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MIL-G-3111C(SHIPS)
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SUPERSEDING
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MILITARY SPECIFICATION

GENERATORS, ELECTRIC, DIRECT-CURRENT

(NAVAL SHIPBOARD USE)

1. SCOPE

1.1 Generators. - This specification covers direct-current (d. c.) generators up to 1,000 kilowatt (kw.).

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids, form a part of this specification, to the extent specified herein:

SPECIFICATIONS

FEDERAL

FF-B-171 - Bearing Ball, Annular, (General Purpose).
FF-B-185 - Bearings, Roller, Cylindrical; and Bearings, Roller, Self-Aligning

MILITARY

MIL-W-806 - Wire, Armature-Banding, Steel, Tinned.
MIL-S-901 - Shockproof-Equipment, Class HI (High-Impact); Shipboard Application, Tests for.
MIL-E-917 - Equipment, Electric Power, Basic Requirements for (Naval Shipboard Use).
MIL-D-963 - Drawings, Production, Procedure For Procurement of.
MIL-E-2036 - Enclosures for Electric and Electronic Equipment (Naval Shipboard Use).
MIL-W-3068 - Wire, Armature-Banding, Nonmagnetic, Iron-Chrome-Nickel-Alloy.
MIL-B-3743 - Brushes, Electrical Contact; and Carbon Stock Electrical Contact, Brush.
MIL-Q-9858 - Quality Control System Requirements.
MIL-M-15071 - Manual, Technical, for Mechanical and Electrical Equipment (less Electronics).
MIL-T-15108 - Transformers, Power, Step-Down, Single Phase, 60 Cycle. 1-KVA Approximate Minimum Rating; And Reactors (Balance Coils)-Dry, Naval Shipboard
MIL-R-15109 - Resistors and Rheostats, Shockproof (Naval Shipboard Use).
MIL-E-17555 - Electronic And Electrical Equipment And Associated Repair Parts, Preparation For Delivery Of.

STANDARDS

MILITARY

MIL-STD-167 - Mechanical Vibrations of Shipboard Equipment.
MIL-STD-740 - Noise Measurements of Shipboard Machinery and Equipment.

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

2.2 Other publications. - The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids shall apply.

AMERICAN SOCIETY FOR TESTING MATERIALS

ASTM A27-58 - Mild To Medium Strength Carbon Steel Castings For General Application
ASTM A47-52 - Malleable Iron Castings
ASTM A243-55 - Carbon And Alloy Steel Ring And Disk Forgings
ASTM A339-55 - Nodular Iron Castings
ASTM B23-49 - White Metal Bearing Alloys
ASTM B26-58T - Aluminum Base Alloy Sand Castings
ASTM B85-58T - Aluminum Base Alloy Die Castings
ASTM B139-58 - Phosphor Bronze Rod, Bar, And Shapes
ASTM B146-52 - Leaded Yellow Brass Sand Castings For General Purposes
ASTM B209-59T - Aluminum Alloy Sheet and Plate

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(Application for copies should be addressed to the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa.).

3. REQUIREMENTS

3.1 Definitions. -

3.1.1 Continuous duty. - Operation at a substantially constant load for an indefinite period of time.

3.1.2 Efficiency. - Ratio of the useful power output to the total power input.

3.1.3 Conventional efficiency. - Ratio of output to input where input is determined by addition of all component losses to the output.

3.1.4 Air-gap line. - Extended straight line part of the no-load saturation curve.

3.2 Performance requirements. -

3.2.1 Rating. - The rating in kw, voltage and revolutions per minute (r.p.m.) shall be as specified (see 6.1).

3.2.2 Efficiency. - The efficiency of the generator shall be as specified (see 6.1).

3.2.3 Voltage. - Generators shall be designed for the following voltages, as specified (see 6.1):

120 Volts
240 Volts
120/240 Volts

3.2.4 Duty. - Generators shall deliver rated current continuously at rated voltage and rated r.p.m..

3.2.5 Overload. - When specified (see 6.1), each generator shall also be capable of delivering at rated voltage and r.p.m., 125 percent rated kw load for 2 hours and 150 percent rated kw load for 5 minutes.

3.2.6 Unbalanced load rating (three wire generators only). - The unbalanced load rating shall be 15 percent of the rated full load current unless the generator rating is 100 Kw or less, in which case it shall be 25 percent.

3.2.7 Overspeed. - Generators shall be designed and constructed to withstand safely an overspeed of 25 percent (see 4.4.7).

3.2.8 Parallel operation. - When specified (see 6.1) generators shall be designed for parallel operation.

3.2.9 Ambient temperatures. - Generators shall be designed for operation in an ambient temperature of 50° Centigrade (C).

3.2.10 Ripple voltage. - At any load from no load to full load and considering only peak-to-peak voltage values, the commutator ripple at any frequency from zero to 16 kilocycles shall not exceed 2 percent of the rated output voltage.

3.2.11 Voltage regulation. - At rated r.p.m. the following requirements shall apply:

(a) With the field rheostat so adjusted that the generator is operating at rated voltage at no load, the drop in voltage shall be not more than 10 percent when rated load is applied to the generator (see 4.4.11).
(b) With the field rheostat so adjusted that the generator is operating at rated voltage at rated load, the rise in voltage shall not be more than 6 percent when the load is reduced to zero (see 4.4.11).
(c) At any point on the voltage-load curve with the generator field rheostat adjusted as specified in (a) and (b) above, there shall be no rise in voltage with increase in load, or any drop in voltage with a drop in load.

3.2.12 Prime movers. - Generators shall operate satisfactorily with the following types of prime movers as specified (see 6.1):

Steam turbine
Gas turbine
Diesel engine
Gasoline engine.

3.2.13 Responsibility of prime mover manufacturer. - It shall be the responsibility of the prime mover manufacturer to provide a prime mover of sufficient capacity to drive the generator under all conditions of load and overload specified herein (see 6.3).

3.3 Design and construction. -

3.3.1 Basic requirements. - Generators shall conform to Specification MIL-E-917 and the requirements specified herein.

3.3.2 Reliability. - The design shall include features which will result in reliable and stable operation with minimum need for adjustment and alignment, minimum frequency of failure and minimum requirements for maintenance.

3.3.3 Distribution system. - The distribution system shall be two-wire unless three-wire is specified (see 6.1).

3.3.4 Winding. - Generators shall be either shunt-wound where no series field is provided or stabilized shunt wound where a light series field winding is provided to maintain the required voltage regulation. For stabilized shunt wound generators, at rated full

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load voltage and current, the ratio of series field ampere-turns to shunt field ampere-turns shall not exceed 15 percent.

3.3.5 Dielectric strength. - Generators shall withstand a dielectric strength test voltage of twice normal voltage of the circuit concerned plus 1,000 volts, when tested in accordance with 4.4.9.

3.3.6 Insulation resistance. - The insulation resistance, when corrected to 25°C., shall not be less than the following (see 4.4.8):

	Megohms
Armature circuit (class A insulated)	12
Armature circuit (class B, F or H insulated)	50
Field circuit (class A insulated)	25
Field circuit (class B, F, or H insulated)	50

3.3.7 Temperature limits. - At rated r.p.m., voltage and kw. load (see 4.4.12), the temperature rise of the various parts of the generator, shall not exceed the maximum permissible temperature rises specified in table I.

Table I - Maximum permissible temperature rises (based on 50°C ambient continuous rated load).

Part	Insulation class			
	A	B	F	H
Coils and connections; (Method 1, measured by the thermometer, as specified in MIL-E-917).				
(a) Open	30	50	75	110
(b) Protected, dripproof protected	40	60	85	120
(c) Others	45	65	90	125
Windings - method 2 (resistance as specified in Specification MIL-E-917)				
(a) Open	40	65	90	130
(b) Protected, dripproof protected	50	70	95	135
(c) Others	55	75	100	140
Commutators				
(a) Open	45	75	100	135
(b) Others	55	75	100	135
Bearings	60	60	60	110
Miscellaneous parts as brush holders, brushes, pole tips, and similar parts may attain such temperatures as will not injure the generators in any respect.				
Mechanical parts: Cores, poles, and other mechanical parts in contact with insulation	Same as for the insulation with which the parts are in contact			

3.3.8 Radio interference. - Generators shall be designed to cause a minimum of radio interference at all loads and speeds within the operating range. Radio interference suppression equipment shall not be used unless permitted by the contract or order to meet specific radio interference limits (see 6.1). As a means of reducing radio interference, consideration shall be given the following:

(a) Commutating poles.
(b) Compensating windings.
(c) Split series, commutating pole and compensating windings with half of the windings on each side of the armature.
(d) Increased number of armature coils and commutator bars.
(e) Shallow armature slots.
(f) Short-pitch armature windings.
(g) Reduced eccentricity between commutator and bearing.
(h) Balanced design to eliminate shaft and bearing currents without the use of auxiliary brushes.

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3.3.9 Airborne noise. - Generators shall be designed to produce minimum airborne noise at all loads and speeds within the operating range. In addition, when specified (see 6.1), these generators shall meet specified airborne noise limits. As a means of reducing airborne noise, consideration shall be given the following:

(a) Number of slots per pole pitch.
(b) Number of slots magnetically under one pole.
(c) Slot frequency as a function of natural frequency of the frame.
(d) Skewing of slots or pole tips.
(e) Eliminating brush chatter.
(f) Stiffening of brush rigging.
(g) Aerodynamic design of the ventilating or cooling system.
(h) Mechanical balance.

3.3.10 Stray magnetic fields. - When specified (see 6.1), generators shall incorporate the following design features in order to reduce stray magnetic fields. In addition, when specified (see 6.1), these generators shall meet specified stray magnetic field limits:

(a) The area of electrical current loops shall be made as small as possible and adjacent loops shall be arranged so that their fields will be in opposition.
(b) Current loops shall enclose no magnetic material unless essential for proper performance of equipment.
(c) All generator windings and connections shall be balanced for ampere turns around the shaft.
(d) 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.
(e) All connections shall be as short as possible.
(f) Brush rings shall be complete rings of uniform resistance throughout.
(g) Leads to the positive and negative brush rings shall be located as close together as possible.
(h) Individual main pole gaps shall be within plus or minus 10.0 percent of the average main pole gap. The sum of the north pole main gaps shall be within 5 percent of the sum of the south pole gaps. The same requirements shall apply to commutating pole gaps.
(i) Generators rated 100 watts and larger shall have four or more main field poles.
(j) The number of commutating poles shall be the same as the number of main field poles.
(k) The number of turns in any field pole winding (shunt, series, commutating) shall be the same on each pole.
(l) Magnetic frames shall be solid.
(m) Yoke welds shall be at main poles.
(n) The outside of the magnetic frame shall be a smooth figure of revolution. Protuberances of magnetic material, such a 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.

3.3.11 Shock. - Generators shall be capable of withstanding high impact shock in accordance with Grade I of Specification MIL-S-901.

3.3.12 Vibration and balance. - Generators shall meet the vibration and balance requirements of Type II of Standard MIL-STD-167. Balancing shall be effected by the use of steel balance weights attached by noncorrodible bolts securely locked by steel weights dovetailed and suitably anchored in balance grooves, by drilling out material, or by securely welded steel weights. The use of babbitt or lead as a balancing medium is not permitted. When metal strips or wedges are used in armature slots for final balancing of wound armatures, they shall be well insulated from the armature core. Final dynamic balancing of completely wound armatures by the use of solder on the banding wire is permissible subject to the following limitations:

(a) Diameter of the armature shall not exceed 16 inches.
(b) Peripheral speed shall not exceed 6,500 feet per minute at rated speed.
(c) All armature cores shall be balanced before the windings are inserted.
(d) The solder shall not cover an arc more than 25 percent of the armature measured on the banding wire. Where the manufacturer takes care in placing the windings in the slots to reduce unbalance due to axial misalignment of the coils this value may be increased to 33 percent.
(e) Thickness of solder over banding wire shall not exceed 3/32 inch, and in no case extend past the center of the air gap.

3.3.13 Material. - The minimum requirements for materials to be used in generators shall conform to the requirements of Specification MIL-E-917 and table II. For those materials where no specifications are listed the material shall be of a grade suitable

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for the performance and shockproofness intended. Drawings shall indicate the specific commercial identification of commercial materials used.

3.3.13.1 Non-magnetic generators. - When non-magnetic generators are specified (see 6.1) generators shall conform to the following material requirements:

(a) Except as specified in 3.3.13.1(c), all parts including nuts, bolts, screws, lifting eyes and miscellaneous hardware shall be of non-magnetic material.

(b) Non-magnetic material is defined as material having a maximum relative permeability of 2.0 after fabrication.

(c) The use of magnetic material will be permitted for the following parts only:

(1) Parts in magnetic circuits.

(2) Parts for which substitution of non-magnetic materials would seriously impair either the strength or satisfactory operation of the generator. The use of magnetic materials for such parts shall be approved by the bureau or agency concerned.

(d) The use of non-magnetic material shall not relieve the manufacturer of meeting high-impact shock requirements.

Table II - Minimum material requirements.

Item	Material	Specification
Ball bearing caps and cartridges; handhole or access covers; terminal boxes and terminal box covers; internal air baffles; blower shrouds	Steel Malleable iron Nodular graphitic iron 2/ Aluminum	 ASTM A47-52, Grade 35018 ASTM A339-55, Grade 60-45-10 ASTM B26-59T ASTM B85-58T
Bearing oil rings	Brass	ASTM B146-52, Alloy 6A or 6B
Bearing seals (ball bearings)	Steel Malleable iron Nodular graphitic iron 2/ Aluminum Bronze Brass Copper	 ASTM A47-52, Grade 35018 ASTM A339-55, Grade 60-45-10 ASTM B26-59T; B85-58T
Bearing seals (sleeve bearings)	Antifriction metal (brass, bronze copper or aluminum)	
Bearing shells	Steel 1/ Bronze	 ASTM B139-58, Alloy A
Bearings, sleeve	Antifriction metal or babbit	ASTM B23-49, Grade 2 or 3
Brushes	Graphite, electrographite or copper-graphite	MIL-B-3743.
Brushholders including springs	Steel Nodular graphite iron 2/ Brass Bronze Bronze aluminum	 ASTM A339-55, Grade 60-45-10
Brushholder springs	Copper-beryllium Corrosion resistant steel-cadmium plated carbon steel	
Brushholder yokes	Steel Laminated Thermosetting plastic	 MIL-E-917
Collector rings	Bronze Brass Steel	

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Table II – Minimum material requirements. (Continued)

Item	Material	Specification
Collector ring shell; quills; spiders, flanges	Steel[1]	
Commutator segments	Copper	Hard-drawn, hard rolled or drop forged.
Commutator V-rings and shells; frames	Steel[1] Malleable iron[3] Nodular graphitic iron[2]	 ASTM A47-52, Grade 35018 ASTM A339-55, Grade 60-45-10
Cores	Steel	Non-aging, low hysteresis
End brackets	Steel[1] Malleable iron[3] Nodular graphitic iron[2] Aluminum	 ASTM A47-52, Grade 35018 ASTM A339-55, Grade 60-45-10 ASTM B26-59T ASTM B85-58T
Fans	Steel[1] Aluminum Nodular graphitic iron[2]	 ASTM B26-59T ASTM B85-58T ASTM B209-59T ASTM A339-55, Grade 60-45-10
Grease cups and pipes; lifting eye bolts	Steel	
Identification plates	Brass Nickel-copper Steel	
Insulation[4]		MIL-E-917 Class A, B, C, F or H as specified (see 6.1).
Shafts	Steel	ASTM A243-55 Class E
Shafts with fabricated spiders (flutes welded to shaft).	Steel, carbon	ASTM A243-55 class C (.35 max. carbon)
Wire, armature banding	Steel (magnetic) Steel (non-magnetic)	MIL-W-806 MIL-W-3068

1/ Steel parts may be cast, fabricated, or forged. Cast steel shall be in accordance with ASTM A27-58 Grade 60-30.

2/ Nodular graphitic iron will be acceptable provided the first complete generator of any new design is given a high shock test and successfully passes shock resistance requirements and provided no welding of any kind is done on the nodular iron components.

3/ Malleable iron is usable only where complete generators are of a size which can be shock tested. No welding on malleable iron components is permitted.

4/ The use of silicone materials, in any form, in confined spaces within which brushes will have to operate is prohibited.

3.3.14 Steel inserts. - All screw threads tapped in aluminum to receive cap screws shall be protected by the installation of steel inserts.

3.3.15 Bearings. - Bearings shall be sleeve, ball, or roller, as specified (see 6.1). The lubrication system shall be designed so that oil or grease

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will not be spilled from the reservoir under the inclined operation conditions specified in Specification MIL-E-917. Bearing housings shall have sufficient metal to permit re-drilling or re-machining and bushing of housing.

3.3.15.1 Sleeve bearings. - Sleeve bearings mounted in a pedestal shall be of the self-aligning type. Bracket-mounted sleeve bearings need not be of the self-aligning type. Sleeve bearings for generators having frame sizes larger than that corresponding to 100 kw. at 1,200 r.p.m. shall be split in such a manner as to permit their removal and replacement without the necessity of taking the armature out of the frame, of removing the coupling from the driving end, or of removing the bearing bracket from the generator. Sleeve bearings for generators having frame sizes corresponding to 100 kw. at 1,200 r.p.m. and smaller need not be of the split type provided the bearing shell and oil seal are readily removable and replaceable without the necessity of removing the bracket or disturbing the brush rigging.

3.3.15.1.1 Oil rings. - Where oil rings are used the number of oil rings shall be such that no ring is required to distribute lubricant for an axial distance greater than 3 inches on either side of the ring. Rings shall have a true circular shape. The cross section shall preferably be that of a trapezoid with the base on the shaft. Rings shall be machined all over and shall have all corners rounded. The finish shall be smooth and free from flaws. Unless specifically approved by the bureau or agency concerned, split rings shall not be used. Under no conditions shall hinged snap oil rings be used. The inside diameter of the oil ring shall be as specified in table III.

Table III - Diameter of oil rings for sleeve bearings.

Diameter of shaft (inches)	Minimum ratio of inside diameter of ring to diameter of shaft
2 and under	2.00
Over 2 to 6, inclusive	1.75
Over 6 to 10, inclusive	1.6
Over 10	1.5

3.3.15.1.2 Clearances. - The oil clearances shall be as specified in table IV.

3.3.15.1.3 Housing. - The housing shall be designed to permit the oil rings to rotate freely up to the maximum 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 subjected to shock. The housing shall be designed to prevent the escape of oil along the shaft. This shall be accomplished by the use of close-clearance metallic (antifriction metal) seals. The use of felt and friction-type seals is not acceptable. Provision shall also be made for observation of the oil rings while the generator is running. These observation openings shall be made oiltight by a cover secured by screws, screw plugs, or equivalent means. Provision shall also be made to insure against the suction of oil vapor into the interior of the generator.

Table IV - Oil clearances for sleeve bearings.

Basic diameter of journal (inches)	Maximum designed diametrical oil clearance including shaft and bearing tolerances (inches).
1.000	0.004
2.000	.005
3.000	.007
4.000	.009
5.000	.010
6.000	.012
7.000	.014
8.000	.016
9.000	.018
10.000	.020

3.3.15.1.4 Oil filler. - For generators having frame sizes larger than that corresponding to 1 kw. at 1,800 r.p.m. an opening or standpipe for filling, for preventing overfilling, and for indicating the oil level, shall be provided in the reservoir and shall be fitted with an oiltight plug or cap to prevent the escape of oil due to the motion of the vessel. The diameter of the filling opening shall not be less than 3/8 inch. For generators having frame sizes corresponding to 1 kw. at 1,800 r.p.m. or smaller, the manufacturer's standard type filler may be used.

3.3.15.1.5 Temperature indicating devices. - Generators 200 Kw and larger shall be provided with a thermostatic switch in accordance with the requirements of Specifications MIL-S-901 and MIL-E-917 and shall be bound in a watertight enclosure. The temperature sensing element shall be inserted in the bearing shell in such a manner that when the bearing attains a predetermined temperature the thermostatic switch contacts shall close to operate an alarm system either directly or through the use of relays. A terminal block shall be provided for the connection of external electrical leads (from the alarm system) and shall be mounted within the enclosure. The alarm system shall not be furnished.

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The bearing housings of generators smaller than 200 kw shall be provided with thermometer wells.

3.3.15.1.6 Magnetic center. - Generators shall be marked to show the location of the magnetic center.

3.3.15.2 Ball and roller bearings. -

3.3.15.2.1 Types. - The types of ball and roller bearings shall be as specified in 3.3.15.2.1.1 and 3.3.15.2.1.2.

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

(a) Single shield, single row, radial, type III, class 2 of Specification FF-B-171 or single sealed, single row, radial, type III, class 6 of Specification FF-B-171 having the same envelope dimension as the single shield, single row, radial, type III, class 2, Specification FF-B-171.
(b) Radial single row, both races extended, sealed, cartridge type, type 120 of Specification FF-B-171. Where this type of bearing is used a warning plate which reads "Do Not Lubricate" shall be secured to the end brackets.
(c) Radial single row, class 1, open, in accordance with specification FF-B-171, with the approval of the bureau or agency concerned.

3.3.15.2.1.2 Roller bearings. - Roller bearings shall be in accordance with Specification FF-B-185 and shall be used only with the approval of the bureau or agency concerned.

3.3.15.2.2 Temperatures. - Maximum bearing temperature shall be as indicated in table I. Silicone grease shall be used where bearing temperature is in excess of 110°C except as prohibited by table II [illegible] 1). All bearing temperatures referred to are [illegible] the outer race.

3.3.15.2.3 Heat stabilization. - Bearings operating above 110°C., shall be heat stabilized so that their dimensions do not increase more than 0.0001 inches per inch of diameter during 2500 hours at 149°C. Where heat stabilized bearings are used they shall be of the type specified in 3.3.15.2.1.1(b).

3.3.15.2.4 Grease cups (for single shielded and single sealed type bearings only). - Compression grease cups shall be used on all generators where grease is the means of lubrication. Fittings for grease cups shall be plugged with pipe plugs. The correct amount of grease shall be added to the bearing housing before the generator leaves the place of manufacture.

3.3.15.2.5 Securing. - The bearings shall be secured on the shaft by means of locknuts and lockwashers or other methods approved by the bureau or agency concerned. The driven end shall be fixed axially in the housing by suitable housing and end cap shoulders.

3.3.15.2.6 Axial end play. - The installation of bearings shall be in accordance with Specifications FF-B-171 or FF-B-185, as applicable, except that the axial clearance between the outer race and the housing shoulders may be such as to make the possible axial movement of the shaft not more than 0.04 nor less than 0.020 inch, including bearing end play on two bearing generators when the application does not require the end play to be minimized.

3.3.15.2.7 Seals. - Except where double sealed bearings are used the housing shall provide for a close-clearance metallic seal on both sides of the bearings (one side only where shaft does not extend through cap) to prevent the leakage of oil or grease along the shaft. Washers of felt or other suitable material may be used on generators having frame sizes corresponding to 1 kw. at 1,800 r.p.m. and smaller in combination with grooves, labyrinths, or slingers if specifically approved by the bureau or agency concerned.

3.3.15.2.8 Housing. - The bearing housing shall be so constructed as to permit ready removal of the end bracket without the necessity of removing the bearings.

3.3.15.2.9 Removal of bearings. - The design shall be such as to permit removal of bearings by pulling on the inner race of the bearing. Special tools as defined by Specification MIL-E-917 shall not be required to remove the bearing.

3.3.16 Shafts. - The shaft shall be provided with deflecting flanges or slingers or other suitable means so as to prevent the escape of oil from the bearing housing and suction into the electric windings under all service conditions. All generators larger than 60 kw. shall be provided with a forged-on half coupling for connection to the prime mover. Generators 60 kw. and smaller may be provided with a shaft extension with a keyway and shrunk-on coupling.

3.3.17 Armature cores. - The laminations shall be insulated from each other. 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 laminations shall be clamped together in such a manner as to insure that the assembled core is tight at the top of the teeth. Keys in conjunction with press or shrink fits, or other means satisfactory to the bureau or

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agency concerned shall be provided to prevent movement of the armature core, spider, or quill on the shaft. Provision shall be made to prevent axial displacement under operating or test conditions. A pin through the shaft is not an acceptable means of preventing axial displacement. Welding shall not be used to secure the core or quill to the shaft. The use of spiders constructed of individual flutes welded to the shaft is acceptable when preheat and stress relieving procedures satisfactory to the bureau or agency concerned are employed.

3.3.18 Armature windings. - All armature coils for generators rated 25 Kw., at 1,800 r.p.m. and larger shall be form-wounded, that is, wound, formed, and insulated before assembly in the core slots, and shall be interchangeable. Armature coils for all generators shall be securely retained in the slots by slot wedges, however, for generators rated below 25 Kw., at 1,800 r.p.m. other means, approved by the bureau or agency concerned, may be used.

3.3.19 Banding. - Armature end turns and coil leads to risers shall be bound with securely clipped banding wire. Resin treated glass tape may be used for armature banding only with the approval of the bureau or agency concerned.

3.3.20 Equalizer connections. - Equalizer connections shall be supplied on all lap wound armatures of generators having four or more main poles.

3.3.21 Commutators. -

3.3.21.1 Securing. - The commutator shall be secured rigidly to the shaft or spider by keying or other method satisfactory to the bureau or agency concerned. The method used shall positively secure the commutator in such a manner as to prevent either rotational or axial motion of the commutator relative to its support, under operating or test conditions.

3.3.21.2 Copper segments. - The copper segments shall be securely retained in such manner as will prevent their relative displacement as a result of centrifugal forces and the stresses imposed by repeated expansion and contraction in service. The segments, when worn to the full extent of the allowable wearing depth specified in table V shall be of ample section to operate satisfactorily.

3.3.21.3 Connections. - The connections to the armature windings shall be brazed or soldered, and if separate risers are used, they shall be connected to the commutator bars by brazing.

Table V - Wearing depth of commutators.

Commutator diameter (inches)	Minimum allowable reduction in diameter (inch)
2 and over	3/16
Over 2 and up to 4, inclusive	3/8
Over 4 and up to 6, inclusive	1/2
Over 6 and up to 8, inclusive	5/8
Over 8 and up to 12, inclusive	3/4
Over 12 and up to 15, inclusive	7/8
Over 15	1

3.3.21.4 Tightening. - In generators rated 5 Kw 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.

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

3.3.21.6 Mica undercutting. - The mica insulation between bars shall be undercut on all generators. The undercutting shall be accomplished by removing all mica between bars to form a groove not to exceed 1/16 inch in depth.

3.3.21.7 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 due to high bars or flat spots.

3.3.21.8 Sparking. - At any load from no load to full load the sparking at the commutator shall not exceed No. 1-1/4 slight intermittent sparking as shown on figure 1.

3.3.22 Collector rings (three wire generators). - Collector rings shall run true, have a smooth polished surface, and be free from porosity or hard spots. The rings with their insulation shall be shrunk over a steel shell and shall be of such thoroughly solid construction throughout as to insure against their becoming loosened or eccentric due to changes in temperature in service. They shall be secured to the shaft or spider by interference as specified in

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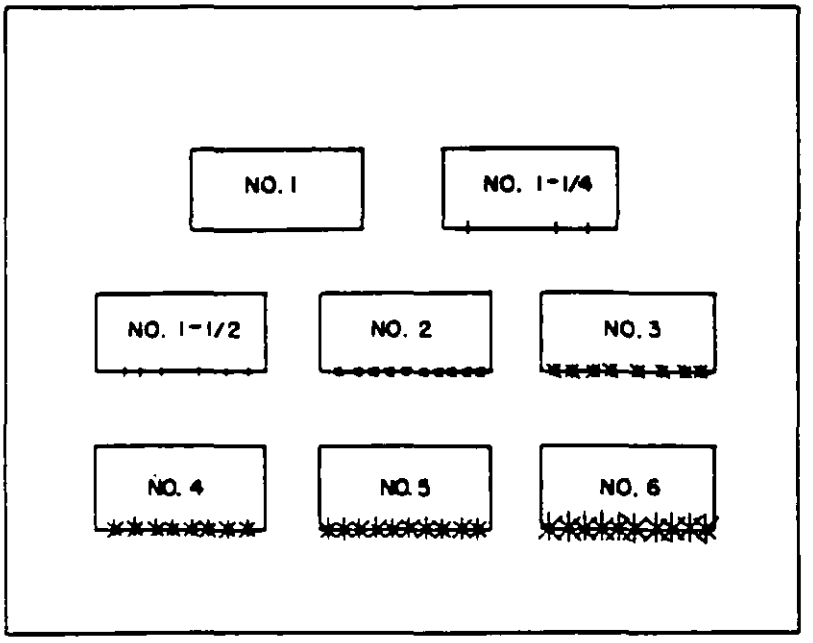

No. 1 Black with no sparks showing.
No. 1-1/4 Slight intermittent sparking.
No. 1-1/2 Slight continuous sparking.
No. 2 Continuous sparking heavier than No. 1-1/2. Streamers just begin to extend from the edge of the brush.
No. 3 Sparks heavier than No. 2.
No. 4 Sparks heavier than No. 3.
No. 5 Sparks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

table VI or other methods specifically approved by the bureau or agency concerned. The method employed shall prevent both rotational and axial movement under test and operating conditions. The wearing depth of collector rings shall be as specified in table VII.

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Table VI - Minimum interference fits for collector ring assembly, shell to shaft.

Shaft diameter at collector ring assembly section	Minimum interference fits
Inches	Inch
Over 0 to 2, inclusive	0.0003
Over 2 to 3, inclusive	.0006
Over 3 to 4, inclusive	.0009
Over 4 to 5, inclusive	.0013
Over 5 to 6, inclusive	.0015
Over 6 to 7, inclusive	.0019
Over 7 to 8, inclusive	.0024
Over 8 to 9, inclusive	.0028
Over 9 to 10, inclusive	.0037
Over 10 to 11, inclusive	.0042
Over 11 to 12, inclusive	.0046
Over 12 to 13, inclusive	.0051
Over 13 to 14, inclusive	.0056
Over 14 to 15, inclusive	.0061
Over 15 to 16, inclusive	.0065
Over 16 to 17, inclusive	.0070

Table VII - Wearing depth of collector rings.

Collector ring diameter	Wearing depth in diameter (min.)
Inches	Inch
4 and under	1/4
Over 4 to 6, inclusive	1/2
Over 6 to 8, inclusive	5/8
Over 8 to 12, inclusive	3/4
Over 12 to 15, inclusive	7/8
Over 15	1.0

3.3.23 Balance coils. - Each three-wire generator shall be furnished with a balance coil built in accordance with Specification MIL-T-15108. Balance coils for generators rated 100 Kw and less shall be mounted on the generators. Balance coils for larger generators shall be furnished for separate mounting. The rating of the balance coils shall be such as will provide the generator performance specified herein.

3.3.24 Brush holders. -

3.3.24.1 Brush contact. - Contact surfaces shall be of such material as to not react chemically to produce corrosion and sticking of brushes when brushes of graphite, electro graphite or copper-graphite are used. The brush holders shall be of such design that the brushes will not bind in the brush holders. The brush-feeding device shall ensure proper brush contact under all normal conditions of brush and commutator or collector ring wear.

3.3.24.2 Brush stop. - Means shall be provided to prevent brushes from being thrown out of their brush holders as a result of severe shock or from being displaced to such a position that they may bind in their brush holders and not return to their normal operating position. The devices used shall not unduly complicate replacement of the brushes, require the use of a special design of brushes, or result in cumbersome or intricate design of brush holders.

3.3.24.3 Pressure finger. - The pressure finger shall be of such design that when operating with a brush having a smooth top surface (not notched) or a hammer clip, it will not slide off the brush or clip under any operating conditions. When the brush is omitted from the holder, a stop shall prevent the finger from making contact with the commutator or collector ring.

3.3.24.4 Springs. - Springs shall be the adjustable type. Means shall be provided for adjusting the brush pressure without special tools.

3.3.24.5 Types. - Brush holders shall be either box type or open front type. The open front type shall be of such design that the frame work covers not less than 50 percent of the front side.

3.3.24.6 Terminal screw. - A separate terminal screw shall be provided for securing the brush shunt terminal lugs to the brush holder, brush holder bracket, or terminal attachment bar.

3.3.24.7 Accessibility. - Brush holders shall be readily accessible for adjustment, replacement or renewal of brushes and springs.

3.3.24.8 Adjustability of brushholders. - Brush holder rigging shall be so designed that the distance between the brush holder and commutator can be adjusted. The minimum amount of adjustment shall be adequate to reposition the brush holders after the commutator is worn or resurfaced to the maximum limits specified in table V.

3.3.24.9 Mounting of brushholder rigging. - When brush holders are secured to the yoke or rocker ring, the yoke or rocker ring shall be secured by one of the following methods:

(a) A split type hub clamped about a machined hub in the end bracket or bearing housing.

(b) Bolts passing through slotted holes in the yoke or rocker ring. If this method is used, the axial movement of the yoke or rocker ring shall be restrained by means of machined fits between the yoke or rocker ring and the end bracket or bearing housing. The bolts shall only be used to lock the yoke or rocker ring in the proper rotational position.

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3.3.24.10 Mounting of collector ring brushholders. - Collector ring brush holders may be mounted on insulated studs attached to the end brackets.

3.3.24.11 Adjustability of brushholder rigging. - The rigging shall be of such design that the yoke or rocker ring is adjustable around the periphery of the commutator. The setting of the rigging shall be marked permanently on the yoke or rocker ring and the frame or end bracket.

3.3.24.12 Staggering. - Commutator brush holders shall be staggered in pairs so as to insure even wear of commutator.

3.3.24.13 Alignment. - Brush holders shall be so mounted and aligned that brushes are parallel to the shaft and do not extend beyond the edge of collector ring or commutator.

3.3.24.14 Brush position connections. - Electrical connections between brush positions shall consist of insulated wire or tapped (insulating) bus bars.

3.3.25 Frames. - Frames of generators with a continuous rating of greater than 100 kw. shall be split in two halves parallel to the shaft so as to permit ready removal of the armature in an upward direction. The frame shall be of rigid construction with feet of ample size large enough to accommodate holding-down bolts, dowel pins, and jack screws where used. The frame feet shall be machined and drilled for holding-down bolts. Fitted bolt holes shall be left with an allowance for reaming at time of installation of generator with prime mover.

3.3.26 Field poles. - Field poles shall be so attached to the frame as to permit movement of the poles for adjustment of air gaps and shall be capable of being removed from the frame without removing the armature.

3.3.27 Field coils. - Field coils shall be form wound (the pole piece may be used as the form). All field coils of the same type for one design of machine shall be readily interchangeable. The coils shall be so secured that they cannot become loosened or damaged by vibration, or produce vibration by a slight shifting in coil position. All like coils (that is, shunt, series, or commutating pole) of the same polarity shall be series connected with respect to each other.

3.3.28 End brackets. - An accurately machined shoulder joint shall be provided between the frame and the end brackets. End brackets shall be secured to the frame by not less than four hexagon-head bolts or cap screws of suitable size and strength. For generators built in frame sizes corresponding to 1 kw. at 1,800 r.p.m. or smaller, the end brackets may be secured by not less than four machine screws or through bolts of suitable size and strength. These machine screws or through bolts may be furnished with slotted or hexagon-heads. Resilient-gaskets shall not be placed between any bearing support member and the frame.

3.3.29 Access openings. - Openings of adequate size and number shall be provided at the front end of the generator so as to give easy access to and a direct view of the commutator, collector rings, and brushes while the generator is in operation. Except for open generators, these openings shall be provided with substantial covers and fastenings of a design satisfactory to the bureau or agency concerned. The enclosing covers (hand-hole 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 cover as the design permits, in such a manner as to preclude the possibility of being lost during maintenance and while the cover is unfastened. The contact surfaces between the enclosing covers and the frame 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 where necessary to prevent sticking. All sheet packing shall be securely attached to the covers.

3.3.30 Marking for correct assembly. - Adjoining portions of machinery shall be given corresponding marks, wherever practicable and advantageous, to insure correct assembly.

3.3.31 Forcing bolts. - Forcing bolts shall be provided where necessary for breaking joints.

3.3.32 Dowels. - All generators except those of the flange-mounted type shall be doweled against movements under shock conditions specified in 3.3.11. This may be accomplished by the use of fitted holding-down bolts. Dowels shall be of ample size for the purpose intended. Dowels 1/2 inch or more in diameter shall be provided with threads and nuts for withdrawal. Taper dowels may be used for size 3/8 inch and smaller. All diameters refer to the small end of the dowel. Dowels shall be so located as to be readily removable.

3.3.33 Jackscrews. - Jackscrews or other suitable means shall be furnished to facilitate vertical adjustment of the frames of generators weighing 1,000 pounds or more. Jackscrews shall be used only for installation purposes and shall not permanently support the generator.

3.3.34 Wiring. - Wiring between such parts as the field coils, brush rigging and terminal boards shall be in accordance with Specification MIL-E-917, the arrangement being as simple as possible consistent with convenience for maintenance and repair.

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3.3.35 Securing connections. - Connections shall be secured with locking devices in accordance with Specification MIL-E-917. Connectors 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 solder connections.

3.3.36 Terminal leads. - Leads for generators with current ratings of 150 amperes and less shall be brought to and terminated at a terminal board or shall be provided with lead clamps. Generators with current ratings greater than 150 amperes shall have all leads brought to and terminated at a terminal board or shall have adequately supported bus-bar leads.

3.3.37 Terminal boards. - Terminal board studs shall be located so as to facilitate connections to the external circuit. The terminal board shall be attached to the frame of the generator, and shall be covered by a dripproof cover.

3.3.38 Lead clamps. - Where lead clamps are used, the terminal leads shall not be attached to the end brackets but shall be attached to the frame, and shall extend at least 6 inches beyond the point of support. The methods of fastening shall be such that no strain from the outside can come upon the connections within the generator frame. The use of rubber bushings unclamped, is not a suitable method of securing such leads. The end of each generator lead shall be fitted with a connector of either the solder type or the solderless type which shall be satisfactory to the bureau or agency concerned. Terminal lead holes in the generator frames shall have all edges rounded to prevent injury to lead insulation. The leads shall be enclosed in a terminal box.

3.3.39 Terminal boxes. - Terminal boxes shall be bolted to the generator frame. A gasket shall be placed between the terminal box and the frame. All joints on the terminal box shall be of the same degree enclosure as specified for the generator but not less than dripproof.

3.3.40 Bus bar leads. - Bus bar leads need not be provided with terminal boards. The leads shall be clamped into position so that no strain from the outside can be transmitted to the connections within the generator frame. The leads shall be of sufficient length and shall be provided with a means for making suitable connections to the ship's cables. The terminal lugs to fit the terminal boards or terminal lugs for connecting the generator terminals to ship's cables shall not be furnished by the contractor.

3.3.41 Lead identification. - All generator leads shall be permanently marked with designating letters which correspond with the markings shown on the diagram of connections for the generator (see 3.9.3).

3.3.42 Auxiliary terminals. - Auxiliary terminals energized from an outside source of power, such as space heaters, temperature detectors, etc., should be protected by suitable removable barriers over individual circuit terminals so that personnel working on any one circuit is protected from all other circuits. Also, exposed component terminals within the generator frame which might be contacted during regular maintenance should be adequately insulated with tape or fixed barrier.

3.3.43 Ventilation. - Ventilating systems for generators rated above 100 Kw shall provide for the passage of cooling air outward over the commutator to prevent dust being drawn toward the risers, armature, and field coils. The air inlets shall be so arranged that the hot air developed by the prime mover will not be circulated through the generator.

3.3.44 Enclosures. - Enclosures shall be in accordance with Specification MIL-E-2036, and shall be one of the following, as specified (see 6.1):

(a) Open
(b) Protected
(c) Dripproof protected
(d) Totally enclosed
(e) Totally enclosed, fan cooled
(f) Water-air-cooled

3.3.45 Condensation drain. - On all totally enclosed and water-air-cooled generators a drain and plug shall be provided in the lowest part of the generator.

3.3.46 Lifting means. - Eyebolts or other means of suitable size and strength shall be provided for the lifting of generators weighing 150 pounds and over. The use of a strap having two or more holes one of which is fastened to an end bracket retaining bolt is not an acceptable lifting means.

3.3.47 Permanent marking. - The manufacturer's name, serial number and the Stock number (if available) shall be stamped underneath the identification plate in the solid metal of the frame. Armatures shall be marked so as to identify the manufacturer and the style and type of the generator. The manufacturer's serial number of the armature and Stock number (if available) shall be plainly stamped on the shaft at the front end. In the case of generators built in frame sizes corresponding to 1 kw. at 1,800 r.p.m. and smaller, the serial number or the manufacturer's designation (model, type, or part number) sufficient to completely identify the part shall be stamped on the armature shaft. Field coils shall be marked so as to identify the manufacturer and the design of the generator by manufacturer's catalog or coil drawing number.

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3.3.48 Identification plates. - The identification plates shall be attached to the part of the generator which will not ordinarily be renewed during its normal service life, and shall be located in a readily accessible position where they can be read at all times without danger to personnel. The markings on these plates shall be either etched, stamped, engraved or cast in such a manner as to produce permanent and durable markings to last the anticipated life of the generator under environmental conditions to which it will be subjected. All etchings, engravings or stampings shall not be less than 0.003 inches deep. The characters on cast plates shall be raised to at least 0.03 inches. All etched, engraved or stamped markings shall be filled with black paint enamel or lacquer.

3.3.49 Identification plate markings. - Identification plates for generators shall include the following minimum data:

a. Manufacturer's name, identification symbols, serial number, and drawing number.
b. Stock number.
c. Contract number and year of manufacture.
d. Salient design characteristics, for example, type, kilowatt capacity, voltage, current, overload rating, r.p.m., class of insulation and maximum ambient temperature.
e. Activity for which built.
f. Blank space for Government inspector's official stamping.

3.4 Field rheostats. - Generator field rheostats shall be furnished as a part of the generator equipment, and shall conform to Specification MIL-R-15109.

3.5 Voltage regulator. - Automatic voltage regulators, if specifically called for (see 6.1), shall be furnished as a part of the generator equipment. The requirement for automatic voltage regulators shall be as specified in the contract or order.

3.6 Field discharge resistors. - Field discharge resistors shall not be furnished.

3.7 Onboard repair parts. - Onboard repair parts, based upon the total number of generators of each design and size furnished for each ship, shall be supplied as shown in table VIII. The word "set" as used herein means the total components of a particular item required for one generator. The phrase "of each size and type" or any contraction thereof means parts made by the same manufacturer for generators of the same design, size, and rating. Each onboard repair part shall be suitable for immediate replacement of the originally installed part in any generator involved, and shall be equal to the original part when new.

Table VIII - Onboard repair parts.

Description of onboard repair part	Quantities to be furnished per ship and carried on board - number of identical generators per ship.								
	1	2	3	4	5	6	7	8	9 or over
Bearings or bearing linings, sets. Sleeve bearings shall be complete.	1	1	1	1	1	1	1	1	1
Oil gages for sleeve bearings (each type used)	1	1	1	1	1	1	1	1	1
Commutator brushes, sets	2	3	4	4	5	6	7	8	8
Collector ring brushes, sets	2	3	3	4	4	5	5	5	6
Commutator brush rigging insulation, sets	1	1	1	1	1	1	1	1	1
Collector ring brush rigging insulation sets	1	1	1	1	1	1	1	1	1
Commutator brush holders, complete with springs	1	1	1	1	2	2	2	2	2
Collector ring brush holders, complete with springs	1	1	1	1	2	2	2	2	2
Commutator brush holder springs	2	3	3	3	4	4	4	5	6
Collector ring brush holder springs	2	3	3	3	4	4	4	5	6
Bearing lubricant seals, set for sleeve bearing generators only	1	2	3	3	4	4	4	5	5
Field coils, each size and type, except for electronics application. When shunt and series coils are so constructed that they cannot be readily separated from each other the unit will be considered a repair part for both. In generators rated 250 KW and over, no repair series or interpole field coils shall be furnished.	1	1	1	1	1	1	1	1	1
Grease cups, one of each type	1	1	1	1	1	1	1	1	1
Radio interference suppression equipment	As specified (see 6.1)								

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3.8 Interchangeability. - All parts, including onboard repair parts of corresponding equipment furnished on the same contract or order or built to the same drawings, shall be strictly interchangeable without the necessity of further machining, selective matching, drilling, filing, hand fitting of any kind or the use of undue force. Repair coils may require leads being cut to length and rebalancing of armatures, and, repair bearings may require slight scraping of the lining. Also, repair brushes will usually require sanding to fit the commutator or collector ring.

3.9 Drawings. - Master drawings and certification data sheets (C. D. S.) shall be furnished in accordance with Specification MIL-D-963 and as specified herein. The number of drawings and the number of C. D. S. to each drawing shall be kept to a minimum.

3.9.1 Preliminary drawings. - Preliminary drawings shall be submitted for approval and shall be either blue prints, blue line prints, or equal.

3.9.2 Final drawings. - Final drawings shall be either microfilms, tracings, or direct reading blackline prints in accordance with Specification MIL-D-963. Where microfilms are furnished, one full size non-reproducible copy of each drawing shall also be furnished.

3.9.3 Contents of master drawings. - In addition to the contents specified in Specification MIL-D-963, master drawings shall identify the generator by manufacturer's type, class or model number and shall include the following minimum data:

(a) Performance table consisting of the following:

(1) Kilowatt and duty ratings.
(2) Voltage rating.
(3) Current ratings.
(4) Guaranteed efficiencies, 2/4, 3/4, 4/4 load.
(5) Field current and voltage required for no load, rated load and overload.

(b) Net calculated weights:

(1) Generator complete (wet and dry weight for water-air-cooled generators).
(2) Armature complete
(3) Total WK^2 value of rotating parts.
(4) Total weight of magnetic material for generators installed on minesweepers.

(c) Shafts, bearings and lubrication:

(1) Type and size of bearing.
(2) Type of lubrication (grease, ring, disk, or forced oil feed).
(3) Additional information for sleeve bearing application only:

a. Designed oil clearance.
b. Bearing pressure.
c. Surface speed.
d. Material composition of antifriction bearing lining.

(4) Additional information for ball or roller bearing application only:

a. Shaft fit.
b. Shaft shoulder diameter.
c. Housing fit.
d. Housing shoulder diameter.

(d) Poles:

(1) Number of main poles, nominal air gap.
(2) Number of commutating poles, nominal air gap.

(e) Armature:

(1) Diameter.
(2) Core length.
(3) Number of turns, size, material and band tension of banding wire. Type, material, band dimensions and band tension of glass tape (if used).

(f) Commutator:

(1) Diameter.
(2) Length of active surface.
(3) Wearing depth on diameter.
(4) Depth of undercut.
(5) Thickness and type of insulation between bars.
(6) Thickness and type of insulation to ground.

(g) Collector rings (if used):

(1) Diameter of ring.
(2) Width of ring.
(3) Wearing depth on diameter.
(4) Insulation between rings, creepage distance, and material.
(5) Insulation to ground, creepage distance, and material.

(h) Brushes:

(1) Number of studs.
(2) Number of brushes per stud.
(3) Military grade and manufacturer's name and grade.

(i) Brush holders:

(1) Number of holders

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(2) Type
(3) Whether leading, trailing or radial
(4) Material of brush holder body
(5) Type of spring. The end style of torsion springs shall be illustrated or otherwise described to permit ready identification for replacement
(6) Material of spring.

(j) Alarm contact devices (as applicable):

(1) Air temperature alarm contact calibrated ___°F. to ___°F. set at ___°F.
(2) Bearing temperature alarm contact calibrated ___°F. to ___°F. set at ___°F.

(k) Periodic test data consisting of the following as determined from actual tests or reference to the approved test report and corresponding approval letter.

(1) Effectiveness of enclosure.
(2) Efficiency at 2/4, 3/4 and 4/4 load and to include in kilowatts the following breakdown of losses at 4/4 load:

a. Full load armature circuit copper loss.
b. Friction and windage loss less brush friction loss.
c. Brush friction loss.
d. Brush contact loss.
e. Shunt field circuit I^2R loss.
f. Core loss.
g. Stray load loss.

(3) Resistance (ohms) cold at ___°C and hot (75°C, calculated) of:

a. Shunt field.
b. Armature.
c. Series field if utilized.
d. Commutating field, or commutating plus compensating field.

(4) Saturation data at rated full-load speed, ascending and descending line volts and field current.

(5) Ceiling voltage of generator if used as an exciter.

(6) Voltage regulation.

a. Decreasing load-line volts, line current, field current, and speed.
b. Increasing load-line volts, line current; field current, and speed.

(7) Air gap and where measured.

(8) Reference to radio interference and airborne noise test reports.

(9) Heating and overload to include the following at normal load:

a. Time in hours.
b. Line volts and current.
c. Field current.
d. Speed.
e. Temperature rise in °C., of:

Armature core, winding, banding wire.
Commutator.
Field, shunt (methods 1 and 2).
Field, series (if utilized).
Field, commutating.
Bearings.
Ambient temperature.

(10) Voltage unbalance (three-wire generators only).

(11) Overspeed in r. p. m.

(12) Dynamic balance. Both permissible (calculated) and actual (measured) unbalance in ounces-inches.

(13) Dielectric strength in volts.

(14) Insulation resistance in megohms (hot and cold).

(15) Net actual weights:

a. Generator complete.
b. Armature complete.

(16) Drawing covering a generator which has been shock-tested and found to be satisfactory shall be so indicated on the drawing by the following: "This generator has satisfactorily passed shock tests as recorded in (activity) test report number "_____" forwarded to the bureau or agency concerned via (activity) letter _____, dated _____."

(17) Drawing covering a generator which is identical to a generator which has been shock tested and found to be satisfactory and on which extension approval has been granted shall be so indicated on the drawing by a note similar to that specified in 3.9.3k(16) and including identification of the shock tested generator by manufacturer's type, class or model number, drawing number and contract number and reference to the extension approval letter.

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(18) A space for referencing the purchasing activity approval letter.

(l) Drawing of armature coil drawing and end view, with all dimensions. Where form-wound coils are used, information shall be given for coils before and after forming.

(m) Armature winding data:

(1) Number of slots.
(2) Number of coils per slot.
(3) Number of turns per coil.
(4) Pitch of slot.
(5) Size and type of conductor.
(6) Number of commutator bars.
(7) Resistance of the winding at 25°C.
(8) Developed length of coil.
(9) Weight of copper per machine.
(10) Insulation data as specified in 3.9.3(aa).

(n) Armature winding diagram facing connection end, giving rotation.

(o) Development of armature winding.

(p) Detailed drawing of section through each field coil and pole showing:

(1) Number of turns per coil, method of winding, size of wire.
(2) Developed length of coil, mean length of turn (where applicable).
(3) Resistance of the coil at 25°C.
(4) Weight of copper per coil.
(5) Type of thickness and location of protection strips.
(6) Pole dimensions.
(7) Insulation data as specified in 3.9.3(aa).

(q) A drawing showing connection diagram for field coils.

(r) An assembly end and side view, showing all parts of the generator which are identified with piece numbers in the list of materials. The assembly side view shall show a longitudinal section of the generator above the centerline. The assembly end view shall show a transverse quarter section above the centerline. The following minimum information shall be shown in these views:

(1) Bearing housing construction, fits and tolerances.
(2) Sectional view of commutator, collector rings, brush rigging and brushes, indicating 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 should be included on the drawing.
(3) Method of retaining commutators and collector rings to shaft.
(4) Sectional view of field coils.
(5) Method of securing field coil to poles and poles to frame.
(6) Method of securing armature punchings.
(7) Method of attaching terminal box to frame.
(8) Dimensions, drilling and tapping of terminal box, and the number and size of cover bolts.
(9) Method of bringing cables out of frame into terminal box and the method of protecting these cables against chafing at sharp metallic corners.
(10) Method of clamping generator leads in the terminal box to prevent strain on internal connections, and method of protecting lead insulation against abrasion by the clamp.
(11) Direction of air flow.
(12) Over-all dimensions, including mounting, shaft extensions, the necessary limits required to remove the generator armature and the center of gravity.
(13) Lifting means.
(14) The type and size of electrical conductors connecting such parts as field coils, brush rigging and terminal parts; the arrangement of these conductors and the method of making connections.
(15) Any details required by this specification but not covered in the foregoing enumeration.

(s) Enlarged view of sleeve-bearing housing, showing provision for filling, preventing overfilling, and draining of bearings.

(t) Detailed drawing of sleeve-bearing shell and liner showing all dimensions, including insulation when required.

(u) A detailed working drawing of the shaft including dimensions of coupling end.

(v) Side view drawing of brush holder and brush retaining mechanism.

(w) Information required by Specification MIL-B-3743 for brushes.

(x) Details of all terminal boards, including terminal markings.

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(y) Drawing showing dimensions and construction of fans including detail of method of securing fan blades to shrouds and fan to shaft.

(z) Details of radio noise suppression equipment including rating of resistors, capacitors, inductance coils, and other accessories.

(aa) The following additional insulation data shall be included on each generator master drawing or on a separate drawing previously approved by the bureau or agency concerned. If the data is shown on a separate drawing covering insulation practice for a number of generators, the Government drawing of the insulation drawing shall be referred to on each applicable generator master drawing. These data shall completely describe all insulation used, indicating the materials, thicknesses, forms, sequence of winding and insulating operations, number of layers and amount of overlapping of tape applications, limiting voltages and mechanical conditions, number and types of thinner to be used, temperature and duration of baking treatments, vacuum and pressure employed during impregnation. These data shall contain complete detailed information on each type of wound assembly including:

(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) 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.

(4) Other sketches and data as necessary to show method of manufacture (insulation and forming) of each winding. These sketches should show such details as the direction and overlap of the various tape windings 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 insulation process.

(5) Each sketch under (3) and (4) above should be identified as to the type of generator and the type of winding. The sketches should contain a table of standard and alternate insulating materials, identified by piece numbers and giving applicable Government specifications.

(6) Method of bringing out and insulating leads from each coil.

(7) Slot sections, showing details of slot wedges, slot armor coil spacers, slot tubes, and similar items. Sketches showing in detail how field coils are assembled, insulated, and supported on the pole pieces, and method of preventing excessive relative motion between the various conductors and windings when subjected to high impact shock.

(8) Bureau approval letter for insulation suitability tests when class H insulation is used.

(bb) A note identifying replacement ball bearings by Stock number, if available, otherwise all suitable replacement bearings shall be identified by manufacturer's names and identification numbers.

(cc) A note identifying the number and type of the applicable standard bearing puller (See 3.3.15.2.9). If the 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.

(dd) Grease pipes (where used) shall be shown with a pipe plug in the end as solid lines. Grease cups shall be shown in phantom, flagged, and indicated in the List of Materials with the comment "Repair Part Item Only" in the remarks column.

(ee) Paint and primer materials and the method of their application.

(ff) Stress relief heat treatment when this treatment is required (see MIL-E-917).

(gg) Welding details and symbols as required by Specification MIL-D-963.

(hh) Class of welded joints for rotating parts.

3.9.4 Certification data sheets. - Certification data sheets shall be furnished. In addition to the contents specified in Specification MIL-D-963, certification data sheets shall include the lead data for line and field along with type of terminals and Government cable sizes, and a list of the generator and air cooler repair parts and tools.

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3.10 Technical manuals. - Technical manuals shall conform to type III of Specification MIL-M-15071, and the following equipment as applicable shall be covered:

(a) Generator.
(b) Voltage regulator.
(c) Field rheostat.
(d) Balance coils (for three-wire generators).
(e) Temperature indicating and alarm equipment.
(f) Special devices on equipment.
(g) Generator air cooler.

3.10.1 Drawings. - Technical manuals shall contain full or reduced size prints of all approved drawings, except certification data sheets, of complete unit assemblies, subassemblies, and bills of material to completely identify all parts (except minor miscellaneous hardware such as nuts, bolts and screws), and a list of approved drawings indicating the manufacturer's drawing number.

3.10.2 Radio interference suppression. - Technical manuals shall include a description of the radio interference equipment (when required), including; rating, manufacturer's catalog or part number and instructions for discharging capacitors.

3.11 Workmanship. - The workmanship shall be first class in every respect.

4. QUALITY ASSURANCE PROVISIONS

4.1 The Supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own or any other inspection facilities and services acceptable to the Government. Inspection records of the examination and tests shall be kept complete and available to the Government as specified in the contract or order. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 General requirements. - All action of the supplier and the inspector shall be directed toward production of machinery conforming to the requirements of this specification. Objectives of quality assurance actions shall be not only prevention of delivery of defective material but also improvement in productivity and achievement of economy in production. The contractor shall provide and maintain a quality control system acceptable to the Government for this equipment. The system of quality control shall be in accordance with specification MIL-Q-9858. It is not intended that these quality assurance requirements result in increased production costs out of proportion with the quality and reliability levels needed by the Government. The Bureau of Ships desires to be informed promptly if any of the quality assurance requirements of this specification are considered to be unnecessarily increasing the cost of the equipment covered herein.

4.2.1 Design. - The supplier shall design equipment to meet the requirements of this specification. Quality assurance actions of the supplier and the inspector require intimate familiarity with the specification and the use of both bureau or agency approved drawings and shop drawings.

4.2.2 Manufacture. - Quality in manufacture and assurance that shop processes and methods agree with specification requirements are responsibilities of the supplier. Control of shop practices and criteria for acceptance and rejection of items should be documented on required drawings, shop drawings, industry standards or contractor standards.

4.2.3 Purchased items. - Purchased materials and parts shall conform to the applicable specifications and the supplier's approved design. The supplier shall be responsible for quality assurance measures and in process inspection at the plant of his subsupplier. The supplier shall inspect incoming purchased materials using sampling methods as necessary to assure requisite quality of purchased materials and parts.

4.2.4 In-process inspection. - The supplier shall perform in-process inspection of processes, materials, parts, subassemblies, assemblies and finished machines to demonstrate conformance with applicable drawings and specifications. The supplier's in-process inspection shall include the applicable items of inspection contained in Appendix I herein, selected in accordance with the design, manufacturing methods and sequence of operations. In-process inspection procedures, measuring gauges, instruments and written records shall be acceptable to the inspector.

4.2.5 Performance tests. - Performance tests specified in table IX shall be conducted by the supplier using facilities, methods and instrumentation acceptable to the inspector. The supplier shall prepare a test agenda listing the tests applicable to each contract or order and submit the agenda to the bureau or agency concerned for approval prior to conducting tests. Performance tests shall be conducted under the close supervision of the inspector.

4.2.6 Test reports. - Test results shall be recorded by the supplier on form NavExos 3037 or on test forms prepared by the supplier and approved by the inspector. When the supplier's test forms

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Table IX — Performance tests.

Description of test	Applicable test paragraph	
	Routine tests	Periodic tests
Material tests	4.4.1	4.4.1
Air-gap measurements	4.4.2	4.4.2
Resistance	4.4.3	4.4.3
Airborn noise	4.4.4	4.4.4
Vibration and balance	4.4.5	4.4.5
Lubrication	4.4.6	4.4.6
Overspeed	4.4.7	4.4.7
Insulation resistance (cold)	4.4.8	4.4.8
Dielectric	4.4.9	4.4.9
Commutation	4.4.10	4.4.10
Voltage regulation	4.4.11	4.4.11
Heating and overload		4.4.12
Unbalanced load (three wire generators)		4.4.13
No-load, rated voltage, saturation data		4.4.14
Insulation resistance (hot)		4.4.15
Ripple voltage		4.4.16
Efficiency		4.4.17
Effectiveness of enclosure		4.4.18
Weight		4.4.19
Shock		4.4.20
Onboard repair parts		4.4.21

are used, provision shall be made for recording of all required data. Each test report form shall be identified by the number of this specification and by the particular test requirement paragraph number and its title. When oscillograms are required, each trace shall be identified as to the circuit measurement involved and its calibration shall be indicated to permit ready use without reference to associated documents. Copies of all test reports shall be forwarded to the Bureau.

4.2.6.1 Periodic test reports. - Periodic test data for the first generator of a particular design and size offered for delivery on a contract or order shall be forwarded to the bureau or agency concerned for approval prior to shipment of the equipment. This data shall be bound into a 9 X 11-1/2 inch binder. The cover and title page shall give sufficient information to identify the equipment. A table of contents shall be included and shall list each test required by table IX. Test form NavExos 3037 or test forms prepared by the supplier shall be used. When the supplier's test forms are used, each test shall be prefaced by the name of the test and applicable test paragraph as specified in table IX. This data submitted shall be copies of the actual data taken on the test floor or a reproduction (not carbon copies) and not retyped data. The forms used shall allow sufficient columns to make instrument corrections and necessary calculations. Instrument corrections and calculations shall be made and entered on the test forms by the supplier. All pages shall be verified and signed by the inspector. Wherever practical, the final results of the test shall be listed adjacent to the specification requirement for that test.

4.2.7 Government verification inspection. - The inspector may perform complete or partial inspection on an appropriate sampling basis to verify that the requirements of this specification have been met and to substantiate that the manufacturer's inspection records indicate the true quality of the generators.

4.2.8 Sequence of tests. - The sequence of tests shall be such that the most destructive tests are conducted first.

4.3 Sampling for performance tests. -

4.3.1 Sampling for routine tests. - Each generator on a contract or order shall be subjected to the routine tests specified in table IX.

4.3.2 Sampling for periodic tests. - The first generator of a particular design and size offered for delivery on a contract or order shall be subjected to the periodic tests specified in table IX. Thereafter, one generator of each design and size shall be selected during each subsequent 12 month period during which such generators are offered for delivery. The shock test and weight measurement shall be conducted only on the first unit of a given design. A periodic test shall be made after any change in design which affects the performance characteristics.

4.4 Test procedures. - Performance tests shall be performed in accordance with table IX. Before starting these tests, the full-load speed and the speed regulation of the prime mover shall be adjusted as required. The shunts on the series fields of generators, if used, shall be permanently connected and insulated. Generator brushes shall be properly set and the setting permanently marked. No adjustments shall be made to the shunts, governor, brushes, or brush setting after the tests have been started. Any such change which affects the performance characteristics of the generator will necessitate complete new tests.

4.4.1 Material tests. - While it is not the intention of this specification, in general, to require that all the material used in the construction of generators be tested in accordance with specifications referred to in each individual case, the inspector shall require such material tests whenever, in his judgment, 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.

4.4.2 Air-gap measurements. - The rotor diameter and stator bore shall be measured in several places for each pair of poles and readings recorded. The average (sum of all values measured divided by the total number of measurements made) air gap calculated from the differences between the rotor diameter and stator bore shall be indicated.

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4.4.2.1 Using feeler gages measure the air gap (take average of three readings) at the centerline of as many main poles and commutating poles as possible (at each end for two bearing generators) indicating approximately where measurements were taken. Measurements shall be made at a minimum of 2 places spaced 90 mechanical degrees apart. These readings shall be within approximately 15 percent of the actual value determined from measurements of rotor and stator bore diameters. If readings are outside of an approximate 15 percent tolerance, the machine should be disassembled sufficiently to check the concentricity of the rotor and stator with respect to each other and adjustments made as necessary.

4.4.2.2 Where it is physically impossible to measure some or all of the air gaps directly as specified, an alternate indirect method may be used at the discretion of the inspector.

4.4.3 Resistance. - The resistances of the armature and all fields and the temperatures at which they are measured shall be taken and recorded.

4.4.4 Airborne noise. - For periodic test measurements shall be made in accordance with Standard MIL-STD-740. For routine tests observation shall be made of generator noise during the progress of testing to determine that the generator is free from any degree of noise comparably greater than that inherent in the given type and size of generator. The test may be conducted on water-air-cooled generators with or without the generator air cooler and access covers in place.

4.4.5 Vibration and balance. - Generators shall be tested to determine compliance with 3.3.12 in accordance with Type II of Standard MIL-STD-167. The generator armature shall be balanced dynamically, prior to assembly with its own frame and bearing, to meet the balance limits specified in Standard MIL-STD-167. The remaining unbalance, based on the calibration curve for the balancing machine used, shall be recorded on the test form. After the armature has been assembled with its intended frame and bearings, the armature shall be balanced as necessary to limit the vibration to the requirements of 3.3.12.

4.4.6 Lubrication. - By a careful observation and general inspection of the parts, it shall be determined that the performance of the lubricating system is satisfactory with the generator in normal horizontal position. This test shall be observed during the progress of other tests, or by special tests as the circumstances may warrant. Lubricant similar to that required for service operation shall be used. The routine test reports shall plainly indicate that such bearing tests have been made. In the event that the necessary facilities are not available at the place of manufacture for making the test under specified ambient conditions, the test may be made at some convenient lower ambient temperature. In such case, however, compliance with all other specified conditions is required. Provisional acceptance, based on satisfactory performance at the lower ambient temperature, shall not act to relieve the contractor from the necessity of complying strictly with the specified requirements.

4.4.7 Overspeed. - Each generator shall be subjected to an overspeed test at a speed 25 percent greater than the normal operating speed for a period of 5 minutes. Field excitation sufficient to produce rated voltage shall be applied to the field. The speed shall be increased slowly until the generator reaches the maximum test speed. The generator shall be at no-load condition. The generator shall be checked for noise, mechanical balance, and smoothness of running during the test and for loose solder, evidence of distortion, injury, or noticeable change in the condition of any part after shutdown. This is the maximum overspeed test required and no attached rotating parts, such as welded fans and spiders, need be tested for a greater overspeed.

4.4.8 Insulation resistance (cold). - This test shall be made before the dielectric tests. Prior to the application of the test voltage, the windings of the machine shall be thoroughly discharged. Separate measurements shall be made on the armature and field 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. The time of test voltage application shall be not less than 60 seconds. The temperature of the generator windings at the time of the test shall be measured and recorded. Insulation resistance measurements shall be corrected to 25°C. Corrections shall be made on the basis of insulation resistance doubling for each 15°C. decrease in temperature. The insulation resistance test may be conducted at any convenient ambient temperature. The relative humidity at the time of the test shall be measured and recorded.

4.4.9 Dielectric tests. - 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, because of dirt or moisture or damage to windings, this condition shall be remedied before the application of the dielectric test voltage. The dielectric test shall be made on the completely assembled generator and not upon individual parts. An exception is made in the case of repair parts such as coils and armatures.

4.4.9.1 Test voltage. - The dielectric test voltage shall be equal to twice the rated value of the terminal voltage plus 1,000 volts. The frequency of the testing voltage shall not be less than 60 cycles.

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The voltage wave shall approximate a sine wave. The testing voltage shall be applied continuously for a period of 60 seconds. Generators built in large quantities for which the test voltage is 2,500 volts or less may be tested for 1 second with a test voltage 20 percent higher than the 60 second test voltage.

4.4.9.2 Measurements of test voltage. - The measurements of the voltage used in dielectric tests shall be made by means of a voltmeter whereby the meter derives its voltage directly from the high voltage circuit, either by means of a voltmeter coil placed in the testing transformer or through an auxiliary potential transformer.

4.4.9.3 Points of application. - The test voltage shall be successively applied between each electric circuit and the frame with 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.

4.4.10 Commutation. - The observation of commutation shall be made in conjunction with and during the progress of other tests, to determine compliance with 3.3.21.8. Before the start of the test, it shall be ascertained that the brush holders are equally spaced around the commutator, that the brushes are set in the correct commutating zone and that this setting is permanently marked, that the brushes are well seated on the commutator, and that the commutator itself has a smooth and uniformly colored surface. During the progress of the tests, the brushes and the commutator shall remain untouched. If the generator is provided with commutating poles it shall be ascertained 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 is not acceptable. Proper correction of commutating pole strength shall require a change in the commutating pole air gap or the commutating pole winding. Observation of the commutation shall be made at varying loads throughout the service range, including the 50 percent overload point. Also, at shutdown, the armature shall be rotated slowly by hand and any irregular markings or lack of uniform coloration of polish on the surface of the commutator covered by the brushes shall be carefully noted.

4.4.11 Voltage regulation. - Voltage regulation tests shall be conducted on all generators. With the field rheostat so adjusted that the generator is operating at rated voltage, rated r.p.m. and no load, the load shall be applied in 20-percent steps up to the rated output to determine if the generator performance conforms to 3.2.11(a) and (c). With the field rheostat so adjusted that the generator is operating at rated voltage, rated r.p.m. and rated load, the load shall be reduced to zero in 20-percent steps to determine if the generator performance conforms to 3.2.11 (b) and (c). Following each initial setting for these two tests, there shall be no readjustment of the field rheostat for the remainder of the test. Voltage regulation tests are not required for d.c. generators used only as exciters.

4.4.12 Heating and overload tests. -

4.4.12.1 Conditions. - The heating and overload tests shall be made for the applicable set of conditions specified in the contract or order.

4.4.12.2 Duration. -

4.4.12.2.1 Continuous duty generators. - Normal load heat runs on continuous-duty generators shall be continued until steady final temperatures have been attained in all parts of the generator to determine compliance with table I. For generators 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 before-hand the generator shall be tested separately for each rating. To abridge the long heating period in the case of large generators, reasonable overloads of current during the preliminary period are permissible. It shall be considered that steady final temperatures have been reached when at least four consecutive readings taken at 15-minute intervals shall be within plus or minus 1°C. in the temperature rise of any part of the generator.

4.4.12.2.2 Intermittent duty generators. - The duration of the temperature test of a generator with a short-time or intermittent service rating shall be the time specified for that rating. In every case the equivalent short-time test shall commence only when the windings and other parts of the generator are within 5°C. of the ambient temperature at the time of starting the test.

4.4.12.3 Observable temperature. - Temperature measurements shall be taken during the progress of the heat run in each location where practicable otherwise the observable temperature shall be the temperature measured immediately after shutdown.

4.4.12.4 Ambient temperature. - The ambient temperature shall be measured in accordance with specification MIL-E-917. For water-air-cooled generators the ambient temperature shall be measured in accordance with Specification MIL-E-2036.

4.4.12.5 Method of measuring temperature. - Except as specified below the method of measuring temperature rise shall be optional with the manufacturer. Only one method of temperature determination shall be required for any particular part. Commutators, collector rings, bearings, and mechanical

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parts shall be measured by method 1 of Specification MIL-E-917.

4.4.12.5.1 Thermometers. - Where thermometers are furnished for permanent measurements of bearings in the case of ring and disk lubrication, additional thermometer measurements need not be taken. Where test thermometers are necessary, the temperature of the oil shall be taken by the thermometer inserted in the inspection hole at the top of the bearing cap and touching the bearing shell.

4.4.12.5.2 Forced lubrication. - In the case of forced lubrication the maximum temperature rise of the bearing shall be taken as the difference between the temperature of the entering oil adjacent to the bearing pedestal and the oil leaving the bearing pedestal as determined by the thermometer in the oil feed and drain line.

4.4.12.5.3 Shutdown. - On shutdown, preheated thermometers shall be placed on the armature commutator, core and windings, and banding wire and on the collector rings. Every precaution should be taken to reduce to a minimum the period of time elapsing between the stopping of the generator and the application of the thermometers. A curve should be platted with temperature readings as ordinates and time as abscissae. That portion of the linear curve starting where successive readings show decreasing temperatures should be extrapolated back to the instant of shutdown. The temperature at the instant of shutdown as determined in this manner shall be considered the shutdown temperature.

4.4.13 Unbalanced load (three-wire generators.)- The commutation, voltage regulation and heating and overload test procedures specified in 4.4.10, 4.4.11 and 4.4.12 shall be performed under maximum unbalanced load conditions specified in 3.2.6 in addition to balanced load conditions.

4.4.14 No-load, rated-voltage saturation data. - Sufficient data to plot no-load saturation curves shall be obtained. A copy of these curves shall be included in the report of the periodic tests. The readings for one curve shall always be taken with increasing values of field current; when it is necessary to reduce the field, it shall be reduced to zero and then increased to the desired value. The readings for the other curve shall always be taken with decreasing values of field current; when it is necessary to increase the field, it shall be increased to full field excitation and then decreased to the desired value. Points for each curve shall be taken as follows: Four below 60 percent of rated voltage, one between 60 and 90 percent, one at rated voltage, and three between rated voltage and full field excitation. Readings of line voltage, field current, field voltage, and speed shall be taken and recorded. The generator shall be driven by any convenient prime mover.

4.4.15 Insulation resistance (hot). - Immediately following the full load heat run, measurements of insulation resistance shall be taken. Details of test procedure shall be as specified in 4.4.8.

4.4.16 Ripple voltage. - The frequency spectrum from zero to 16 kilocycles shall be scanned with a harmonic wave analyzer to determine compliance with 3.2.10. The maximum amplitude measured and the frequency at which it occurs shall be recorded.

4.4.17 Efficiency. - When the efficiency of a generator is stated without specific reference to the load conditions, rated load is always to be understood. The efficiency shall correspond to, or be corrected to conditions, of rated voltage, current, speed, or such of the factors as may apply. The efficiency shall be determined and recorded for 2/4, 3/4 and 4/4 of rated continuous kilowatt load at rated voltage.

4.4.17.1 Detailed measurement of losses. - In the case of generators of normal rating below 25 kw., it will not be necessary to segregate the several losses to the extent indicated in the following paragraphs. In such cases it will be sufficient to measure the sum of those losses which remain substantially constant at all loads (bearing friction and windage, brush friction of commutator, core losses, and I^2R losses in shunt windings), separating these from each other and from those losses which vary with the load (load I^2R, brush contact losses and stray load losses) only insofar as may be necessary for the proper computation of efficiency at the various loads. For generators of normal rating of 25 Kw. and over, the several losses shall be measured in the manner specified as follows:

4.4.17.1.1 I^2R loss. - The armature and field I^2R loss shall be based upon the current and the measured resistance of the circuit corrected to 75°C. for generators having class A, 90°C. for class B, 105°C. for class F, and 125°C. for class H insulation.

4.4.17.1.2 Friction and windage. - The generator shall be driven at rated speed by an independent motor, the output of which shall be determined. The generator under test shall have the brushes raised from the commutator surface and shall not be excited. The motor output when driving the generator represents the bearing friction and windage of the generator under test.

4.4.17.1.3 Brush friction. - The generator shall be driven at rated speed by an independent motor, the output of which shall be determined. The brushes shall be in contact with the commutator or collector rings, but the generator shall not be excited. The difference between the motor output obtained by the test and that obtained in the friction and windage test shall be taken as the brush friction. The surfaces of the commutator, collector rings, and brushes

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shall be smooth and glazed from running when the test is made.

4.4.17.1.4 Core losses. - The generator shall be driven at rated speed from an independent motor, the output of which shall be determined. The brushes shall be in contact and the generator 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 motor output obtained by this test and that obtained in the brush friction test shall be taken as the core loss.

4.4.17.1.5 Brush contact loss. - A standard drop in determining brush contact loss shall be assumed constant for all loads as follows:

(a) 2 volts for electrographic and graphite brushes with shunts attached.

(b) 3 volts for electrographic and graphite brushes without shunts.

(c) 0.5 volts for metal-graphite brushes with shunts attached.

4.4.17.1.6 Stray load losses. - These losses include iron and copper eddy current losses not otherwise included in the foregoing loss tests and which are due to flux variation with the load. The stray load losses shall be taken as 1 percent of the output of generators having frame sizes corresponding to larger than 150 kw. at 575 r.p.m. On smaller generators, the stray load losses shall be omitted.

4.4.17.1.7 Field-rheostat losses. - These losses shall be included in the generator losses, where there is a rheostat in series with the field coils of the generator.

4.4.18 Effectiveness of enclosure. - The effectiveness of enclosures for open, protected, drip-proof protected, totally enclosed, and totally enclosed fan-cooled generators shall be determined by inspection. Water-air-cooled generators shall be tested in accordance with Specification MIL-E-2036.

4.4.19 Weight. - The weights of the d.c. generator (wet and dry weight for water-air-cooled generators) and the boxes of repair parts shall be measured and recorded (See 4.3.3).

4.4.20 High-impact shock test. - Generators shall be tested in accordance with Specification MIL-S-901 (see 4.3.2). The features of the test shall be as follows:

(a) The required type of shock test. - Grade I.

(b) The weight designation of the shock test. - As required by the generator. If the generator shaft in application will be required to support a heavy weight the shock tests shall be conducted with the generator shaft so loaded.

(c) Principal functions of the equipment. - Electric power supply.

(d) Definitions of failure to perform principal functions. -

(1) Breakage of any parts including mounting bolts.
(2) Appreciable distortion or dislocation of any parts such as mounting feet, poles, coils, brushes, and bearings.
(3) Any significant change in insulation resistance.
(4) Any significant change in mechanical unbalance.
(5) Any significant change in bearing temperature rise.
(6) Objectionable noise. Any noticeable increase or decrease in noise of the generator 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 4.4.20 (d) (8).
(7) Low dielectric strength. The generator shall be operated to obtain approximately rated temperature rise of steel and windings, then disconnected 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 4.4.9 except that it shall be made with an applied voltage equal to 65 percent of that specified in 4.4.9. Under these conditions, insulation failures shall be cause for rejection.
(8) Failure to pass inspection. The generator shall be disassembled following (1) to (7), inclusive, above, and inspected thoroughly for damage. The extent of disassembly need be only to the point where the condition of the generator can be easily observed. The effects of the shocks and subsequent check tests on the structure, bearings, and insulation should be carefully observed and recorded.

(e) Description or designation of acceptable method of mounting the equipment on the shock-testing machine. - The mounting adapters shown on the following figures

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of Specification MIL-S-901 shall be used:

(1) Figure 4C for generators to be tested on the shock testing machine for lightweight equipment.
(2) Figure 7A for generators to be tested on the shock testing machine for medium weight equipment.
(3) For heavyweight equipment, the method of mounting shall be as specified in Specification MIL-S-901.

(f) Place at which the 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 at his expense at a Government or commercial laboratory suitably equipped to conduct tests. Where shock tests are conducted at a Government laboratory, a copy of the master drawing shall accompany the generator.

(g) The number of generators to be tested. - One generator of the longest core length in each diameter and of similar construction out of each group of enclosures listed below, shall be shock tested:

(1) Group 1:
Open.
Protected.
Dripproof protected.
(2) Group 2:
Totally enclosed.
(3) Group 3:
Totally enclosed, fan cooled.
(4) Group 4:
Water-air-cooled.

If the manufacturer desires, he may submit a generator frame of less than the longest core length for the shock test. However, satisfactory compliance with the shock requirements will only determine conformance of generators having a core length equal to or less than the core length of the generator tested.

(h) Disposal of shock tested generators. -

(1) Generators which have been subjected to the high impact shock test and have failed to meet the requirements shall not be acceptable. The generator in whole or any of its parts shall not be used on any contract or order without the specific approval of the bureau or agency concerned.

(2) Generators which have been subjected to high impact shock test and have passed this test shall be considered acceptable for such service as the bureau or agency concerned may authorize and shall apply on contracts or orders provided the following conditions are met:

a. Mounting flanges connecting directly to the prime mover shall be replaced in the event of minor deformation. Minor deformations affecting alignments, including alignments with the prime mover, shall be corrected. Minor deformations are 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 generator drawings.
b. Prior to acceptance, all ball bearings on generators which have passed the high impact shock test shall be replaced.
c. Generators shall be subjected to a 2 hour full load heat run test, and be given an insulation resistance test and a dielectric strength test in accordance with 4.4.8 and 4.4.9.
d. A "substandard" plate will not be required.

4.4.21 Onboard repair parts. - Resistance readings at normal room temperature shall be made upon all repair field coil windings and the results checked against the values obtained for the coils of the generator. If the resistances are materially different from those of the generator coils, the repair coils shall be rejected. All repair coils shall be submitted to the dielectric test specified in 4.4.9.

5. PREPARATION FOR DELIVERY

5.1 Preservation, packaging, packing and marking. - The equipment, accessories, technical publications and repair parts shall be preserved and packaged by Level A or C; packed by Level A, B or C and marked, as specified (see 6.1) in accordance with Specification MIL-E-17555.

6. NOTES

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

(a) Title, number, and date of this specification.

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(b) Rating (voltage, kilowatt capacity, and, r.p.m.) (see 3.2.1 and 3.2.3).

(c) Efficiency (3.2.2).

(d) Whether overload rating is required (see 3.2.5).

(e) Whether parallel operation is required (see 3.2.8).

(f) Prime mover (see 3.2.12).

(g) Whether a three-wire distribution system is required (see 3.3.3).

(h) Specific radio interference limits, if required, whether radio interference suppression equipment may be used to meet specified limits, and, onboard repair parts on radio interference suppression equipment, if used (see 3.3.9 and table VIII).

(i) Airborne noise limits if required.

(j) Whether generators shall include design features to reduce stray magnetic fields, stray magnetic field limits (if specified), and whether non-magnetic generators are required (see 3.3.11 and 3.3.14.1).

(k) Class of insulation (see table II).

(l) Type of bearing(s) (see 3.3.16).

(m) Type of enclosure (see 3.3.45).

(n) Whether automatic voltage regulators are required (see 3.5).

(o) Type of preservation, packaging and packing (see 5.1).

6.2 Bid information. - Procurement documents should include the following statements:

(a) If a master drawing is not available at the time of the invitation for bid the manufacturer shall incorporate in the invitation for bid the information contained in 3.9.3(a), and (b).

(b) The generator to be shock tested shall be one on order provided the test is passed and the conditions specified in 4.4.20 (h)(2) are met.

6.3 Requirements for prime mover driven generators. - Requirements for complete prime mover driven generator sets incorporating generators built in accordance with this specification, are contained in Specification MIL-G-3087, if steam turbine driven, Specification MIL-G-22077 if gas turbine driven, Specification MIL-G-3048 if diesel engine driven, and Specification MIL-G-2145 if gasoline engine driven.

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 right or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

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APENDIX I

10. INSPECTION CHECK LIST FOR IN-PROCESS INSPECTION

10.1 Scope. - This appendix lists those items which should be included in the in-process inspection of generators furnished in accordance with this specification. This list is not an all inclusive list and additions and deletions as applicable can be made by the manufacturer subject to the approval of the inspector.

20. APPLICABLE DOCUMENTS

20.1 Not applicable

30. REQUIREMENTS

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

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

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

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

(a) Material is as specified on approved drawing. Material was ordered in accordance with applicable material or component specification and was inspected in accordance with the requirements of the material or component specification.

(b) All welding is done by qualified welders and is in accordance with the approved drawing. There is no evidence of non-fusion, weld cracks, under-size welds, incomplete welds, heavy porosity, weld splatter or slag.

(c) All soldered connections are solidly bonded; there is no cold soldering, no rosin joints, no corrosive flux, no fractured joints, or excess solder. Satisfactory connections were made prior to soldering. Bolted connections include approved locking devices and are secured against vibration. Solderless connectors are properly crimped and the connector and crimping tool are proper size.

(d) Finished castings are as shown on approved drawing and are clean and free of molding sand, cracks, blow holes, splits and deformations. Sufficient material is allowed for machining. Casting defects have not been covered by unauthorized repairs.

(e) Machining is as shown on approved drawing. The surfaces, including mating surfaces, as applicable, are smooth, square and are free of burrs, sharp edges, tool marks, chatter marks, and scratches and damage due to handling. Surface finish is as shown on approved drawing, and there are no tool marks except those normally associated with the indicated surface finish. There are no flaws exposed as the result of machining.

(f) No parts are government surplus or have been previously used or reclaimed.

(g) All items including hardware (nuts, bolts, lockwashers, etc.) are made of corrosion resistant material or are given a corrosion resistant treatment as shown on the approved drawing.

(h) The inspector may require a coil or winding to be cut apart to see the extent of varnish treatment and filling if there is any question as to the effectiveness of varnish treatment used.

(i) All bolts, nuts, set screws and other fasteners are as shown on the approved drawing and are secured in a manner which will preclude loosening in service. All locking devices are as shown on the approved drawing.

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(k) Insulation creepage and clearance distances are in accordance with approved drawing. Creepage distances are not achieved by means of cemented or butt joints.

(l) All similar parts of corresponding apparatus furnished on the same contract or order or built to the same drawing are strictly interchangeable without the necessity of further machining, selective assembly or hand fitting of any kind.

(m) Workmanship is first class in all respects.

30.3 Generators

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

(a) Shafts.

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

(b) Collector rings.

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

(c) Commutators.

(1) Items (a), (c), (e), (f), (j), (k), (l) and (m) of 30.2 apply.
(2) The fit of components is in accordance with the approved drawing.
(3) Commutators have received a curing treatment in accordance with the approved drawing.
(4) Riser slots have no thin walls and are as shown on the approved drawing.

(d) Fans.

(1) Items (a), (b), (d), (e), (f), (g), (h), (i), (j), (l) and (m) of 30.2 apply.
(2) Fans, except those covered by 30.3.1d (5) are balanced.
(3) All dimensions and the number of blades are as shown on the approved drawing.
(4) The fan surfaces which move the air are free from any irregularities, surplus weld material or any other projections which may be a source of airborne noise.
(5) Fans which break down into several parts are indexed in a manner such that they can be assembled in one way only.

(e) End brackets and bearing housings, end caps and frames.

(1) Items (a), (b), (d), (e), (f), (l) and (m) of 30.2 apply.
(2) Sufficient metal is available for drilling and tapping.
(3) All drilling, tapping and bolt centers are as shown on the approved drawing. Holes are clean, free of chips and are drilled straight. There are no burred threads. Holes are spot faced and are located so that edge distance is adequate in accordance with the approved drawing.
(4) All rust and grease is removed before painting. End brackets and frames fabricated and stored for periods prior to assembly were cleaned, and given a coat of primer or rust preventive before storing.
(5) The end brackets, except mating surfaces, such as bearing housings and

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rabbets, are cleaned, primed and painted on the inside surface prior to assembly. The inside of the frame is primed and painted if it did not receive at least two dips and bakes during the varnish treatment of the stationary electrical components.

(6) Mating surfaces of brackets and frame are concentric as shown on the approved drawing.

(7) All dimensions, dimensional tolerances and concentricities are as shown on the approved drawing.

(8) Bearing housings have sufficient metal to permit redrilling and bushing of the housing.

30.3.2 Items to be installed during assembly. -

(a) General.

(1) Items specified in 30.2 apply.

(2) Assembly and disassembly of all equipment can be done without the use of special tools except as otherwise specified in the contract.

(3) No shims, spacers or washers are required in the assembly to correct machining or material discrepancies.

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

(1) Keys as shown on the approved drawing are used to prevent rotational movement of all rotating parts, (i.e. collector rings, commutators, spiders, armatures).

(2) When rotating parts are pressed on the shaft, the pressure required to press on these parts is as shown on the approved drawing.

(3) When rotating parts are shrink fitted on the shaft, the interference shrink fits of the parts are as shown on the approved drawing.

(4) Axial movement of all parts is prevented by the methods shown on the approved drawing.

(5) Fans are secured to the shaft as shown on approved drawing.

(6) Coil connections for armatures and all equalizer connections are insulated adequately as shown on the drawing.

(7) Bearings are of the size and type as shown on the approved drawing. Bearings and bearing housings are free from dirt, sand, metal particles, corrosion, or other foreign material.

(8) The inner races of ball and roller bearings are secured to the shaft by means of shaft shoulders, lock washers and nuts or by the opposed shoulder method as shown on the approved drawing.

(9) Lamination size and stacking are as shown on the approved drawing.

(10) Slot or ground insulation are as shown on the approved drawing.

(11) Slot or ground insulation extends beyond stacking as shown on the approved drawing.

(12) Wire size and type used is as shown on the approved drawing.

(13) Preformed coils formed in accordance with the dimensions shown on the approved drawing and given at least one varnish treatment with clear baking varnish before installation in the slots.

(14) Undue force is not required to put slot wedge in place and insulation is not damaged or pushed out of place as the wedge is inserted.

(15) Slot wedges are of material and size as shown on the approved drawing. Length of wedge exceeds length of slot as shown on approved drawing.

(16) Coils are not loose after the wedges are in place.

(17) The wedge size is proper for the size and shape of the slot and there is no possibility that the wedge will cock in the slot and slip out.

(18) Coil connections are adequately insulated as shown on the drawing.

(19) Coil support insulation is as shown on the approved drawing.

(20) Coil extensions are insulated and secured as shown on the approved drawing.

(21) Insulation materials used are as shown on the approved drawing.

(22) Dimensions of wound coils are as shown on the approved drawing.

(23) The copper segments of commutators are securely retained as shown on the approved drawing.

(24) After assembly commutators have been given a proper sealing treatment.

(25) Insulation is cleaned off and unless self fluxing wire is used coil wire ends are tinned before making solder connections. Connections are properly soldered. There is no evidence of cold solder joints. Commutator riser slots are filled with solder and any excess removed.

(26) Lead wires are of the type shown on the approved drawing.

(27) Windings are mechanically secured as shown on the approved drawing.

(28) When preformed coils are used, the coils are given one varnish treatment prior to insertion in the slots and the completed winding assembly is given

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the varnish treatments with approved clear baking varnish. In the case where preformed coils are not used the complete assembly is given at least three varnish treatments.

(29) Type of varnish, treatment and baking time cycle, and baking temperatures are as shown on the approved drawing.

(30) The treated windings and coils are clean, smooth and glossy with good bonding and filling. Varnish seals are complete and show no signs of cracks or breaks. The completed windings have no air bubbles, air pockets, voids or dry spots on the surface and are not soft or sticky.

(31) There is no sign of excessive varnish buildup on one side of the winding assembly and lack of varnish buildup on other side. The thickness of the varnish on the winding assembly shall be uniform over the entire surface of the windings.

(32) Lead wires are insulated from ground and secured to prevent them from moving due to centrifugal force. Length and arrangement of wires shall permit ready repair; there is no aimless wiring resulting in "rats nests". Wiring agrees with the approved drawing.

(33) No glyptal or non-approved type of varnish or paint was put on any of the rotating elements.

(34) Coils or windings are not nicked or damaged during handling and processing.

(35) All completed rotating elements (including bearings), are dynamically balanced. The type of balance weights and method of securing are as shown on the approved drawing. They are secured in a manner such that they will not loosen in service. Balance weights are not attached in the airstream of the fan.

(36) Mica is under cut to specified depth. Copper segments are not damaged.

(c) Items to be checked during winding and assembly of stationary elements.

(1) Items 30.3.2(b), (10), (12), (21), (22), (26), (27), (29) thru (31) inclusive, and (34) apply.

(2) All lead wires are insulated from ground and secured within the frame with a suitable clamp or fastening device.

(3) All lead wires pass through the frame, enter the terminal box and are secured in such a manner to prevent chafing or abrasion as shown on the approved drawing.

(4) Terminal lugs of the type shown on the approved drawing are provided on the leads. Terminal lugs are properly crimped and there are no cut wire strands.

(5) Terminal boxes are of the type and size shown and are secured in the manner shown on the approved drawing.

(6) All leads are properly marked as shown on the approved drawing.

(7) All nuts, bolts, screws and other hardware are tight and provided with locking devices as shown on the approved drawing.

(8) Field pole coil is not unduly stressed while tightening pole securing bolts. Insulation is not damaged in the tightening process.

(9) Each field coil received at least three separate dips and bakes with an approved clear baking varnish either before or after assembly into the frame.

(10) All field coil connections were either soldered or bolted and a solid joint was made.

(11) All field coil connections are adequately insulated as shown on the approved drawing.

(12) Terminal board material is as shown on the approved drawing.

(13) Terminal studs are secured to the board in a manner to preclude turning when attaching external cables.

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

(a) All items of 30.2 apply.

(b) End brackets properly match frames bearing housings and end caps. All holes align, there is no excess clearance, and no undue force is required to assemble parts.

(c) Coil ends do not protrude to a point where they may be damaged by assembly or removal of the end bracket and there is no possibility of interference with the rotating elements.

(d) Field poles and commutating poles are capable of being removed from the frame without removing the armature.

(e) Between the armature and any load lead all series coils are connected together and

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all commutating pole coils are connected together.

(f) Field poles are so attached to the frame as to permit movement of the poles for adjustment of air gaps.

(g) Bearing outer races are secured in their housings as shown on approved drawing. The inside diameter of the retaining shoulders is within the dimensional tolerances shown on the approved drawing.

(h) There is no evidence of grease leakage past the close clearance non-rubbing seals into the generator or along the shaft.

(i) Spring washers, if used to provide preloading of the bearing, shall be selected and secured in the housing as shown on approved drawing.

(j) Seals of pre-lubricated bearings are not damaged and there is no evidence of grease leaking out of the bearing.

(k) Except where prelubricated bearings are used, grease pipes, cups and drains are as shown on the approved drawing.

(l) Where oil lubrication is used, the lubrication system is as shown on the approved drawing and there is no leakage of oil into or out of the generator.

(m) Sleeve bearings are in accordance with approved drawings, are of the self-aligning type, fit properly, are split on sets above 100 Kw and have proper oil clearance.

(n) Alarm contact maker settings for bearings are proper and in accordance with approved drawings.

(o) Brush holder studs are secured as shown on the approved drawing.

(p) Brush rigging insulation is as shown on the approved drawing.

(q) Brush rigging is adjustable so that the position of the brushes can be adjusted. The neutral position is permanently marked. The brush rigging is set on the position providing best performance.

(r) Brush holders and springs are of the type and size shown on the drawing.

(s) Brush holders are secured as shown on the approved drawing.

(t) Brush stops are provided as shown on the approved drawing.

(u) Brushes are of the manufacturer's grade designation shown on the approved drawing.

(v) Brushes have been properly seated on commutator or collector rings over a minimum of 90% of contact area of brush and excess carbon has been removed from the machine.

(w) Brush shunts are attached to the brush material by tamping or riveting.

(x) Brush size is as shown on the approved drawing and fits properly in the holder without sanding or filing and brushes move freely in the brush holders in the direction parallel to the length of the brush.

(y) Brush tension is adjustable and is set as shown on the approved drawing. Spring tension can be readily measured by spring scale.

(z) Brushes are properly aligned parallel to the shaft and do not extend beyond the edge of the collector rings or commutator.

(aa) Brush lug terminals are properly secured by screws which are not used for securing the brush holders to the rigging.

(bb) Brushes are properly spaced and staggered on the generator so that the commutator will wear evenly.

(cc) Brush shunts are furnished with lugs and are adequately secured.

(dd) Air gaps have been adjusted to design value and are uniform within the limits shown on the approved drawing.

(ee) Bearings have been lubricated with grease as specified on the approved drawing.

(ff) Air baffles are securely attached and do not interfere with rotating elements.

(gg) Lifting means is provided as shown on the approved drawing.

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(hh) Equipment enclosure is as shown on the approved drawing.

(ii) Drain plugs are provided as shown on approved drawing.

(jj) Entire exterior, other than identification plates or shaft extensions is painted as indicated on the approved drawing.

(kk) Identification and instruction plates are as shown on the approved drawing; contain all required information and are legible.

(ll) Mounting feet are flat, square, and are as shown on approved drawing.

(mm) The overall dimensions, mounting dimensions, and location of terminal boxes are as shown on the approved drawing.

(nn) Friction type (rubbing) seals, are the type and are secured as shown on the approved drawing.

(oo) Where high tensile bolts or screws such as socket head types, are used, provision is made to prevent replacement with a lower tensile strength bolt or screw. There are no slotted head bolts or screws used to secure end brackets to the frame. Thread-cutting screws (self tapping) are not used to secure any part of the generator.

(pp) Spot facing shall be as indicated on the approved drawing.

(qq) The generator, particularly the bearing housings, is clean and free of dirt, metal chips or other foreign materials.

(rr) The weight of the complete unit is as shown on the drawing.

(ss) Stationary lead wires do not contact rotating parts.

(tt) Jackscrews and dowels are as shown on the approved drawing.

(uu) Direction of rotation is correct and is properly marked.

30.4 Onboard repair parts.

(a) All items of 30.2 and 30.3 apply as applicable.

(b) All onboard repair parts are exact duplicates of the corresponding parts used on the generator.

(c) The inspector may require a suitable demonstration of the ready interchangeability of the onboard repair parts with the corresponding parts used on the generator if he has reason to doubt such interchangeability.

30.5 Preparation for delivery. - Preservation, packaging, packing and marking of complete generators, accessories and onboard repair parts are in accordance with requirements.

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2. DOCUMENT TITLE

3a. NAME OF SUBMITTING ORGANIZATION

b. ADDRESS *(Street, City, State, ZIP Code)*

4. TYPE OF ORGANIZATION *(Mark one)*

- ☐ VENDOR
- ☐ 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)*

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