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SUPERSEDING
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MILITARY SPECIFICATION

MOTORS. DIRECT CURRENT, INTEGRAL Ho P. , NAVAL SHIPBOARD

All lnterested Bureaus of the Navy department have concurred in the use of this specification.

1. SCOPE

1.1 Scope. - This specification covers integral horsepower, corrosion resistant, direct-current, motor for shipboard use.

1.2 Classification. - Motors shall be of the following services as specified (see 6. 2).

Service A (see 3.1.22 and 6.1).
Service C (see 3.1.23 and 6.1).

2. APPLICABLE DOCUMENTS

2.1 The following specifications and standard, of the issue in effect on date of invitation for bid, form a part of this specification:

SPECIFICATIONS

FEDERAL

FF-B-171-Bearing, Ball, Annular, (General Purpose).
FF-B-185-Bearings, Roller, Cylindrical, and Bearings, Roller, Self-Aligning.
HH-I-538-Insulation, Electrical, Pasted-Mica
QQ-I-666 - Iron, Malleable; Castings.
QQ-S-692 - Steel, Sheet, Cold Rolled.
QQ-S-693 - Steel, Sheet, Hot Rolled.
GGG-P-781 - Puller, Bushing, Bearing, Gean, Wheel Hub and Cylinder Sleeve, Installing and Removing.

MILITARY

MIL-P-14 - Plastic-Materials, Molding and Plastic-Parts, Molded, Thermosetting.
MIL-C-25 - Capacitors, Fixed, Paper-Dielectric, Direct Current (Hermetically Sealed in Metallic Cases).
MIL-P-79 - Plastic-Materials, Laminated, Thermosetting Rods and Tubes
MIL-B-233 - Boxes, Repair Parts.
JAN-E-251 - Electrical-Equipment; Rotation, Connections, and Terminal Markings for.
JAN-W-583 - Wire, Magnet.
MIL-I-631 - Insulation, Electrical Synthetic-Resin Composition, Nonrigid.
JAN-T-638 - Tape, Insulating (Electrical), Linen-Finish, Plain.
MIL-I-695 - Insulation, Electrical, Paper (Slot-Cell).
MIL-W-806 - Wire. Armature-Banding, Steel, Tinned.
MIL-S-890 - Steel, Forgings and Bars for Hulls, Engines, and Ordnance (Heat Treated).
MIL-S-901 - Shockproof-Equipment, Class HI (High-Impact) Shipboard Application Tests for.

MILTARY (cont'd.)

MIL-E-917 - Equipment, Electric Power, Basic Requirements for (Naval Shipboard

MIL-D-963 - Drawings; Production (for Electrical and Mechanical Equipment - Naval Shipboard Use),

MIL-P-997 - Plastic-Material, Laminated, Thermosetting, Electrical-Insulatting; Sheets, Glass Cloth, Silicone Resin.

MIL-V-1137 - Varnish, Insulating (Electrical).

MIL-F-1148 - Fiber, Insulating.

JAN-R-1149 - Rubber, Synthetic; Gaskets, Packing, Sheets, And strips.

MIL-E-2036 - Enclosures for Electric and Electronic Equipment (Naval shipboard Use).

MIL-W-3068 - Wire Armature Banding, Non-Magnetic Iron, Chrome, Nickel-Alloy.

MIL-I-3190 - Insulation, Electrical, Sleeving, Flexible, Treated.

MIL-I-3505 - Insulation, Electrical, Coil and Slot, High Temperature.

MIL-B-3743 - Brushes, Electrical Contact and Carbon Plates, Electrical Contact Brush.

MIL-I-15024 - Identification Plates, Information Plates and Marking Information for Identification of Electrical, Electronic and Mechanical Equipment.

MIL-P-15037 - Plastic Materials, Laminated, Thermosetting, Sheets, Glass-Cloth Melamine-Resin.

MIL-S-15083 - Steel, Castings.

MIL-R-15137 - Repair Parts for Electrical and Mechanical Equipment (Naval Shipboard Use).

MIL-A-15153 - Aluminurn-Base-Alloy; Die Castings.

MIL-L-15719 - Lubricating Grease, High-Temperature, Electric Motor, Ball and Roller Bearing.

MIL-W-16072 - Wire, Magnet, High Temperature.

MIL-B-16261 - Bronze, Bearing, Casting.

ML-P-16298 - Preservation, Packaging, Packing and Marking of Electric Machines Having Rotating Parts (Includes Associated Repair Parts).

MIL-E-16366 - Electrical Clamps and Lug Terminals; Pressure Grip.

MIL-O-16485 - Ohmmeter, Insulation-Resistance Indicating.

MIL-W-16878 - Wire, Electrical, Insulated, High Temperature.

MIL-I-16910 - Interference Measurement, Radio, Methods and Limits; 14 Kilocycles to 1000 Megacycles.

MI L-A- 17129 - Aluminum Alloy Casting, Sand; Resistant to Salt-Water.

MIL-I-17166 - Iron Castings; Nodular Graphitic (Ductile) Iron (for Shipboard Application).

MIL-H-17678 - Holder, Electrical Contact Brush.

MIL-P-17721 - Plastic, Sheet, Laminated, Thermosetting, Glass Mat, Melamine Resin.

MIL-P-17840- Pump, Centrifugal, Close-Coupled; Navy Standard.

MIL-P-20085 - Packing, Sheet, Plant or Animal Fiber.

MIL-S-20166 - Steel; Bars and Shapes (for Hull Construction) (Including Material for Drop and Miscellaneous Forgings).

NAVY DEPARTMENT

General Specifications for inspection of Material.

14L3 - Lubricant, Ball - and Roller -Bearings.

42B10 - Bearings, Roller.

46M2 - Metal, Antifriction; Ingots and Castings.

STANDARDS

MILITARY

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

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

2.2 Other publications. The following document forms a part of this specification. Unless otherwise indicated, the issue effect on date of invitation for bids shall apply.

AMERICAN STANDARDS
224.7- Apparatus Noise Measurements.

(Application for copies should be addressed to American standards Association, 70 East 45th Street, New York 17, New York.)

3. REQUIREMENTS

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

3.1.1 Continuous duty. - Continuous duty is a requirement of service that demands operation at a substantially constant load for an indefinitely long time (see 3.2.6. 1).

3.1.2 Intermittent duty. - Intermittent duty is a requirement of service that demands operation for alternate intervals of (a) load and no-load, or (b) load and rest, or (c) load, no-load, and rest (see 3.2.6.2).

3.1.3 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 3.2.6.3).

3.1.4 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 3.2.6.4).

3.1.5 Contact-speed motor. - A constant-speed motor is one of which the normal speed of operation is constant or practically constant; for example, a shunt-wound motor.

3.1.6 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.

3.1.7 Adjustable-speed motor. - An adjustable-speed motor is one the speed of which can be varied gradually over a considerable range, but when once adjusted remains practically unaffected by the load.

3.1.8 Base speed of adjustable-speed motor. - The base speed of an adjustable-speed motor is the lowest speed obtained at rated load and rated voltage at normal operating temperatures.

3. 1.9 Varying-speed motor. - A varying-speed motor is one the speed of which varies in considerable degree with change in load, ordinarily decreasing when the load increases, such as a series motor.

3.1.10 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.

3.1.11 Front (of motor). - The front of a motor is the end opposite the coupling. For a motor having a coupling on each end, it is the end with the commutator.

3.1.12 Back (of motor). - The back of a motor is the end which carries the coupling or driving pulley. For a motor having a coupling on each end, it is the end opposite the commutator.

3.1.13 Shunt-wound motor. - A shunt-wound motor is a direct current motor in which the field circuit and armature circuit are connected in parallel. If a light series winding is added to prevent a rise in speed with increase of load, the motor is termed stabilized shunt-wound.

3.1.14 Series-wound motor. - A series-wound motor is one in which the field circuit and armature circuit are connected in series.

3.1.15 Compound-wound motor. - A compound-wound motor is one which has two separate field windings: one, usually the predominating field, connected in parallel with the armature circuit, and the other connected in series with the armature circuit.

3.1.16 Efficiency. - The efficiency of a motor is the ratio of the useful power output to the total power input.

3.1.17 Direct measured efficiency. - The output is determined by direct measurement of torque and speed.

3.1.18 Conventional efficiency. - The output is determined by subtraction of the component losses from the input.

3.1.19 Thermal protective (inherenting 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 overhearing due to overload or failure to start.

3.1.20 Integral horsepower-motor. - An integral horsepower motor is one built in a frame size 203 or larger as shown in table B of figure 1 or table for d. c. motors of Specification MIL-I-17840,

3.1.21 Set. - The word "set" as applied to any particular item in the list of repair parts and tools means the total number of such parts incorporated in the construction of one motor.

3.1.22 Service A. - A service "A" motor is a high grade, class HI shockproof motor meeting the requirements specified in 3.1 to 3.6.1 inclusive (see 6. 1).

3.1.23 Service C. - A service "C" motor is a marine type commercial motor meeting the requirements specified in 3.1 to 3.5.2 inclusive and 3.6.2 (see 6.1).

3.1.24 Speed regulation. - The speed regulation of a motor is the change in speed when the load is reduced from full load (hot) to no load (hot) with constant applied voltage and field rheostat setting, expressed as a percent of rated full load (hot) speed.

3.2 General design. -

3.2.1 Ambient temperature. - Motors shall be designed for the following ambient tern peratures as specified (see 6.2):

40°C --------- 65°C.
50°C --------- Special

3.2.2 Audible noise. - Motors shall operate without objectionable audible noise at al loads and speeds within the service range. where specified (see 6. 2), specific limits on the audible noise produced by the motor shall apply.

3.2.3 Voltage limitation. Motors shall be designated for the following voltages as specified (see 6. 2): For submarine voltages, see 3.7.1.1.

115
230
special

3.2.4 Voltage limitation. - Except for submarine service (see 3.7. 1), motors shall operate successfully at rated load with voltage not more than 10 percent above or below rated voltage, but not necessarily in accordance with the standards of performance established for operation at rated voltage.

3.2.5 Winding and speed. - The rated speed in revolutions per minute (r.p.m) or rated speed range in r.p.m. shall be as specified (see 6.2). Except for submarine service (see 3.7.2), the winding and speed classification of motors shall be one of the following, as specified (see 6. 2):

Shunt (or stabilized shunt) constant-speed.
Shunt (or stabilized shunt) adjustable.
Shunt (or stabilized shunt) multispeed.
Compound, varying speed.
Compound, adjustable varying-speed.
Compound, varying multispeed.
Series, varying speed.
Series, adjustable varying-speed.
Series, varying multispeed.

3.2.5.1 Stabilized shunt need not be specified in the contract or order, since the method of obtaining stability is at the option of the manufacturer.

3.2.6 Duty. - The duty of motors shall be continuous, intermittent, varying, or short-time as specified (see 6.2).

3.2.6.1 Continuous duty. - Continuous duty motors shall be rated at the horsepower load that can be carried continously at the ambient temperature specified (see 6.2) without exceeding allowable temperature rises (see table V and 3.1.1).

3.2.6.2 Intermittent duty. - Intermittent duty motors shall be rated at the horsepower load and for the time duration which will permit operation of the motor indefinitely at the ambient temperature specified (see 6.2) and at the cycle of load, no load and rest specified (see 6.2) without exceeding the allowable temperature rises (see table V and 3.1. 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 shall be furnished.

3.2.6.3 Varying duty. - Varying-duty motors shall be rated at the horsepower loads and for the time duration which Will permit operation of the motor indefinitely at the ambient temperature specified (see 6.2) and at the cycle of varying loads specified (see 6.2) without exceeding allowable temperature rises (see table V and 3.1. 3). Unless otherwise specified in the contract or order, varying-duty motors shall be capable of operating at 1/4 load until temperature stabilizes followed by full rated load for the specified period.

3.2.6.4 Short-time-duty. - Short-time-duty motors shall be rated at the horsepower load which, starting at the ambient temperature as specified (see 6. 2), can be carried constantly for the period specified (see 6.2) without exceeding allowable temperature rises (see table V and 3.1. 4).

3. 2.7 Enclosure. - Enclosures shall conform to Specification MIL-E-2036. Motors shall be of the following enclosures as specified (see 6. 2):

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

3.2.8 Standard horsepower sizes. - Motors shall be furnished in the following standard horsepower sizes (see 6.2):

1		20	40
1-1/2	7-1/2	25	45
2	10	30	50
3	15	35	Over 50 as required

3.2.9 Overspeed. - Except for submarine motors (see 3.7. 4), motors except varying speed motors shall withstand without injury, continuous speeds of 125 percent of maximum no-load speed. Varying speed motors that have no definite no-load speed shall withstand a continuous speed of not less than 200 percent of the rated full-load speed of the driven auxillary except that where the maximum speed of the auxiliary under normal operating conditions exceeds 200 Percent of rated full-load speed, the motor shall withstand this maximum speed.

3.2.10 Insulation resistance - The insulation resistance, when corrected to 25°C. , shall be not less than the following:

Armature circuit (class A insulated) -12 megohms.
Armature circuit (class B and H insulated) -25 megohms.
Field circuit (class A insulated) -25 megohms.
Field circuit (class B and H insulated) -50 megohms.

3.2.11 Dielectric strength. - Motors shall be capable of withstanding a dielectric test voltage equal to twice the rated value of the terminal voltage plus 1,000 volts at a frequency of not less than 60 cycles per second. The voltage wave shall approximiate a sine wave. The testing voltage shall be applied continuously for a period of not less than 1 minute. As an alternate, motors for which the test voltage is 2,500 volts or less may be tested for not less than 1 second with a test voltage 20 percent higher than the 1-minute test voltage.

3.2.12 Dynamic 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 steel weights attached by noncorrodible bolts securely locked, drilling out of material, securely welded steel weights, or by babbitt 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) Diameter of the rotor not to exceed 16 inches.
(b) Peripheral speed not to exceed 6,500 feet per minute at rated load.
(c) All armature cores to be balanced before the windings are inserted.
(d) Only tinned banding wire is to be used.
(e) 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 pre-balances 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 33-1/2 percent if satisfactory to the bureau or agency concerned.
(f) Thickness of solder over banding wire not to exceed 3/32 inch, and in no case to extend past the center of the air gap.

3.2.12.1 The degree *of* balance shall be "standard" in accordance with table I unless otherwise specified (see 6. 2). For submarine motors see 3.7.12. When tested as specified in 4.2.4.6.1, the maximum allowable amplitude in inches shall be in accordance with table I.

Table I - Maximum allowable amplitude.

Weight of motors (pounds)	Maximum allowable total amplitude		
	Standard balance	Precision balance	Superprecision balance
	Inch	Inch	Inch
Up to 350	0.001	0.0005	0.0002
From 351 to 800, inclusive	.0015	.00075	.0003
From 801 to 2,000, inclusive	.002	.001	.0004
From 2,001 and up	.003	.0015	-----

3.2.12.2 Metal strips. - When metal strips or wedges are used in the armature slots for final balancing, they shall be well insulated from the armature core and windings.

3.2.13 Field coils. - Field coils shall be thoroughly insulated from adjacent, conducting and grounded parts and shall be positively secured so that they cannot become loosened by vibration. As far as practicable, field coils of the same type shall be interchangeable. All motors shall have commutating poles.

3.2.14 Field poles and shoes. - The design shall be such as to allow for adjustment of the air gaps. The field poles and shoes still not be secured by dowels or otherwise in such a manner as to prevent their ready removal, replacement or adjustment. It shall be possible to remove the field poles from the frame without removing the armature.

3.2.15 Frame. - The frame shall be of rigid construction. If approved by the bureau or agency concerned, frames of the larger size horizontally mounted motors may be split in two halves parallel the shaft and in a horizontal plane so as to permit ready removal of the armature in an upward direction.

3.2.16 Feet. - Except for submarine motors (see 3.7. 5), the feet shall be machined and shall be either cast integral with or welded to the frame. The feet shall be provided with round holes for holding down bolts.

3.2.17 End brackets (explosionproof and explosionproof, fan-cooled excluded). - An accurately machined shoulder joint shall be provided between the frame and the end brackets. When so specified, (see 6. 2), the design *of* the end brackets shall provide for, and the accuracy of machining shall be such as to permit, the rotation of the bearing through 90 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 the case of spraytight, watertight and submersible motors, the contact surfaces between enclosing covers and the motor frame or end brackets shall be free from fins, burrs, or other imperfections detrimental to watertightness, and shall be provided with gaskets suitably secured and treated with graphite on the contact surface to prevent sticking. All sheet packing shall be securely attached to the covers.

3.2.17.1 General. - Each end bracket shall be secured to the frame with not less than four hexagon-head screws or bolts of suitable size and strength, Openings of adequate size and number shall be provided so as to give easy access to and a direct view of commutator, collector rings and brushes while the motor is in operation. These openings shall be provided with covers and fastenings. The enclosing covers (handhole or access-hole covers) shall be readily removable. The engaging bolts or locking devices shall be attached to the frame, the end bracket, or the covers as the design Permits in such manner as to prevent the bolts or locking devices from being misplaced or dropped into the machine during repair operations. Except as specified in 3.2.17.3, ready access shall be provided to permit the measurement of the air gap in at least four places approximately 90 mechanical degrees apart on both ends of motors.

3. 2.17.2 Aluminum end brackets. - Alum inure end brackets (see table IV) shall not support the total weight of the motor or diven auxiliary unless approved by the bureau or agency concerned. Steel inserts shall be provided for all threaded portions and bearing housing.

3.2.17.3 Ball bearing and roller bearing motors. - Motors equipped with ball bearings or roller bearings which permit the measurement of the air gap by the method specified in 4.2.4.2, or by an alternate indirect method satisfactory to the bureau or agency concerned, need not be provided with apertures for checking the uniformity of the air gap.

3.2.18 Shafts. - A shaft extension with keyway shall be provided to suit the driven apparatus.

3.2.19 Bearings. - Bearings shall be of the ball, sleeve or roller type as specified (see 6. 2).

3.2.19.1 Ball or roller bearings. - When ball or roller bearings are used, the following requirements shall apply:

3.2.19.1.1 Grease cups. - Compression cups shall be used where grease is a means of lubrication and relubrication of bearings is required but the cups shall be furnished as an onboard repair part item (see table III). The grease cup shall not be mounted on the motor and the threaded hole used to attach the grease cup shall be provided with a pipe plug. The grease pipes, where used, shall be left on the motor and the end fitted with a pipe plug.

3.2.19.1.2 Seals. - Except where double sealed ball bearings are used, the housing shall provide *for a seal* on both of the bearings to prevent the leakage of oil or grease along the shaft.

3.2.19.1.3 Housing construction - Except in the case of split frame motors the bearing housing shall be so constructed as to permit ready removal of the end bracket without the necessity of removing the bearings.

3.2.19.1.4 Addition of grease lubricant. - Where grease lubrication is used the correct amount of lubricant shall be added to the motor before the motor leaves the place of manufacture.

3.2.19.2 Sleeve bearings. -

3.2.19.2.1 General. - Ample bearing surface shall be provided for each sleeve bearing. in general, sleeve bearings shall be of the split type to permit their removal without necessity of removing the armature from the frame or removing equipment mounted on the shaft. Motors having rotors weighting less than 200 pounds may use either the split or solid-bushing type of sleeve bearing.

3.3.19.2.2 Lubrication. - Sleeve bearings shall be lubricated by means of an efficient ring, mask, or force feed lubrication system as required. The number of oil rings shall be such that no ring is required to distribute lubricant for an axial distance greater to 3 inches on either side of the ring.

3.2.19.2.3 Bearing housing. - The housing shall be designed to permit the oil rings to rotate freely up to the maxinum degree of inclination. The rings shall not rub or strike against the sides or ends of the oil reservoir, and shall not show a pronounced irregularity of movement. A means shall be provided to prevent the rings from being thrown out of place when the vessel is permanently listed, rolling or when subject to shock. The housing shall provide for a close-clearance metallic seal on both sides of the bearings to prevent the leakage of oil along the shaft. This is in addition to the deflecting flanges or slingers required on the shaft. Provision shall be made to insure against the suction of oil vapor into the interior of the motor. Provision shall also be made for observation of the oil rings while the motor is running. These openings shall be made oiltight by a cover secured by screw plugs, or other suitable means.

3.2.19.2.4 Filling. - An openidng or standpipe for filling, for preventing overfilling, and for indicating the oil level shall be provided in the reservoir arid shall be fitted with an oiltight plug or cap to pre - v t the escape of oil due to the motion of the vessel. The diameter of the filling opening shall be not less than 1/4 inch for machines built in frames of motors corresponding to 3 horsepower, continuous rating, at .,800 r. p. m. and not less than 3/8 inch for larger machines.

3.2.19.3 Provision for measuring speed (explosionproof and explosionproof fan cooled exclude(i). - In all motors having a single shaft extension, provision shall be made for the measurement of speed with a hand type tachometer. This may be accomplished either by extending the shaft flush with (or slightly beyond) the outer face of the bearing housing, or by providing a hole and a plug in the outer end of the bearing housing. If a hole and plug are provided in the end of the bearing housing, the hole shall be not smaller than 9/16 inch in diameter and the design shall be such that the plug cannot be inserted in the housing to such a depth that the plug will interfere with the end of the shalt. A lathe center or other suitable hole shall be provided in the end of the shaft for the insertion of the tachometer tip.

3.2.20 Armatures - The laminations shall be properly insulated from each other. The spacers used for ventilation shall be mechanically rigid, and shall be secured so as to prevent their coming loose due to vibration in service. In the assembly of the cores, care shall be taken to remove all burrs or projecting laminations in the slot portion of the core which might result in injury to the coils. The lam laminations shall be clamped together in such a manner as to insure that the assembled core is "tight" at the top of the teeth.

3.2.20.1 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. A Pin through the shaft is not an acceptable m cans of preventing axial displacement. In general, welding shall not be used to secure the core to the shaft, however, tack welding in conjunction with other means will be permissible to prevent axial displacement of the core along the shaft. The use of a quill secured on the shaft by means of a press fit may be used if approved by the bureau or agency concerned.

3.2.20.1 Securing core to shaft. - Equalizer connections shall be supplied on all lap-wound armatures of motors having four or more main poles.

3.2.21 Commutators. -

3.2.21.1 General. - The commutator shall be secured rigidly to the shaft or spider in such a manner as to prevent their either rotational or axial motion of the commutator relative to its support under operating or test conditions.

3.2.21.2 Copper seqments. - 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, when worn to the full extent of the allowable wearing depth specified in table II, shall be of ample section to operate satisfactorily.

Table II - Wearing depth of copper segments.

Commutator diameter (inches)	Permissible reduction in diameter
	Inch
2 and under	3/16
Over 2 and up to 4, inclusive	3/8
Over 4 and up to 6, inclusive	1/2
Over 6	5/8

3.2.21.3 Connections. - The connections to the windings shall be effectively soldered, and, if separate risers are used, they shall be mechanically and electrically connected to the commutator bar in a satisfactory manner.

3.2.21.4 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 a manner as to prevent the entrance of moisture, oil, carbon, or copper dust, or other deleterious substances at these points, likewise, the creepage path 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.

3.2.21.5 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.

3.2.21.6 Curing. - All commutators 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.

3.2.22 Brush holders. -

3.2.22.1 Staggering. - In general, brush holders shall be staggered in pars so as to insure even wear of commutator.

3.2.22.2 Accessibility. - Brush holders shall be readily accessible for adjustment and renewal of brushes and springs.

3.2.22.3 Adjustability. - The brush holders shall be installed so that the angular position around the motor shaft of all brush h elders may be adjusted. The construction shall also provide for maintaining the spacing of the various holders at all times during adjustment. Means shall be provided to prevent loosening and shifting of brush holders under vibration and spring pressure.

3.2.22.4 Brush setting. - The correct brush setting shall be plainly indicated by corresponding permanent marks on the brush holder yoke and the motor frame or end brackets.

3.2.23 Terminal boxes and terminal box covers. - Terminal boxes shall be provided and shall be securely bolted or welded to the f ram e. The use of pipe nipples where they are necessary or where motors are to be used in inaccessible locations is acceptable.

3.2.24 Connections and terminals. -

3.2.24.1 Securing connections. - All connections liable to become loosened by vibration shall be provided with locking devices satisfactory to the bureau or agency concerned. 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.

3.2.24.2 Field connections. - In general, and where practicable, all field connections shall be made on the front (commutator) end. In split-frame motors, the field connections which must be broken for disassembly shall be readily accessible.

3.2.24.3 Securing terminal leads. - The terminal leads shall not be attached to the end brackets.

3.2.24.4 Cable connectors. - The end of each motor lead shall be fitted with a connector for joining the motor lead to the supply circuit cable or wire. Unless otherwise specified in the contract or order, the power cables and the terminal lugs for connecting motor leads to power cables shall not be supplied by the manufacturer.

3.2.24.5 Flexible leads. - All terminal leads shall be of flexible, stranded cable or wire. An insulating sleeve or other suitable means shall be provided to prevent abrasion of the lead insulation by metallic edges of the motor frame, terminal box, piping or cable clamp.

3.2.25 Frame, armature and terminal markings. - The manufacturer's serial number shall be stamped (or otherwise permanently marked in the solid metal of the frame underneath (covered by) the main identification plate. The part number, or other information sufficient to completely identify one armature, shall be stamped (or otherwise permanently marked) on the shaft or armature core. The marking of armatures and field coils shall identify the manufacturer and the style and type of motor. Motor leads shall be permanently marked with designating letters which correspond to the markings shown on the diagram of connections for the motor and for the controller used therewith. Terminal markings shall be in accordance with Specification JAN-E-251.

3.2.26 Interchangeability. - All similar parts, including repair parts, of corresponding apparatus furnished on the same order or built to the same drawings, shall be strictly interchangeable without the necessity of further machining, selective assembly or hand fitting of any kind.

3.2.27 Class of insulation. - The class of insulation shall be A, B, or H as specified (see 6. 2).

3.2.28 Lifting means. - Suitable means shall be provided for lifting motors weighing 150 pounds and over.

3.2.29 Painting. -

3.2.29.1 Exterior. - Except for shafts and identification plates, exterior parts shall be painted in accordance with Specification MIL-E-917.

3.2.29.2 Interior. - Electrical insulation of all types, surfaces in contact with lubricating oil or grease, commutators, collector rings, brushes, bearings and bearing surfaces shall not be painted. Also peripheries of armatures and rotors and any other rotating part of a machine from which centrifugal force may cause the paint to be thrown on the windngs when the machine is operated at rated load and rated ambient temperature shall not be painted; insulation varnish conforming to Specification MIL-V-1137, instead of paint, may be applied to such parts. Noncorrosive resisting parts (see Specification MIL-E-917) other than the above shall be painted in accordance with Specification ML-E-917 except that one coat of enamel of any suitable color will be sufficient.

3.3 Identification plates. -

3.3.1 General. - Identification plates shall be attached to the part of the motor which will not ordinarily be renewed during its normal service life, and be located in a readily accessible position where they can be read at all times without danger to personnel. These plates shall be in accordance with type A, B, C or D of Specification MIL-I-15024 except that aluminum alloy and plastic materials will not be permitted.

3.3.2 Identifcation plate markings - The minimum data to be marked on the identification plate for motors shall include the following items:

(a) Manufacturer's name, identification symbols, serial numbers, bureau or agency concerned drawing number, Government contract number, date (year) of manufacture.
(b) Salient design characteristics namely, horsepower, voltage (nominal voltage and voltage range shall be given for submarine service), current, type of winding, speed and duty.
(c) Blank space for Government inspector's official stamping.
(d) Class of insulation and permissible ambient temperature.
(e) Government stock number.

3.4 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. In general, the design shall be such that no specical tools are required; however, where the design and construction is such as to require the use of special tools for their proper maintenance, such tools shall be furnished. The requirements of Specification MIL-R-15137 shall apply.

9.4.1 Onboard repair parts and tools. -

3.4.1.1 Quantity. - Repair parts, based upon the total number of motors furnished for each vessel on a contractor or order, shall be supplied as specified in table III.

Table III - Onboard repair parts.

Item	Repair parts applicable to the motor installed	Quantities to be furnished per vessel		
		1 to 5 identical parts or sets of parts installed per vessel	6 to 20 identical parts or sets of parts installed per vessel	21 or more identical parts or sets of parts installed per vessel
1.	Armature complete with shaft			
	a. Close coupled pumps	1	1	1
	b. Submarine applications	0	0	0
	c. Other applications	As specified (see 6.2)		
2.	Bearings, or bearing linings, sets (sleeve bearings shall be complete with oil rings)	1	2	3
3.	Brushes, sets	4	8	12
4.	Brush-rigging insulation, sets	1	2	3
5.	Brush holders (complete with springs)	1	2	3
6.	Brush holder springs	2	3	4
7.	Friction type (rubbing) seals, sets, where permitted	3	4	5
8.	Capacitors, sets	1	2	3
9.	Special tools [1]	1	1	1
10.	Grease compression cups - (where used), each size and type	1	1	1
11.	Repair parts for radio noise suppression equipment	As specified (see 6.2)		
12.	Additional repair parts required for gear case motors (gear end only)			
	a. Bearings, sets	1	2	3
	b. Friction type (rubbing) seals, sets, where permitted	3	4	5
	c. Sets of gears	As specified (see 6.2)[2]		

[1] A tool for removing the ball bearings need not be furnished when the ball bearing can be removed by removed by pulling on the inner race with one of the tools contained in a "Complete" Naval shipboard set of tools specified in Specification GGG-P-781.

[2] If any gear is not readily removable from its shaft, the shaft shall be furnished as a repair part.

3.4.1.2 Repair parts boxes. - Where specified in the contract or order onboard repair parts and tools shall be furnished in repair parts boxes conforming to type M of Specification MIL-B-233 (see 6.2).

3.4.1.3 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 setisfactory only when an acceptable schedule of shipment of onboard repair parts has been arranged between the manufacturer and the ordering activity.

3.4.2 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 Specification ML-R-16137.

3.5 Drawings. - Master drawings and certificate data conforming to type I of Specification ML-D-963 shall be furnished, except that for service C motor a List of material shall not be required. The approval activity for master drawings shall be the bureau or agency concerned or its field agency. The approval activity for certification data shall be the ordering activity.

3.5.1 Master drawings.- (See 3.6.1.14 for service A motor and 3.6.2.5 for service C motors.)

3. 5.2 Certification data sheet. - In addition to the data required by Specification ML-D-963, certification data shall include the following information:

(a) Reference drawings including drawings of the driven auxillary, brakes, magnetic clutches, and motor controller and disconnect switch, manufacturer's drawing numbers, bureau or agency concerned drawing numbers, and certification data of the referenced drawings.
(b) Additional remarks, notes and data including horsepower, voltage, current, speed, type of winding and whether of a special type such as close coupled.

3.6 Requirements applicable to individual services. -

3.6.1 Service A. -

3.6.1.1 General. - Service A motors shall conform to Specification MIL-E-917.

3.6.1.1.1 Materials. -

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

Table IV. Minimum material requirements for service A motors.

Item	Limitations	Material	Remarks
Armatures:			
Quills and spiders	Where used	Steel[1]	----------
Flanges	Where used	Steel[1]	----------
		Nodular graphitic iron[2]	Specification MIL-I-17166
Cores	All sizes	Steel	Commercial, nonaging, low hysteresis
V-rings and shells	All sizes	Steel[1]	----------
		Malleable iron[2]	Grade I, of Specification QQ-I-666
		Nodular graphitic iron[2]	Specification MIL-I-17166
Insulation between commutator bars	Classes A and B	Pasted mica	Specification HH-I-538
	Class H	Pasted mica (silicone binder)	----------
Commutator ground insulation	Classes A and B	Pasted mica	Specification HH-I-538
	Class H	Pasted mica (silicone binder)	----------
Ball bearings	All sizes	--------	Specification FF-B-171

Table IV. Minimum material requirements for service A motor (cont'd.)

Item	Limitations	Material	Remarks
Ball bearings caps and cartridges	All sizes	Steel[1]	---
		Malleable iron[2]	Grade I of Specification QQ-I-666
		Nodular graphitic iron[2]	Specification MIL-I-17166
Brushes	All sizes		Specification MIL-B-3743
Brush holders	Reversible motors	Steel[1]	Box, Specification MIL-H-17678
	---	Nodular graphitic iron[2]	---
	---	Malleable iron[2]	---
	---	Brass	---
	Nonreversible motors	Steel[1]	Box or open front, Specification MIL-H-17678
	---	Nodular graphitic iron[2]	---
	---	Malleable iron[2]	---
	---	Brass	---
Brush holder studs	All sizes	Steel[1]	Commercial-treated for corrosion resistance
	---	Brass	Commerical
Brush holder springs	All sizes	Phosphor bronze	Specification MIL-H-17678
	---	Steel	---
Collector rings	All sizes	Brass	Commercial
		Bronze	Commercial
Collector ring insulation	Classes A and B	Pasted mica	Specification HH-I-538
		Mica glass composite	Specification MIL-I-3505
		Plastic	Mineral filled type, Specification MIL-P-14, types MAI-60 or MMI-30
	Class H	Plastic	Glass-silicone combination
Cores	All sizes	Steel	Commercial, nonaging low hysteresis
End brackets	All sizes	Steel[1]	---
		Malleable iron[2]	Grade I, Specification QQ-I-666
		Nodular graphitic iron[2]	Specification MIL-I-17166
	Motors 225 pounds and less	Aluminum (see 3.2.17.2)	Specification MIL-A-15153 or MIL-A-17129
Eyebolts, lifting	Where used	Steel	Type B, grade M, Specification MIL-S-20166
Fans - external and internal	All sizes	Steel[1]	---
		Aluminum	Specification MIL-A-17129
	---	Malleable iron[2]	Grade I, Specification QQ-I-666
	---	Nodular graphitic iron[2]	Specification MIL-I-17166

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

Item	Limitations	Material	Remarks
External	External fan on totally enclosed fan cooled motors	Plastic, molded	MIL-P-14, reinforced material of nominal impact strength of 1.0 foot-pounds per inch notch or greater
	Insulation class A, B, or H (class A or B limits)		
Frames	All sizes	Steel [1]	---
	---	Malleable iron[2]	Grade I, Specification QQ-I-666
	---	Nodular graphitic iron[2]	Specification MIL-I-17166
Grease cups and pipes	All sizes	Steel[1]	Treated for corrosion
Grease	Bearings total temperature of 90°C. and below	Petroleum	Specification 14L3
	Bearings total temperature above 90°C.	Silicone	Specification MIL-L-15719
Ground insulation	Class A	Insulation paper	Types FP, RP and FC, Specification MIL-I-695
	Class B	Mica glass composite	Specification MIL-I-3505
		Pasted mica	Specification HH-I-538
	Class H	Mica glass composite (silicone binder)	Specification MIL-I-3505
		Pasted mica - (silicone binder)	
Hand hole or access covers	All sizes	Steel[1]	---
		Malleable iron[2]	Grade I, Specification QQ-I-666
	---	Nodular graphitic iron[2]	Specification MIL-I-17166
Lead wire	All classes	---	Type E or F, Specification MIL-W-16878
Lead and connection insulation	Class A	Synthetic resin sleeving	Specification MIL-I-631
	Class B	Varnish glass sleeving	Specification MIL-I-3190
	Class H	Silicone rubber glass sleeving	---
Lead clamp insulation	Classes A and B	Plastic laminate	Type GMM, Specification MIL-P-17721 or type GMG, Specification MIL-P-15037
	Class H	Plastic laminate	Type GSG, Specification MIL-P-997
Oil rings	All sizes	Brass	Commercial

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

Item	Limination	Material	Remarks
Part covers for totally enclosed 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, Specification QQ-I-666
	---	Nodular graphitic iron[2]	Specification MIL-I-17166
Shafts	Close-coupled pumps	---	Corrosion resistant material
	Motors 25 horsepower and larger for other than close-coupled pumps	Steel	Specification MIL-S-890 except tensile strength not less than 75,000 p.s.i. and elongation not less than 20 percent in 2 inches
	Motors less than 25 horsepower for other than close-coupled pumps	Steel	Commercial
Sleeve bearings	All sizes	Bronze babbitt	Grade III, Specification MIL-B-16261
		Antifriction metal	Specification 46M2
Spacers and coil separators	Classes A and B	Plastic laminate	Type GMM, Specification MIL-P-17721 or type GMG, Specification MIL-P-15037
	Class H	Plastic laminate	Type GSG, Specification MIL-P-997
Terminal boxes and terminal box covers	All sizes	Steel[1]	---
		Malleable iron[2]	Grade I, Specification QQ-I-666
		Nodular graphitic iron[2]	Specification MIL-I-17166
Terminal boards	Classes A and B	Plastic	Mineral filled type, Specification MIL-P-14, type GMM, Specification MIL-P-17721 or type GMG, Specification MIL-P-15037
	Class H	Plastic	Type GSG, Specification MIL-P-997
Varnish, insulating	Classes A and B		Grade CB, Specification MIL-V-1137
	Class H		Silicone, baking type

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

Item	Limitations	Material	Remarks
Washers, bushings and tubes (insulating)	Classes A and B	Pasted mica	Specification HH-I-538
		Plastic laminate	Type GMM, Specification MIL-P-17721 or type GMG, Specification MIL-P-15037 or MIL-P-79
	Class H	Plastic laminate	Type GSG, Specification MIL-P-997
Wedges	All sizes	Steel	Commercial
		Brass	
Wedges, flat	Classes A and B	Plastic laminate	Type GMM, Specification MIL-P-17721 or type GMG, Specification MIL-P-15037
	Class H	Plastic laminate	Type GSG, Specification MIL-P-997
Wedges, formed	Class A - to be used where wedge cannot be made in a flat sheet	Fiber	Specification MIL-F-1148
Wire, armature end turn bandings	All sizes	Steel	Specification MIL-W-806
	All sizes	Nonmagnetic alloy	Specification MIL-W-3068
Wire, electric, round	Type C, sizes 4 to 40 inclusive only	Copper	Specification JAN-W-583, whole sizes only
Wire, electric, round	Type C2, sizes 0 to 36 inclusive only	Copper	Specification JAN-W-583, whole sizes only
Wire, electric, round	Type R2, sizes 8 to 40 inclusive only	Copper	Specification JAN-W-583, whole sizes only
Wire, electric, round	Type R4, sizes 15 to 23 inclusive only	Copper	Specification JAN-W-583, whole sizes only
Wire, electric, round	Type AV, sizes 4 to 25 inclusive only	Copper	Specification JAN-W-583, whole sizes only
Wire, electric, round	Type GV, sizes 8 to 25 inclusive only	Copper	Specification JAN-W-583, whole sizes only
Wire, electric, round	Type GV, sizes 27, 28, 29, 30 and 33 only	Copper	Specification JAN-W-583, whole sizes only
Wire, electric, round	Type G2V, sizes 8 to 25 inclusive only	Copper	Specification JAN-W-583, whole sizes only
Wire, electric, round	Type GH, sizes 14 to 30	Copper	Specification MIL-W-16072, whole sizes only
Wire, electric, round	Type GH, sizes 32 34 and 36 only	Copper	Specification MIL-W-16072, whole sizes only
Wire, electric, round	Type G2H, sizes 11 to 26 inclusive only	Copper	Specification MIL-W-16072, whole sizes only

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

Item	Limitations	Material	Remarks
Wire, electric, rectangular	Type R4, 50 x 187, 60 x 200, 60 x 240 or 80 x 170 mils only	Copper	Specification JAN-W-583
Wire, electric, rectangular	Type AV and G2V, 64 x 325, 80 x 325, 258 x 258, or 289 x 289 mils only	Copper	Specification JAN-W-583
Wire, electric, rectangular	Type AV, 258 x 365 mils only	Copper	Specification JAN-W-583
Wire, electric, rectangular	Type G2V, 182 x 182 mils only	Copper	Specification JAN-W-583
Wire, electric, rectangular	Type G2H, 24 x 65; 40 x 80, 90, 95, 100 or 125; 52 x 62; 50 x 80, 110, 120, 200, 300 or 310; 57 x 82; 65 x 115 or 240; 45 x 180; 54 x 160; 72 x 72; 80 x 110, 185, 235, 295 or 320; 51 x 180 or 258; 60 x 200 or 240; 75 x 155, 200 or 215; 102 x 125; 114 x 114; 55 x 245; 95 x 150 or 245; 70 x 250; 85 x 205; 90 x 200; 130 x 150; 88 x 243; 82 x 324; 105 x 285; 182 x 182; 135 x 275; 162 x 162; 130 x 250; 200 x 375 mils	Copper	Specification MIL-W-16072

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

[2]For Bureau of Ordnance contracts or equipment, specific approval from the Bureau of Ordnance shall be obtained prior to use of these materials.

Note. - Alternate wire sizes - Types C, C2, R2, R4, AV, GV and G2V of Specification JAN-W-583 and types GH and G2H of Specification MIL-W-16072 of sizes other than those in table IV may be used provided the design is such as to permit rewinding with a type and size listed in table IV and having an equivalent or higher temperature rating.

3.6.1.1.3 All instulated 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.

3.6.1.2 Temperature limits. - The motors shall be so designed as not to exceed the values of maximum permissible temperature in table V. The methods Of temperature measurements specified in table V shall apply.

Table V - Maximum permissible temperature rises.

Item	Part	40°C. ambient			50°C. ambient			65°C. ambient		
		A	B	H	A	B	H	A	B	H
1	Armature windings wire field windings and all windings other than those given in item 4									
	a. Open									
	Method 1	40	60	120	30	50	100	15	35	95
	Method 2	50	75	140	40	65	130	25	50	115
	b. Protected, dripproof protected, splashproof and splashproof protected									
	Method 1	50	70	130	40	60	120	25	45	105
	Method 2	60	80	145	50	70	135	35	55	120
	c. Spraytight, fan-cooled, watertight fan-cooled, totally enclosed, fan-cooled									
	Method 1	55	75	135	45	65	125	30	50	110
	Method 2	60	80	145	50	70	135	35	55	120
	d. Others									
	Method 1	55	75	135	45	65	125	30	50	110
	Method 2	65	85	150	55	75	140	40	60	125
2	Cores and mechanical parts in contact with or or adjacent to the insulation									
	a. Open	40	60	120	30	50	110	15	35	95
	b. Motors listed under 1b	50	70	130	40	60	120	25	45	105
	c. Motors listed under 1c and 1d	55	75	135	45	65	125	30	50	110
3	Commutator									
	a. If class A insulation is employed in commutator or is adjacent thereto	65[1]	65	---	55[1]	55	---	40[1]	40	---
	b. If class B insulation is employed in commutator	85[1]	85	85	75[1]	75	---	60[1]	60	---
	c. If class H insulation is employed in commutator	--	--	145	--	--	135	--	--	120
4	Bare copper windings and single-layer field windings with exposed uninsulated surfaces									
	a. Open	50	70	140	40	60	130	25	45	115
	b. Motors listed under 1b	60	80	150	50	70	140	35	55	125
	c. Motors listed under 1c and 1d	65	85	155	55	75	145	40	60	130
5	Bearing	50	50	110	40	40	110	25	25	85
6	Miscellaneous parts as brush holders, brushes, pole tips and other mechanical parts, may attain such temperatures as will not injure the motor in any respect	--	--	---	--	--	---	--	--	---

J These values shall be reduced by 10" C. in the case of open motors.

Note. - With but few exceptions, the values applicable to windings in table V are determined by the following "hottest spot" allowances, based on the "hot spot" temperatures in Specification MIL-E-917 and applicable to the various types of motor construction and methods of temperature measure:

Motor enclosure	Method of measurement	Class of insulation A	B	
Open	Method 1 (thermometer)	25	30	40
	Method 2 (resistance)	15	15	20
Protected, dripproof protected, splashproof and splashproof protected	Method 1	15	20	30
	Method 2	5	10	15
Totally enclosed, fan-cooled spraytight, fan-cooled watertight, fan-cooled		10	15	25
		5	5	10
Others		10	15	25
		0	5	10

3.6.1.2.1 Where the resistance of the winding is 1.0 ohm or more, method 2 (resistance) applies. Where the resistance of the winding is less than 1 ohm, the temperature measurements shall be determined by method 1 (themometer) except for those motors where the windings are inaccessible, in which case method 2 (resistance) shall be used.

3.6.1.3 Shock resistance. - The motors shall be capable of withstanding the high-impact shock test specified in Specification MIL-S-901 and 4.2.4.22 herein.

3.6.1.4 Armature windings. - In motors of a frame size larger than that used for a motor having a rating of 5 horsepower at 1150 r. p. m. the armature coils shall be form-wound (that is, wound, formed, and Insulated before assembly in the core slots) and interchangeable. The coils shall be securely retained in the slot by wedges. Banding wire shall not be used to secure the windings in the slot. Where steel banding wire is used to band the armature end turn windings, the wire shall be in accordance with Specification MIL-W-806 or MIL-W-3068. The insulation used Uncle r the wire shall be type FP, FC or RP of Specification MIL-I-695 for class A and pasted mica in accordance with Specification HH-I - 538 or mica-glass combination in accordance with Specification MIL-I-3505 for class B or H.

3.6.1.5 Brush holder springs. - Brush holder springs shall be in accordance with Specification MIL-H-17678. The spring shall not be depended upon to carry current.

3.6.1.6 Brush holders. - The type of brush holders shall be as follows:

(a) For reversible motors: Box type only.
(b) For nonreversible motors: Box or type open.

3.6.1.7 Radio noise. - The design of the motors shall be such as to minimize the generation of radio interference. Where suppression harnesses are required to reduce radio noise to the limits specified (see 6.2) impedance coils and capacitors designed for suppression purposes shall be satisfactory to the bureau or agency concerned, and shall be capable of withstanding high impact shock test in accordance with Specification MIL-S-901. Capacitors shall be in accordance with Specification MI L-C -25.

3.6.1.7.1 Radio interference suppression devices, where required, shall be readily removable for replacement purposes and shall be capable of withstanding a voltage of 600 volts. If necessary the radio interference suppression devices may be removed from the circuit when the motor in being subjected to the dielectric test specified in 4.2.4.12.

3.6.1.7.2 When specifically required (see 6. 2), the motors covered by this specification shall comply with Specification MIL-I-16910, including suppression limits, under all load and speed conditions.

3.6.1.8 Change in speed due to heating. - Motors shall be so designed that the change in motor speed from rated load cold to rated load hot, based on rated load speed hot shall not exceed the following percentages:

Class A insulation

Open - 10 percent Others - 15 percent

Classes B and H insulation

All degrees of enclosure - 15 percent

3.6.1.9 Ball bearings. - Ball bearings shall be of the following types:

(a) Single shield, single row, radial, type III class 1 in accordance with Specification FF-B-171 or single sealed, single row, radial type III class 6 of Specification FF-P-171 having the same envelope dimension as the single shield, single row, radial, type III class 1 in accordance with Specification FF-B-171.
(b) Radial, single row, both races extended, sealed, cartridge type, type 120 in accordance with Specification FF-B-171. Where this type of bearing is utilized, a plate bearing the warning "DO NOT LUBRIGATE" shall be secured to the end bells.

3. 6.1.9.1 Size and series. - Unless otherwise specified in the contract or order, the bearings shall oe of the size and series as shown in table B of figure 1 and the applicable table for d. c. motors of Speci - fication MIL-P-17840.

3.6.1.9.2 Mounting. - The bearings shall be secured on the shaft by means of locknuts and lockwashers. The pulley end bearing shall be fixed axially in the housing by suitable housing and end cap shoulders. For gear case motors the front end bearing shall be fixed in the housing. The axial movements of the shaft shall be not more than 0.010 inch including bearing end play where the application does not require the end play to be minimized. All fits and tolerance shall be in accordance with Specification FF-E-171 (see 3.6.1.14 (b) (l)).

3. 6. 1. 9.3 Heat stabilization. - Bearings operating above 90° C. shall be heat stabilized so that their dimensions do not increase more than 0.0001 inch per inch of diameter during 2500 hours at 149°C. Where heat stabilized bearings are used they shall be of the type specified in 3.6,1.9 (b).

3. 6. 1.10 Roller bearing. - When roller bearings are used, they shall conform to Specification 42B10 and Specification FF-B-185.

3.6.1.11 Sleeve bearings. - The inside diameter of the oil ring shall be in accordance with table VI.

Table VI - Diameter of oil ring.

Diameter of shaft	Minimum inside diameter of ring
Inches	
Up to 2, inclusive	2 times diameter of shaft
Over 2 up to 6, inclusive	4 inches or 1.75 times diameter of shaft, whichever is greater
Over 6	10. 5 inches or 1. 60 times diameter of shaft, whichever is greater

3.6.1.11.1 Rings shall have a true circular shape and shall be of uniform cross-sectim. The cross-section shall preferably be that of a truncated cone with the base on the shaft. Rings shall be machine all over and shall have all corners rounded. The finish shall be smooth and free from flaws. Split oil, rings shall not be used.

3.6.1.12 Methods of attaching fans to shaft. - Where fans are not an integral part of the shaft, one of the following methods shall be used in attaching fans to the shaft.

(a) A key, shaft shoulder and a nut with keyed lockwasher.
(b) A key, shaft shoulders and rings or tubing.
(c) A long key tack welded to the fan and secured in a closed-end key seat.
(d) A Woodruff key with a locked set screw secured on the key. The design shall be such that the set screw will not produce unbalance.
(e) A split fan with clamping bolts and key.

3.6.1.13 Shafts. - Except where double-sealed ball bearings are used, the shaft shall be provided with deflecting flanges or slingers so as to prevent the escape of lubricant from the bearing housing and its suction into the electrical windings under my operating service conditions.

3.6.1.14 Master drawings. - In addition to the requirements of 3.5, master drawings shall conform to figure 2, in form and general arrangement and shall contain the following minimum data:

(a) Schematic wiring diagram of motor windings, with directions covering connections for operating clockwise and counterclockwise rotation or both.
(b) An assembly end and side view showing al1 parts of the motor identified with piece numbers in the list of materials. 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) Bearing housing construction, fits and tolerances.
    (2) Sectional view of commutator, brush rigging and brushes indicating brush rake (angle with respect to commutator), design and materials of all brush rigging and brush holder stud insulation, and methods of supporting brush rigging, brush holders, 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.
    (3) Method of retaining commutator core, sleeve rings, and armature core to shaft. Where a press fit is used to secure the rings or cores to the shaft the interference fit and minim urn pressure to force the core or rings on the shaft should be shown.
    (4) Sectional view of shunt field, series field, if used, and commutating field.
    (5) Baffles.
    (6) Method of attaching terminal box to frame.
    (7) Method of bringing cables out of frame into terminal box and the method of protecting these cabies against chafing at sharp metallic corners.
    (8) 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.
    (9) Dimensions, drilling and tapping of terminal box, and the number of size of cover bolts. (For submarine applications see 3.7. 6.)
    (10) All overall dimensions including mounting, shaft extensions and key.
    (11) Direction of mounting.
    (12) Direction of air flow.
    (13) Lifting means where required (see 3.2. 28).
    (14) All details required by this specification and not covered in the foregoing enumeration.
{c) A detailed working drawing of the shaft.
(d) Design requirements, guaranteed performance (load, efficiency, amperes) for 2/4, 3/4 and 4/4 loads.
(e) Armature diameter and core length.
(f) Commutator diameter, length, wearing depth, depth of undercutting of mica segments, minim urn distance to ground.
(g) Government and manufacturer's brush grade, Government form number, of brushes per stud, number or studs and grade of brush and manufacturer.
(h) Number of main poles and nominal air gap, number of commutating poles and nominal air gap.
(i) Table of armature winding data and insulation of coils, including the following information:
    (1) Number of slots.
    (2) Number of commutator segments.
    (3) Number of single coils.
    (4) Conductor copper.

(5) Conductor insulation and Government specification.
(6) Turns in series per coil.
(7) Feet of wire per coil.
(8) Total weight of copper in armature (pounds).
(9) Insulation of coils.
(10) Resistance in ohms at 25°C.

(j) Development of armature winding. A partial diagram is sufficient, provided it establishes the winding patter and shows dummy coils if any.
(k) Cross-sectional view of armature slot showing insulation used.
(l) Treatment of wound armature. Number of dips, bakes (including baking temperature and period of baking), and Government grade of varnish.
(m) Table of field winding data for all fields, including the following information:
(1) Conductor copper.
(2) Conductor insulation and Government specification.
(3) Conductors in parallel.
(4) Turns per coil.
(5) Feet of wire per coil.
(6) Pounds of wire per coil.
(7) Resistance/oil in ohms at 25°C.
(n) Cross-sectional view of all field coils showing insulation used.
(o) Treatment of field coils. Number of dips, bakes (including baking temperature and period of baking), and Government grade of varnish.
(P) Table of insulation materials showing material used, thickness and applicable Government specifications.
(q) Test data
(1) Table of temperature conditions, overload and full load currents containing the following:
Time, line volts and amperes, shunt volts, field amperes, speed, temperature readings, rise while running, maximum rise after shutdown, of armature coils, core, commutator, front head, rear head location of thermometers.
(2) Resistances both cold and hot of the following:
Armature, shunt field, series field and commutating field.
(3) Field rheostat resistance while hot vs. r. p. m.
(4) Speed regulation, all speed, hot and cold, and percentages of change.
(5) Full load losses, including I^2R fields, I^2R armature, bearing friction and windage, brush friction, core, brush contact, loss stray load, field rheostat and the total of all.
(6) Minimum air gaps, inches, by poles, main and commutating.
(7) Weight of armature in pounds.
(8) Weight of complete motor in pounds.
(9) Performance data at 0, 2/4, 3/4, 4/4 and 5/4 load including line volts and amperes, shunt field volts and amperes, speed and percent of efficiency.
(10) change in speed due to heating, all speeds, hot and cold, and percentages of change.
(11) Variation between actual and rated full load speed (hot), all speeds and percentages.
(12) Additional test data for submarine motors.
a. Test data of 3.6.1.14 (q) (1), (2), (3), (4) and (5) for nominal voltage and the voltage range extremities except overload heat run data is not required unless specified (see 4. 2.4.14.1 and 6. 2).
b. Test data of 3.6.1.14 (q) (9) above for nominal voltage. For the voltage range extremities the performance data at no load and 4/4 load shall be shown.
c. Speed-voltage data (see 4.2.4.23).

(r) 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.

(s) The number and date of the radio noise test report, when a radio noise test is required (see 6.2), and the file number and date of the Bureaus' concerned letter of approval.

(t) Audio noise test data, when required (see 6.2), including readings at no load (except series motors) and full load speeds.

(u) A note identifying the type and class of the applicable Government standard bearing puller (see Spec. GGG-P-781). If the Government standard bearing pullers are not suitable, the note shall so state and shall identify the type, brand and catalog number of a suitable bearing puller.

(v) The following additional insulation data which shall be included on each master drawing or on a separate master drawing previously approved by the bureau or agency concerned. If the data are shown on a separate master drawing covering insulation practice for a number of motors, the bureau or agency concerned drawing of the insulation master drawing shall be referred to on each applicable motor master drawing. These additional data, together with the information required by 3.6.1.14 (b) to 3.6.1.14 (1), inclusive, shall completely describe all insulation used, indicating the materials, thickness, forms, sequence of winding and insulating operations numbers of layers and amount of overlapping of tape applications, limitations (limiting voltages and mechanical conditions), treatment schedules (number of dips and class of varnish used, temperature and duration of baking treatments, vacuum and pressure employed during impregnation). These additional data shall con - tain complete detailed information on each type of wound assembly (main field coils, commutating field coils, armature and commutator assembly) incluing:
  (1) 'Conductor strand and turn insulation.
  (2) Coil insulation including slot and end turn insulation of each armature coil, ground insulation, coil turn separators, coil banding insulation, and support pads between coils and armature spider or pole piece.
  (3) Commutator insulation, including insulation between bars, insulation between bars and shell insulation creepage distances.
  (4) Sketches for each type of winding, showing a cross-section of the winding with relative location and identification by piece numbers, of insulating materials shown.
  (5) 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 winding~ on strands, conductors, turns and coils, the distance that armature coil slot insulation and slot armor extend beyond the armature iron, and the original and final shape of conductors and coils before and after each insulating process.
  (6) Each sketch under (4) and (5) above shall be identified as to the design of motor and the type of winding. The sketches should Contain a table of standard and alternate insulating materials, identified by piece numbers and giving applicable specification.
  (7) Method of bringing out and insulating leads from each coil.
  (8) Slot sections, showing details of slot wedges, slot armor, coil spacers, slot tubes.
  (9) Sketches showing in detail how field coils are assembled, insulated and supported on the pole pieces, insulation between shunt and series coils, and method of preventing excessive relative motion between the various conductors and windings when subjected to high-impact shock.

(w) Stock number for motors.
(x) Government specification, size and quantity applicable to motor terminal lugs.
(y) Detail of identification plate.
(z) Title block in size, form and arrangement in accordance with Specification MIL-D-963.
(aa) Classification block directly above title block including manufacturer's type and class, frame size, duty, enclosure, speed class, full load r. p. m., horsepower, volts, identification plate ampere, lnsulation class, type of mounting, type of winding, service classification and permissible ambient temperature.
(bb) Phantom view of grease cups. Flagged and listed in list of material with following comment in Remarks column "Repair part only".

Note. - Figure 2 is indicative of the general arrangement and information desired by the bureau or agency concerned for a master drawing for a two-speed integral horsepower direct-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 columns, and information, so as to fit the particular motor.

3.6.1.15 Standardization. - Unless otherwise specified in the contract or order, motors shall be in conform ante with the standardization requirements shown on figure 1 for general purpose motors and Specification MIL-P-17840 for close-coupled pump motors. Where nonstandard motors are procured, the requirements of figure 1 and Specification MIL-P-17840 may be used as a guide in determining the frame and bearing sizes to be used.

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

3.6.1.17 Seals. - Except where double sealed ball bearings in accordance with 3.6.1.9 (b) are used, 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, the deflecting flanges 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 3.2.19.1.2).

3.6.1.18 Securing armature core to shaft. - Keys or keys in conjunction with press or shrink fits shall be provided to prevent rotation of the core around the shaft, (see 3.2.20. 1).

3.6.1.19 Securing commutator core to shaft. - The commutator core shall be secured rigidly to the shaft or spider by keying to prevent rotational movement of the core around the shaft. Means shall be provided to prevent axial movement of the core along the shaft, (see 3.2.21. 1).

3.6.1.20 Commutator tightening. - In motors having frame sizes corresponding to 5 horsepower at 1800 r. p. m. and above, suitable provision shall be made for tightening the commutator retaining flanges without the necessity of removing the commutator from the shaft or spider.

3.6.1.21 Securinng brush holder yoke. - The yoke shall be secured to the end bracket in such a manner as to prevent loosening of the yoke under shock or vibration. In general, securing the yoke to the end bracket by means of a set screw is not considered satisfactory, (see 3.2.22. 4).

3.6.1.22 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, unclam peal, is not a suitable method of securing such leads. Sealing compounds for anchoring leads shall not be used, (see 3.2.24.3).

3.6.1.23 Cable connectors. - For motors having frame sizes corresponding to 7-1/2 horsepower at 1800 r.p.m and larger, this connector shall be of the solderless type Conforming to Specification MIL-E-16366, (see 3.2.24.4).

3.6.1.24 Permissible variation from rated speed. - The variation of the actual motor speed at rated voltage and load from rated speed shall not exceed the tolerances required for satisfactory operation of the driven auxiliary. Unless closer tolerances are required for satisfactory operation of the driven auxiliary, the variation of the actual speed at rated loads rated voltage, at normal operating ternperature, and for both directions of rotation from rated full-load speed shall not exceed the following:

Constant-speed motors

Seven and one-half percent for motors UP to and including 7-1/2 horsepower at 1,150 r. p. m.
Five percent for motors larger than 7-1/2 horsepower at 1,150 r. p. m.

Adjustable-speed motors

Seven and one-half percent for motors having a rating up to and including 5 horsepower at 650 r.p.m.
Five percent for motors larger than 5 horsepower at 650 r. p. m.

3.6.1.25 Speed regulation. -

3.6.1.25.1 Motor speed regulation shall be positive, that is, it shall decrease to at least a slight extent with increase of load. Motors having a full-load or overload speed greater than the no-load speed, at corresponding temperatures, will not be accepted.

3.6.1 .25.2 The speed regulation of constant-speed, continuous-duty motors at normal operating tern - peratures, shall not exceed the following:

(a) For motors up to and including 5 horsepower at 850 revolutions per minute, 12 percent.
(b) For motors larger than 5 horsepower at 850 revolutions per minute, 10 percent.

3.6.1.25.3 The speed regulation of adjustable-speed motors at normal operating temperatures, shall not exceed the following:

(a) For motors having a speed range of 4:1, at full-speed rating, 18 percent.
(b) For motors having a speed range of less than 4:1, and for ratings of 3 horsepower and below, at full-speed rating, 18 percent.
(c) For motors having a speed range of less than 4:1, and for ratings above 3 horsepower, at full speed rating, 15 percent.

3.6. 1.25.4 The speed regulation of varying-speed motors shall not exceed the amount specified (see 6. 2).

3.6. 1.25.5 Where the safe satisfactory operation of the driven auxiliary requires a speed regulation which is closer than the value specified in 3.6.1.25.2, 3.6.1.25.4, the needs of the driven auxiliary shall determine the permissible speed regulations in the particular cases.

3.6.1.26 Stray field reduction. - To reduce the stray magnetic field the motor shall incorporate the following:

(a) Stray magnetic fields caused by electrical circuits shall be kept to a minimum by making the area of electrical current loops as small as possible and arranging adjacent loops so that their fields will be in opposition. Current loops shall enclose no magnetic material unless essential for proper performance of equipment. All motor windings and connections shall be balanced for ampere-turns around the shaft to eliminate stray fields insofar as possible. Each circuit which makes even part of a turn around the machine shall return on itself back to the starting point, with conductors for the forward and reverse currents arranged at the same end of the machine and as close as adequate insulation permits. All connections shall be as short as possible.
(b) Brush rings shall be complete rings of unifomn resistance throughout.
(c) Leads to the positive and negative brush rings shall be located as close together as posible.

3.6.1.27 Nonmagnetic motors. - Nonmagnetic motors, when specified (see 6. 2), shall meet the following additional requirements:

3.6.1.27.1 Design. - The design of the motors shall be as follows:

(a) Motor shall have not less than four main field poles.
(b) The number of interpoles shall be the same as the number of main field poles.
(c) The number of turns in any field pole winding (shunt, series, commutating) shall be the same on each pole.
(d) Solid magnetic frames shall be used. Split frames shall not be used.
(e) The outside of the magnetic frame shall be a smooth figure of revolution. Protuberances of magnetic material, such as feet or supports shall not be used. Field pole bolts shall be recessed, and, in general, every effort shall be made to ensure that the outside of the magnetic frame is a smooth surface generated by revolving the arc of a curve about the axis of the machine.

3.6.1.27.2 Materials. -

(a) All parts shall be of nonmagnetic material unless otherwise specifically approved by the bureau or agency concerned. Nonmagnetic material is defined as material which has a maximum permeability of less than 2 after fabrication.
(b) The use of ferromagnetic material will be considered for the following parts only:
    (1) Parts in the electrical magnetic circuits.
    (2) Parts for which substitution of nonmagnetic materials would seriously impair either the strength or satisfactory operation of the motor. The use of magnetic materials, however, shall be approved by the bureau or agency concerned.
(c) The use of nonmagnetic material shall not relieve the manufacturer of meeting high-impact shock requirements.

3.6.2 Service C.-

3.6.2.1 General. - Protection against corrosion shall conform to Specicification MIL-E-917. Temperature limits shall conform to table V.

3.6.2.2 Maqnet wire. - The magnet wire shall be of such size as to permit rewinding with one of the types listed in table IV without affecting motor performance

3.6.2.3 Ball bearings. - The ball bearings shall be of such type as to permit replacement with any of the types specified 3.6.1.9. For bearings which are replaceable by the type of bearings specified in 3.6. 1.9 (a), provisions for greasing shall be furnished (see 3.2.19. 1). The axial movement of the shaft shall be not more than 0.045 inch including bearing end play, when the application does not require the end play to be minimized.

3.6.2.4 Radio noise. - If specified, (see 6.2) the requirements of 3.6. 1.7 shall apply.

3.6.2.5 Master drawings. - In addition to the requirements of 3.5, meter drawings shall conform to figure 3 form and general arrangement and shall contain the following minimum data

(a) An outline drawing showing side and end views and giving the following dimensions: overall, mounting bolt holes, tapped holes, bolt spacing, shaft extension, key and keyway.
(b) Armature diameter and core length.
(c) Commutator diameter, length, wearing depth, depth of undercutting of mica segments.
(d) Government and manufacturer's brush grade, Government form number, number of brushes per stud, number of studs and grade of brush and manufacturer.
(e) Number of main poles and nominal air gap, number of commutating poles and nominal air gap.
(f) Table of armature winding data and insulation of coils, including the following information:
    (1) Number of slots.
    (2) Number of commutator segments.
    (3) Number of single coils.
    (4) Conductor copper.
    (5) Conductor insulation and Government specification.
    (6) Turns in series per coil.
    (7) Feet of wire per coil.
    (8) Total weight of copper in armature (pounds).
    (9) Insulation of coils.
    (10) Resistance in ohms at 25°C.
(g) Development of armature winding. A partial diagram is sufficient provided it establishes the winding pattern and shows dummy coils if any.
(h) Cross-sectional view of armature slot showing insulation used.
(i) Treatment of wound armature. Number of dips, bakes (including baking temperature and period of backing), and Government grade of varnish.
(j) Table of field winding data for all fields, including the following information:
    (1) Conductor copper.
    (2) Conductor insulation and Government specification.
    (3) Conductors in parallel.
    (4) Turns per coil.
    (5) Feet of wire per coil.
    (6) Pounds of wire per coil.
    (7) Resistance/coil in ohms at 25°C.
(k) Cross-sectional view of all field coils showing insulation used.
(l) Treatment of field coils. Number of dips, bakes (including baking temperatures and period of baking) and Government grade of varnish.
(m) Table of insulation materials showing material used, thickness and applicable Government specifications.
(n) Guaranteed performance at 2/2, 3/4 and 4/4 load including line amperes and percent of efficiency.
(o) Title and classification block as required in 3.6.1.14 (x) and (y).
(p) Weight of complete motor in pounds.
(q) Stock number for motors.
(r) Detailed working drawing of the shaft.
(s) List of repair parts and tools with manufacturer's part numbers and Government stock numbers.
(t) Phantom view of grease cup with note indicating that it is a repair part item only.

3.7 Motors for submarine service. -

3.7.1 Limitations. -

3.7.1.1 Voltage - The nominal voltage and voltage range of motors shall be one of the following as specified (see 6.2):

Nominal voltage	Voltage range
250	175-345
250	200-355
500	350-710
special	Special

3.7.1.2 Duty. -

3.7.1.2.1 Continuous. - The duty of continuous rated motors shall be as specified in table VII.

Table VII - Duty of continuous rated motors.

Nominal voltage and voltage range 250 (175-345)	250 (200-355)	500 (350-710)	Duty
Terminal voltage	Terminal voltage	Terminal voltage	
345	355	710	Continuous
250	250	500	Continuous
200	200	400	30 minutes
175	---	350	10 minutes

3.7.1.2.2 Short time, varying or intermittent. - The duty cycle of these motors for the various terminal voltages shall be as specified (see 6. 2).

3.7.1.2.3 Special voltage. - The duty of special voltage motors shall be as specified (see 6.2).

The winding and speed classification of motors shall be one of those listed under 3.2.5 or shall be special as specified (see 6.2).

3.7.3 Enclosure. - The enclosure shall be one of those listed under 3. 2.7 or shall be special as specified (see 6. 2).

3.7.4 Overspeed. -

3.7.4.1 For motors not requiring a field rheostat. - Motors not requiring a field rheostat shall withstand without injury a continuous speed equal to 110 percent of the warm no-load speed attained under the conditions specified in 4.2.4.10.2.2.

3.7.4.2 For motors requiring a field rheostat. - Motors requiring a field rheostat shall withstand without injury the no-load speed attained under the conditions specified in 4.2.4.10.2.2.

3.7.4.3 Motors not having a definite no-load speed. - The requirements of 3.7.4.1 shall apply.

3.7.4.4 Overspeed trip device. - An overspeed trip device shall be employed if specified (see 6. 2). Motors requiring overspeed trip devices need not comply with 3.7.4.1. The overspeed trip device shall be set at the r. p. m. considered by the manufacturer to be a safe r.p.m. but no case shall permit the motor to run at an r. p. m. greater than 125 percent rated r.p.m. at the highest voltage rating of the motor.

3.7.5 Mounting.- Horizontal motors shall be suitable for either deck or underside suspension.

3.7.5.1 Feet. - The feet may be detachable and secured by means of bolts if by this arrangement the motor can be passed through a 25 inch diameter round hatch.

3.7.6 Terminal boxes. - Terminal boxes shall not be drilled or tapped by the contractor. This requirement shall be indicated on the master drawing (see 3.6.1.14, listing ('b) (9)). Provision shall be made for mounting the terminal box on either side of the motor. The internal leads shall be of sufficient length so as to be brought to the terminal box on either side of the motor.

3.7.7 Repair parts. - The requirements of 3.4 shall apply except that armatures shall not be furnished as onboard repair parts. In addition, repair parts boxes (see Specificatlon MIL-B-233) shall not be furnished.

3.7.8 Skewing.- Armature slots shall be skewed with respect to the pole tips.

3.7.9 Brush rake angle. - A rake angle of the brush other than zero shall be provided

3.7.10 Bearings. - In addtiion to the requirements of 3.6.1.9, bearings specially selected for quiet operation shall be used when specified (see 6.2).

3.7.11 Center of gravity. - The center of gravity of the motor shall be indicated on the drawing.

3.7.12 Dynamic balance. - The degree of balance shall be "Precision" in accordance with table 1 unless otherwise specified (see 6.2).

4. QUALITY ASSURANCE PROVISIONS

4.1 Inspection procedures. - For Naval purchases, the general inspection procedures shall be in accordance with General Specifications for Inspection of Material.

4. 1.1 Lot. - A lot shall consist of a group of motors of the same enclosure and of similar design, construction and materials, produced under uniform conditions and over a short period of time.

4.2 Service A. -

4.2.1 Sampling. - sampling shall be in accordance

4.2.1 Sampling procedure for selective tests (at the Place of manufacture) .- Motors shall be selected by Government inspector in accordance with table VII. The inspector may at his discretion require these tests to be made on additional motors if the routine tests show large variations from the accepted design and performance.

Table VII - Sampling for selective tests.

Number of motors on order	Minimum number of motors to be tested (tests in table VIII)
1 to 4	1
5 to 8	2
9 to 25	3
26 to 40	4
41 to 65	5
66 to 110	6
111 to 180	8
181 to 300	10

4.2.1.1 Sampling procedure for periodic tests (at the place of manufacture). - The first motor of a design and size offered for delivery on a contract or order shall be subjected to the specified periodic tests. Thereafter, one mot or of identical design and size shall be selected during each calendar year during which such motors are offered for delivery. If the Government inspector is satisfied that the motors conform to the requirements of this specification, he may waive the subsequent periodic tests. The subsequent periodic shock tests shall be waived in all cases except where there has been a change in design which affects the shockproof characteristics. A periodic test will be required after any change in design which affects the performance characteristics. If routine and selective test data reveal variations beyond a normal manufacturing tolerance, the Government inspector may require that any or all of the periodic tests be made on a particular motor to demonstrate that it conforms to this specification.

4.2.2 Inspection (at the place of manufacture). -

4.2.2.1 Motors. - Each motor shall be subjected by the Government inspector 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.

4.2.2.2 Repair parts. - All motor repair parts shall be subjected to a careful examination to ascertain that the materials, workmanship, and finish are first-class in every respect and that they conform fully to the manufacturer's approved drawings. The principal object of this inspection shall be to determine if the repair parts are exact duplicates of those used in the motor. If the Government inspector has reason to doubt the ready interchangeability of the repair parts with the original motor parts he may require a suitable demonstration of such interchangeability.

4.2.3 Tests. - Motors shall be tested l at the manufacturer's plant in the presence of the Government inspector. Those tests that require assembly with driven auxiliary for which the motor Is designed may be conducted at either the plant of the auxiliary manufacturer or the motor manufacturer. It shall be the responsibility y of the prime (contractor to insure that tests required on assembled units are made. The manufacturer shall make, previous to tests to be witnessed by the inspector, sufficient tests to

insure that the design of the motor conforms in all respects to this specification. To prevent delays of repeated tests, not more than two tests shall be made; the second test shall be made within such time after the first test as stipulated by tie inspector. Failure to make the necessary repairs or remedy defects within that time shall be considered sufficient cause for the final rejection of the motor. Tests shall be performedas shown in table VIII. The results of Periodic tests shall be recorded by the manufacturer on standard factory test record form NIS-21 (this form maybe used at the option of the manufacturer fox routine and selective tests).

Table VIII - Routine, selective, and periodic tests.

Description of test	Applicable test paragraph		
	Routine tests	Selective tests	Periodic tests
Material	4.2.4.1	4.2.4.1	4.2.4.1
Air-gap measurements	4.2.4.2	4.2.4.2	4.2.4.2
Resistance (cold and hot)	4.2.4.3	4.2.4.3	4.2.4.3
Lubrication	4.2.4.4	4.2.4.4	4.2.4.4
Audible noise (by observation)	4.2.4.5.1	4.2.4.5.1	4.2.4.5.1
(by meter) (where required)	---	---	4.2.4.5.2
Dynamic balance:			
With bearings of standard grade (by instrument)	---	4.2.4.6.1	4.2.4.6.1
With bearings of standard grade (by hand).	4.2.4.6.2	---	---
With bearings above standard grade (by instrument)	4.2.4.6.1	4.2.4.6.1	4.2.4.6.1
End play (sleeve bearing motors)	4.2.4.7.1	4.2.4.7.1	4.2.4.7.1
Ball or roller bearing motors	4.2.4.7.2	4.2.4.7.2	4.2.4.7.2
Speed regulation	4.2.4.8	4.2.4.8	4.2.4.8
Commutation	4.2.4.9	4.2.4.9	4.2.4.9
Overspeed	4.2.4.10	4.2.4.10	4.2.4.10
Insulation resistance (cold)	4.2.4.11	4.2.4.11	4.2.4.11
Dielectric strength	4.2.4.12	4.2.4.12	4.2.4.12
Effectiveness of enclosure			
Submersible	4.2.4.13	4.2.4.13	4.2.4.13
Explosionproof - subsequent test waived	---	---	4.2.4.13
All others	---	4.2.4.13	4.2.4.13
Overload and heat run	---	4.2.4.14	4.2.4.14
Insulation resistance (hot)	---	4.2.4.15	4.2.4.15
Change in speed due to heating	---	4.2.4.16	4.2.4.16
Permissible variation from rated speed	---	4.2.4.17	4.2.4.17
Radio noise (subsequent test waived) (where required)	---	---	4.2.4.18
Weight	---	---	4.2.4.19
Efficiency	---	---	4.2.4.20
Inclined operation	---	---	4.2.4.21
Shock (subsequent tests waived)	---	---	4.2.4.22
Speed-voltage (submarine service only)	---	---	4.2.4.23

4.2. 3.1 Routine tests. -

4.2.2. 1.1 Each motor shall be subjected by or under the supervision of the Government inspecor to the routine tests specified in table VIII, to determine conform ante with this specification. Nonconforming motors shall be individually rejected.

4.2.3.1.2 Repair parts. -

4.2.3.1.2.1 Coil tests. - Resistance readings at ordinary room temperature shall be made upon all repair field coil windings and the results checked against the values obtained for the coils of the motors. If the resistances are materially different from those of the motor coils, the repair coils shall be rejected. All repair coils shall be submitted to a dielectric test.

4.2.3 .1.2.2 Repair armature tests. - The tests on repair armatures shall comprise those routine tests normally made on the motor itself. Any armature that has been routine tested in the frame of any motor of the size and design on order may be designated as the repair armature. In the case of armatures on subsequent contracts or orders for which suitable frames are not available at the place of manufacture, the following tests shall be made:

4. 2.3.1.2.2.1 General inspection - The armature shall be subjected to a thorough examination to ascertain that the material workmanship, dimensions, and design are in conformance with specified requirements.

4.2.3.1.2.2.2 Dynamic balance. - The armature shall be dynamically balanced.

4.2.3.1.2.2.3 Insulation resistance. - The requirements of 4.2.4.11 shall apply.

4.2.3.1.2.2.4 Dielectric strength. - The requirements of 4.2.4.12 shall apply.

4.2.3.2 Selective tests. - Each sample motor selected in accordance with 4. 2.1.1 shall be subjected to the selective tests specified in table VIII. If any sample is found not to conform to this specification, the lot which it represents shall be rejected. A rejected lot may be resubmitted for selective tests provided the manufacturer, after being informed of the reasons for rejection, has inspected or tested each motor in the lot for deficiencies noted and has removed all nonconforming motors.

4.2.3.3 Periodic tests. - Each sample motor selected in accordance with 4.2. 1.2 shall be subjected to the periodic tests specified in table VIII.

4.2.3.4 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. in instances where the finished drawings do not include such data, this information shall be recorded on standard Navy forms. Where such data are compiled on standard Navy forms, these forms shall be either carbon-backed, inked, or otherwise prepared so that they may serve as master copies from which reproductions can be made by blueprinting or a similar process. Only one master copy shall be prepared and forwarded to the Navy shipyard, shipbuilder, or design activity responsible for compiling the “Record of Electrical Auxiliaries with Performance Data”. Copies of the master type test data shall not be made or distributed to any other Naval activity, contractor or shipbuilder, except that one copy shall be furnished to the inspector responsible for conducting the tests. Routine test data and selective test data recorded at time of tests on motors other than periodic-tested motors shall be retained by the Government inspector and shall not be distributed to other activities, except when specifically requested.

4.2.4 Methods of test. -

4.2.4.1 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 inspector shall require such material tests whenever, in his judgement, it is 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.

4.2.4.2 Air-gap measurements.-

4.2.4.2.1 Where apertures are provided as specified in 3.2.19.1, the minimum air gap between the armature and field poles shall be measured by suitable feelers or gages. The measurements shall be made in at least 4 places approximately 90 mechanical degrees apart. One of these measurements, where practicable, shall be made at the bottom on each end of the motor. The air gap at any point on the armature periphery shall be not less than 70 percent of the nominal gap, the nominal gap being half the difference between field poles and outside diameter of the armature. Where it is impracticable to measure some or all of the air gaps directly as specified, an alternate, indirect method may be used at the discretion of the Government inspector. The air-gap measurements shall be recorded and made a part of the test record.

4.2.4.2.2 Where apertures are not provided, the uniformity of the air gap shall be determined by ascertaining that the rotor turns freely in the assembled motor, when wound with a wire spaced spirally around the rotor periphery. For this test, the diameter of the wire shall be 70 percent of the nominal air gap of the motor. When this method of checking air-gap uniformity is employed, it need only be applied to those motors chosen for selective tests.

4.2.4.3 Resistance. - The resistance of all windings and the temperature at which they are measured shall be taken and recorded for the cold and hot conditions.

4.2.4.4 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. The oil rings of sleeve bearing motors shall turn freely and there shall be no foaming of the oil. Lubricants approved by the bureau or agent y concerned, 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.

4.2.4.5 Audible noise. -

4.2.4.5.1 By observation. - Observation 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.

4.2.4.5.2 By instrument. - Audible noise meter tests are applicable when audible noise limits are specified (see 6. 2) and measurements shall be made in accordance with the procedure specified in American Standard “Apparatus Noise Measurements” Z24.7 - 1950 with the following exceptions:

(a) The airborne noise level of each motor shall be measured with the ‘ ‘flat” weighing network at a distance of 3 feet.
(b) Observers or reflecting surfaces, other than the floor When necessary, Shall be not less than 3 feet from either the microphone or the motor being measured.
(c) In cases where the measurements cover a range of 10 db or m ore, as in the case of motors producing a highly directional noise, the individual readings at each microphone location shall be reported and summarized in terms of power average together with the maximum and minimum values.

4.2.4.6 Dynamic balance .-

4.2.4.6.1 By instrument.- The dynamic balance of the completely assembled motor (and any special attachments such as brakes, overspeed switches), shall be measured. Motor shall be tested at their no-load speed except that in motors having a varying speed, but no definite no-load speed shall be tested at not less than 100 percent above the rated full-load speed of the driven auxiliary or at the maxi-m urn normal operating speed of the driven auxiliary whichever is higher. 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.

4.2.4.6.2 By hand. - The blance shall be checked by "touch" without the necessity of mounting on an elastic base. If motor feels to vibrate excessively it shall be retested in accordance with 4.2.4.6.1 to determine whether or not the dynamic balance is within the acceptable limit.

4.2.4.7 End play. -

4.2, 4. 7.1 Horizontal sleeve-bearing motors shall be tested for "end play" while running by alternately pressing and releasing the rotor shaft at each end. To insure floating of the shaft, there shall be at least 1/64 inch end play in either direction. The armature shall not oscillate and bump the bearing end. The longitudinal mechanical and electrical centers shall coincide.

4.2.4.7.2 All ball or roller bearing motors shall be tested for end play. The requirements of 3.6. 1.9.2 and Specification MIL-P-17840 apply.

4.2.4.8 Speed regulation (except series motors). -

(a) With the motor operating at rated load, and with fated voltage (for submarine service, the test shall be conducted at nominal and the extremities of the voltage range (see 3.6.1.14 (q) (12) and 3.7.1. 1) applied, the speed in revolutions per minute shall be observed and recorded. The motor shall be immediately disconnected from the load as by the throwing off of the driving belt or unloading a dynamometer, and another set of readings taken. The difference between the full:load speed and the no-load speed shall be expressed as a percentage of the full-load speed.

(b) In the case of adjustable-speed motors the test for speed regulation shall be made at the highest speed rating.

4.2.4.9 Commutation. - The inspector shall ascertain that the brush holders are equally spaced t the brushes are set in the correct commutating zone, and that the setting is permanently marked, that the brushes are well seated on the commutator, and that the commutator itself has a smooth surface. Thereafter during the progress of the tests, the brushes and the commutator shall remain untouched.

4.2.4.9.1 The inspector shall ascertain that practically sparkless commutation is attained by correct commutating pole field strength and not by brush shift from the neutral or by commutating pole shunts. Brush shift from neutral or the use of shunts across the commutating pole field terminals are not acceptable. Proper correction of sparking requires a change in the commutating pole air-gap or the commutating winding.

4.2.4.9.2 The observation of commutation will not, in general, require any special tests as such, but will usually be made in conjunction with and during the progress of other tests. specific observation of the commutation shall be made at approximately 150 percent load at rated voltage for one - half hour or for the time necessary to heat the commutator to a temperature approximately 10 degrees above the total commutator temperature, rated ambient temperature plus rise, permitted in table V, whichever is shorter. Specific observation of commutation shall also be made at rated load, at rated voltage. Readings of volts and amperes shall be taken. The test report shall indicate that commutation noise, and vibration were observed. Figure 4 shall be used as a guide in determining satisfactory commutation. After shut-down, the brushes and commutator shall be checked to determine whether there has been excessive wear, pitting, or other injuries.

4.2.4.9.3 The commutation shall be observed at the same speed, within permissible variations, in both directions of rotation, except for motors whose operation will be in one direction only.

4.2.4.10 Overspeed. - Each motor shall be subjected to the following overspeed test for a period of not less than 5 minutes. Government inspector shall check for noise, balance, and smoothness of running during the test, for loose solder, and for evidence of distortion, injury or noticeable change in the condition of the commutator bars, balance weights fans windings, or any part after shutdown.

4.2.4.10.1 Motors except submarine motors the overspeed tests shall be made at a speed not less than 25 percent above the maximum no-load speed of the motor. On varying speed motors which do not have a definite no-load speed the test shall be made at not less than 100 percent above the rated full-load speed of the driven auxiliary or at the maxim urn normal operating speed of the driven auxiliary, which-ever is higher.

4.2.4.10.2 Submarine motors. -

4.2.4.10.2.1 For motors not requiring a field rheostat. - The overspeed test shall be made at the speed 10 percent above the maximum warm no-load speed of the motor at maxim urn voltage.

4.2.4.10.2.2 For motors requiring a field rheostat. - The overspeed tests shall be made at the speed attained under the following conditions:

(a) Sufficient resistance shall be added to the field circuit to increase the field rheostat resistance to 110 percent of the rated value of the field rheostat designed to be used with the motor. This additional 10 percent increase in resistance is to allow for the variation in the manufacture of field rheostats.
(b) Sufficient addtional resistance shall then be added to the field circuit so as to increase the speed of the motor to 110 percent of the speed attained alter the conditions in (a) above have been complied with.

4.2.4.10.2.3 Motors not having a definite no-load speed. - The test shall be made at not less than 100 percent above the rated full-load speed of the driven auxiliary or at the maximum normal operating speed of the driven auxiliary, whichever requires the higher test speed.

4.2.4.11 Insulation resistance (cold). - This test shall be made before the delectric 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. Separate measurements shall be made on the field and armature windings. Circuits of equal voltage above ground shall be connected together. Circuits or groups of circuits of different voltage above ground shall be separated. Insulation resistance shall be measured with an insulation-resistance-indicating instrument conforming to type GC of Specification MIL-O-16485. The time of test voltage application shall be not less the 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. Unless otherwise specified in the contract or order, 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.

4.2.4.12 Dielectric tests. -

4.2.4.12.1 General. - The dielectric test shall be made after all other tests have been completed. 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, coils and rotating elements with insulated windings.

4.2.4.12.1 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-voltage 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 O. 707.

4. 2.4.12.3 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.

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

4.2.4.14 Overload and heat run test. -

4.2.4.14.1 Overload tests. - The overload test shall be made at 150 percent rated load only on continuous-duty motors in accordance with the following: Start with motor cold and record temperature at end of run. Temperature rises shall not exceed those specified for continuous operation at rated load. The conditions of test shall be as follows:

Rated motor load - 150 percent.
Voltage - Rated.
Time - 10 minutes.

4.2.4.34.1.1 The permissible temperature rises specified in 3.6.1.2 shall not be exceeded. Unless specified (see 6.2) overload tests for submarine motors are not required.

4. 2.4.14.2 Heat-run test. - The heat run test shall be made on continuous duty motors in accordance with the following:

Rated motor load - 100 percent.
Voltage - Rated. (For submarine service - the test shall be conducted at nominal and extremities of the voltage range (see 3.6.1.14 (q) (12) and 3.7.1. 1).
Time - All temperatures are constant.

4.2.4.14.2.1 The heat run maybe made immediately following the overload test. Motor load maybe obtained by maintaining the current torque or watts input corresponding to rated motor horsepower output.

4.2.4.14.2.3 Detail of temperature tests, correction to shutdown. -

4.2.4 .14.3.1 Normal load heat runs on contiuous-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 taken with the rating giving the highest temperature rises. In cases where this cannot be determined beforehand the motor shall be tested separately for each rating. 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 of any part of the motor.

4.2.4.14.3.2 The duration of the 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.

4.2.4.14.3.3 Wherever possible, temperature measurements shall be taken during the progress of the heat run as well as after shutdown. The highest figures; thus obtained shall be adopted as the observable temperatures. Temperature readings shall be obtained for items listed in table V.

4.2.4.14.3.4 Wherever sufficient time has elapsed between the instant of shutdown and the time of the final temperature measurement to permit the temperature to fall, suitable corrections shall be applied so as to obtain as nearly as possible the temperature at the instant of shutdown.

4.2.4.15 Hot insulation resistance. - The insulation resistance and the temperature at which it is measured shall be taken and recorded immediately following the heat run. (See 4.2.4.11 for details of test.)

4.2.4.16 Change in speed due to heating. -

4.2.4.16.1 Starting with the motor at approximately room temperature and at rated voltage and load conditions, the speed in revolutions per minute shall be observed and recorded at the earliest practicable moment before the field and armature resistances have materially changed in value.

4.2.4.16.2 After the machine temperatures have attained their approximate normal operating valties, and with the rated load and voltage applied to the motor, the speed in revolutions per minute shall again be observed and recorded.

4.2.4.16.3 The difference between the full-load cold and full-load hot speeds shall be expressed as a percentage of the full load hot speed. It shall not exceed the maximum percentage specified in 3.6.13.

4.2.4.17 Permissible variation for rated speed. - The difference between the full-load speed obtained in 4. 2.4.16.2 and rated speed shall be expressed as a percentage, plus or minus depending upon whether it is greater than or less than rated speed. It shall not exceed the maximum percentage specified in 3.6.1.24.

4.2.4.18 Radio interference tests. -

4.2.4.18.1 General. - Where specified in the contract or order (see 6.2), the radio interference tests shall be conducted in accordance with Specification MIL-I-16910. The contractor shall be responsible for providing the test equipment, a suitable location for the performance of the tests, the necessary technical personnel and all facilities for conducting radio interference tests.

4.2.4.18.2 Test records.- A record of radio noise tests indicating ambient noise, conducted noise and, when required, radiated noise measurements and the date and location of tests shall be included in the motor test records.

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

4.2.4.20 Efficiency. -

4.2.4.20.1 The efficiency shall be determined at rated load. In general, the efficiency shall be the directly measured efficiency as determined by dynamometer. If test facilities are limited and the efficiency cannot be measured by the foregoing method, the conventional efficiency will be acceptable. The manufacturer shall state definitely in the test records if other than the directly measured efficiency is given. A curve of efficiency plotted againsthorsepower output shall be made a part of the test record. The efficiency shall be determined for 1/4, 1/2, 3/4, 4/4, and 5/4 rated load. Total losses at rated output shall be segregated as follows:

I^2R fields
I^2R armature
Bearing friction and windage
Brush friction
Core losses
Brush contact loss
Stray load
Field rheostat
Miscellaneous

4.2.4.20.2 Copper losses. - The I^2R loss shall depend on the measured current and the resistance of the windings. For conventional efficiency the resistance of the windings shall be corrected to 75°C, For the directly measured efficiency these losses shall be based on the "hot" resistance of the windings at the temperature of the windings under actual operating conditions.

4.2.4.20.3 Bearing friction and windage. - Drive the motor at rated speed from an independent motor the output of which shall be suitably determined. The motor under test shall have the brushes removed and shall not be excited. This output represents the bearing friction and windage of the motor under test.

4.2.4.20.4 Brush friction of commutator. - Drive the motor at rated speed from an independent motor the output of which shall be suitably determined. The brushes shall be in contact with the commutator, but the motor under test shall not be excited. The difference between the output obtained in the "bearing friction and windage" test and this output shall be taken as the brush friction. The surface of the commutator and brushes shall be smooth and glazed from running when this test is made.

4.2.4.20.5 Core losses. - Drive the motor at rated speed from an independent motor the output of which shall be suitably determined. The brushes shall be in contact, and the motor shall be excited so as to produce at the terminals a voltage corresponding to the calculated internal voltage for the load under consideration. The difference between the output obtained by this test and that obtained under the "brush friction of commutator" test shall be taken as the core loss.

4.2.4.20.6 Brush contact loss. - Two volts total drop shall be considered as the standard drop corresponding to the brush contact loss, for carbon and graphite brushes with pigtails attached. Three volts total drop shall be allowed where pigtails are not attached. Metal graphite brushes shall be considered as special and hence require an actual determination of the drop in each case.

4.2.4.20.7 Stray load losses. - These include those iron and copper eddy-current losses not otherwise included in the foregoing loss tests.

4.2.4.20.7.1 Where the efficiency is directly measured the stray load loss shall be the difference between the total losses and the sum of the I^2R of fields, I^2R armature, brush contact loss, bearing friction and windage, brush friction and core losses.

4.2.4.20.7.2 If "conventional" efficiency is given in lieu of directly measured efficiency; the stray load loss shall be assigned a value of 1 percent of the output and this value used in determination of the conventional efficiency.

4.2.4.20.8 Field rheostat losses. -Field rheostat losses shall be included in the losses of the motor.

4.2.4.20.9 Miscellaneous losses. - When a separately driven blower supplies air to a single motor, the power required to drive it shall be charged against the motor; but when one or more separately driven blowers supply air through a single duct to two or more motors, the power required to drive the blower or blowers shall be charged against the plant or station and not against the single motor.

4.2.4.21 Inclined operation. -

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

(a) Surface vessels motors:
For sleeve-bearing 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.
For ball-bearing and roller-bearing motors:
Shaft inclined 15 degrees, front end low.
Shaft inclined 15 degrees, rear end low.
(b) Submarine motors: Same as 4.2.4 .21.1 (a) except that inclination shall be at 30 degrees.

4.2.4.21.2 Under each of the positions of inclination specified in 4. 2.4.21.1 the motor shall run for a period of not less than 30 minutes for surface vessel motors and 1 hour for Submarine motors. This test may be made on the combined motor driven auxliary. 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. If the motor is provided with oil-ring lubrication It shall be ascertained that the rings do not rub or strike against the sides or ends of the oil well, that they do not “dance” or show pronouced irregularity of movement, and that the shaft does not sling oil into the motor. For submarine motors the bearing or lubricating oil temperature at the completion of test shall be recorded and shown, on the drawing.

4.2.4.21.3 Vertical motors shall be tested by inclining them to an angle of 15 degrees for surface vessels motors and 30 degrees for submarine motors from their normal position, in any direction (that direction which imposes the most service condition, if there be any dissymmetry) and for a period of 30 minutes for surface vessel 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 vessel unitts and 30 degrees for submarie 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 4.2.4.21 2 for horizontal motors and combined motor-driven auxiliaries.)

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

4.2.4.22 High-impact shock test. - The tests shall be as specified in Specification 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. - As requires by the motor. If the motor shaft in application will be required to support 3 heavy weight such as a clutch-type coupling

(c) Principal functions of the equipment or apparatus. - Motive power for various auxiliaries.

(d) A definition of "failure to perform principal functions".-
Breakage of any parts, including mounting bolts.
(2) Appreciable distortion or dislocation of any parts such as mouting feet, poles, coils, brushes, and bearings.
(3) A value of insulation resistance (corrected to 25°C. less than that permitted by 3.2,10,
(4) A mechanical unbalance of more than two times the value of unbalance specified in 3.2.12.1.
(5) A bearing temperature rise in excess of that permitted in table V.
(8) 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 4.2.4.22 (d) (8).
(7) Low dielectric strength. The motor shall be operated to obtain approximately related 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 4.2.4.12 except that it shall be made with an applied voltage equal to 65 percent that specified in 4.2.4.12. Under these conditions, insulation failures shall be cause for rejection.
(8) Failure to pass inspection. The motor shall be disassembled following checks 4.2.4.22 (d) (1) to 4.2.4.22 (d) (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.

(e) Acceptable method of mounting on shock-testing machine. - The mounting adapters shown on the following figures of Specification MIL-S-901 shall be used:
(1) Figure 4C for motors to be tested on the shock-testing machine for lightweight equipment.
(2) Figure 7A for motors to be tested on the shock-testing machine for medium weight equipment.
(3) For heavy weight equipment, the methods of mounting shall be as specified in Specification MIL-S-901.

(f) Exceptions to Specification MIL-S-901. - None.

(9) Place at which shock test will be conducted. - At the manufacturer's plant. Where a manufacturer is unable to conduct these tests at his own plant, he may arrange to have them conducted it a commercial laboratory, or Government laboratory suitably equipped to conduct tests. Where shock tests are conducted at a Government laboratory, a copy of the applicable master drawing shall accompany the motor.

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

Group 1:
Open.
Protected.
Dripproof.
Dripproof protected.
Splashproof protected.

Group 2:
Spraytight
Watertight
Totally enclosed

Group 3:
Spray tight fan-cooled.
Watertight fan-cooled.
Totally enclosed fan-cooled.
Group 4:
Explosionproof.
Group 5:
Explosionproof fan-cooled.
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.

(i) Disposal of shock-tested motors. -

. . 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 under the contract or order provided the post-shock tests specified hereinafter are satisfactorily passed and provided the mechanical corrective measures specified hereinafter are satisfactorily met. Continuous duty motors shall be subjected to a full-load heat run test of 2 hours duration. Intermittent, varying and short-time duty motors shall be subjected to a heat run test corresponding to but not exceeding the specified rating of the motors. All motors shall be given an insulation resistance test and a dielectric strength test in accordance with 4.2.4.15 and 4.2.4.22 (d) (7), respectively, Mounting flanges connecting directly to the driven auxiliary shall be replaced in the event of minor deformation. Minor deformations affecting 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 drawings. A “substandard” plate will not be required. Prior to acceptance of the motor, all ball bearings shall be replaced.

4.2.4.23 Speed-voltage test. - Set field current for full load nominal voltage rating of the motor. With no adjustment of the field rheostat setting as per above, record, no load and full load speed at nominal voltage and the extremities of the voltage range.

4.3 Service C.-

4.3.1 Sampling and inspection for service C motors shall be as specified in 4.2.1 and 4.2.2. Tests shall be as specified in 4.2.3 but limited to only those tests listed in table IX.

Table IX - Service C tests.

Description of test	Applicable test paragraph		Periodic
	Routine tests	Selective tests	
Material	4.2.4.1	4.2.4.1	4.2.4.1
Lubrication	4.2.4.4	4.2.4.4	4.2.4.4
Dynamic balance (by hand)	4.2.4.6	4.2.4.6	4.2.4.6
Insulation resistance (cold)	4.2.4.11	4.2.4.11	4.2.4.11
Dielectric strength	4.2.4.12	4.2.4.12	4.2.4.12
Effectiveness of enclosure	4.2.4.13	--------	--------
Submersible	4.2.4.13	4.2.4.13	4.2.4.13
Explosionproof - subsequent test waived	--------	--------	4.2.4.13
All others	--------	4.2.4.13	4.2.4.13
Air-gap measurement	4.2.4.2	4.2.4.2	4.2.4.2
Resistance (cold only)	4.2.4.3	4.2.4.3	4.2.4.2
Efficiency	--------	--------	4.2.4.20

5. PREPARATION FOR DELIVERY

5.1 Motors together with their repair parts shall be preserved, packaged, packed, and marked in, accordance with Specification MIL-P-16298.

6. NOTES

6.1 Intended use. - Motors covered are all types of d.c. integral hp. motors, except internal combustion engine starting motors and propulsion motors, and are intended for shinboard use. Service A motors are intended for applications where they are essential to the Military effectiveness of a ship. Service C motors are intended for applications where they are not essential to the Military effectiveness of a ship.

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

(a) Title, number, and date of this specification.
(b) Service (see 1.2).
(c) Ambient temperature (see 3.2.1).
(d) Audible noise limits (see 3.2.2).
(e) Rating (volts must always be stated; horsepower or torque requirements, either or both, shall be specified), (see 3.2.3, 3.2.4 and 3.2.8).
(f) Winding and speeds (see 3.2.5).
(g) Duty (specified time of duty cycle) (see 3.2.6).
(h) Load and period of rest for intermittent duty motors (see 3.2.6.2).
(i) Varying load for varying duty motors (see 3.2.6.3).
(j) Period of load time for short-time duty motors (see 3.2.6.4).
(k) Enclosure (see 3.2.7),
(l) Horsepower (see 3.2.8).
(m) Degree of balance if other than “standard” (see 3.2.12.1),
(n) End bracket design (see 3.2.17).
(o) Type of bearings (see 3.2.19).
(P) Insulation (see 3.2.27).

(q) Number of repair armatures (see table III).
(r) Repair sets of gears (see table III).
(s) Repair radio noise suppression equipment (see table III).
(t) Repair parts boxes (see 3.4.1.2).
(u) Whether suppression harnesses and specific radio noise limits are are required (see 3.6.1.7 and 3.6.1.7.2).
(v) Direction of rotation (where non-reversible).
(w) Speed regulation of varing speed motors (see 3.6.1.25. 4).
(x) Whether nonmagnetic motors are required (see 3.6.1.27).
(y) Whether shipment is for domestic shipment, immediate use; domestic shipment involving storage 180 days or less; domestic shipment involving stortage more than 180 days; or over (see 5.1).
(z) For submarine service only:
    (1) Rated voltage and voltage range (see 3.7.1).
    (2) Duty of short time, varying or intermittent motors (see 3.7.1.2.2).
    (3) Duty of special voltage motors (see 3.7.1.2.3).
    (4) Winding and speed classification (see 3.7.2).
    (5) Enclosure, including details for special enclosures (see 3.7.3).
    (6) Whether an overspeed trip device is required (3.7.4.4).
    (7) Whether bearings specially selected for quiet operation are required (see 3.7.10).
    (8) Degree of balance if other than "Precision" (see 3.7.12).

6.3 Reduction of audible noise. - As a means of reducing audible noise, special attention should be given the following:

Magnetic:
1. Number *of* slots per pole pitch.
2. Number of slots magnetically under one pole.
3. Slot frequency as a function of natural frequency of the frame.
4. Skew of slots or pole tips.

Mechanical:
1. Elimination of brush chatter.
2. Stiffeners of brush rigging.
3. Aerodynamic design of the ventilating or cooling system.
4. Mechanical balance.

6.4 Reduction of radio interference. - As a means of reducing radio interference, special attention should be given to the following:

(a) The use of interpole windings.
(b) The use of compensating windings.
(c) Increasing the number of armnature coils and commutator bars.
(d) The use of shallow armature slots.
(e) The use of short-pitch armature windings.
(f) Reducing concentricity between commutator and bearings.
(g) Balanced design to eliminate shaft and bearing currents without the use of auxiliary brushes.

Patent notice. - When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

custodian:
Navy - Bureau of Ships
Other interest:
Navy - Or

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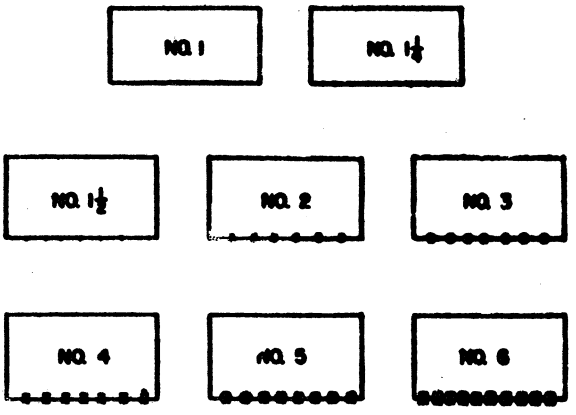

No. 1 Black with no sparks showing.
No. 1-1/4 Slight intermittent sparking.
No. 1-1/2 Slight continuous sparking.
No. 2 Continuous sparking heavier than No. 1-1/2. Streamers just begin to extend from the edge of the brush.
No. 3 Sparks heavier than No. 2.
No. 4 Sparks heavier than No. 3.
No. 5 Sparks heavier than No. 4.
No. 6 Sparks - entire brush covered with continuous heavy sparks.

From 0 to 100 percent load, the sparking shall be equal to No. 1-1/4 or better.
From 100 to 125 percent load, the sparking shall be equal to No. 1-1/2 or better.
From 125 to 150 percent load, the sparking shall not exceed No. 2.

Figure 4 - Sparking chart.

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR
b. ADDRESS *(Street, City, State, ZIP Code)*	☐ USER
	☐ MANUFACTURER
	☐ OTHER *(Specify)*: _____

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

(TO DETACH THIS LINE.)

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