MIL-D-24C

20 April 1984

SUPERSEDING
MIL-D-24B
14 April 1958

MILITARY SPECIFICATION

DYNAMOTORS

GENERAL SPECIFICATION FOR

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the general requirements for dynamotors used in electronic equipment (see 6.1).

1.2 Classification.

1.2.1 Type designation. The type designation of dynamotors is derived from the AN nomenclature system specified in MIL-STD-196 (eg, DY-97/GRC) or an individual service designation (eg, DM-34) and shall be as specified (see 3.1 and 6.2).

2. APPLICABLE DOCUMENTS

2.1 Government Documents.

2.1.1 Specifications, standards and handbooks. Unless otherwise specified, the following specifications, standards and handbooks of the issue listed in that issue of the Department of Defense Index of Specification and Standards (DoDISS) specified in the solicitation, form a part of this specification to the extent specified herein.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, US Army Electronic Research and Development Command, Electronics Technology and Devices Laboratory, ATTN: DELET-R-S, Fort Monmouth, NJ 07703 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426)) appearing at the end of this document, or by letter.

SPECIFICATIONS

FEDERAL

J-W 1177	-	Wire, Magnet, Electrical
L-P-513	-	Plastic Sheet and Insulation Sheet, Electrical (Laminated, Thermosetting, Paper Base, Phenolic Resin).
FF-B-171	-	Bearings, Ball, Annular (General Purpose).

MILITARY

MIL-I-10	-	Insulating Materials, Electrical, Ceramic, Class L.
MIL-M-14	-	Molding Plastics and Molded Plastic Parts, Thermosetting.
MIL-P-79	-	Plastic Rod and Tube, Thermosetting, Laminated.
MIL-T-152	-	Treatment, Moisture-and-Fungus-Resistant, of Communications, Electronic, and Associated Electrical Equipment.
MIL-V-173	-	Varnish, Moisture-and-Fungus-Resistant (For the Treatment of Communications, Electronic and Associated Equipment).
MIL-S-901	-	Shock Tests H. I. (High Impact), Shipboard Machinery, Equipment and Systems, Requirements for (NAVY).
MIL-P-997	-	Plastic-Material, Laminated, Thermosetting Electric-Insulating: Sheets, Glass Cloth, Silicone Resin.
MIL-F-14072	-	Finishes for Ground Electronic Equipment.
MIL-P-15037	-	Plastic Sheet, Laminated, Thermosetting, Glass-Cloth, Melamine-Resin.
MIL-P-15047	-	Plastic-Material, Laminated Thermosetting Sheets, Nylon Fabric Base, Phenolic-Resin.
MIL-E-16298	-	Electric Machines Having Rotating Parts and Associated Repair Parts, Packaging of.
MIL-G-23827	-	Grease, Aircraft and Instruments Gear and Actuator Screw.

Dynamic unbalance

STANDARDS

FEDERAL

FED-STD-H28 - Screw Thread Standards For Federal Services.

MILITARY

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-130 - Identification Marking of U.S. Military Property.
MIL-STD-195 - Marking of Connections for Electrical Assemblies.
MIL-STD-196 - Joint Electronics Type Designation System.
MIL-STD-202 - Test Methods for Electronic and Electrical Compo Parts.
MIL-STD-454 - Standard General Requirements for Electronic Equipment
MIL-STD-461 - Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference
MIL-STD-462 - Electromagnetic Interference Characteristics, Measurement of.
MIL-STD-810 - Environmental Test Methods.

2.1.2 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein, the text of the specification shall take precedence.

(Copies of specifications, standards and handbooks required by manufacturers in connection with specific acquisition functio should be obtained from the contracting activity or as directed by the contracting officer).

3. REQUIREMENTS

3.1 Specification Sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheet. In the event of any conflict between requirements of this specificat and the specification sheet, the latter shall govern.

3.2 First Article. When specified, a sample shall be subjected to First Article Inspection (see 4.5)

3.3 Material. The material for each part shall be as specified herein. However, when a definite material is not specified, a material shall be used which will enable the dynamotors to meet the performance requirements of this specification. Acceptance or approval of any constituent material shall not be construed as a guarantee of the acceptance of the finished product.

3.3.1 Restricted materials.

3.3.1.1 Flammable and explosive materials. Dynamotors shall incorporate in their construction the smallest practical amount of flammable and explosive materials consistent with good commercial practice.

3.3.1.2 Corrosive materials. Corrosive materials used in any of the processes in the manufacture of dynamotors shall be neutralized to minimize corrosion in the completed unit. Materials shall be of a corrosion-resistant type or shall be suitably treated to resist corrosion and shall not impair performance.

3.3.1.3 Wax-coated capacitors. Capacitors having wax-coated external surfaces shall not be used within the dynamotor enclosure.

3.3.2 Plastic.

3.3.2.1 Laminated. Laminated plastic sheets shall conform to L-P-513, MIL-P-997, MIL-P-15037, or MIL-P-15047. Laminated rods and tubes shall conform to MIL-P-79. All tubes shall be seamless rolled.

3.3.2.2 Molding. Molding plastic materials shall conform to MIL-M-14. Where a high degree of arc resistance is required, type CMG, CMI-5, or MME shall be used.

3.3.3 Ceramic. Ceramic materials shall conform to MIL-I-10.

3.3.4 Fungus-resistant materials. All non-metallic parts of the dynamotor shall be made of inherently fungus-resistant materials. When materials and components which are not inherently fungus-resistant are used in a filter or associated subassembly, they shall be treated to conform with MIL-T-152, with type II varnish conforming to MIL-V-173, unless they are in close proximity to or in the air stream that circulates about the commutator.

3.3.5 Lubricant. The lubricant employed in dynamotors shall conform to MIL-G-23827.

3.3.6 Wire.

3.3.6.1 Magnet wire. Magnet wire shall conform to J-W-1177.

3.3.6.2 Lead wire. Lead wire shall be insulated, flexible, stranded wire. Lead wire shall be AWG size 22, or larger.

3.4 Design and construction. Dynamotors shall be of the design, construction, and physical dimensions specified (see 3.1).

3.4.1 Threaded parts. All threaded parts shall be class 2 fit for conformance with FED-STD-H28. Unified screw threads shall be used whenever possible. The fine-thread series shall be used only for applications that might show a definite advantage through their use. Where a special diameter-pitch combination is required, the thread shall be of American National form and of any pitch between 16 and 36 which is used in the fine-thread series.

3.4.2 Safety wiring and staking. Accidental loosening of screws and screw parts and other connections shall be prevented by safety wiring, which shall not be less than 0.032 inch (.81 mm) OD, where practicable, staking, or other approved methods. Washers and cotter pins, where used, shall be assembled in a manner which prevents rotation of washers and movement of cotter pins under conditions of vibration (see 3.13 and 4.7.10).

3.4.2.1 Through bolting. Through bolting shall be used wherever practicable.

3.4.3 Securing lead wires. Field-coil leads shall be secured to the windings by some mechanical means in addition to the solder connection.

3.4.4 Impregnation. Windings shall be suitably impregnated. Impregnating materials and processes shall be such that there shall be no flowing, cracking, chipping, crazing, or giving off of fumes that will in any way interfere with normal dynamotor operation or cause a hazardous condition to personnel.

3.4.5 Coating. The exposed ends of the armature and field coils and the leads to the commutator shall be insulated and coated to protect them from damage due to servicing and normal operation.

3.4.6 Bearings. Ball bearings, when used, shall be as specified in FF-B-171. The fit tolerance of the bearings in the housing bores shall not exceed that recommended by the bearing manufacturer. When antifriction bearings are used, shaft and housing fit-ups shall be such that the performance requirements of this specification are met. All bearings shall be selected and applied so as to withstand vibration.

3.4.6.1 End play and clearance. The dynamotor bearings shall not be preloaded by differential expansion or contraction in the operating temperature range.

3.4.7 Brushes, brush assemblies, and brush holders.

3.4.7.1 Brushes. Brushes shall be of a composition which will tend to reduce commutator wear to a minimum consistent with a minimum brush-operating life as specified (see 3.1).

3.4.7.2 Brush assemblies. Each brush assembly supplied in a dynamotor or as a spare part, shall comprise a connected assembly of brush, coil spring, shunt cable (pig-tail connection), and shunt terminal.

3.4.7.2.1 Spare brush assemblies. When specified (see 6.2), spare brush assemblies shall be supplied with each dynamotor. Each set shall be packed in a container which is securely attached to the dynamotor as specified (see 6.2). All spare brushes shall be formed to a radius of approximately the radius of the new commutator and shall be duplicates of those supplied in the dynamotor.

3.4.7.3 Brush holders. Brush holders shall be of the slotted-cartridge type and the insulated portions shall be made of material which will not impair the operating characteristics of the dynamotor if a flashover occurs (see 6.4). Each brush holder shall be fixed so that it cannot be displaced by vibration or shifted during the normal procedure of servicing. The shunt terminal shall not turn or twist in its holder. The design and construction shall eliminate exposed springs and shunt connections, shall insure positive contact between the shunt terminal and the brush holder, and shall not permit rotation of the brush in the holder. Brush-holder caps shall be suitably insulated. The holder shall be so designed that brushes may be changed without the use of special tools.

3.4.7.4 Brush marking. The brush shall be permanently and legibly marked with a line or groove extending from the end opposite the wearing surface to the point of 75 percent of wear, as shown on figure 1.

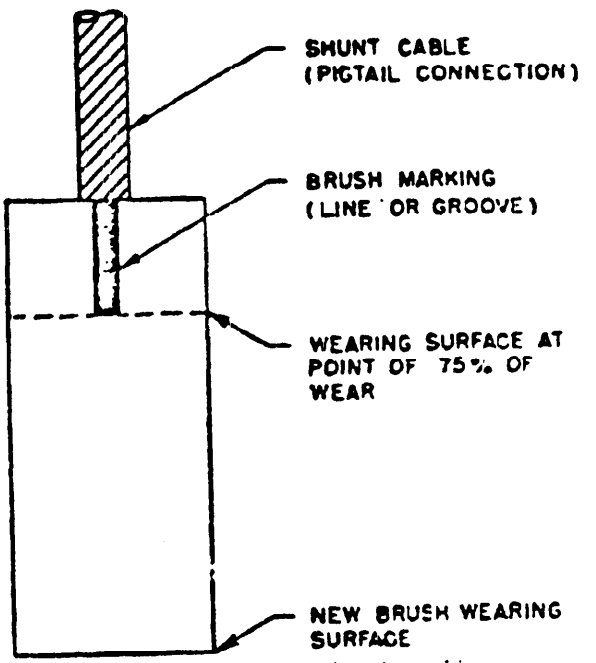

FIGURE 1. *Typical brush marking.*

3.4.8 Commutators. The surface of the commutator shall be free from burrs and other protrusions that may cause excessive brush wear. Where the insulation will not wear as rapidly as the commutator bars, it shall be undercut, and care shall be taken to insure that no insulation remains on the sides of the undercut (see 6.5).

3.4.8.1 Commutation. During any period of operation specified herein, there shall be no excessive sparking; and after operation, there shall be no evidence of excessive wear, pitting, or other injuries to the commutator.

3.4.9 Armature. Dynamotors shall be so contructed that the armature may be readily removed without special tools (see 6.6).

3.4.10 Permanent magnets. When used, permanent magnets shall be air stabilized.

3.4.11 End brackets and covers.

3.4.11.1 End brackets. The arrangement of the end brackets shall provide easy access to the commutator and brushes without removal of the end brackets. Except where double-shielded or double-sealed bearings are used, end brackets shall also permit addition of the bearing lubricant without removal of the end brackets.

3.4.11.2 End covers. Dynamotors shall operate for short periods with end covers removed to expose the commutator for the purpose of inspection. The end covers shall completely cover the end brackets and brush holders. The covers shall be capable of being removed without the use of special tools.

3.4.12 Finish (for Army purchases). The finish shall conform to MIL-F-14072.

3.4.13 Duty cycle. Dynamotors shall be designed to operate at one of the duty cycles shown in Table I, as specified (see 3.1).

TABLE I. DUTY CYCLE.

Designation	Full load	Rest
Continuous....	$\geq$ 1,000 hr	0
Short Life....	< 1,000 hr	0
Intermittent A....	5 min	15 min
Intermittent B....	1 min	9 min
Intermittent C....	1 min	29 min

3.4.14 Run-in period. All dynamotors shall be subjected to a suitable run-in period.

3.4.15 Weight. The weight of the dynamotor shall be as specified (see 3.1).

3.5 Electromagnetic interference. When specified on the contract or order (see 6.2), the radiated and conducted interference shall be as specified (see 3.1), when dynamotors are tested as specified in 4.7.1.

3.6 Dielectric withstanding voltage. There shall be no puncture of solid insulation, no continuing sparkover, no permanent decrease in dielectric strength of the insulation sufficient to cause failure, and the insulation resistance shall be as specified in 3.7, when dynamotors are tested as specified in 4.7.3.

3.7 Insulation resistance. Dynamotors shall have an insulation resistance of 100 megohms or greater, when tested as specified in 4.7.4.

3.8 Corona discharge. (when applicable). The corona shall not exceed the value specified (see 3.1), when dynamotors are tested as specified in 4.7.5.

3.9 Dynamic balance. The free vibration dynamotor under any load conditions between one-tenth and full value of the rated current (see 3.1) shall be not greater than 0.0007 inch total excursion when dynamotors are tested as specified in 4.7.6.

3.10 Load. The output voltage, efficiency, output-voltage regulation, and ripple voltage shall be as specified (see 3.1) and there shall be no excessive sparking or improper positioning of brushes, when dynamotors are tested as specified in 4.7.7.

3.11 Temperature rise. The temperature rise of the armature winding and of the frame shall not exceed the values specified (see 3.1) when dynamotors are tested as specified in 4.7.8.

3.12 Temperature cycling. The dielectric withstanding voltage and the load shall be as specified in 3.6 and 3.10, respectively, when dynamotors are tested as specified in 4.7.9.

3.13 Vibration. There shall be no mechanical or electrical damage, when dynamotors are tested as specified in 4.7.10; in addition, the load shall be as specified in 3.10, when dynamotors are tested as specified in 4.7.10.2.1.

3.14 Shock.

3.14.1 Test I. Dynamotors shall be operative after each blow and there shall be no binding or rubbing of parts, when dynamotors are tested as specified in 4.7.11.1 to 4.7.11.1.2, inclusive. Momentary stopping is permissible provided the dynamotor resumes operation after each blow.

3.14.2 Test II. There shall be no mechanical or electrical damage, when dynamotors are tested as specified in 4.7.11.2 and 4.7.11.2.1.

3.14.3 Test III (for dynamotors weighing 4 pounds or less). There shall be no mechanical or electrical damage, when dynamotors are tested as specified in 4.7.11.3.

3.15 Low-temperature storage and operation. Dynamotors shall reach 65 percent of output voltage measured during the load test (see 4.7.7) within 5 seconds, and the load shall be as specified in 3.10, when dynamotors are tested as specified in 4.7.12.

3.16 High-altitude brush life (when applicable). No brush shall fail in less than 350 hours of operation, when tested as specified in 4.7.13 and 4.7.13.1. The average operating life prior to brush failure, if any, of all dynamotors tested shall be not less than 500 hours. The brush shall have failed when normal operation of the dynamotor is prevented by conditions related to the brush, brush holder or commutator.

3.17 Moisture resistance. The dielectric withstanding voltage and the load shall be as specified in 3.6 and 3.10, respectively. The insulation resistance shall not be less than 1 megohm , when dynamotors are tested as specified in 4.7.14 and 4.7.14.1. Corrosion shall not impair performance and marking shall remain legible.

3.18 Sea-level life. No brush or dynamotor shall fail in less than 350 hours of operation, when tested as specified in 4.7.15. The average operating life prior to brush failure, if any, of all dynamotors tested shall be not less than 500 hours. The brush shall have failed when normal operation of the dynamotor is prevented by conditions related to the brush, brush holder or commutator.

3.19 Range of operating voltages. The dielectric withstanding voltage and the load shall be as specified in 3.6 and 3.10, respectively, when dynamotors are tested as specified in 4.7.16.

3.20 Enclosure. Dynamotors shall conform to one of the following enclosures as specified in the applicable specification sheet (see 3.1).

of generator, including curing using a tip suitable for the thickness

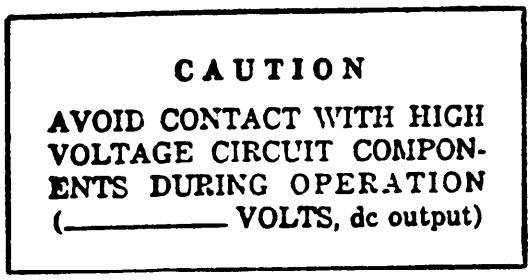

FIGURE 2 Typical caution plate marking.

3.23.3 Internal marking. The symbols "+" and "-" for polarity indication, and "HV" and "LV" for high voltage and low voltage, respectively, shall be marked on the end brackets near the applicable brushes. The container for spare brushes shall also be so marked. Instructions for relubrication shall be marked on the interior surfaces of the end covers; these instructions shall indicate that the dynamotor shall be relubricated after a minimum operation time of 1,000 hours, with grease conforming to MIL-G-23827.

3.23.4 Color coding. External leads, when specified, shall be color coded conforming to MIL-STD-195.

3.24 Workmanship. Dynamotors shall be manufactured and processed in a careful and workmanlike manner, in accordance with good design and sound practice.

3.24.1 Prevention of corona. All metal parts, fittings, and attachments which operate at higher potential than other adjacent parts of the housing shall be carefully finished in order to insure that all sharp corners, edges, etc., are removed to minimize the possibility of corona discharge under the specified service conditions. Parts from which the removal of sharp corners and edges would be impractical, such as conductors, shall be spaced in a manner designed to prevent corona discharges under the specified service conditions (see 4.7.5).

3.24.2 Connections. The electrical connections of dynamotors shall not depend on wires, lugs, terminals, or other connectors clamped between a metallic member and an insulating material. Where the maintenance of a tight connection would otherwise depend on the resistance of an insulating material to compressive or shearing stress, such a connection shall be securely soldered. Soldered connections shall not be used for mechanical support. Electrical connections shall be made mechanically secure and electrically continuous before soldering. Soldering shall conform to requirement 5 of MIL-STD-454.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein,unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of inspection. The inspection requirements specified herein are classified as follows:

a. First article inspection (see 4.5)
b. Quality conformance inspection (see 4.6)

4.3 Inspection conditions. Unless otherwise specified herein, all inspections shall be made at room ambient temperature, pressure, and humidity.

4.4 Test equipment and inspection facilities. Test equipment and inspection facilities shall be of sufficiant accuracy, quality, and quantity to permit performance of the required acceptance inspection. The manufacturer shall establish adequate calibration of test equipment to the satisfaction of the Government.

4.5 First article inspection. After award of contract, unless otherwise specified in the contract or purchase order, first article inspection shall be performed by the contractor as specified in 4.5.1 and 4.5.4.

4.5.1 Sample. The first article sample shall be made and assembled by the manufacturer with tools and methods that, as far as practicable, are the same as those which will be used for quantity production of the product. The manufacture of dynamotors for a Government contract, prior to approval of the first article sample, shall be at the manufacturer's risk. Six specimens of each type of dynamotor shall be submitted.

4.5.2 Inspection routine. The first article specimens shall be subjected to the examinations and tests specified in Table II in the order shown.

TABLE II First Article Inspection.

EXAMINATION OR TEST	REQUIREMENT PARAGRAPH	METHOD PARAGRAPH
GROUP I --- 2 specimens		
Electromagnetic interference	3.5	4.7.1
GROUP II --- 6 specimens	3.1, 3.3 to 3.4.2.2, incl,	4.7.2.1
Visual and Mechanical examination (external)	3.4.11, 3.4.12, 3.4.15, 3.20.3, 3.20.4, 2.23 and 3.24 to 3.24.2, incl	
Dielectric withstanding voltage	3.6	4.7.3
Insulation resistance	3.7	4.7.4
Corona discharge (when applicable)	3.8	4.7.5
Dyanamic balance	3.9	4.7.6
Load	3.10	4.7.7
Temperature rise 1/	3.11	4.7.8
Temperature cycling	3.12	4.7.9
GROUP III --- 3 specimens 2/		
Vibration	3.13	4.7.10
Shock	3.14	4.7.11
Low-temperature storage and operation	3.15	4.7.12
High-altitude brush life (when applicable)	3.15	4.7.13 and 4.7.13.1
Moisture resistance	3.17	4.7.14 and 4.7.14.1
Sea-level life	3.18	4.7.15
Range of operating voltages	3.19	4.7.16
Enclosure	3.20	4.7.17
Visual and mechanical examination (internal)	3.1,3.3 to 3.4.11.2, incl, 3.23, and 3.24 to 3.24.2, incl	4.7.22
GROUP IV --- 3 specimens 3/		
Life	3.21	4.7.12 to 4.7.18.3, incl
Salt spray (corrosion) (when applicable)	3.22	4.7.19
Visual and mechanical examination (internal)	3.1, 3.3 to 3.4.11.2, incl 3.23, and 3.24 to 3.24.2,incl	4.7.22

1/ Only the two specimens submitted to the electromagnetic interference test in Group I shall be subjected to the temperature-rise test.
2/ None of the specimens shall have been subjected to the electromagnetic interference and temperature-rise tests.
3/ Two of the specimens shall have been subjected to the temperature-rise test.

4.5.3 Failures. Failure of any dynamotor to comply with any of the examinations or tests shall be cause for failure of first article inspection.

4.5.4 Noncompliance. If a sample fails first article inspection, the contractor shall take corrective action on the materials or processes, or both, as warrented, to eliminate the cause of failure. The contractor, at no additional cost to the Government, shall be required to fabricate an additional first article inspection lot and subject them to inspection. A description of the corrective action taken shall be included in the first article inspection test report. Government approval to begin production will be given only upon successful completion of first article inspection.

4.6 Quality conformance inspection. Quality conformance inspection shall consist of groups A, B and C.

4.6.1 Inspection lot. An inspection lot shall conform to MIL-STD-105.

4.6.2 Resubmitted lots. If an inspection lot is rejected, the manufacturer may rework the lot or screen out defectives and resubmit it for acceptance inspection. Resubmitted lots shall be kept separate from new lots. The resubmitted lot shall be inspected, using tightened inspection.

4.6.3 Group A inspection. Group A inspection shall consist of the examinations and tests specified in talbe III, in the order shown. Statistical sampling and inspection shall conform to MIL-STD-105. The acceptable quality levels (AQL) shall be as specified in table III. Major and minor defects shall be as defined in MIL-STD-105.

TABLE III. GROUP A INSPECTION.

Examination or test	Requirement Paragraph	Method Paragraph	AQL (percent defective)	
			Major	Minor
Visual and mechanical examination (external)	3.1, 3.3 to 3.4.2.2, incl, 3.4.11,3.4.12, 3.4.15,3.20.3, 3.20.4, 3.23, and 3.24 to 3.24.2, incl	4.7.2.1	1.0	4.0
Dielectric withstanding voltage	3.6	4.7.3		
Insulation resistance	3.7	4.7.4	1.0	...
Load	3.10	4.7.7		

4.6.4 Group B inspection. Group B inspection shall consist of the examinations and tests specified in table IV, in the order shown.

Table IV. Group B inspection.

Examination or test	Requirement paragraph	Method paragraph
Dynamic balance	3.9	4.7.6
Temperature rise	3.11	4.7.8
Range of operating voltages	3.19	4.7.16
Visual and mechanical examination (internal)	3.1, 3.3, 3.4 to 3.4.11.2 incl, 3.23, and 3.24 to 3.24.2, incl	4.7.2.2

4.6.4.1 Sampling procedure. The sampling procedure shall conform to MIL-STD-105. Unless otherwise specified herein, normal inspection shall be used at the start of the contract. The AQL shall be 6.5 (percent defective) and the inspection level shall be S-4 for normal and tightened inspection and S-3 for reduced inspection.

4.6.4.2 Disposition of sample units. Sample units which have passed all the group B inspections shall be delivered on the contract or order, if the lot is accepted.

4.6.5 Group C inspection. Group C inspection shall consist of the tests specified in table V, in the order shown.

Table V. Group C inspection.

Test	Requirement paragraph	Method paragraph
Electromagnetic Interference	3.5	4.7.1
Temperature cycling	3.12	4.7.9
Life	3.21	4.7.18 to 4.7.18.3 incl

4.6.5.1 Sampling procedure. Group C inspection shall be performed on three sample units which have been subjected to and have passed the group A inspection but which have not been subjected to the group B inspection. No defectives shall be allowed. When production continues for a period beyond the rated life of the sample units under test, three additional sample units, selected from current production, shall be placed on test periodically at intervals equal to the rated life of the dynamotor. Delivery on the contract or order shall not be delayed pending reuslts of the group C inspection.

4.6.5.2 Disposition of sample units. Sample units subjected to group C inspection shall not be delivered on the contract or order.

4.6.5.3 Noncompliance. If a sample fails to pass group C inspection, the manufacturer shall notify the qualifying activity and the cognizant inspection activity of such failure and take corrective action on the materials or processes, or both, as warrented, and on all units of product which can be corrected and which are manufactured under essentially the same materials and processes, and which are considered subject to the same failure. Acceptance and shipment of the product shall be discontinued until corrective action, acceptable to the qualifying activity has been taken. After the corrective action has been taken, group C inspection shall be repeated on additional sample units (all tests and examinations, or the test which the original sample failed, at the option of the qualifying activity). Groups A and B inspections may be reinstituted; however, final acceptance and shipment shall be withheld until the group C inspection has shown that the corrective action was successful. In the event of failure after reinspection, information concerning the failure shall be furnished to the cognizant inspection activity and the qualifying activity.

4.7 Methods of examination and test.

4.7.1 Electromagnetic interference. (see 3.5 and 6.2) Dynamotors shall meet the applicable requirements of MIL-STD-461B using the test procedures of MIL-STD-462.

4.7.2 Visual and mechanical examination.

4.7.2.1 External. Dynamotors shall be examined insofar as possible without disassembly to verify that the materials, design, construction, physical dimensions, enclosure, arking, and workmanship are in accordance with the applicable requirements (see 3.1, 3.3 to 3.4.2.2, incl, 3.4.11, 3.4.12, 3.4.15, 3.20.3, 3.20.4, 3.23, and 3.24 to 3.24.2 incl.).

4.7.2.2 Internal. Dynamotors shall be disassembled. The internal materials, design, construction, marking, and workmanship shall be examined for compliance with this specification (see 3.1, 3.3 to 3.4.11.2, incl., 3.23, and 3.24 to 3.24.2 incl.).

4.7.3 Dielectric withstanding voltage (see 3.6). Dynamotors shall be tested for conformance with method 301 of MIL-STD-202. The following details shall apply:

a. Special preparations or conditions - capacitors connected to the circuit under test shall be disconnected so that they will not be stressed during test. All brushes may be removed from each commutator and the dynamotor may be disassembled sufficiently to unground each winding in turn.

b. Magnitude of test voltage - the test voltage shall be of the magnitude shown in Table VI, and shall be applied for not less than 5 seconds nor more than 1 minute during acceptance inspection.

c. Nature of potential - alternating current.

d. Points of application of test voltage - the test voltage shall be applied between the frame and each winding which is not permanently connected to the frame by soldering, brazing or welding, with all other windings connected to the frame.

e. Measurements after dielectric withstanding voltage test - the insulation resistance shall be measured as specified in 4.7.4 (may be measured before proceeding to the next winding), and the dynamotors shall be examined for puncture of solid insulation and any permanent decrease in the dielectric strength of the insulation sufficient to cause failure.

Table VI. Dielectric-withstanding-voltage test voltages.

Rated winding voltage	Test voltage
Volts (dc or peak ac)	Volts (rms)
<180	500
180 to 700, incl	2.8x rated voltage
>700	1.4x rated voltage +1,000

4.7.4 Insulation resistance (see 3.7). Dynamotors shall be tested for conformance with method 302 of MIL-STD-202. The following details shall apply:

a. Test condition letter - B

b. Special preparations or conditions - All brushes may be removed from each commutator and the dynamotor may be disassembled sufficiently to unground each winding in turn.

c. Points of measurement - Measurements shall be made between the frame and each winding which is not permanently connected to the frame by soldering, brazing, or welding, with all other windings connected to the frame.

4.7.5 Corona discharge (when applicable).

4.7.5.1 Test circuit. The test circuit shall be as shown on figure 3. The waveform of the full test voltage shall be substantially sinusoidal and shall contain no apparent distortion when observed on an oscilloscope used in conjunction with a suitable voltage divider. The complete test circuit, excluding the dynamotor, shall be free from corona when 150 percent of the test voltage (see 3.1) is applied. The supply line shall be sufficiently

attenuated by shielding or other means so as to eliminate spurious signals which might be mistakenly recognized as corona.

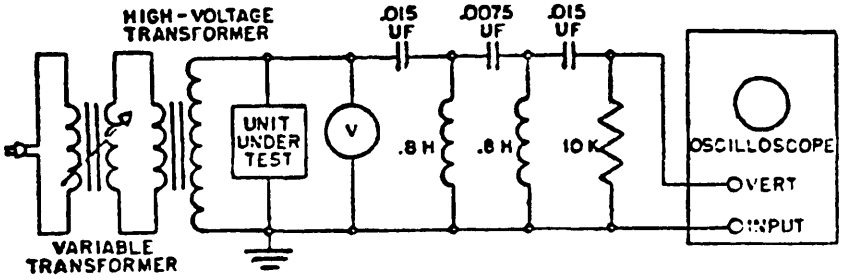

Figure 3. Corona-discharge test circuit.

4.7.5.2 Test Procedures. The altitude shall be as specified (see 3.1). The oscilloscope used for this test shall have the sensitivity set at approximately 0.1 peak volt per inch and shall have reasonalby uniform response up to 1 megacycle. The dynamotor frame and all armature and stator windings shall be grounded except the winding under test. All connections between the winding under test and other windings or ground shall be removed, and the test voltage shall be applied as specified (see 3.1). The test voltage shall be increased to obtain the specified test value (see 3.1). Exposure to corona during testing shall be no more than necessary (see 3.8).

4.7.6 Dynamic balance. The completely assembled dynamotor shall be elastically mounted to allow vibration in all axes. The elastic members of the mounting may be either compression or tension. The weight of the dynamotor, when not rotating, shall cause the mounting to be compressed (stretched) to not less than the amount shown below:

Rated Speed, rpm	Minimum displacement, inch (mm)
900	1 (25.4)
1,200	9/16 (14.29)
1,500	3/8 (9.53)
1,800	1/4 (6.35)
3,600	1/16 (1.59)
7,200	1/64 (.40)

For any rated speed other than shown above, the minimum compression (tension), which is inversely proportional to the square of the dynamotor speed, shall be interpolated. The static compression (tension) shall be not greater than 50 percent of the original length of the compression (tension) member. With the dynamotor mounted and rotating, the load shall be applied and varied continuously between one-tenth and full value of the rated load current (see 3.1). The dynamotor shall also be operated at no-load conditions. Vibration at the bearing housing shall be measured with a vibration indicator in the direction giving the maximum amplitude. The mounting shall be isolated to the extent necessary to allow vibration amplitudes of the bearing housing with the dynamotor mounted but not rotating, not greater than one-tenth of the maximum allowable amplitude for the rotating dynamotor (see 3.9).

4.7.7 Load. Dynamotors shall be operated at rated input voltage (see 3.1). The open-circuit output voltage shall be measured. A resistive load of such magnitude as to draw rated output current (see 3.1) sahll be connected. The following shall be determined:

a. Output voltage.
b. Efficiency in percent.
c. Output voltage regulation in percent.
d. Average ripple voltage at output. 1/

During and after operation, the dynamotors shall be examined for excessive sparking or improper positioning of brushes (see 3.10).

4.7.8 Temperature rise. The temperature rise of the armature winding shall be determined by resistance measurements in an area free of drafts and direct thermal radiation, while the dynamotor is mounted to material of low thermal conductivity such as wood or porcelain. Two commutator bars (on the hottest winding, if possible) shall be marked for identification. The resistance (r) between these marked bars shall be determined with the brushes removed. The dynamotor shall then be operated at rated load and the specified duty cycle (see 3.1) until the temperature of the frame remains stabilized. An intermittent-duty dynamotor shall be cycled until there is no change in the maximum temperature reached during a cycle for three successive duty cycles.

1/ Average ripple-voltage measurements shall be made with a Ballantine model 300 vacuum tube voltmeter, or equal, and a 2-microfarad capacitor with a suitable voltage rating in series with the positive lead of the motor. The aggregate accuracy of the combination shall be ±5 percent from 30 to 10,000 cycles per second (cps).

Resistance measurements shall be made immediately at the end of the "on" portion of the duty cycle. The temperature of the frame, measured on the external surface of the yoke at the center of the pole shoes, shall be determined by thermocouple or thermometer. The resistance between the marked commutator bars shall be measured at intervals of not more than 30 seconds immediately after the dynamotor has been stopped, and shall be extrapolated back to the resistance at time of shutdown for determination of R. The temperature rise of the armature winding shall be computed by the following formula:

$$\Delta T = \frac{R - r}{r} (t + 234.5) - (T - t)$$

Where

ΔT = temperature rise in degrees centigrade
R = hot resistance in ohms at time of shutdown
r = cold resistance in ohms
t = temperature of dynamotor at the time of measurement of r in degrees centigrade
T = mean ambient temperature during final quarter of test in degrees centigrade

The ambient temperature shall vary by not more than 2 degrees C. during the final quarter of this test. In case of failure, this test shall be performed again at the maximum ambient temperature (see 3.1) as a referee test (see 3.11).

4.7.9 Temperature cycling. Dynamotors shall be tested for conformance with method 107, test condition A, of MIL-STD-202. Immediately after removal from the chamber following completion of the final cycle, the dynamotors shall be subjected to the dielectric-withstanding-voltage test with 90 percent of the voltage specified in 4.7.3 applied for a period of 5 seconds, and the load test specified in 4.7.7 (see 3.12).

4.7.10 Vibration. Dynamotors shall be tested in accordance with test I or II, as specified (see 3.1 and 3.13). When an intermittent duty cycle is specified (see 3.1), vibration shall be continued during the "off" and "on" portion of the cycle.

4.7.10.1 Test I. Dynamotors shall be tested for conformance with method 201 of MIL-STD-202. The following details and exceptions shall apply:

a. Tests and measurements prior to vibration - Not applicable
b. Method of mounting - By normal mounting means, in normal operating position. All shock-absorbing devices that are an integral part of the dynamotor shall be in place and unblocked.
c. Duration of vibration - 90 minutes in each direction.
d. Direction of motion - in each of the following directions:
   1. Parallel to the armature axis and parallel to the base.
   2. Perpendicular to the armature axis and parallel to the base.
3. Tests and measurements during and after vibration - Dynamotors shall be examined for mechanical or electrical damage.

4.7.10.2 Test II. Dynamotors shall be mounted by normal mounting means, in normal operating position. All shock-absorbing devices that are an integral part of the dynamotor shall be in place and unblocked. This test shall be conducted in two separate steps. Step 1 may be performed in two parts so that vibration over the frequency range of 5 to 53 cps can be conducted separately from the remainder of the range provided that the applicable requirements for rate of change of frequencies are met.

4.7.10.2.1 Step 1 (operational-vibration-test). Dynamotors, while operating at rated load and the specified duty cycle (see 3.1), shall be subjected to a simple harmonic vibration in the frequency range of 5 to 500 cps. The amplitude shall be as shown on figure 4. This step shall be performed for a period of time and at a rate of change of frequency adequeate to determine that the load is as specified (see 3.10) over the specified vibration-frequency range, when dynamotors are tested as specified in 4.7.7

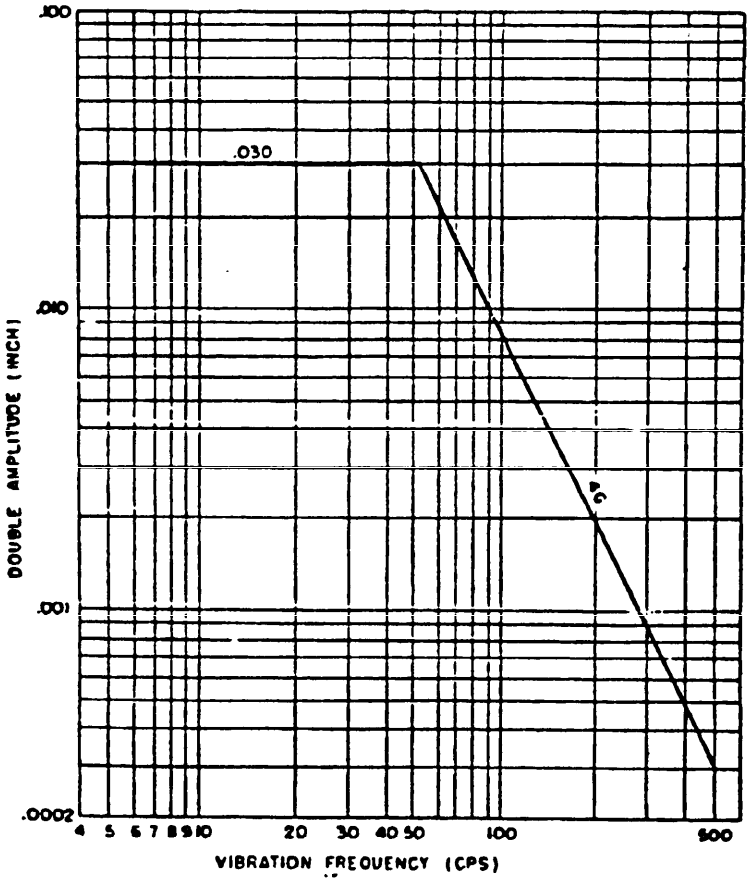

Figure 4. Vibration test curve.

4.7.10.2.2 Step 2 (vibration-life test). Dynamotors shall be tested for conformance with method 204, test condition A, of MIL-STD-202. After this test, the dynamotors shall be examined for mechanical or electrical damage.

4.7.11 Shock. Dynamotors shall be tested for conformance with test I, II or III, as specified (see 3.1 and 3.14).

4.7.11.1 Test I. Dynamotors shall be operated at rated input voltage (see 3.1) and no loading during this test.

4.7.11.1.1 Equipment and mounting. The shock-testing machine shall be that specified for lightweight equipment in MIL-S-901. Dynamotors shall be mounted by normal mounting means, in normal operating position. All shock-absorbing devices that are an integral part of the dynamotor shall be in place and unblocked.

4.7.11.1.2 Number of blows. Three blows shall be applied parallel to each of the three principal axes of the dynamotor for a total of nine blows. The height of the hammer drop for each blow shall be successively: 1 foot, 3 feet, and 5 feet.

4.7.11.2 Test II. The shock testing machine shall be that specified in MIL-STD-202. Dynamotors shall be mounted by normal mounting means, in norman operating position. All shock-absorbing devices that are an integral part of the dynamotor shall be in place and unblocked.

4.7.11.2.1 Equipment operation. The dynamotor shall be subjected to 18 impact shocks of 30 gravity units, each shock impulse having a time duration of 11 ± 1 milliseconds. The intensity shall be within 10 percent when measured with a filter having a band width of 5 to 100 cps. The shock shall be applied in the following directions:

a. Vertically, three shocks in each direction.
b. Parallel to the major horizontal axis, three shocks in each direction.
c. Parallel to the minor horizontal axis, three shocks in each direction.

Dynamotors shall be operated at rated input voltage (see 3.1) and no load throughout this test. After this test, the dynamotors shall be examined for mechanical or electrical damage.

4.7.11.3 Test III (for dynamotors weighing 4 pounds or less). Dynamotors shall be tested for conformance with method 213 of MIL-STD-202 (see 3.14.3). The following details shall apply:

a. Mounting method and accessories - By normal mounting means, in normal operating position. All shock-absorbing devices that are an integral part of the dynamotor shall be in place and unblocked.

b. Test condition - K.

c. Electrical load conditions - Dynamotors shall be operated at rated input voltage (see 3.1) and no load.

d. Measurements after shock - Dynamotors shall be examined for mechanical or electrical damage.

4.7.12 Low temperature storage and operation. Dynamotors shall be placed within the chamber, then cooled to and maintained at a temperature of $-65^{\circ} \pm {}^{0}_{3}$ C. during first article inspection and $-65^{\circ} \pm {}^{0}_{20}$ C. during acceptance inspection for a period of 48 hours. The temperature shall then be changed to $-55^{\circ} \pm {}^{0}_{3}{}^{\circ}$C. during first article inspection and $-55^{\circ} \pm {}^{0}_{20}{}^{\circ}$ C. during acceptance inspection, and maintained for an additional 24 hour period. At the conclusion of this exposure period, and while at this temperature, a resistive load, determined by dividing the rated output voltage by the respective rated output current (see 3.1) shall be connected to the dynamotor. The low temperature starting time for the dynamotor shall be determined by applying an input voltage equal to 75 percent of rated input voltage (see 3.1). The time needed to reach 65 percent of the output voltage measured during the load test (see 4.7.7) shall be determined. The load test specified in 4.7.7 shall then be performed prior to removal of the dynamotors from the cold chamber (see 3.15).

4.7.13 High altitude brush life (when applicable). Each dynamotor shall be equipped with brushes that have been subjected to a suitable run-in period. Dynamotors shall be operated at rated load and the specified duty cycle (see 3.2), and under the following ambient conditions:

Temperature.....$-55^{\circ} \pm {}^{0}_{3}{}^{\circ}$ C.

Dewpoint.....-70° C.

Altitude.....50,000 feet

Each dynamotor shall be operated under these conditions until brush failure occurs, or until the requirements have been met, but in no case shall this test exceed 800 hours per dynamotor.

4.7.13.1 Test facilities. Provisions shall be made for a continuous dry-air supply to the test chamber. The ambient atmosphere within the chamber shall have a dewpoint not higher than -70°C. throughout the test. Air may be continuously pumped from the chamber at a rate per minute of one-fifth the volume of the chamber. Altitude shall be maintained at 50,000 feet within a variation corresponding to 0.1 inch of mercury. The chamber shall be capable of maintaining the required temperature throughout the test. Care should be taken to insure that there is no contaminant present in the chamber or introduced into the chamber since these can drastically affect brush tests (see 3.14).

4.7.14 Moisture resistance. Dynamotors shall be mounted by normal mounting means and tested for five continuous cycles, each cycle to conform with the cycle shown on figure 5.

4.7.14.1 Measurements. Upon completion of the final cycle, dynamotors shall be removed from the humidity chamber and allowed to dry for 24 hours at a temperature of 25°±5° C. and a relative humidity of 50±5 percent. In the case of nonventilated dynamotors it is permissable to remove the end covers to facilitate the removal of surface moisture. Dynamotors shall then be subjected to the dielectric-withstanding-voltage test at 90 percent of the voltage specified in 4.7.3, and the insulation resistance and load tests specified in 4.7.4 and 4.7.7, respectively, and shall be examined for corrosion and legibility of marking (see 3.17).

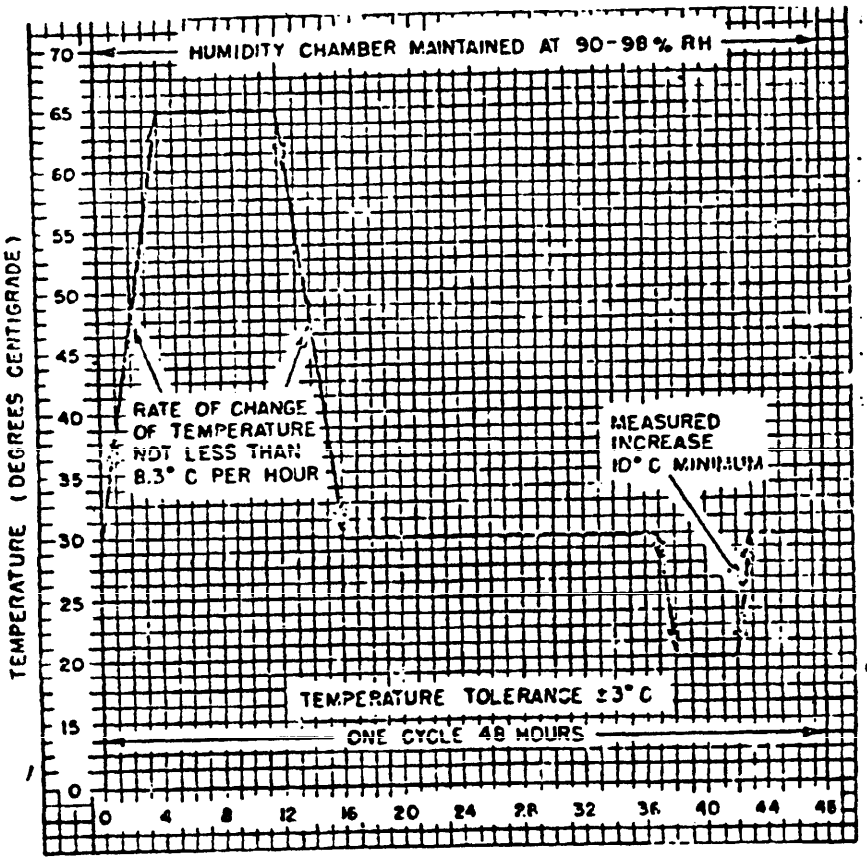

Figure 5. Graphical representation of moisture-resistance test.

4.7.15 Sea-level life. If the dynamotor has been subjected to the high altitude brush life test, it shall be equipped with a complete set of new brushes that have been subjected to a suitable run-in period prior to performance of this test. Dynamotors shall be operated at rated load and the specified duty cycle (see 3.1). Each dynamotor shall be operated under these conditions until brush or dynamotor failure occurs, or until the requirements have been met, but in no case shall this test exceed 800 hours per dynamotor (see 3.18).

4.7.16 Range of operating voltages. A resistive load, determined by dividing the rated output voltage by the respective rated output current (see 3.1), shall be connected to the dynamotor. Dynamotors shall then be tested for two 2-hour test periods in a chamber maintained at the maximum ambient temperature (see 3.1). For the first 2-hour test period, the dynamotors shall be operated at the duty cycle and minimum input voltage specified (see 3.1). For the next 2-hour test period, the voltage shall be raised to the maximum input voltage specified (see 3.1). After completion of the last test period and when the dynamotors have returned to room temperature, the dynamotors shall be subjected to the dielectric-withstanding-voltage test at 90 percent of the voltage specified in 4.7.3, and the load test specified in 4.7.7 (see 3.19).

4.7.17 Enclosure.

4.7.17.1 Explosionproof. Dynamotors shall be tested for conformance with method 511 of MIL-STD-810 (see 3.20.1). Tests at pressures simulating altitudes above sea level shall be performed only when specified (see 3.1).

4.7.17.2 Dustproof. Dynamotors shall be tested for conformance with method 510 of MIL-STD-810 (see 3.20.2).

4.7.18 Life. During the life test, precautions shall be taken against undue air contamination of a type which would not be expected in service use (see 3.1 and 3.21).

4.7.18.1 Continuous duty. The life test on continuous dynamotors shall be performed for a total of 1,000 hours. The dynamotors shall be operated at any voltage value within the specified range of operating voltages (see 3.1) with a resistive load, determined by dividing the rated output current, at the maximum ambient temperature (see 3.1), for 25 hours in normal operating position. The load test specified in 4.7.7 shall be made at any time during the last 20 hours of operation at maximum ambient temperature (see 3.1). The remainder of the test shall be performed at room ambient temperature. During the next 100 hours, a switching cycle of 2 minutes "on" and 1 minute "off" shall be employed. For the remaining 875 hours, the dynamotors shall be operated continuously, except that brushes may be replaced and brush dust blown out when the number of hours of operation equals the minimum brush life specified (see 3.1). During this test, the dynamotors shall be operated for 100 hours with the axis of rotation in a vertical position. After this test, the dynamotors shall be subjected

to the dielectric-withstanding-voltage test at 75 percent of the voltage specified in 4.7.3 and the dynamic-balance and load tests specified in 4.7.6 and 4.7.7, respectively. These measurements may also be made at any time during the test when proper performance of the dynamotors is questionable.

4.7.18.2 Short-life duty. The life test on short-life dynamotors shall be performed as specified for continuous dynamotors for a total length of time equal to the rated life of the dynamotor (see 3.1), except that no switching cycle shall be employed.

4.7.18.3 Intermittent duty. The life test on intermittent-duty dynamotors shall be performed for a total of 1,000 hours with the dynamotors operating at any voltage value within the specified range of operating voltages (see 3.1) with a resistive load, determined by dividing the rated output current, at the maximum ambient temperature (see 3.1). Measurements shall be made as specified for continuous dynamotors.

4.7.19 Salt spray (corrosion) (when applicable). Dynamotors shall be tested in accordance with method 101, test condition B, of MIL-STD-202. The salt solution shall be as specified (see 3.1). After this test, the external metal parts of the dynamotors shall be examined for harmful corrosion or pitting of finish, and any illegible marking (see 3.22).

5. PACKAGING.

5.1 Packaging requirements. The requirements for packaging shall be as specified in MIL-E-16298.

6. NOTES.

6.1 Intended use. Dynamotors covered by this specification are intended for use in ground, air, and shipboard communication equipment (see 1.1).

6.2 Ordering data. Procurement documents should specify the following:

a. Title, number, and date of this specification.
b. Title, number, and date of the applicable detail specification, and the complete type designation (see 1.2 and 3.1).
c. Number of spare brush assemblies, and method of attachment to dynamotors (see 3.4.7.2.1).
d. The laboratory at which first article inspection is to be performed (see 4.5).
e. Level A or B preservation and packing (see section 5).
f. Electromagnetic interference requirements and tests.

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