine for lightweight equipment.

(g) Number of motors to be tested. - Unless otherwise specified in the contract or order, one motor of the longest core length in any one diameter and of similar construction out of each group of enclosures listed below, shall be shock-tested:

Group 1:
Open
Protected
Dripproof
Dripproof protected
Group 2:
Watertight.
Spraytight.
Totally enclosed.
Group 3:
Watertight fan-cooled.
Spraytight fan-cooled.
Totally enclosed fan-cooled.
Group 4:
Explosionproof, group D.
Group 5:
Explosionproof fan-cooled, group D.
Group 6:
Submersible, all degrees.

If the manufacturer desires he may submit a motor frame of less than the longest core length to the shock-test. However, satisfactory conformance with the shock requirements will give approval only to motors having a core length equal to or less than the core length of the motor tested.

(h) Disposal of shock-tested motors. -
(1) Motors which have been subjected to the high-impact shock-test and have failed to conform to the requirements will not be acceptable, either in whole or any of the parts.
(2) Motors which have been subjected to the high-impact shock-test and have successfully passed this test shall be considered acceptable as an item in the contract provided the post- shock-tests specified hereinafter are satisfactorily passed and provided the mechanical corrective measures specified hereinafter are satisfactorily met. Mounting flanges connecting directly to the driven auxiliary shall be

replaced in the event of minor deformation. Minor deformations affecting alignments, including alignments with the auxiliary, shall be corrected. Minor deformations shall be defined as those which do not cause unqualified rejection of the design under the high-impact shock test but which are in excess of the dimensional tolerances specified on the applicable motor drawing. Prior to acceptance of the motor, all ball bearings shall be replaced.

(i) Shock extension. - Motor shock test approval may be extended from the longest core length (same outside diameter and similar construction) to a motor of a shorter core length. The manufacturer shall submit a letter of request together with the drawings of each motor. Upon receipt of bureau or agency approval, the manufacturer shall note on the master plan the test number and date or original shock test, the inspector's approval letter, serial number and date and a statement of shock extension including bureau or agency approval letter.

(j) Where the motor will be shock tested as part of an overall package, shock test of the motor alone is not required.

4.3.4.17 Encapsulation. - The encapsulated stator shall be submerged in tap water for a period of 8 hours with full load current applied. The insulation resistance (see 40.4.1 of appendix II) shall be measured before and after the submergence period. The tested motor shall be hosed off with tap water and dried. The insulation resistance shall again be measured. Insulation resistance value lower than that specified in 3.1.28.l(d) shall be cause for rejection of the stator.

4.4 Service C. -

4.4.1 Inspection of repair parts for service C motors shall be as specified in 4.3.2. Inspection of service C motors shall consist of the tests specified in table XV.

Table XV - Service C tests.

Description of test	Applicable test paragraph	
	Routine tests	Periodic tests
Material	4.3.4.1	4.3.4.1
Resistance (cold only)	4.3.4.2	4.3.4.2
Dynamic balance (by hand)	4.3.4.5.2	4.3.4.5.2
End play:		
Sleeve bearing motors	4.3.4.6.1	4.3.4.6.1
Ball bearing motor	4.3.4.6.2	4.3.4.6.2
No-load input (induction motors)	4.3.4.7	----
Load test	----	4.3.4.14
Pull-up, breakdown and locked rotor torque	----	4.3.4.8
Dielectric strength	4.3.4.9	4.3.4.9
Effectiveness of enclosure	----	----
Submersible	4.3.4.10	4.3.4.10
Explosionproof - subsequent test waived	----	4.3.4.10
All others	----	4.3.4.10
Weight	----	4.3.4.13
Encapsulation	4.3.4.17	4.3.4.17

4.4.1.1 Each motor shall be subjected to a thorough examination to ascertain that the material, workmanship, and design are in conformance with this specification. The fit of parts shall be observed with particular reference to the interchangeability of such parts as are likely to require replacement during the normal service life of the motor.

5. PREPARATION FOR DELIVERY

5.1 Preservation, packaging, packing and marking. - Motors together with their repair parts shall be preserved, packaged, packed, and marked in accordance with the applicable levels of MIL-E-16298 (see 6.1).

6. NOTES

6.1 Ordering data. - Procurement documents should specify the following:

(a) Title, number, and date of this specification.
(b) Service (see 1.2). Whether motor is for submarine service (see 3.5.1.17).
(c) Ambient temperature (see 3.1.1).
(d) Voltage (see 3.1.3).
(e) Duty (specified time of duty cycle) (see 3.1.7).
(f) Enclosure (see 3.1.8, 3.5.1.17.1 and 3.1.28.l(a)).
(g) Horsepower and speed ratings (see 3.1.9).
(h) R.p.m. and speed (see 3.1.10).
(i) Type (see 3.1.11).
(j) End shield design (see 3.1.17).
(k) Type of bearings (see 3.1.19.1) and if ball bearings are required, specify type (see 3.1.19.2).
(l) Class of insulation (see 3.1.27).
(m) Encapsulation (see 3.1.28).
(n) Number of motors per ship (see 3.3.1.1).
(o) Repair sets of gears (see table VII).
(p) Degree of balance if other than standard (see 3.5.1.5).
(q) Level of preservation, packaging, packing and marking required (see 5.1).

6.2 Definitions. - The following definitions shall apply to the various technical terms wherever such terms appear in this specification:

6.2.1 Continuous duty. - Continuous duty is a requirement of service that demands operation at a substantially constant lead for an indefinitely long time (see 3.1.7.1).

6.2.2. Intermittent duty. - Intermittent duty is a requirement of service that demands operation for alternate intervals of (a) load and no-load, (b) load and rest, or (c) load, no-load, and rest (see 3.1.7.2).

6.2.3 Varying duty. - Varying duty is a requirement of service that demands operation at loads and for intervals of time, both of which may be subject to wide variation (see 3.1.7.3).

6.2.4 Short-time duty. - Short-time duty is a requirement of service that demands operation at a substantially constant load for a short and definitely specified time (see 3.1.7.4).

6.2.5 Constant-speed motor. - A constant-speed motor is one of which the normal speed of operation is constant or practically constant; for example, a synchronous motor or an induction motor with small slip (see 3.1.10).

6.2.6 Multispeed motor. - A multispeed motor is one which can be operated at any one of two or more definite speeds, each being practically independent of the load. In the case of multispeed permanent-split capacitor and shaded pole motors, the speeds are dependent upon the load (see 3.1.10).

6.2.7 Varying speed motor. - A varying speed motor is one the speed of which varies with the load, ordinarily decreasing when the load increases, such as a high-slip motor (see 3.1.10).

6.2.8 Adjustable varying speed motor. - An adjustable varying speed motor is one the speed of which can be adjusted gradually, but when once adjusted for a given load, will vary in considerable degree with change in load, such as a wound rotor induction motor (see 3.1.10).

6.2.9 Front (of motor). - The front of a motor is the end opposite the coupling.

6.2.10 Back (of motor). - The back of a motor is the end which carries the coupling or driving pulley.

6.2.11 Capacitor-start motor. - A capacitor-start motor is a capacitor motor in which the capacitor phase is in the circuit only during the starting period (see 3.1.11).

6.2.12 Permanent-split capacitor motor. - A permanent split capacitor motor is a capacitor motor having the same value of capacitance for both starting and running conditions (see 3.1.11).

6.2.13 Two-value capacitor motor. - A two-value capacitor motor is a capacitor motor using different values of effective capacitance for the starting and running conditions (see 3.1.11).

6.2.14 Shaded pole. - A shaded-pole motor is a single-phase induction motor provided with an auxiliary short-circuited winding or windings displaced in magnetic position from the main winding (see 3.1.11).

6.2.15 Split phase. - A split-phase motor is a single-phase induction motor equipped with an auxiliary winding, displaced in magnetic position from, and connected in parallel with the main winding. Unless otherwise specified herein, the auxiliary circuit is assumed to be opened when the motor has attained a predetermined speed. The term split-phase motor used without qualification describes a motor to be used without impedance other than that offered by the motor windings themselves, other types being separately defined (see 3.1.11).

6.2.16 Universal. - A universal motor is a series-wound motor or a compensated series-wound motor which may be operated either on direct-current or single-phase alternating-current at approximately the same speed and output. These conditions must be met when the direct current and alternating-current\voltages are approximately the same and the frequency of the alternating-current is not greater than 60 cycles per second (see 3.1. 11).

6.2.17 Squirrel-cage induction. - A squirrel-cage induction motor is one in which the secondary circuit consists of a squirrel-cage winding suitably disposed in the secondary core (see 3.1.11).

6.2.18 Synchronous. - A synchronous motor is a motor in which the average speed of normal operation is exactly proportional to the frequency of the system to which it is connected (see 3.1.11).

6.2.19 Efficiency. - The efficiency of a machine is the ratio of the power output to the total power input.

6.2.20 Thermal protector (inherent overheating protective device). - A thermal protector is a protective device which is responsive to motor current and temperature whose purpose, when applied to a motor, is to protect the motor against excessive overheating due to overload or failure to start.

6.2.21 Fractional horsepower-motor. - A fractional horsepower motor is one built in a frame of any size smaller than 182.

6.3 CHANGES FROM PREVIOUS ISSUE. THE EXTENT OF CHANGES (DELETIONS, ADDITIONS, ETC.) PRECLUDE THE ANNOTATION OF THE INDIVIDUAL CHANGES FROM THE PREVIOUS ISSUE OF THIS DOCUMENT.

Preparing activity:
Navy - SH
(Project 6105-NO21SH)

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INDEX (cont'd.)

APPENDIX I

IN-PROCESS INSPECTION OF SERVICE A MOTORS

10. SCOPE

10.1 This appendix covers a list of items which should be included in the in-process inspection of Service A motors furnished in accordance with this motor specification. This list is not an all inclusive list and additions and deletions as applicable can be made by the manufacturer.

20. APPLICABLE DOCUMENTS

20.1 Not applicable.

30. REQUIREMENTS

30.1 To facilitate the in-process inspection procedure the manufacturer shall prepare a manufacturing flow chart showing the normal flow of materials, parts, subassemblies, and assemblies through the manufacturing process. The manufacturer shall indicate on the flow chart the points at which the manufacturer conducts in-process inspection and these points shall be designated as inspection stations.

30.1.1 The manufacturer shall list what items of inspection occur at each of his inspection stations. This list and inspection documents including tolerance standards, inspection requirements and criteria for acceptance and rejection shall be at the inspection station and made available to the Government. Positive records of the inspection results shall be made verifying conformance to all inspection requirements. Such records shall either physically accompany each item or lot of items or shall be otherwise made available to the Government. Marking of items after inspection to indicate acceptance is not considered an inspection record.

30.1.2 The words "approved drawing'" as used herein mean a required drawing (that is, class A drawing) approved by the cognizant approval activity, or a manufacturer's shop drawing if needed for in-process inspection to depict details not shown on required drawing. Manufacturer's shop drawings which agree with approved required drawings may be used for in-process inspection. Inspection requirements are not to be waived or reduced by selection of drawings.

30.2 General inspection items. - General inspection items shall be as follows:

(a) Material is as specified on approved drawing. Material was ordered in accordance with applicable material or component specification and was inspected in accordance with the requirements of the material or component specification.
(b) All welding and brazing is done by qualified welders, and is in accordance with approved drawing. There is no evidence of non-fusion, weld cracks, under-size welds, incomplete welds, heavy porosity, weld splatter or slag.
(c) AH soldered connections are solidly bonded; there is no cold soldering, no rosin joints, no corrosive flux, no fractured joints, or excess solder. Satisfactory connections were made prior to soldering. Bolted connections include approved locking devices and are secured against vibration. Solderless connectors are properly crimped; the connector and crimping tool are proper size.
(d) Finished castings shall be as shown as on approved drawings and are clean and free of molding sand, cracks, blow holes, splits and deformations. Sufficient material is allowed for machining. Casting defects have not been covered by unauthorized repairs.
(e) Machining shall be as shown on approved drawings. The surfaces, including mating surfaces, as applicable, are smooth, square and are free of burrs, sharp edges, chatter marks, and scratches or damage due to handling. Surface finish is as shown on approved drawing and there are no tool marks except those normally associated with the indicated surface finish. There are no flaws exposed in the material as a result of machining.
(f) No parts are Government surplus or have been previously used or reclaimed.
(g) All items including hardware (nuts, bolts, lockwashers, and so forth) are made of corrosion resistant material or are given a corrosion resistant treatment as shown on the approved drawing.

(h) The Government may require a coil or winding to be cut apart to see the extent of varnish treatment and filling if there is question as to the effectiveness of varnish treatment used.
(i) All bolts, nuts, set screws and other fasteners are secured in a manner which will preclude loosening in service. All locking devices are as shown on the approved drawing.
(j) Insulation creepage and clearance distances are in accordance with approved drawings. Creepage distances were not achieved by means of cemented or butted joints.

30.3 Items to be inspected prior to assembly. - Items to be inspected prior to assembly shall be as follows:

(a) Shafts. -

(1) Items (a), (b), (e), and (f), of 30.2 apply.
(2) All dimensions, tolerances, keyways, fillets, shoulders, threads, and surface finish are as shown on approved drawing.
(3) Eccentricity tolerances including out of round for the bearing seats, bearing shoulder, collector ring seats, and the core seats are as shown on the approved drawing.
(4) After welding on appurtenances, shaft has been stress relieved as shown on approved drawing.
(5) The shaft was not built up in any way to correct errors or reclaim material (unless specific case basis approval of Bureau of Ships is obtained in advance).
(6) All shoulders are square as shown on the approved drawing.

(b) Commutator assemblies. -

(1) Items (a), (b), (d), (e), (f), and (j) of 30.2 apply.
(2) All dimensions and dimensional tolerances are as shown on the approved drawing.
(3) Manufacturing and assembly processes used are as specified on the approved drawings. Specific temperatures and curing cycles are as shown on approved drawing.
(4) Brush contact surfaces are smooth and are free of sharp edges, burrs, porosity, tool or chatter marks. Slip ring grooves have no burrs.
(5) Terminal studs are fixed to the rings in a positive manner as shown on approved drawing.
(6) Terminal stud insulation is as shown on the approved drawing.

(c) Fans.

(1) Items (a), (b), (d), (e), (f), (g), and (j) of 30.2 apply.
(2) All dimensions and the number and contour of blades are as shown on the approved drawing.
(3) The fan surfaces which move the air are free from any irregularities, surplus weld material or any other projections which may be a source of excessive airborne noise.
(4) Fans which break down into several parts are indexed in a manner such that they can be assembled in one way only.

(d) End shields and bearing housings, end caps and frames. -

(1) Items (a), (b), (d), (e), and (f) of 30.2 apply.
(2) Sufficient metal is available for drilling and tapping.
(3) All drilling, tapping and bolt centers are as shown on the approved drawing. Holes are clean, free of chips and are drilled straight. There are no burred threads. Holes are spot faced and are located so that edge distance is adequate in accordance with approved drawing.
(4) End shields and frames were cleaned, and given a coat of primer and enamel or a coat of rust preventive before storing.
(5) The end shields, except mating surfaces, such as bearing housings and rabbets, are cleaned, primed and painted on the inside surface prior to assembly. The inside of the frame is primed and painted if it did not receive at least two dips and bakes in the varnish treatment of the stationary electrical components.
(6) Mating surfaces of shields and frames are concentric and square as shown on approved drawing.

(7) All dimensions, dimensional tolerances and concentricities are as shown on the approved drawing.
(8) Bearing housings have sufficient metal to permit redrilling and bushing of the housing.

30.4 Items to be inspected during assembly. - Items to be inspected during assembly shall be as follows:

(a) General. -

(1) Items specified in 30.2 apply.
(2) All part-s are interchangeable and no hand fitting or selective matching of parts is necessary.
(3) No shims, spacers or washers are used in the assembly to correct machining or material discrepancies.
(4) Assembly and disassembly of all equipment can be done without the use of special tools. (Special tools are all tools other than those listed in the Federal Supply Catalog.)

(b) Items to be checked during winding and assembly of rotating elements. -

(1) Keys shown on the approved drawing are used to prevent rotational movement of all rotating parts, (that is, commutators, rotors or armatures).
(2) When any parts are pressed on the shaft, the pressure required to press on these parts is within the limits shown on the approved drawing.
(3) When any parts are shrink fitted on the shaft, the interference shrink fits of the parts are as shown on the approved drawing.
(4) Axial movement of all parts is prevented by means of press rings, snap rings, press fit, shrink fit, or lockwashers and nuts as shown on the approved drawing.
(5) Fans are secured to the shaft as shown on approved drawing.
(6) Bearings are of the size and type as shown on the approved drawings.
(7) The inner races of ball bearings are secured to the shaft by means of shaft shoulders, lockwashers and nuts or by the opposed shoulder method as shown on the approved drawing.
(8) Bearing locknuts and lockwashers, where used, are as shown on approved drawing.
(9) Bearings and bearing seats are free from dirt, sand, metal particles, corrosion, or other foreign material.
(lo) Lamination size and stacking are as shown on the approved drawing.
(11) Slot or ground insulation are as shown on the approved drawing.
(12) Slot or ground insulation extends beyond stacking as shown on the approved drawing.
(13) Wire size and type is as shown on approved drawing. No substitutions.
(14) Wound coils including preformed have dimensions and number of turns as shown on the approved drawing.
(15) Undue force is not required to insert slot wedge in place and insulation is not damaged or pushed out of place of the wedge.
(16) Slot wedges are of material and size as shown on the approved drawing. Length of wedge exceeds length of slot as shown on approved drawing.
(17) Coils are not loose after the wedge is in place.
(18) The wedge size is proper for the size and shape of the slot and there is no possibility that the wedge will cock in the slot and slip out.
(19) Coil connections are insulated as shown on the drawing.
(20) Coil support and phase insulation is as shown on the approved drawing. Phase insulation is inserted between the phase coils and is shaped to fit coil configuration.
(21) Coil extensions are insulated and secured as shown on the approved drawing.
(22) Insulation materials are as shown on the approved drawing.
(23) Insulation is cleaned off unless self fluxing wire is used and coil wire ends are tinned before making soldered connections.
(24) Lead wires are of the type and size shown on the approved drawing.
(25) Windings are mechanically secured as shown on the approved drawing.
(26) Comlpleted winding assembly, including winding and pole, given a minimum of two varnish treatments with an approved clear baking varnish when preformed coils are used and are given one varnish treatment prior to insertion in the slots or on the poles. In the case where preformed coils are not used, the complete assembly is given at least three varnish treatments.

(27) Type of varnish, treating and baking time cycle, and baking temperatures are as shown on the approved drawing.
(28) The treated windings and coils are clean, smooth and glossy with good bonding and filling. Varnish seals shall be complete and show no signs of cracks or breaks. The completed winding shall have no air bubbles, air pockets, voids or dry spots on the surface and shall not be soft or sticky.
(29) There is no sign of excessive varnish buildup on one side of the winding assembly and lack of varnish buildup on other side. The thickness of the varnish on the winding assembly shall be uniform over the entire surface of the windings.
(30) Lead wires are insulated from ground and secured to prevent them from moving due to centrifugal force. Length and arrangement of wires shall permit ready repair; there is no aimless wiring resulting in "rats nests". Wiring agrees with approved drawing. Wiring agrees with approved drawing.
(31) No glyptal or nonapproved type of varnish or paint was put on any of the rotating elements.
(32) Coils or windings are not nicked or damaged during handling and processing.
(33) All completed rotating elements are dynamically balanced. The type of balance weights and method of securing are as shown on the approved drawing. They are secured in a manner such that they will not loosen in service. Balance weights are not attached in the air stream of the fan.

(c) Items to be checked during winding and assembly of stationary elements. - Items to be checked shall be as follows:
(1) Items 30.4(b) (10) through (22) inclusive, (23) through (28) inclusive, (31) and (32) apply.
(2) Complete stator assembly or stator core is keyed to frame as shown on approved drawing.
(3) Force required to press complete stator assembly or stator core into the frame or frame spider is within the limits shown on the approved drawing.
(4) Axial movement of the stator within the frame is precluded by means of snap rings, welds, or other means as shown on the approved drawing .
(5) All lead wires are insulated from ground and secured within the frame with a suitable clamp or fastening device.
(6) All lead wires pass through the frame, enter the terminal box and are secured in such a manner to prevent chafing or abrasion as shown on the approved drawings.
(7) Terminal lugs are of the type and size shown on the approved drawing are provided on the leads. Terminal lugs are properly crimped and there are no cut wire strands.
(8) Terminal boxes are of the type and size and are secured as shown on the approved drawing.
(9) All leads are properly marked as shown on the approved drawing, (for example T1, T2, T3).
(10) Coil end extensions dimensions are as shown on the approved drawing.

30.5 Items to be inspected during final assembly. - Items to be inspected shall be as follows:

(a) Items (a), (b), (c), (d), (e), (f), (g), (h), (i) and (j) of 30.2 apply.
(b) Coil ends do not protrude to a point where they may contact the end brackets or the rotating elements.
(c) End shields properly match frames and bearing housings and end caps. AU holes align, there is no excess clearance, and no undue force is required to assemble parts.
(d) Bearing outer races are secured in their housings as shown on approved drawing.
(e) There is no evidence of grease leakage past the close clearance nonrubbing seals into the motor or along the shaft.
(f) Spring washers, if used, to provide preloading of the bearing, shall be selected and secured in the housing as shown on approved drawing.
(g) Seals of prelubricated bearings are not damaged and there is no evidence of grease leaking out of the bearing.
(h) Brushholder studs are secured as shown on the approved drawing.
(i) Brush rigging insulation is as shown on approved drawing.
(j) Brushholders and springs are of the type and size shown on the drawing.
(k) Brushholders are secured as shown on the approved drawing.
(l) Brushes are of the manufacturer's grade designation shown on the approved drawing.
(m) Brushes have been properly seated over a minimum of 90 percent of contact area of brush and carbon dust has been removed from the machine.

(n) Brush shunts are adequately attached to the brush material by embedding or riveting.
(o) 'Brush size is as shown on the approved drawing and fits properly in the holder without sanding or filing and brushes move freely in the brushholders in the direction parallel to the length of the brush.
(p) Brush tension is adjustable and is set as shown on the approved drawing. Spring tension can be readily measured by spring scale.
(q) Brushes are properly aligned parallel to the shaft and do not extend beyond the edge of the slip rings.
(r) Brush lug terminals are properly secured by screws which are not used for securing the brush- I holders to the rigging.
(s) Brush leads are furnished with lugs which are adequately secured.
(t) Water slingers are secured to the shaft as shown on approved drawing.
(u) Air gaps have been adjusted to design value and are uniform within the limits shown on the approved drawing.
(v) Bearings have been lubricated with grease as specified on approved drawing.
(w) Except where prelubricated bearings are used, grease pipes, cups and drains are as shown on approved drawing.
(x) Air baffles are securely attached and do not interfere with rotating elements.
(y) Equipment enclosure is as shown on the approved drawing.
(z) Drain plugs are provided as shown on approved drawing.
(aa) The motor, other than identification plates or shaft extensions is painted as shown on the approved drawing.
(bb) Identification and instruction plates are legible and are complete as shown on the approved drawing.
(cc) Mounting feet are flat, square, and are as shown on approved drawing.
(dd) The overall dimensions, mounting dimensions, distance from shaft center line to bottom of feet, and location of terminal boxes are as shown on the approved drawing.
(ee) For close-coupled motors, the shaft runouts, mounting flange concentricity and squareness are as shown on the approved drawings.
(ff) Shaft seals, are the proper type and are secured as shown on the approved drawing.
(gg) Where high tensile bolts or screws such as socket head types are used, provision is made to prevent replacement with a lower tensile strength bolt or screw. Thread-cutting screws (self tapping) are not used to secure any part of the motor.
(hh) Where oil lubrication is used, the lubrication system is complete as shown on the approved drawing and there is no leakage of oil into or out of the motor.
(ii) Motor, particularly bearing housings, is clean and free of dirt, metal chips or other foreign materials.
(jj) Stationary lead wires do not contact rotating parts.

APPENDIX II

PROCEDURE FOR TESTING OF ENCAPSULATED MOTORS

10. SCOPE

10.1 Scope. - This appendix covers the suitability testing procedure for encapsulated motors.

10.2 Purpose. - The purpose of this test is to determine the insulation resistance, dissipation factor, and capacitance of an electric motor encapsulation system under conditions of submergence.

10.3 Classification. - Insulation suitability tests for encapsulated motors shall be of the following types and shall be so designated in the application for test:

Type R- Random winding (see 3.1.28.3).
Type F - Form winding (see 3.1.28.4).

10.4 Definitions. -

10.4.1 Insulation resistance. - The insulation resistance between two electrodes which are in contact with, or embedded in, an insulating structure, is the ratio of the direct voltage applied to the electrodes to the total current between them. It is dependent upon both the volume and surface resistances of the insulation structure.

10.4.2 Dissipation factor. - The dissipation factor of an insulating structure is the ratio of its parallel reactance to its parallel resistance. It is also the tangent of the loss angle (also called loss tangent) and the cotangent of the phase angle.

10.4.3 Capacitance. - The capacitance is the ratio of the charge which can be stored in a capacitor to the potential applied to it.

20. APPLICABLE DOCUMENTS

20.1 Not applicable.

30. REQUIREMENT'S

30.1 Reliability. - Reliability of operation shall be considered of prime importance in the design and manufacture of the equipment. As encapsulated motors are usally specified to be used under extreme moisture environmental conditions beyond the limitations of conventionally insulated motors, motors for this service shall meet the performance-requirements specified herein.

40. QUALITY ASSURANCE PROVISIONS

40.1 Encapsulated motor suitability tests. -

40.1.1 Place of tests. - The encapsulated motor suitability tests shall be conducted at the manufacturer's plant or at a laboratory and under conditions satisfactory to the Bureau of Ships.

40.1.2 Equipment to be tested. - As it is not practical to test each encapsulated motor rating to determine compliance with the specification requirements, only a representative rating, typical of the line manufactured, need be tested. Table XVI lists equipment by horsepower and the type of sample to be tested.

40.1.3 Application for test. - Application for test shall be submitted to the Bureau of Ships, Code 660, and shall include the following:

(a) Manufacturer's name and address.
(b) Test specimen rating and type of encapsulated motor winding.
(c) Availability of test facilities including manufacturer's name and designation or style number for each equipment or instrument.

Table XVI - Specimens for encapsulated motor suitability test.

Winding type	Frame size range	Enclosure	Sample quantity	Size to be tested 1/
Random	All sizes	Dripproof protected	2	56 frame 3/4 hp., 1800 r. p. m.

1/ Motors presented for test shall preferably be production motors rather than laboratory prototypes. A minimum of one complete motor and one stator will be required for the test. If laboratory prototypes are furnished the encapsulation system used shall be a system suitable for production use. The prototype may use corrosion protection methods that need only be sufficient for the 500 hour submergence test. Motors shall be designed to give full load, rated output horsepower when operated in air. The motors shall be tested at no load when submerged in water. Fans may be removed for this test. The motors shall not stall when tested under these conditions.

40.1.3 Application for test. - Application for test shall be submitted to the Bureau of Ships, Code 660, and shall include the following:

(a) Manufacturer's name and address.
(b) Test specimen rating and type of encapsulated motor winding.
(c) Availability of test facilities including manufacturer's name and designation or style number for each equipment or instrument.
(d) Master drawing including complete details of proposed encapsulating procedures and materials to be used.

40.2 Test equipment needed. - The following test equipment shall be provided:

(a) Chiller and submergence test tanks.
(b) Potential test equipment.
(c) Insulation resistance test bridge.
(d) Capacitance test bridge.
(e) Ohmmeter.

40.3 Type of test equipment. -

40.3.1 Tanks. -

(a) Chiller tank. - A tank shall be provided with an open top design. Water used shall be 4 percent salt water and the water temperature shall be maintained between 0 - 3°C.
(b) Submergence tank. - A suitable size tank shall be provided. Water used shall be 4 percent salt water and the water temperature shall be adjusted so that it does not exceed 40 ± 2°C.

40.3.2 High potential test equipment. - Any standard high potential test equipment of suitable capacity may be used provided the frequency of the test voltage is not less than 60 nor more than 100 cycles per second (c. p.s.) and provided the wave shape approximates a true sine wave. The test voltage shall be measured with a voltmeter deriving its voltage from the high-voltage circuit either directly or through an auxiliary ratio transformer or by means of a voltmeter coil placed in the testing transformer.

40.3.3 Insulation resistance test bridge. - A megohm bridge shall be used having a direct current test voltage of 500 volts and with a range of 0.1 to 1,000,000 meghoms.

40.3.4 Capacitance test bridge. - A capacitance test bridge shall be used having a 60 c.p.s. input with a range of 5 micromicrofarads to 1100 microfarads and with a range of dissipation factor of zero to 50 percent. It shall be suitable for measuring circuits to ground.

40.3.5 Ohmmeter. - Any standard laboratory instrument may be used provided the smallest center scale reading is not over 15 ohms.

40.4 Tests. - In addition to the tests required in 4.3.3 the following apply:

40.4.1 Insulation resistance. - This test shall be made before the dielectric tests. Prior to the application of the test voltage, the windings of the motor shall be thoroughly discharged by connecting the windings to the frame. The time of test voltage application shall be not less than 60 seconds. The temperature of the motor windings at the time of the test shall be measured and recorded. Insulation resistance

measurements shall be corrected to 25°C. Corrections shall be made on the basis of insulation resistance doubling for each 15°C. decrease in temperature. The relative humidity at the time of the test shall be measured and recorded.

40.4.2 Dielectric - normal potential. - A potential of normal rated voltage shall be applied for a period of 1 minute between isolated circuits and between each circuit and ground to test their insulation.

40.4.3 Capacitance and dissipation factor. - The capacitance and dissipation factor shall be measured with the capacitance test bridge and the values shall be read directly from the bridge. The capacitance e and dissipation factor between each winding and ground and between each of the windings shall be made.

40.4.4 Temperature. - The temperatures of the windings shall be measured by method 2. Thermometers, thermocouples, or ammeters shall be used in adjusting the temperature and keeping it constant. To measure the temperature by method 2, a bench mark or the cold resistance shall be set up by measuring the resistance at room temperature and recording this value. When the operating temperature is to be checked, a stop watch shall be started the instant the power is shut off, the ohmmeter bridge shall be connected as quickly as possible and then simultaneous readings of resistance and time shall be taken. This is usually a two man job. One man sets the bridge at regular intervals of resistance readings and calls "read" when the galvanometers of the bridge swings through zero. The other man reads and records the elapsed time to each "read" signal. This data shall be plotted and the value of resistance, obtained by extrapolating to zero time, shall be used with bench mark values to calculate the operating temperature. It is apparent that the sooner the first point is taken the greater will be the precision of measurement. The maximum time between power shut off and the first resistance reading shall be 30 seconds. This method is always desirable and for high temperature it becomes a "must", since the temperature drop is so rapid. In making the calculation, any of several formulae may be used. However, the following form is preferred

$$\frac{r}{R} = \frac{t + 234.5}{T + 234.5}$$

Where:

r = low or cold resistance in ohms.
R = high or hot resistance in ohms.
t = coil temperature (cold) in °C.
T = coil temperature (hot) in °C.

NOTE: It is also advisable to check the bench mark or cold resistance values at regular intervals because of the increase in resistance of the copper due to aging.

40.5 Test procedures. - The motors shall be tested in accordance with the procedures specified in 40.5.1 and 40.5.2.

40.5.1 All motors. - All motors presented for test shall have satisfactorily passed the following periodic tests specified in table XIV. After completion of these tests a potential of rated voltage shall be applied as specified in 40.4.1.

Description of test	Applicable test paragraph
Resistance (cold)	4.3.4.2
Dynamic balance	4.3.4.5.1
End play	4.3.4.6.2
No-load input	4.3.4.7
Pull-up, breakdown and lock-rotor torque	4.3.4.8
Dielectric strength	4.3.4.9
Heat run	4.3.4.11
Electrical balance	4.3.4.12
Weight	4.3.4.13
Load test	4.3.4.14
Inclined operation	4.3.4.15
Shock	4.3.4.16
Encapsulation	4.3.4.17

40.5.2 One motor of each type. - Sample motors of the type specified in table XVI shall be subjected to the following tests:

(a) Submergence test for the 1st motor. -

(1) Photographs of encapsulated stator winding shall be taken and condition of all parts noted and recorded.
(2) Measure and record insulation resistance, capacitance, and dissipation factor in air.
(3) Submerge motor in salt water and run 500 hour test. Record and measure insulation resistance, capacitance, and dissipation factor after each 50 hour period. This time may be adjusted to suit the work day. Bearings should be replaced after each 100 hours or sooner if inspection reveals bearing failure is imminent.
(4) Upon completion of submergence test a normal potential test shall be applied and motor shall be inspected and condition of all parts noted and recorded. Photographs of encapsulated stator winding shall be taken.

(b) Temperature cycling test for the 2nd motor (stator only need be used). -

(1) Photographs of encapsulated stator winding shall be taken.
(2) Measure and record insulation resistance, capacitance, and dissipation factor in air (cold stator).
(3) Heat sttor in an oven at 130°C ± 3°C. for a 22 hour period and measure hot insulation resistance, capacitance, and dissipation factor.
(4) Remove from oven and immediately (within 5 minutes) submerge stator in chilled water tank until winding temperature (by the resistance method) reaches 10°C. (within one-half hour). Measure insulation resistance, capacitance, and dissipation factor.
(5) Repeat 3 and 4 nineteen times.
(6) After completion of test a normal potential test shall be applied and the stator shall be inspected and the condition noted. A photograph of the stator shall be taken.

Table XVII - Submergence test data. Sample #1 Ser. No.

	Insulation resistance, megohms	Capacitance, uuf	Dissipation factor, percent
Air, initial			
Submergence times 1/ (hours)			
50			
100			
150			
200			
250			
300			
350			
400			
450			
500			

1/ This time may be adjusted to suit the work day.
Normal potential test.
Inspection report.
Photographs.

40.6 Assembly of data. - All data shall be recorded in the following order:

FORM Sample #1 and 2

Mfgr's Name _____ Address (City and State) _____

Date of Mfgr. _____ Frame _____ HP _____

volts _____ Phase _____ Type _____

RPM _____ Duty _____ — Cycles _____

Serial No. Sample #1 _____ Sample #2 _____

Drawing No. _____

TEST DATA

(a) Periodic test data.
(b) Shock test report and approval letter.
(c) Submergence test data as shown in table XVII.
(d) Temperature cycling test data as shown in table XVIII.

Table XVIII - Temperature cycling test data. Sample #2 Ser. No. _____

Cycle	Elapsed time (hours)	Insulation resistance megohms	Capacitance, uuf	Dissipation factor, percent	Temperature 'c.
Initial-air-cold					
1st Oven submerged					
2nd Same conditions - as					
3rd cycle one for each cycle					
20					

Normal potential test _____
Inspection report.
Photographs.

40.7 Definition of failure. - Failure is considered to have occurred if any sample does not comply with the requirements specified herein and the following

(a) Open, grounded or short circuited winding.
(b) Failure to pass normal potential test.
(c) Insulation resistance value of less than 10 megohms (corrected to 25°C.) at any time during the submergence or temperature cycling test. An insulation resistance value of not less than 100 megohms should be considered as a goal.
(d) A dissipation factor (cold) of more than 50 percent at any time during the submergence or temperature cycling test. A dissipation factor of not more than 20 percent should be considered as a goal.

40.8 Approval of equipment. - Three copies of the encapsulated motor suitability test reports shall be prepared by the manufacturer, authenticated by the Government inspector, and submitted to the Bureau of Ships for approval action. The format of the report may be in any convenient form. The data to be submitted in the report shall include the results of all tests and photographs specified in 40.5.1 and 40.5.2. Upon receipt of the above report, approval action will be taken on the basis of test results to allow the use of the equipment for the widest intended purposes. Approval will be given to cover all fractional horsepower frame sizes and the manufacturer will be authorized to manufacture and furnish motors covered by this specification.

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ALTERNATING-CURRENT MOTORS SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF THIS SPECIFICATION AND SHALL CONFORM TO THE FOLLOWING REQUIREMENTS:

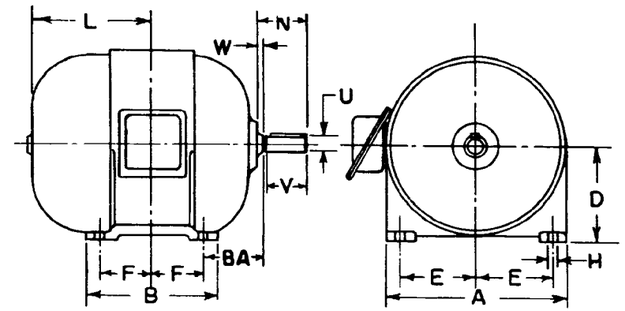
SERVICE	"A"
AMBIENT TEMPERATURE	50C
DUTY	CONTINUOUS
SPEED CLASS	CONSTANT
CLASSIFICATION	SQUIRREL CAGE INDUCTION
BEARINGS	BALL
MOUNTING	HORIZONTAL
	(SEE SECTION HEADED "DIMENSIONS")
INSULATION	CLASS B

SIZES, HORSEPOWER, SPEED, FRAME AND DEGREE OF ENCLOSURE SHALL BE AS SPECIFIED IN THE CONTRACT OR ORDER.

DIMENSIONS - MOTOR SHALL BE SUITABLE FOR FLOOR, BULKHEAD AND CEILING. MOUNTING. MOUNTING DIMENSIONS SHALL BE IN ACCORDANCE WITH THE DETAILED REQUIREMENTS TABULATED ON THIS FIGURE.

TOLERANCES:

"D" DIMENSION	+ 0", - 1/32"
"2F" DIMENSION	+ 1/32" - 1/32
"H" DIMENSION (WIDTH OF SLOT)	+ 3/64" - 0
"U" DIMENSION (SHAFT DIAMETERS)	+ 0.0000" - 0.0005"



CONVENTIONAL MOTOR FRAME

KEYWAYS:
WIDTH + 0.000" - 0.002"
DEPTH

SHAFT DIAMETER	KEY DIMENSION	BOTTOM OF KEYSEAT TO OPPOSITE SIDE OF SHAFT
5/8	3/16 X 3/16	0.517 - 0.502

TABLE A - STANDARD MOUNTING DIMENSIONS

FRAME NO.	KEYWAY WIDTH	KEYWAY THICKNESS	KEYWAY LENGTH	A MAX	B MAX	D	E	F	BA	H	N-W	U	V MIN
48	←	3/64 FLAT	→	—	—	3	2 1/8	1 3/8	2 1/2	11/32 SLOT	1 1/2	1/2	—
56	3/16	3/32	1 3/8	—	—	3 1/2	2 7/16	1 1/2	2 3/4	11/32 SLOT	1 7/8	5/8	—

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Figure 1 - Standards for fractional 1 horsepower alternating current general purpose constant speed motors.

GUARANTEED PERFORMANCE AT RATED VOLTAGE AND FREQUENCY		
LOAD	EFFICIENCY	P.F.
LOCKED ROTOR POWER FACTOR		
LOCKED ROTOR CURRENT		
LOCKED ROTOR TORQUE _____% OF FLT.		
PULL-UP TORQUE _____% OF FLT.		
BREAKDOWN TORQUE _____% OF FLT.		

SPECIFICATIONS AND EXCEPTIONS

THE MOTOR DESCRIBED ON THIS DRAWING IS IN ACCORDANCE WITH MIL-M-17059 WITH THE FOLLOWING EXCEPTION: (IF NONE SO STATE)

STATOR: DIAMETER INSIDE _____IN., CORE LENGTH _____IN.
ROTOR: DIAMETER OUTSIDE _____IN., NO. OF BARS ___ BAR MATERIAL ___
SIZE OF END RING _____ END RING MATERIAL _____

WINDING DATA	STATOR	
NUMBER OF POLES		
TYPE OF CONNECTION		
NUMBER OF SLOTS		
NUMBER OF COILS		
WINDING PITCH IN SLOTS		
TURNS IN SERIES PER COIL		
CONDUCTOR DIAMETER		
CONDUCTOR INSULATION		
RESISTANCE BETWEEN TERMINALS IN OHMS		
WEIGHT OF COPPER ____ LBS.		

TREATMENT OF STATOR WINDING

INSULATION	MATERIAL	SPEC.
SLOT CELL		
SPACER		
TOP WEDGE		
"U" WEDGE		
INS. BETWEEN PHASES		
INS. ON COIL EXT.		
INS. ON COIL LEADS & CONNS.		
COMPLETED STATOR		
LEAD WIRE		

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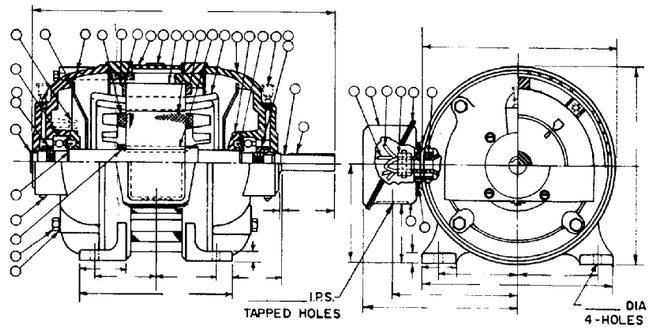
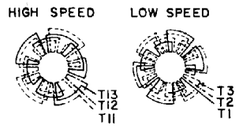
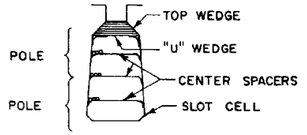




STATOR CONNECTION DIAGRAMS



SKETCH OF STATOR SLOT

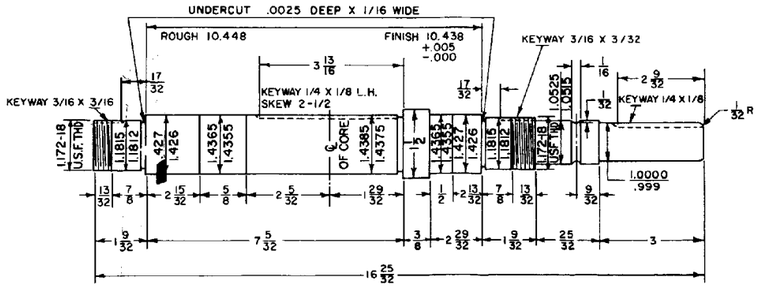


Figure 2 - Service "A" motor.

PERFORMANCE AT RATED VOLTAGE AND FREQUENCY														
DESIRED LOAD	HIGH SPEED							LOW SPEED						
	ACTUAL LOAD(%)	LB.FT.	AMP.	WATTS	R.P.M.	EFF.	P.F.	ACTUAL LOAD(%)	LB.FT.	AMP.	WATTS	R.P.M.	EFF.	P.F.
4/4														
3/4														
2/4														
0														

SPEED TORQUE DATA											
	HIGH SPEED					LOW SPEED					
	VOLTS	AMP.	WATTS	R.P.M.	LB.FT.	VOLTS	AMP.	WATTS	R.P.M.	LB.FT.	
LOCKED ROTOR				—					—		
PULL-UP		—		—			—		—		
BREAKDOWN		—		—			—		—		

TEMPERATURE RISE DATA – DEGREES CENTIGRADE

LOAD ON TEMPERATURE RUN _____% LOAD _____ HRS. PLUS _____% LOAD _____ HRS.
LENGTH OF TEMPERATURE RUN HOURS MINUTES

TEMPERATURE RISE	AMP.	SPEEDS	THERMOCOUPLE NUMBERS					
			1	2	3	4	5	6
1 HOUR BEFORE SHUTDOWN		HIGH SPEED						
		LOW SPEED						
FINAL WHILE RUNNING		HIGH SPEED						
		LOW SPEED						
AFTER SHUTDOWN AMBIENT C°		HIGH SPEED						
		LOW SPEED						

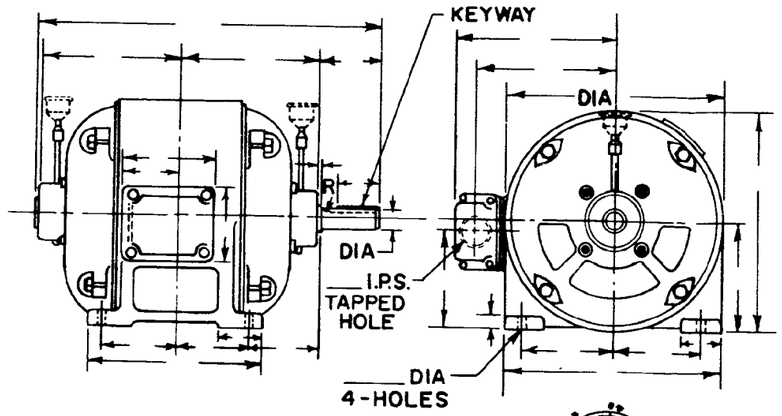
LOCATIONS OF NUMBERED THERMOCOUPLES

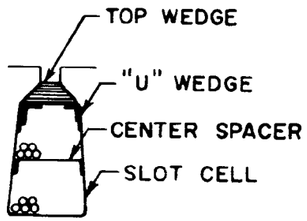
NO. 1 _____ NO. 2 _____ NO. 3 _____
NO. 4 _____ NO. 5 _____ NO. 6 (FRAME) _____

RESISTANCE (OHMS) AND RISE BY RESISTANCE (DEGREES CENTIGRADE)						
	HIGH SPEED			LOW SPEED		
	T1 - T2	T2 - T3	T3 - T1	T11 - T12	T12 - T13	T13 - T11
COLD @ °C						
HOT						
RISE BY RESISTANCE						

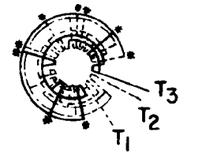
SHOCK TEST REF.

INSPECTOR'S SIGNATURE _____
OFFICE _____ DATE _____





TATOR SLOT DETAIL



STATOR CONNECTION DIAGRAM

STATOR: DIAMETER INSIDE _____ IN., CORE LENGTH _____ IN.
ROTOR: DIAMETER OUTSIDE _____ IN. NO. OF BARS ___ BAR MATERIAL ___
SIZE OF END RING _____ END RING MATERIAL _____

WINDING DATA	STATOR
NUMBER OF POLES	
TYPE OF CONNECTION	
NUMBER OF SLOTS	
NUMBER OF COILS	
WINDING PITCH IN SLOTS	
TURNS IN SERIES PER COIL	
CONDUCTOR DIAMETER	
CONDUCTOR INSULATION	
RESISTANCE BETWEEN TERMINALS IN OHMS	
WEIGHT OF COPPER ___ LBS	

TREATMENT OF STATOR WINDING

INSULATION	MATERIAL	SPEC.
SLOT CELL		
SPACER		
TOP WEDGE		
"U" WEDGE		
INS. BETWEEN PHASES		
INS. ON COIL EXT.		
INS. ON COIL LEADS		
COMPLETED STATOR		
LEADWIRE		

GUARANTEED PERFORMANCE AT RATED VOLTAGE AND FREQUENCY				
LOAD	AMP	RPM	EFF	P.F.
4/4				
3/4				
2/4				
0				
LOCKED ROTOR				
LOCKED ROTOR TORQUE ____ % OF FLT.				
PULL-UP TORQUE ____ % OF FLT				
BREAKDOWN TORQUE ____ % OF FLT				

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Figure 3 - Service "C" motor.

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