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MILITARY SPECIFICATION

GENERATORS, MOTORS, AND AUXILIARY EQUIPMENT, DIRECT CURRENT, NAVAL SHIP PROPULSION

This specification is approved for use by the Naval Sea Systems Command and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers direct current (d.c.) generators, motors, and auxiliary equipment for naval ship propulsion service.

2. APPLICABLE DOCUMENTS

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

SPECIFICATIONS

FEDERAL

FF-B-171 - Bearings, Ball, Annular (General Purpose).
HH-I-538 - Insulation, Electrical, Pasted-Mica.
QQ-A-250 - Aluminum and Aluminum Alloy Plate and Sheet; General Specification for.
QQ-A-250/1 - Aluminum Alloy 1100, Plate and Sheet.
QQ-A-250/8 - Aluminum Alloy 5052, Plate and Sheet.
QQ-I-666 - Iron, Malleable, Ferretic, for Castings.
QQ-S-365 - Silver Plating, Electrodeposited; General Requirements for.
QQ-S-571 - Solder, Tin Alloy: Lead-Tin Alloy; and Lead Alloy.
QQ-T-390 - Tin Alloy Ingots and Castings, and Lead Alloy Ingots and Castings (Antifriction Metal) for Bearing Applications.
GGG-P-781 - Puller, Mechanical Puller Attachment, Mechanical, and Puller Set, Mechanical.

MILITARY

MIL-M-14 - Molding Plastics and Molded Plastic Parts, Thermosetting.
MIL-P-79 - Plastic Rods and Tube, Thermosetting, Laminated.
MIL-B-117 - Bags, Sleeves and Tubing-Interior Packaging.
MIL-B-233 - Boxes, Repair Parts, Storage.
MIL-S-901 - Shock Tests, H.I. (High-Impact); Shipboard Machinery, Equipment and Systems, Requirements for.
MIL-E-917 - Electric Power Equipment, Basic Requirements for (Naval Shipboard Use).
MIL-E-2036 - Enclosures for Electric and Electronic Equipment, Naval Shipboard.
MIL-M-2130 - Motor-Generators, General Purpose (Naval Shipboard Use).
MIL-C-2212 - Controller, Electric Motor, AC or DC and Associated Switching Devices, Naval Shipboard.
MIL-G-3111 - Generators, Electric, Direct-Current (Naval Shipboard Use).
MIL-B-3743 - Brush, Electrical Contact.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Ship Engineering Center, SEC 6124, Department of the Navy, Washington, DC 20362 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

MILITARY (Continued)

MIL-P-5425 - Plastic, Sheet Acrylic, Heat Resistant.
MIL-P-15024 - Plates, Tags and Bands for Identification of Equipment.
MIL-P-15024/5 - Plates, Identification.
MIL-P-15037 - Plastic Sheet, Laminated, Thermosetting, Glass-Cloth, Melamine-Resin.
MIL-T-15377 - Temperature Monitor System, Naval Shipboard.
MIL-E-16298 - Electric Machines Having Rotating Parts and Associated Repair Parts, Packaging of.
MIL-F-16377 - Fixtures, Lighting; and Associated Parts Shipboard Use, General Specification for.
MIL-F-16377/1 - Fixture Light, Incandescent, Detail Lighting for Motors and Generators, Symbol 126.3, 50 Watts, 120-Volts.
MIL-O-16485 - Ohmmeters, Insulation-Resistance-Indicating, Portable.
MIL-M-17060 - Motors, 60-Hertz, Alternating Current, Integral-Horsepower, Shipboard Use.
MIL-M-17413 - Motors, Direct-Current, Integral H.P. Naval Shipboard.
MIL-B-17931 - Bearing, Ball, Annular, for Quiet Operation.
MIL-F-18953 - Fans, Vaneaxial and Tubeaxial, Fixed and Portable, Ventilation and Air Conditioning, Naval Shipboard.
MIL-C-19836 - Coolers, Fluid, Industrial, Air Motor and Generator, Naval Shipboard.
MIL-S-20166 - Steel Structural Shapes, Weldable Medium Carbon and High Tensile; Hull and Structural.
MIL-H-22577 - Heating Elements, Electrical; Cartridge, Strip and Tubular Type.
MIL-S-23284 - Steel Forgings, Carbon and Alloy, for Shafts, Sleeves, Couplings, and Stocks (Rudders and Diving Planes).
MIL-I-24092 - Insulating Varnish, Electrical, Impregnating, Solvent Containing.
MIL-I-24178 - Insulation Tape, Electrical, Semi-Cured Thermosetting Resin Treated Glass, Armature Banding, Naval Shipboard.
MIL-P-24364 - Plastic Sheets, Laminated, Thermosetting, Electrical Insulating Sheet, Glass-Mat.
MIL-P-24364/3 - Plastic Sheets, Laminated, Thermosetting, Electrical Insulating Sheet, Polyester Glass-Mat Grade GPO-N3.
MIL-M-24365 - Maintenance Engineering Analysis; Establishment of and Procedures and Format for Associated Documentation; General Specification for.
DOD-G-24508 - Grease, High Performance, Multi-Purpose (Metric).
MIL-W-30508 - Wire, Armature Banding.
MIL-I-45208 - Inspection System Requirements.

STANDARDS

MILITARY

MIL-STD-167-1 - Mechanical Vibrations of Shipboard Equipment (Type I - Environmental and Type II - Internally Excited).
MIL-STD-167-2 - Mechanical Vibrations of Shipboard Equipment (Reciprocating Machinery and Propulsion System and Shafting) Types III, IV and V.
MIL-STD-195 - Marking of Connections for Electrical Assemblies.
MIL-STD-278 - Fabrication Welding and Inspection; and Casting Inspection and Repair for Machinery, Piping and Pressure Vessels in Ships of the United States Navy.
MIL-STD-408 - Brushes, Electrical Contact, Rectangular Standard Designs and Dimensions for.
MIL-STD-454 - Standard General Requirements for Electronic Equipment.
MIL-STD-470 - Maintainability Program Requirements (for Systems and Equipments).
MIL-STD-471 - Maintainability Verification/Demonstration/Evaluation.
MIL-STD-721 - Definitions of Effectiveness Terms for Reliability, Maintainability, Human Factors, and Safety.
MIL-STD-740 - Airborne and Structureborne Noise Measurements and Acceptance Criteria of Shipbuilding Equipment.
MIL-STD-756 - Reliability Prediction.
MIL-STD-759 - Packaging Procedures for Submarine Repair Parts Utilizing Transparent, Flexible, Heat Sealable Film.
MIL-STD-785 - Reliability Program for Systems and Equipment Development and Production.
MIL-STD-882 - System Safety Program Requirements.
MIL-STD-1472 - Human Engineering Design Criteria for Military Systems, Equipment and Facilities.

MILITARY (Continued)
MS 90363 - Box, Fiberboard, With Cushioning Insert, Limited Re-Use (For Items 10 Pounds or Less).

HANDBOOK

MILITARY
MIL-HDBK-472 - Maintainability Prediction.

PUBLICATION

MILITARY
NAVSEA 0908-LP-000-3010 - Surface Ship Shock Design Criteria.

DRAWING

MILITARY
NAVSHIPS 9000-S6202-74427 - Switch Box, Toggle.

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific acquisition functions should be obtained from the contracting 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 or request for proposal shall apply.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
B209 - Aluminum-Alloy Sheet and Plate.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

UNIFORM CLASSIFICATION COMMITTEE
Uniform Freight Classification Ratings, Rules and Regulations.

(Application for copies should be addressed to the Uniform Classification Committee Agent, G. F. Earl, Tariff Publication Officer, Room 1106, 222 South Riverside Plaza, Chicago, IL 60606.)

NATIONAL CLASSIFICATION BOARD
National Motor Freight Classification Classes and Rules.

(Application for copies should be addressed to the ATA Tariff Section, 1616 P Street, N.W., Washington, DC 20036.)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

3. REQUIREMENTS

3.1 Sample for first article inspection. Prior to beginning production a sample shall be tested as specified in 4.3 (see 6.3).

3.2 Materials. Unless otherwise specified (see 6.2.1), materials shall be in accordance with MIL-E-917, and shall be as specified in table I. Unless otherwise specified herein, all equipment, material, and articles incorporated in the products covered by this specification shall be new and shall be fabricated using materials produced from recovered materials to the maximum extent practicable without jeopardizing the intended use. The term "recovered materials" means materials which have been collected or recovered from solid waste and reprocessed to become a source of raw materials, as opposed to virgin raw materials. None of the above shall be interpreted to mean that the use of used or rebuilt products is allowed under this specification unless otherwise specifically specified.

TABLE I. Minimum material requirements.

Item number	Item	Material	Remarks
1	Ball Bearings	--------	MIL-B-17931 or FF-B-171
2	Ball bearing Cap cartridges	Steel Malleable iron	Grade I, QQ-I-666
3	Bearing shells	Steel or bronze	-------
4	Brushes	--------	MIL-B-3743 and MIL-STD-408
5	Brush holders: (a) Holders	Steel or brass	-------
	(b) Springs	Steel	Protected for corrosion prevention
	(c) Washers and bushings	Mica or pressed mica plate	HH-I-538
		Plastic	Mineral-filled type, molding-compounds (glass fiber reinforced) of MIL-E-917
		Plastic	Type GME, MIL-P-15037; or MIL-P-79; or MIL-P-24364 and MIL-P-24364/3, glass polyester, grade GPO-N3
6	Brush holder studs	Steel or brass	Steel shall be treated for corrosion-resistance
7	Commutator V-rings and shells	Steel	-------
8	Commutator segments	Copper	Hard drawn, hard-rolled or drop forged
9	Commutator insulation	Mica or pressed mica plate	HH-I-538
10	Covers, hand hole or access	Steel	-------
		Malleable iron	Grade I, QQ-I-666
		Aluminum	QQ-A-250 and QQ-A-250/1 or QQ-A-250/8; or ASTM B209, alloy 1100 or 5052
	Transparent cover	Plastic	MIL-P-5425
11	End brackets	Steel 1/	-------
12	Eyebolts, lifting	Steel	Type B, grade M, MIL-S-20166
13	Fans, integral	Steel	-------
14	Fans, separate	--------	MIL-F-18953
15	Frames	Steel 1/	-------

See footnotes at end of table.

TABLE I. Minimum material requirements. - Continued

Item number	Item	Material	Remarks
16	Grease cups and pipes	Steel	-------
17	Heaters, space	--------	MIL-H-22577
18	Heat exchangers	--------	MIL-C-19836
19	Oil rings	Brass	-------
20	Oil seals: (a) Sleeve bearings	Antifriction metal (copper or aluminum)	-------
	(b) Ball bearings	Steel or malleable iron	-------
21	Punchings, armature, and field	Steel	Nonaging, low hysteresis
22	Shafts[2/]	Steel	MIL-S-23284, class 3
23	Shafts, submarine propulsion motor	Steel	MIL-S-23284, class 2[3/]
24	Sleeve bearings	Antifriction metal or babbitt	QQ-T-390
25	Spacers and coil separators	Plastic	Type GME, MIL-P-15037; or MIL-P-24364 and MIL-P-24364/3, glass polyester, grade GPO-N3
26	Spiders	Steel	Fabricated, cast, forged, laminated
27	Terminal boards and clamps	Plastic	Type GME, MIL-P-15037; or MIL-P-24364 and MIL-P-24364/3, glass polyester, grade GPO-N3
			Mineral-filled type, MIL-M-14
28	Terminal boxes, terminal box covers, housings, and ducts	Steel Malleable iron Aluminum[4/]	------- Grade I, type A, QQ-I-666 -------
29	Varnish, insulation	--------	MIL-I-24092
30	Wedges	Plastic	Type GME, MIL-P-15037
31	Wire, armature banding	Steel Glass	MIL-W-30508 MIL-I-24178

[1/] Unless otherwise specified in table I, steel parts may be cast, fabricated or forged.

[2/] Shafts from electric-motor driven generators shall conform to minimum requirements for the motors.

[3/] Class I may be substituted when acceptable to the command or agency concerned.

[4/] QQ-A-250/1 and QQ-A-250/8 or ASTM B209, alloy 1100 or 5052.

3.2.1 Prohibited materials.

3.2.1.1 General. Materials prohibited by MIL-E-917 shall not be used. Asbestos and cadmium shall also not be used.

3.2.1.2 Submarines. For shipboard submarine applications, propulsion motors, generators, and auxiliaries shall not contain metallic mercury or mercury compounds, and shall be free from mercury contamination. That is, during the manufacturing process, examination, or tests, the equipment shall not have come in direct contact with mercury or any of its compounds, nor with any mercury containing devices employing only a single boundary of containment.

3.2.2 Nonstructural parts, such as terminal boxes, housing, ducts, and similar parts, shall be fabricated from aluminum or aluminum alloy, where feasible.

3.2.3 Electrical insulation. Electrical insulation shall be class B, F, or H as specified (see 6.2.1), and shall conform to MIL-E-917, except that silicones shall not be used. In no case shall untreated fiber glass insulation be utilized as ground insulation. Treated fiber glass insulation may be utilized as ground insulation only when more than one layer is applied. The use of glass-cloth-backed mica as ground insulation is acceptable where the glass-cloth is utilized solely as a backing for the mica insulation.

3.3 Engineering services. When engineering services are specified (see 6.2.1), the contractor shall furnish the services of qualified engineers, regularly employed by the contractor, to provide direction and assistance in the installation of the equipment covered herein. Similarly, such engineers shall also be available for making adjustments, checking and testing the equipment after installation and during dock and sea trials of the ship.

3.4 Design.

3.4.1 General. Generator and motors shall conform to MIL-E-917, except as specified herein.

3.4.1.1 Operating characteristics. The design of all motor and generators shall be matched to provide stable operation under all steady state, maneuvering, and reverse conditions. Time required for each reversal, and ahead and astern reach for each reversal shall be a minimum consistent with other design considerations. Specific limits, where specified (see 6.2.1), shall not be exceeded.

3.4.1.2 Life (endurance). The life expectancy of the propulsion motors and generators shall be 150,000 hours of operation over a period of 30 years. Life shall be predicted on:

(a) 20,000 hours at rated-load.
(b) 90,000 hours at 60 percent rated-load.
(c) 40,000 hours at 40 percent rated-load.

The design shall be such that parts which are not classified as on board repair parts shall not be replaced or repaired between overhauls of the generator or motor, except where damage is incurred due to external causes unrelated to the design. The design shall minimize the need for replacement of parts which are in the on board repair parts category between ship's overhaul periods.

3.4.1.3 Reliability. The contractor shall develop, submit for review, maintain and implement a reliability program and plan using MIL-STD-785 as a guide (see 6.2.2). The reliability program shall include the management/technical resources, plans, procedures, schedule, and controls for the work needed to assure achievement of reliability requirements. When satisfactory to the contracting activity, and where a program plan and report for similar equipment were previously submitted by the contractor and reviewed by the contracting activity, the contractor need only propose any changes considered appropriate because of dissimilar items and current intended use.

3.4.1.3.1 Reliability prediction (see 6.2.2). Reliability prediction of the generator and motor shall be based on the failure rate of parts. Design and application of these parts shall be such that the inherent mean-time-between-failure (MTBF) of the generator and motor is at least 5,000 hours. The MTBF shall be predicted using the design prediction procedure of MIL-STD-756 and using the failure rate sources specified therein. For parts where no failure rate is available, a failure rate shall be estimated, and the basis for the estimate shall be stated in the calculations. The derating factors used for each part and the stress levels at which each part is operating shall be stated in reliability calculations. The stress levels shall be those as determined from test insofar as practicable. In those

instances where test data is not available, design data shall be used. A failure is defined as an occurrence when either the equipment ceases to function, or its performance degrades below the requirements of this specification.

3.4.1.3.2 Failure modes and effects analysis (FMEA) (see 6.2.2). The contractor shall conduct, before the design test, a FMEA. Prior to conducting the FMEA, the contractor shall prepare a FMEA selection report to describe the depth of the analysis. The analysis shall include as a minimum, the critical components, the accessories, controls, and parts delivered under the contract, whose failure would cause the system to fail. The FMEA shall include the identification and tabulation of all possible failure modes, and the effect of each failure mode on the next higher assembly and on the system as a whole. The FMEA shall include, but not be limited to, the following:

(a) List of critical assemblies, subassemblies, or parts which by their failure rates, contribute the most to the unreliability of the generator and motor.
(b) Failure modes of the assemblies, subassemblies, or parts and corresponding probability of failure.
(c) Effect of each failure on the equipment and the interfacing systems, and the effect of interfaces on the equipment.
(d) Possible means of reducing probability of critical failure modes.
(e) Sufficient detail to assist in preparation of the trouble-shooting manual.

3.4.1.4 Maintainability. Maintainability shall be defined in terms of equipment repair time (ERT). The following requirements are for corrective maintenance only. The specified ERT for generator or motor shall be 2 hours. Maximum repair time for any item shall not exceed 6 hours.

3.4.1.4.1 Maintainability program and plan (see 6.2.2). The contractor shall develop, submit for review, maintain, and implement a maintainability program and plan using MIL-STD-470 as a guide. When satisfactory to the contracting activity, and where a program plan and report for similar equipment were previously submitted by the contractor and reviewed by the contracting activity, the contractor need only propose any changes considered appropriate because of dissimilar items and current intended use.

3.4.1.4.2 Maintainability prediction. The maintainability of the generator or motor shall be predicted in accordance with procedure IV of MIL-HDBK-472. Failure rates used shall be those which have been determined in the reliability predictions. Maintainability predictions shall take into consideration design changes made during the engineering design phase.

3.4.1.5 Maintenance requirements.

3.4.1.5.1 Design for maintenance.

3.4.1.5.1.1 Accessibility. The design shall, within space limitations, provide accessibility to parts which require routine examination, maintenance, or replacement in service without the need for disconnection or removal of another part or assembly other than an access panel or cover.

3.4.1.5.1.2 Interchangeability. All parts, including repair parts, of corresponding equipment furnished under the same contract or order, or manufactured to the same drawings, shall be functionally and physically interchangeable (without the necessity of further machining, selective assembly, or hand fitting of any kind) without degradation of performance, reliability, or operating characteristics, and without selective assembly or modification except calibration and adjustment. Interchangeability of units and parts with those supplied on generators and motors previously furnished under this specification is extremely desirable with particular reference to repair parts. Units and parts serving the same or similar function in different place of application shall be interchangeable, where feasible.

3.4.1.5.2 Maintenance engineering analysis (MEA). The contractor shall conduct a MEA before the design test. The MEA shall be performed for each functional system, equipment, unit, assembly, or subassembly which requires preventative or corrective maintenance, and the continued operation of which is essential to the successful completion of the mission itself. The MEA shall include as a minimum, the completion of work sheets IV and V of MIL-M-24365.

3.4.1.6 Reliability and maintainability (R and M) data collection and reports (see 6.2.2). The contractor shall conduct an R and M data collection, analysis and corrective action program throughout all phases of examination and testing. Where a failure is

experienced or discovered during factory examination and tests, a failure analysis, as defined in MIL-STD-721, shall be provided. The program and related reports shall contain as a minimum the following elements:

(a) R and M prediction report.
(b) Maintainability demonstration test plan.
(c) FMEA report.
(d) MEA report.
(e) A documentation of failure corrective maintenance actions and technical problems relating to R and M.
(f) An analysis of each failure and technical problem.
(g) The determination, implementation, verification of the results of corrective action.
(h) Maintainability demonstration test report.

3.4.1.7 Safety. Generators and motors shall be designed and constructed in accordance with MIL-STD-882 to preclude or minimize the possibility of degraded performance or damage in using the propulsion system, and to preclude or minimize the generation or existence of unsafe conditions or potential hazards. Safety features shall be incorporated into the equipment in the order specified for safety precedence of MIL-STD-882 as follows:

(a) Design for minimum hazard.
(b) Use of appropriate safety devices.
(c) Use of appropriate warning devices.
(d) Use of special procedures.

3.4.1.7.1 Equipment and personnel safety. Appropriate safety provisions shall be included in the design and tests of the generators and motors to satisfy equipment and personnel safety requirements of MIL-STD-1472.

3.4.1.7.2 System safety program (see 6.2.2). The contractor shall develop and maintain an effective system safety program that is planned and integrated into all phases of design production and testing of the equipment. The system safety program shall provide a disciplined approach to identify hazards and prescribe corrective actions in a timely cost effective manner. The system safety program tasks shall be specified in a formal plan (system safety program plan (SSPP)). The plan shall include requirements to be imposed on each subcontractor to assure compatibility with the SSPP for the equipment. MIL-STD-882 shall be used as guidance for preparing the SSPP.

3.4.1.7.3 Safety analyses. Safety analyses shall be performed to identify hazardous conditions for the purpose of their elimination or control. Analyses shall be made to examine the equipment, subsystems, components and their interrelationship to include logistic support, training, maintenance, and operational environments.

3.4.2 Ambient temperatures. Generators and motors shall be designed for an ambient temperature equal to the temperature of the air leaving the coolers (see 3.4.41 and 3.4.41.2).

3.4.3 Temperature rises.

3.4.3.1 Insulated parts. Temperature rises shall be such that the total temperature, including the maximum specified ambient (see 3.4.2), does not exceed a value 20°C less than the limiting temperature for the insulation class permitted by MIL-E-917, when measured by method 1 of MIL-E-917. When measured by method 2 of MIL-E-917, total temperatures shall not exceed a value 10°C less than that permitted by MIL-E-917.

3.4.3.2 Commutators. The temperature rise of commutators shall be such that the total temperature, including the maximum specified ambient, does not exceed a value 10°C less than the limiting temperature permitted by MIL-E-917 for its insulation class.

3.4.3.3 Bearings.

3.4.3.3.1 Ball bearings. Ball bearings shall not exceed a temperature rise of 60°C or a total temperature of 110°C.

3.4.3.3.2 Sleeve bearings. Sleeve bearings shall not exceed a temperature rise of 43°C or a total temperature of 93°C, as measured by embedded temperature detectors.

3.4.3.4 Mechanical parts.

3.4.3.4.1 Parts in contact with insulation. Cores, poles, and other parts in contact with electrical insulation shall not exceed the temperature rises or total temperatures allowed in 3.4.3.1 for the insulation with which the parts are in contact.

3.4.3.4.2 Miscellaneous. Parts such as brush-holders, brushes, pole tips and similar parts shall not attain temperatures which injure the parts themselves, or adjacent parts.

3.4.3.5 Astern operation. The temperature rise limits specified in 3.4.3 shall also apply to the motor, except that an additional temperature rise of 15°C shall be permissible for continuous astern operation at rated output, where the motor has the fan attached directly to the rotor.

3.4.3.6 Other than rated-load. Allowable temperature limits shall not be exceeded when the motor is operating at rated-load and rated-speed and at any operating conditions which would result in a higher temperature of any part of the motor than would occur at rated-load and rated-speed.

3.4.4 Creepage and clearance. Creepage and clearance distances shall be in accordance with MIL-E-917.

3.4.5 Duty. Generators shall deliver continuously rated-current at rated-voltage and rated revolutions per minute (r/min). Motors shall operate continuously at rated-load, rated-voltage and rated r/min.

3.4.5.1 Overload requirements. Unless otherwise specified (see 6.2.1), no overload requirements shall apply.

3.4.6 Rating. Generators and motors shall be rated at the kilowatt (kW) or horsepower (hp), voltage, r/min, and direction of rotation specified (see 6.2.1).

3.4.6.1 Performance. Special performance requirements such as rapid reversal and breakaway torque shall be as specified (see 6.2.1).

3.4.6.2 Efficiency. Efficiencies and losses shall be as specified (see 6.2.1).

3.4.7 Regulation. Generators and motors shall be so designed that with all combinations and at all loads within the operating range, the propulsion plant shall have a stable speed regulation.

3.4.7.1 Generator voltage regulation shall not exceed 15 percent at constant rated-speed and rated-voltage.

3.4.7.2 Motor speed regulation shall be positive, that is, speed shall decrease with an increase in load. Motor speed regulation shall not exceed 10 percent of maximum rated-speed, except that for parallel application, speed regulation shall be as large as practicable.

3.4.8 Vibration. Motors and generators shall meet the requirements of MIL-STD-167-1, type I for environmental vibration up to and including 50 Hz, and the requirements of MIL-STD-167-1, type II for internally excited vibration.

3.4.8.1 Method of balancing - submarine application. Equipment shall be in accordance with the following:

(a) Balancing shall be accomplished by one of the following methods:
    (1) Dovetail shaped weights securely anchored in a balance groove by one of the methods specified in MIL-E-917.
    (2) By drilling out materials.
    (3) By securely welded steel weights.

    Shop balance may include any combinations of (1), (2), or (3). Infield balance shall be performed by (1).

(b) Balance rings, where required for noise reduction in submarine rotating equipment, shall have the design features required by MIL-E-917, except as follows:
    (1) It shall be possible to add weights of various sizes to the balancing rings in a plane perpendicular or parallel to the shaft axis either in a continuous groove, or 12 or more evenly spaced

positions, provided that space is available for that number of positions.

(2) Disassembly of large covers to place or remove balance weights is acceptable.

3.4.8.1.1 Methods to be employed in balancing the rotor during various phases of manufacturing to ensure minimum balance correction during final balance shall be submitted to the contracting activity for information, or this information shall be included in the technical manual (see 3.8.2).

3.4.8.1.2 Rotor designs shall be such that the rotors may be installed upon completion of dynamic balancing without resorting to partial or complete disassembly of the rotor. Dynamic balancing of the rotors shall be accomplished in the manufacturer's plant. In addition, the equipment shall be provided with necessary facilities to in-place balance the unit after installation aboard the ship. These facilities shall include mounting for instrumentation, as specified by the contracting activity, access to rotor for installation and fitting of weights, and provision on the rotor for attaching weights. Detailed in-place balance procedures shall be included in the technical manual (see 3.8.2), and shall be submitted to the contracting activity for information at least 12 weeks prior to in-place shop balancing of the rotors.

3.4.8.1.3 The amount and location of balance weights in each balance plane for the condition, as shipped, shall be indicated in the test report (see 6.2.2).

3.4.8.2 Structureborne vibration. The equipment structureborne vibration shall not exceed the specified limits (see 6.2.1). The vendor shall investigate sources of harmonic noise and means for reduction.

3.4.8.2.1 Concentricity of parts. Special emphasis should be placed on concentricities of rotating parts. Deviation from true roundness for bearing journals shall not exceed the limits specified (see 6.2.1). Deviation from the true roundness is defined as the difference in radii of two coplanar concentric circles, the radial space between which just contains the profile of the journal surface.

3.4.9 Environmental vibration. Generators and motors, as installed on the ship, shall be in accordance with type I of MIL-STD-167-1.

3.4.10 Torsional vibration. The requirements of type III of MIL-STD-167-2 shall apply.

3.4.11 Welded parts. Welding shall be in accordance with MIL-STD-278. Welded rotating parts of generators and motors shall be stress relieved. Moderately stressed welded stationary parts, that is, bearing pedestal, frame, end brackets, fabricated from steel containing less than 0.30 percent carbon need not be stress relieved. Welded joints of attached fans shall have a factor of safety of not less than 2 at rated-speed.

3.4.12 Overspeed. Generators and motors shall safely withstand an overspeed of 25 percent as specified in 4.6.12.

3.4.13 Shock proofness. Unless otherwise specified (see 6.2.1), equipment, including attached subcomponents, shall withstand a high-impact shock test in accordance with MIL-S-901, grade A, without failure to perform specified functions. If size and weight of equipment exceeds the capability of existing shock test facilities, the equipment shall be analyzed for shock. Analysis shall be in accordance with NAVSEA 0908-LP-000-3010. An analysis report shall be provided in accordance with the data ordering document (see 6.2.2). Special shock requirements for submarine equipment shall be as specified (see 6.2.1).

3.4.14 Noise. Motors and generators furnished under this specification shall meet the requirements of MIL-STD-740, except that the airborne noise criteria shall be as identified in table II in lieu of the airborne noise acceptance levels of MIL-STD-740.

TABLE II. Octave band center frequency in hertz (Hz).

Frequency (Hz)	31.5	63	125	250	500	1K	2K	4K	8K
Sound pressure level: Db re 20μ Pa	95	90	85	82	79	76	75	75	75

Note: 20μ Pa = 20 micropascal = 0.0002 dyne/cm^2.

3.4.14.1 Noise design guidance.

3.4.14.1.1 Magnetic. As a means of eliminating magnetic noise, the most favorable combination of the following design features may be employed in the design of submarine propulsion motors:

(a) Number of slots per pole pitch.
(b) Number of slots magnetically under one pole.
(c) Slot frequency as a function of the natural frequency of the magnetic frame.
(d) Skew of slots or pole tips.
(e) Fairing of pole tip edges.
(f) Wedging of armature coils to insure tightness of fit.
(g) Armature coil laminations to provide smooth peripheral contour.
(h) Close tolerance on air gap symmetry.

3.4.14.1.2 Mechanical noise. As a means of eliminating mechanical noise (as it affects structureborne noise), special attention may be given to the following points:

(a) Elimination of brush chatter.
(b) Best aerodynamic design of the ventilating system.
(c) Good mechanical balance.
(d) Stiffness of brush rigging.
(e) Avoid sharp cutoffs and turbulence in air gaps.
(f) Precision machining of rolling or rubbing parts.

3.4.15 Electromagnetic interference (EMI) characteristics. Propulsion generators and motors and auxiliaries shall conform to requirement 61 of MIL-STD-454, when specified (see 6.2.1).

3.4.16 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 0 to 16 kilocycles (kc) shall not exceed 2 percent of the rated-output voltage.

3.4.17 Insulation resistance. Insulation resistance, when corrected to 25°C, for class B, F, or H insulation shall be not less than 50 megohms for field circuits and 25 megohms for armature circuits. Heater and light circuits shall be not less than 25 megohms.

3.4.18 Dielectric strength. Generators and motors shall withstand a dielectric strength test voltage of twice normal voltage of the circuit concerned plus 1,000 volts, when tested in accordance with 4.6.14.

3.4.19 Parallel operation. When specified (see 6.2.1), generators shall be capable of parallel operation. When parallel operation is specified, the generators shall operate in parallel at the specified output and voltage without the use of equalizer connections between the generators.

3.4.20 Air gaps. The air gap between any pole and the armature shall be not less than 0.125-inch when bracket type bearings are employed and 0.175-inch when pedestal type bearings are employed (see 3.4.31.2(h) for tolerances).

3.4.21 Windings. Generators and motors shall be shunt wound and separately excited. Commutating windings shall be employed. Sufficient series field may be added to insure stable operation over the speed and voltage range.

3.4.22 Field frame. The field frame shall be of fabricated steel, split frame construction. The joint between the lower and upper parts of the frame shall be no lower than the bottom line of the shaft. The frame design shall be such as to permit removal and replacement of any field coil without removal of the armature.

3.4.22.1 Frame feet. The feet shall be an integral part of the frame. Generator feet shall be suitable for mounting on a common bedplate with the prime mover, unless otherwise specified (see 6.2.1). Dowel pins shall be provided in the feet unless fitted holding-down bolts are used. Fitted bolt holes shall be left with an allowance for reaming at time of installation.

3.4.23 End brackets.

3.4.23.1 Where end brackets are used, an accurately machined shoulder joint shall be provided between the frame and the end brackets. End brackets, where used, shall be secured to the frame by hexagon-head bolts and shall be split or otherwise constructed to facilitate removal of the armature.

3.4.23.2 Resilient-gaskets shall not be placed between any bearing support member and the frame.

3.4.23.3 Openings (hand holes, access holes, and view ports) of adequate size and number shall be provided at the front end of the generators and motors so as to give easy access to and a direct view of the commutator and brushes while in operation. The view ports shall be provided with substantial transparent covers. Transparent material shall be in accordance with MIL-P-5425. Additional transparent view ports shall be provided in the aft end in order to observe the presence of liquids in the bottom and to observe the attached fan if one is present. Enclosing covers shall be readily removable. 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, secured and treated with graphite on the contact surface where necessary to prevent sticking. Sheet packing shall be securely attached to the covers. A nonhardening sealant may be used on the graphite surface side of gaskets as an additional barrier to prevent water leakage.

3.4.24 Lifting means. Integral lifting eyes or other means shall be provided for the lifting of generators and motors.

3.4.25 Vertical adjustment. Jackscrews or other means shall be furnished to facilitate vertical adjustment of the frames of generators and motors. Jackscrews shall be used only for installation purposes and shall not permanently support the generators and motors.

3.4.26 Assembly details.

3.4.26.1 Joints. Adjoining portions of machinery shall be given corresponding marks, wherever practicable and advantageous, to insure correct assembly. Forcing bolts shall be provided where necessary for breaking joints. Faying surfaces of metal parts shall be machined. Bolt holes shall be deburred, and bolt holes in structural parts shall be spot faced.

3.4.26.2 Pins and dowels. Tapered pins and dowels shall be secured from backing out by staking or other locking devices. Dowels and pins shall be provided with means for removal such as tapped holes, external wrenching flats, pulling heads, or shouldered shanks.

3.4.27 Armatures.

3.4.27.1 Laminations. Armature laminations shall be shrunk and keyed on the spider in order to prevent movement due to vibration and variations in torque. Solid ring type laminations shall be used in preference to segmental type laminations, when practicable. Where segmental laminations are employed, the joints between segments shall be staggered between successive layers and shall be arranged for the greatest possible magnetic symmetry (see 3.4.31.1). Machines using segmental laminations shall have one bearing and all its piping electrically isolated (see 3.4.38.1). Laminations shall be set up under heavy pressure and held securely by end flanges. The laminations shall be properly 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. The design shall be such that the shaft can be removed without requiring unstacking the laminations.

3.4.27.2 Banding. Armatures shall be bound with glass tape in accordance with MIL-I-24178 or wire in accordance with MIL-W-30508. Wire banding shall be securely clipped. The ends of the wire shall be soldered with composition Sn60 solder in accordance with QQ-S-571.

3.4.27.3 Armature windings. Armature coils shall be form-wound from sliver-free copper, that is, wound, formed, and insulated before assembly in the core slots, and shall be interchangeable. The coils shall be securely retained in the slots by slot wedges.

3.4.28 Field poles. Field poles shall be so attached to the frame as to permit movement of the poles for adjustment of air gaps. It shall be possible to remove the field poles from the frame without removing the armature.

3.4.29 Field coils. Field coils shall be either form wound or wound directly on to the field poles. Field coils or poles with pole-wound 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 coils position. Like coils, that is, shunt, series, or interpole of the same polarity shall be series connected with respect to each other.

3.4.29.1 Submarine propulsion generators and motors shall operate without serious overheating or destructive sparking at the commutator with one shunt field coil disconnected.

3.4.30 Shafts. The factor of safety for the motor shaft shall be greater than that of the propeller shaft in order to assure a greater strength in the motor shaft.

3.4.30.1 The motor shaft shall be provided with a forged on half coupling for bolting to the propulsion tail shaft half coupling, by means of fitted bolts. The greater shaft shall be provided with a shrunk on half coupling for bolting to the prime mover half coupling. In-line emergency motors shall be provided with a coupling flange for bolting to the clutch coupling flange. Tapped holes for jacking bolts or other means, shall be provided to facilitate separation of coupling halves. Points on the coupling face shall be within plus or minus 0.0005 inch from a true normal to the axis of the shaft.

3.4.30.2 The shaft shall be provided with deflecting flanges or slingers to prevent under all service conditions, the escape of oil from the bearing housing and suction into the electric windings.

3.4.30.3 Unless otherwise specified (see 6.2.1), the forward end of the motor shaft shall be provided with means for manually jacking or locking the rotor.

3.4.30.4 Unless otherwise specified (see 6.2.1), the forward end of submarine propulsion motor shafts shall be provided with a stub shaft for driving a r/min indicator.

3.4.31 Extraneous magnetic effects.

3.4.31.1 Shaft and bearing currents. Generators and motors shall be designed so that destructive currents will not flow between the shaft and the bearings. Magnetic paths interlinking the shaft with the armature and stator shall be symmetrically distributed (see 3.4.27.1 regarding armature laminations, 3.4.38.1 regarding bearing insulation, and 3.4.31.2 on reduction of external magnetic fields).

3.4.31.2 External magnetic fields. In order to reduce stray magnetic fields and minimize the possibility of shaft currents, the following precautions shall be taken:

(a) The brush rings shall be closed and of uniform cross section except for the overlapping at the joints, of which the number shall be a minimum, preferably two.
(b) The plus connection shall be made to a single point on the positive brush ring and the minus connection to a single point on the negative ring. The points of connection to the brush rings shall be as close to the same angular position and as close together as is consistent with the spacing required for electrical insulation and accessibility. The same requirements shall apply to connections for series, commutating and compensating windings.
(c) In machines which have no series field, the end connections for commutating windings shall be balanced for ampere turns around the shaft at each end of the machine and shall be of either of the following arrangements:
    (1) In one circuit which makes a full turn or a part of a turn around the machine and then returns on itself back to its starting point, or

(2) In an even number of parallel circuits which each make a complete turn and which can be grouped in pairs with the two circuits in each pair carrying equal but oppositely directed currents. The connectors shall be as close together as consistent with the spacing required for electrical insulation and accessibility.

(d) In machines which have a series winding and a commutating winding, the two types of windings may each be balanced separately as specified in (c), or one may be balanced against the other with balanced ampere turns at each end of the machine in accordance with (c).

(e) Compensating windings shall not employ an odd number of slots per pole face, unless the armature circuit stator windings can be magnetically balanced.

(f) In case of a winding in which the connections are not at the commutator end of the machine, the two connections from the commutator end of this winding shall be as close together as consistent with the spacing required for electrical insulation and shall not form a loop around any part of the frame.

(g) Plus and minus leads shall pass through the frame in the same opening to avoid the formation of a loop enclosing part of the iron of the frame, and shall be as close together as consistent with the spacing required for electrical insulation.

(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 interpole gaps.

3.4.31.3 Special requirements. For special applications, additional magnetic requirements and specific limits of magnetic quantities shall be as specified (see 6.2.1).

3.4.32 Commutators.

3.4.32.1 General. The commutator shall be secured rigidly to the shaft or spider by keying or other method satisfactory to the command 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.

3.4.32.2 Copper segments. The copper segments shall be securely retained in such a 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 III, shall be of ample section to operate satisfactorily.

TABLE III. Wearing depth of commutators.

Commutator diameter	Allowable reduction in diameter
Inches	Inch
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

3.4.32.3 Connections. The connections to the armature windings shall be soldered or brazed in accordance with MIL-E-917, and if separate risers are used, they shall be connected to the commutator bars by brazing or tungsten inert gas (TIG) welding.

3.4.32.4 Sealing. After the assembly of the commutator, crevices or joints at each end between the bars and the retaining flanges, shall be completely filled up and sealed over with high-grade flexible baking insulating varnish in such a manner as to prevent the entrance of moisture, oil, carbon or copper dust, or other deleterious substances at these points. Likewise, the creepage 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.

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

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

3.4.33 Brush-holders.

3.4.33.1 General. Conformance with standard brush forms of MIL-B-3743 is desirable, but not mandatory. Standard brush sizes shall be employed where not prohibited by other design considerations. Brush-holders shall securely hold the brushes under shock loading.

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

3.4.33.3 Staggering. Brush-holders shall be staggered in pairs so as to insure even wear of the commutator.

3.4.33.4 Adjustability. Means shall be provided to prevent loosening and shifting of brush-holders under vibration and spring pressure. The brush-holder shall be installed so that the angular position of brush-holders may be adjusted. The construction shall also provide for maintaining the spacing of the various holders at all times during adjustment. The distance between the brush-holder and the commutator shall be adjustable.

3.4.33.5 Brush setting. The correct brush setting shall be plainly indicated by corresponding permanent marks on the brush-holder yoke and the generator frame or end brackets. The yoke should be secured by dowelling or other suitable means.

3.4.34 Terminals and connections.

3.4.34.1 Securing connections. Connections likely to become loosened by vibration shall be provided with locking devices satisfactory to NAVSEC. Connectors and leads shall be secured in a manner as to prevent their coming in contact with moving parts or being chafed by contact with stationary parts. Excess solder shall be removed from solder connections.

3.4.34.2 Terminal markings. Leads shall be permanently marked with designating letters which correspond with the markings shown on the diagram of connections for the generator or motor (see 3.8.1.2.1). Terminal markings shall conform to MIL-STD-195.

3.4.34.3 Cable connectors. Unless otherwise specified (see 6.2.1), the terminal lugs for connecting generator and motor leads to power cables shall not be supplied.

3.4.34.4 Surface ships. Terminal boxes and terminal leads for surface ships shall be as specified in 3.4.34.4.1 and 3.4.34.4.2.

3.4.34.4.1 Terminal boxes. Terminal boxes shall be provided and shall be securely bolted or welded to the frame above the center line. Dripproof terminal box covers shall be provided.

3.4.34.4.2 Terminal leads. Leads shall be brought to and terminated at an accessible terminal board within the terminal box. The method of fastening terminal leads shall be such that no strain from the outside can be transmitted to the connections within the frame. Terminal board studs shall be so located as to facilitate connections to the external circuit.

3.4.34.4.3 Wiring methods. Harnessing materials shall be in accordance with MIL-E-917, and nonflammable cord, tape, or sleeving shall be used as lacing and tying materials. Ties or clamps of nonflammable insulating material may be used. Metal ties or clamps, if used, shall be covered with nonflammable insulating material or nonflammable insulating material shall be installed on wire or bundle being clamped.

3.4.34.5 Submarines. Main terminals and terminal boxes for submarines shall be as specified in 3.4.34.5.1 and 3.4.34.5.2.

3.4.34.5.1 Main terminals. Main terminals shall consist of plain undrilled, copper busses enclosed in terminal boxes in accordance with 3.4.34.5.2. Bus bars shall be silver-plated. The silver surfacing of busses and connections shall be accomplished by plating or by an amalgamation process that does not use mercury. Silver purity shall be greater than 99.9 percent. Silver thus applied shall be not less than 0.0002-inches thick, shall withstand the adhesion test specified in QQ-S-365, and shall show no tendency to peel. The

contact surfaces of the bus shall be silvered up to 1-inch past the joint area. The entire bus bar may be silver surfaced at the discretion of the contractor. Shunt field leads shall be brought to two terminal boards. If space permits, one shall be located in the top half, and one in the bottom half of the enclosure. Shunt fields and lighting leads shall enter the enclosure through terminal tubes.

3.4.34.5.2 Terminal boxes. Terminal boxes, with watertight enclosure, in accordance with MIL-E-2036, shall be provided for the main terminals and shall be securely bolted or welded to the machine enclosure. Location of the terminal box(es) shall be mutually agreed to between the contractor and the contracting activity.

3.4.35 Space heater.

3.4.35.1 Installation. Unless otherwise specified (see 6.2.1), each generator and motor shall have an electric strip type space heater located in the lower part of the enclosure, on the commutator end. Adequate clearance (at least 2-inches) between the heater and other parts shall be provided to avoid local overheating of brush rigging, windings, and other parts of the machine. Heater terminals and heater circuit connecting terminals and leads shall be completely protected or insulated to prevent possible contact by personnel. A warning plate shall be provided to warn personnel against servicing the machine without first deenergizing heater circuits. Provision shall be included for breaking the heater circuit internal connections when required during disassembly. Heater circuit connection terminals shall be located on an accessible terminal board protected to provide watertight cable connections. Heaters shall be in accordance with MIL-H-22577.

3.4.35.2 Heater details. The heater shall have a capacity adequate to maintain the air temperature within the machine about 3°C to 6°C above ambient and shall be rated for operation at the specified voltage. Heater terminals shall be for 9,000 circular mil cable. Heater supports shall be insulated from the surface on which the heater is mounted to insure minimum loss of heat by conduction. The heater shall be firmly mounted to hold the heater rigidly without distortion under all operating conditions.

3.4.35.3 Alternate heating method. Field coils may be excited during periods of stand-still in lieu of utilizing space heaters. Space heaters shall be readily removable from the machine for replacement without disassembly of the machine.

3.4.36 Internal illumination. One or more lighting fixtures shall be installed for internal illumination of the commutator and brushes and for examination for presence of liquids in the bottom of the machine. Each fixture shall be in accordance with MIL-F-16377 and MIL-F-16377/1, symbol 126.3. Lamp shall be 50 watts, 120 volts, rough service. Guards will not be required if sufficient space is not available for the guard. The fixtures shall be located below the centerline with adequate clearance from line parts. The lighting fixtures and circuit shall be rated for 120 volts. Terminals and connecting leads shall be completely protected or insulated to prevent possible contact by personnel. A toggle spot switch, symbol 780.2 of Drawing 9000-S6202-74427 shall be installed on an accessible area on the outside of the machine to deenergize the lighting fixture(s) and to provide a connection means for input power to the lighting fixture circuit. The wiring entrances to the machine and switch shall be made watertight. Internal wiring from the switch to the lighting fixture(s) shall be installed. A warning plate shall be provided to warn personnel against servicing the machine without first deenergizing lighting circuits.

3.4.37 Inclined operation.

3.4.37.1 Surface ships. Propulsion motors, generators, and auxiliaries shall operate in the following inclined positions:

(a) Shaft inclined 15 degrees, front end low.
(b) Shaft inclined 15 degrees, rear end low.
(c) Shaft horizontal, base tilted 30 degrees clockwise.
(d) Shaft horizontal, base tilted 30 degrees counterclockwise.

3.4.37.2 Submarines. Propulsion motors, generators, and auxiliaries shall operate in the following inclined positions:

(a) Shaft inclined 30 degrees, one end low.
(b) Shaft horizontal, base tilted 15 degrees to the right or left.

3.4.38 Bearings. Sleeve bearings shall be provided for propulsion generators and motors, unless otherwise specified (see 6.2.1).

3.4.38.1 Generator bearings. One or two bearings, as specified (see 6.2.1), shall be provided for each generator. Bearings shall have adequate clearance for end play and expansion of the shaft. Bearing construction shall be such that if either one or both bearings should wipe, the armature will not strike the pole pieces and the commutator will not strike the brush rigging. For small machines, bracket type bearings shall be used in preference to pedestal type bearings where possible. Bracket type bearings shall be rigidly supported, preferably on rabbetted surfaces, to prevent dislodgement. Pedestal type bearings, where used, shall be designed for mounting on the foundation and shall be provided with jack screws. Dowel pins shall be furnished unless fitted hold-down bolts are used. Where segmental type armature laminations are employed (see 3.4.27.1 and 3.4.31.1), one bearing shall be electrically insulated, or the shaft grounded by use of brushes, to prevent induced currents in the shaft from flowing through the bearings. Oil piping and other conductive connections to the insulated bearing shall also be insulated. Consideration will be given to waiving the requirement of insulating the bearing or grounding the shaft where the contractor can demonstrate to the satisfaction of NAVSEC or the agency concerned that the design has proved adequate by service experience without the necessity of providing such insulation.

3.4.38.1.1 Unless otherwise specified (see 6.2.1), bearings shall be of split sleeve, self-alining type, with linings in accordance with QQ-T-390. Bearings shall carry the armature end thrust under all conditions of inclined operation as specified herein, unless adequate provision for carrying end thrust is included in the prime mover bearings. A removable depth type micrometer gage with protected reference seats on the bearing caps, or a bridge gage shall be furnished for measuring bearing water. The upper and lower halves of the bearing shell shall be readily removable. Design shall permit raising the shaft off any bearing lining without the use of special equipment. Temperature detectors in accordance with MIL-T-15377 shall be furnished for measuring the lining temperature of each bearing. Satisfactory methods for positively preventing oil or oil vapor from leaking along the shaft or from being drawn into the generator enclosure shall be provided. Methods shall include adequate replaceable bearing seals and an air chamber open to the atmosphere between the bearing and the interior of the machine. An oil overflow shall be provided for each bearing so that excess oil will drain outside the enclosure rather than into the machine. This overflow shall be designed so that oil does not spill out of the bearing under any of the conditions specified for inclined operation.

3.4.38.2 Motor bearings. Motor bearings shall be as specified in 3.4.38.1 for the propulsion generator, except as follows:

(a) Two bearings shall be employed for both single armature and double armature propulsion motors, unless otherwise specified (see 6.2.1).
(b) Bracket type bearings shall be used in preference to pedestal type, where possible.
(c) One of the motor bearings shall carry the armature end thrust with the motor inclined as installed in the ship and under all conditions of inclined operation as specified herein.
(d) Motor bearings shall not be designed to carry propeller thrust unless specified (see 6.2.1). When thrust bearings are specified for submarine use, pivoted segmental type thrust bearings shall be installed. The thrust bearings shall be capable of withstanding the combined thrust due to propulsion and submergence pressure of the ship as specified.
(e) Pedestal type bearings shall be designed for mounting on the ship's structure with fitted holding-down bolts. Jackscrews shall be provided. Dowel pins will not be required. The pedestal feet shall be in the same horizontal plane as the frame feet.

3.4.39 Lubrication. Unless otherwise specified (see 6.2.1), bearing lubrication shall be as specified in 3.4.39.1 and 3.4.39.2.

3.4.39.1 Generator bearings and motor bearings shall be force-lubricated. Generator bearings shall be lubricated by the prime mover lubricating oil system and shall be designed on the basis of using the same grade of oil as is employed for the prime mover lubrication. Motor bearings shall be lubricated from the reduction gear or shaft thrust bearing lubricating oil system and shall be designed on the basis of using the same grade of oil as is employed for reduction gear or shaft thrust bearing lubrication. An oil sight flow glass shall be provided in each bearing drain and a screened orifice at each bearing oil inlet. An oil level gage, a drain cock at the lowest level of the reservoir, and means for examination of oil rings or discs shall be provided. The design shall insure rotation of oil rings under conditions of inclined operation. The bearing lubricating oil system shall operate without flooding or leakage when either end of the machine is permanently tilted 15 degrees fore-and-aft from the horizontal or either side is permanently tilted 30 degrees

athwartship from the vertical, or momentarily rolling 45 degrees from the vertical. For submarine application, the bearing lubricating oil system shall operate satisfactorily when inclined permanently 30 degrees from the normal horizontal in a fore-and-aft direction or when momentarily rolling 60 degrees from the vertical about the axis of the shaft. The maximum temperature rise of the bearing oil shall not exceed 28°C and the maximum temperature of the oil leaving the bearing shall not exceed 82°C, under any normal operating condition in a 50°C ambient. Oil fittings shall be of heavy construction to withstand breakage due to shock and vibration.

3.4.39.2 Oil ring self-lubricating bearings. Where oil ring self-lubricated bearings are utilized by NAVSEC, 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. Split rings shall not be used. Under no conditions shall hinged snap oil rings be used. The housing shall permit the oil rings to rotate freely up to the maximum degree of inclination. 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 ship is permanently listed, rolling, or when subjected to shock. The housing shall 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 oil tight 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.

3.4.40 Enclosures.

3.4.40.1 Surface ships. Enclosures for generators and motors shall be of the water-air-cooled type in accordance with MIL-E-2036 and shall exclude flood water up to within 1/4 inch of the bottom of the shaft.

3.4.40.2 Submarines. Enclosures for submarine propulsion equipment shall be of the water-air-cooled type in accordance with MIL-E-2036. Enclosures shall also be watertight to the bottom of the shaft opening and spraytight above that point. A flanged make-up air opening shall be provided in the enclosures for the introduction of air from an outside source to maintain the pressure inside the enclosure above the ambient pressure at all points. This opening shall be located at a point of minimum pressure, and shall be provided with a watertight cover. Unless otherwise specified (see 6.2.1), a sump shall be provided at each end of the enclosure to collect any oil or water which may accumulate. A pipe shall extend into each sump and shall run upward inside the enclosure pass through the end bell at a point slightly below the enclosure split, and terminate in a connection to which a small hand pump may be attached.

3.4.41 Air coolers - surface ships. Air coolers shall conform to MIL-C-19836. The air cooler shall be capable of cooling the air in the machine so that the specified machine temperatures are not exceeded under any operating condition. A temperature detector in accordance with MIL-T-15377 shall be provided to indicate the temperature of the air leaving the cooler. Air coolers shall be in two or more sections arranged so that any section may be repaired while others are in operation. Water boxes shall be doweled or otherwise fitted to the tube bundles to prevent improper assembly.

3.4.41.1 Each cooler shall have an identification plate furnished by the contractor and installed upon the cooler at a location outside the machine enclosure where it can be easily read by personnel. This identification plate shall show manufacturer's name, serial and type number. Inlet and outlet water connections shall be clearly marked.

3.4.41.2 Air coolers - submarine. Air coolers shall be class 1 in accordance with MIL-C-19836, except that the vent and drain connection shall consist of a 1/4 inch, 0.540 inch by 0.120 inch wall 70-30 copper-nickel square end nipple. There shall be no restriction on the temperature of the air which is circulated through the machine, provided that no machine temperatures exceed those specified. A 1/8-inch pressure tap hole with "MS" plug and "O"-ring shall be provided in the inlet and outlet connections. There shall be two air cooler temperature detectors which shall be located so as to measure the temperature of the air exhausting into and from the air cooler. Each temperature detector shall be removable from the machine without the need for disassembly of the machine, or an installed spare shall be provided. Temperature detectors shall be in accordance with MIL-T-15377. Temperature alarm contact maker shall not be furnished.

3.4.42 Air filter. Air filter shall remove at least 90 percent of the carbon dust and other foreign matter (by weight) from the circulating air and shall have sufficient area so as not to seriously restrict air flow after a reasonable period of continuous operation without servicing. Filter sections shall be readily accessible for examination and replacement, and shall be securely fastened and of rugged construction to withstand shock and vibration. Mechanical type filters shall employ glass fiber or other noncombustible material, and shall have frames constructed of best commercial grade steel which has been galvanized by the hot dip process to give a smooth, shiny surface. The screen and other parts which cannot be galvanized shall be made of corrosion-resistant metal. Electrostatic type filters shall be furnished complete with all necessary associated control equipment. Adequate indicating lights, warning identification plates, interlocks, and other devices as required, shall be provided to protect personnel from high voltage. The filter shall be located on the incoming air side of the cooler. The air filter may be replaceable or reusable type. If a reusable type is supplied, instructions for cleaning shall be contained in the technical manual (see 3.8.2).

3.4.43 Cooling fan. The fan shall have sufficient capacity to circulate the required quantity of air through the generator or motor, cooler, and air filter. If the fan is attached to the rotor, the fan shall be adequately secured and of rugged construction to avoid loosening or breakage due to vibration or torque pulsations. Motor driven blowers or fans shall be as specified in 3.5.4. Unless otherwise specified (see 6.2.1), the direction of air flow shall be such that the air is filtered after leaving the commutator chamber and before entering the machine windings.

3.4.43.1 If the fan is attached to the commutator end of the machine, a warning plate shall be installed, cautioning personnel against the possibility of injury from the fan while servicing the commutator.

3.4.44 Identification plates.

3.4.44.1 General. Identification plates shall be attached to the part of the generator or motor 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. These identification plates shall conform to type C or D of MIL-P-15024 and MIL-P-15024/5 and shall be installed on and furnished as a part of the generator or motor for which they are intended. Type A identification plates in accordance with MIL-P-15024 and MIL-P-15024/5 and constructed of nickel-copper alloy or sheet brass may be used provided no identification plate dimension exceeds 5-inches and not more than one identification plate dimension exceeds 3-inches.

3.4.44.2 Identification plate markings. The main identification plates for generators and motors shall include the following minimum data:

(a) Manufacturer's name, identification symbols, serial number, Government drawing number of assembly drawing or index plan and year of manufacture.
(b) Salient design characteristics, namely, type, kw capacity or hp rating, voltage, current, overload rating, r/min class of insulation.
(c) Government contract number.
(d) National stock number.
(e) Blank space for DCASMA's official stamping.

3.4.44.3 Permanent marking. The manufacturer's serial number shall be stamped underneath the identification plate in the solid metal of the magnet frame. Armatures shall be marked so as to identify the manufacturer and the style and type of the generator or motor. The serial number of the armature shall be plainly stamped on the shaft at the front end. Field coils shall be marked so as to identify the manufacturer and the design of the generator or motor.

3.4.45 Painting.

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

3.4.45.2 Interior. Electrical insulation of all types, surfaces in contact with lubricating oil or grease, commutators, collector rings, brushes, bearings and bearing surfaces shall not be painted. Also peripheries of armatures and rotors and any other rotating part of a machine from which centrifugal force may cause the paint to be thrown on the windings when the machine is operated at rated-load and rated ambient temperature shall not be painted; insulation varnish conforming to MIL-I-24092 instead of paint, may be applied to such parts. Noncorrosion resisting parts (see MIL-E-917) other than the above shall be

painted in accordance with MIL-E-917, except that one coat of enamel of any suitable color will be sufficient. The interior of the end brackets and frame at the commutator end shall be painted with two coats of cellulose air drying lacquer, gloss white.

3.4.46 Welding. Welding and inspection shall meet the requirements of MIL-STD-278.

3.4.47 Processes. Use of insulating varnish as corrosion-resistant treatment for interior surfaces of motors and generators shall be in accordance with MIL-E-917. In addition, inside diameters of hollow shafts shall be painted when and where feasible. Outside diameters shall be painted, except for shrink fits, bearing fits, areas near bearing fits, and at shaft seals.

3.4.48 Weight. Weights shall not exceed those specified (see 6.2.1).

3.5 Propulsion auxiliaries.

3.5.1 Bearings. Propulsion auxiliaries driven by motors, such as blowers and excitation motor-generator sets, shall have specially selected quiet type antifriction bearings in accordance with MIL-B-17931, and bearing fits shall be carefully controlled. Lubrication shall be by grease conforming to DOD-G-24508.

3.5.2 Rotating exciters.

3.5.2.1 General. Propulsion excitation shall be supplied from d.c. generators which may be either motor driven, diesel driven, or turbine driven, as specified (see 6.2.1). An excitation generator directly driven or belt driven from the propulsion generator shall not be used, except as permitted by the contract or order. Submarine propulsion motors and generators shall be designed for separate excitation from a static exciter or from a battery having characteristics to be specified by the command or agency concerned.

3.5.2.2 Characteristics. Exciter generators shall be designed for operation in a 50°C ambient temperature, shall be of dripproof, enclosed construction, self-ventilated, and of sufficient rating to supply excitation currents to propulsion generators and motors for steady running and during reversals. Construction of exciter generators shall comply with MIL-G-3111 except as follows:

(a) Exciter generators shall supply propulsion generator excitation at the voltage and current required.

3.5.2.3 Insulation. Class B, F, or H insulation shall be provided in accordance with MIL-E-917.

3.5.2.4 Interchangeability. Corresponding exciter generator parts shall be interchangeable wherever practicable.

3.5.2.5 Pilot and control exciters. Where pilot exciters or generators for automatic excitation control are employed they shall be driven from the same prime mover as the exciter generator. They may be direct-connected to the exciter shaft.

3.5.3 Motor-generators.

3.5.3.1 General. Motor-generator sets and motor starters used for propulsion excitation shall conform to MIL-M-2130, except as noted hereinafter, and shall have the following characteristics:

(a) Type III or IV, as specified (see 6.2.1).
(b) Ambient temperature: 50°C.
(c) Bearings: Sleeve or double-seal ball.
(d) Radio frequency interference: Sets shall be designed to minimize radiated and conducted radio frequency noise. No tests will be required.
(e) Audible noise: No greater than normal.
(f) Mechanical balance: Standard.
(g) Shock tested machines: Ball bearings in shock tested sets shall be replaced.
(h) Repair parts: See 3.6.1.
(i) Exciter generators: Exciter generators shall comply with 3.5.2.
(j) Driving motors: D.c. motors shall be 2 wire motors with commutating poles.
(k) A.c. motors shall be for 3 phase 60 Hz power. Voltage shall be as specified (see 6.2.1).
(l) Insulation - class B, F, or H.

3.5.3.2 Motor starters for propulsion excitation motor-generator sets. Motor starters for propulsion excitation motor-generator sets shall conform to MIL-C-2212, and shall have the following characteristics:

(a)	Rating	As required
(b)	Duty	Continuous
(c)	Ambient	50°C
(d)	Enclosure	Dripproof
(e)	Operation	Magnetic
(f)	Type	Across-the-line for a.c. Resistor for d.c.
(g)	Performance	Semi-automatic
(h)	Function	Motor starting
(i)	Protection	Low voltage release (overload or short circuit protection not to be furnished)

3.5.3.3 Interchangeability. Corresponding parts of driving motors and exciter generators shall be interchangeable where practicable.

3.5.4 Ventilating blowers or fans. Motor driven ventilating blowers or fans for propulsion motors and generators, where employed, shall have sufficient capacity to fulfill the ventilation requirements. Wherever practicable, interchangeability shall be maintained between all parts of blowers or fans employed for propulsion motors or generators. Airborne noise and structureborne vibration requirements shall be the same as those imposed on the motor or generator. Where low noise level is a consideration (see 6.2.1) multispeed motors and blowers shall be used.

3.5.4.1 Mounting. The blower or fan shall be mounted on its propulsion generator or motor. Blower and motor shall be mounted on Navy type resilient mounts when required for noise reduction. When motor driven blowers and fans are sound isolated, a ground strap is required.

3.5.4.2 Blower motor shall be as specified (see 6.2.1) and shall have the following characteristics:

(a) A.c. (see MIL-M-17060) or d.c. (see MIL-M-17413).
(b) Voltage - D.c. as specified; A.c., 440 volts, 3 phase 60 Hz.
(c) Enclosure - to be determined by contractor if mounted within the motor or generator enclosure.
(d) Mechanical balance - standard, precision, or special.
(e) Ambient temperature - 40°C, 50°C, or special.
(f) Insulation - class B, F, or H. (Class H insulated machines shall not be used in enclosed d.c. motors or generators.)
(g) Bearings - ball.
(h) Shock test - as specified (see 6.2.1).

3.5.4.3 Controller. Characteristics, repair parts, and tests for the blower or fan controller (where employed) shall be the same as for propulsion excitation motor-generator set controllers, except as follows:

(a) Thermal overload protection shall be provided.
(b) Provision for limited speed adjustment shall be provided in d.c. controllers.
(c) An indicating light shall be provided at the remote starting station.

3.5.4.4 Type. Fan or blower may be centrifugal or vane axial type.

3.6 Provisioning parts lists. The contractor shall prepare a provisioning parts list in accordance with the data ordering document included in the contract or order (see 6.2.2). On board repair parts shall be based on the number of identical generators and motors installed per ship, as specified (see 6.2.1), and the following:

(a) A set of special tools which are required for disassembly, repair, adjustment and reassembly, shall be furnished on a per ship basis. Special tools are defined as those tools not listed in the National Supply Catalog (copies of this catalog may be consulted in the office of the Defense Contract Administration Service Management Area (DCASMA)).
(b) The specific repair parts and quantity of each part shall be furnished as specified in the individual equipment specification.
(c) Where special tools are required for installation and alinement of the machine scheduled for installation on any one ship.

3.6.1 On board repair parts and tools. Each on board repair part shall be suitable for immediate replacement of the originally installed part involved and shall be equal to the original part when new. When specified (see 6.2.1), repair parts and tools shall be furnished in repair parts boxes conforming to type M of MIL-B-233.

3.6.1.1 Propulsion generator on board repair parts. The following repair parts and special tools shall be furnished for stowage on board each ship. Quantities noted are the quantities required for each ship.

(a) One complete set of bearings or bearing linings of each size and type, sufficient for one machine of each type furnished.
(b) One complete set of brushes for each machine furnished, each set sufficient for one machine.
(c) Two sets of brush-holders, with three extra springs for each holder, each set sufficient for one brush arm.
(d) Two sets of brush-holder insulation, each set sufficient for one brush arm.
(e) One field coil of each size and type, complete with insulation, wedges, shims, collars, and so forth. Repair parts coils of bare copper strap construction will not be required. For submarine application, repair field coils shall not be furnished as on board repair parts, unless otherwise specified (see 6.2.1).
(f) Two oil sight flow glasses or one oil gage.
(g) One set of bearing lubricant seals of each size and type sufficient for one machine.
(h) One thermometer of each type.
(i) One set of oil rings of each size, sufficient for one bearing, where employed.
(j) One screened orifice, where forced lubricated bearings are employed.
(k) One strip heater unit, complete for one machine.
(l) One complete set of replaceable gaskets.
(m) One complete set of replaceable filters for each filter unit furnished.
(n) One complete set of special tools and accessories as required for servicing, including bearing wear gage and air gap feelers.

3.6.1.2 Propulsion motor on board repair parts. Propulsion motor on board repair parts shall be as specified in 3.6.1.1, except that duplicate special tools for motors and generators will not be required.

3.6.1.2.1 Additional repair parts. In addition, the contractor shall recommend as repair parts any wearing or operating parts, special gear or attachments, considered necessary for dependable and efficient service and maintenance.

3.6.1.3 Propulsion exciter on board repair parts. Unless otherwise specified (see 6.2.1), the following repair parts and special tools shall be furnished for stowage on board each ship. Quantities noted are the quantities required for each ship.

(a) One armature complete with shaft, fan and commutator, when specified. Shore or on board storage shall be as specified in the contract or order.
(b) One complete set of bearings of each size and type, sufficient for one machine.
(c) Four complete sets of brushes, each set sufficient for one machine.
(d) One half set of brush-holders and one set of springs, each set sufficient for one machine.
(e) One set of brush-holder insulation, each set sufficient for one machine.
(f) One field coil of each size and type, complete with insulation, wedges, shims, collars, and similar items.
(g) Three sets of bearing lubricant seals of each size and type.
(h) One grease cup.
(i) One belt for belt-driven exciters.
(j) One complete set of special tools, including bearing puller if pullers in accordance with GGG-P-781 cannot be utilized.

3.6.1.4 Motor for propulsion excitation motor-generator sets on board repair parts. Repair parts and special tools shall be furnished for each ship in accordance with the applicable requirements of 3.6.1.3 for the propulsion exciter, except that duplicate special tools will not be required, and that for a.c. motors, an additional rotor will not be required.

3.6.1.5 Ventilating fan or blower on board repair parts. On board repair parts for the blower or fan motor shall be as specified in 3.6.1.4.

3.6.1.5.1 One impeller and shaft of each size and type shall be furnished per ship as on board repair parts.

3.6.1.6 Propulsion excitation motor-generator set controller on board repair parts. Repair parts and special tools per ship for the controller and remote push button station shall be furnished in accordance with MIL-C-2212.

3.6.1.7 Repair parts for ventilation fan or blower controller. On board repair parts for the ventilation fan or blower controller (where employed) shall be in accordance with 3.6.1.6 for the propulsion excitation motor-generator set controller.

3.6.1.8 Repair parts for air coolers. On board repair parts for air coolers shall be in accordance with MIL-C-19836.

3.6.2 Marking of repair parts. Repair parts shall be clearly marked with identification data. If the part is large enough, the identification data shall be marked on the part in such a manner so as not to interfere with its serviceability. Where the part is small, a tag shall be secured thereto. Where identification tags are liable to be damaged by tearing or dampness, they shall be of metal or fiber, stamped or otherwise marked, and securely wired to the respective parts.

3.7 Interchangeability. Like machines used for installation in the same ship shall have the same direction of rotation; however, the appurtenances, coolers, access, and control equipment shall be handed for use on alternate sides of the ship. Major parts, such as casings and rotors, shall be such as to permit use of one design for both port and starboard application subject to the following limitations:

(a) Complete double armature rotors shall be interchangeable, assuming that the couplings are drilled with a template and may be reamed in place.
(b) The air coolers shall be made interchangeable between armatures on the same set, and between like armatures on different sets by use of drilling templates and extra plugable holes, where necessary.
(c) Parts required to be interchangeable, which are also fastened with fitted bolts, shall be considered interchangeable, with the provision that the mating parts may be reamed together at time of assembly or installation.
(d) The sheet metal, stator frames, bearing pedestals, and components of assemblies which become an integral part of the assembly need not be interchangeable.

3.8 Technical data. The contractor shall prepare technical data in accordance with the data ordering documents included in the contract or order (see 6.2.2) and as specified in 3.8.1 through 3.8.1.3.

3.8.1 Drawings. In addition to the requirements of the data ordering documents (see 6.2.2), data for drawings shall include the information specified in 3.8.1.1 through 3.8.1.3.

3.8.1.1 Preliminary drawings. Preliminary drawings shall show outline dimensions, weights, mounting dimensions, clearances for access and maintenance, locations and dimensions of piping, electrical and ventilation connections, shaft dimensions, and other information needed to determine suitability for installation and for preparing the machinery layout.

3.8.1.2 Content.

3.8.1.2.1 Propulsion generators and motors. Drawings shall include the following minimum data, unless otherwise specified (see 6.2.1):

(a) Performance table for each operating mode or condition shall consist of the following:
    (1) Power rating (hp or kW).
    (2) Voltage rating.
    (3) Current rating.
    (4) Guaranteed efficiencies.
(b) Net calculated weights:
    (1) Generator or motor complete.
    (2) Armature complete.
    (3) Total WR^2 value of rotating parts.
    (4) Unbalanced magnetic pull for 1/32 inch displacement of armature from center. (Required only for machines employing pedestal bearings.)

(c) Shafts, bearings and lubrication:
  (1) Shaft material.
  (2) Type of bearing.
  (3) Type of lubrication (ring or forced feed).
  (4) Designed oil clearance.
  (5) Bearing pressure.
  (6) Surface speed.
  (7) Material composition of antifriction bearing lining.

(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, diameter, and material of banding wire.

(f) Commutator:
  (1) Diameter.
  (2) Length of active surface.
  (3) Wearing depth on diameter.
  (4) Depth of under cut.
  (5) Thickness and type of insulation between bars.
  (6) Thickness and type of insulation to ground.
  (7) Torque and temperature for adjustment of "V" ring.

(g) Commutator brushes:
  (1) Number of studs.
  (2) Number of brushes per stud.
  (3) Dimensions of brush.
  (4) Navy grade, and manufacturer's name and grade, and alternate manufacturer's name, grade and identification number.

(h) Alarm contact devices (as applicable):
  (1) Air temperature alarm contact calibrated ___°C to ___°C set at ___°C.

(i) First article test data consisting of the following as determined from actual tests may be included in the technical manuals.
  (1) Effectiveness of enclosure
  (2) Efficiency for each operating mode or condition to include in kW the following losses:
    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 and hot (operating temperature) of:
    a. Shunt field.
    b. Armature.
    c. Series field it utilized.
    d. Commutating field.
  (4) Efficiency in percentage at 2/4, 3/4, and 4/4 load.
  (5) Saturation data at rated full-load speed, ascending and descending line volts and field current.
  (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) Reference to electromagnetic interference test report - frequency and microvolts.
  (8) 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.

(9) Overspeed in r/min.
(10) Dynamic balance. Both calculated and actual unbalance in ounces-inches.
(11) Dielectric strength in volts.
(12) Insulation resistance in megohms (hot and cold).
(13) Net actual weights:
a. Generator complete.
b. Armature complete.
(14) 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 agency concerned via (activity) letter _____, dated _____."
(15) A space for DCASMAR's signature, office and date.

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

(k) 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 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 coil.
(10) Insulation data as specified in (w).

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

(m) Development of armature winding.

(n) 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 (w).

(o) An assembly end and side view, showing all parts of the machine which are identified with piece numbers in the list of materials. The assembly side view shall show a longitudinal section of the machine 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.
(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 to shaft.
(4) Method of attaching terminal box to frame.
(5) Dimensions, drilling and tapping of terminal box, and the number and size of cover bolts.
(6) Method of bringing cables out of frame into terminal box and the method of protecting these cables against chafing at sharp metallic corners.
(7) Method of clamping leads in the terminal box to prevent strain on internal connections, and method of protecting lead insulation against abrasion by the clamp.
(8) Direction of air flow.
(9) Overall dimensions, including mounting, shaft extensions, and the necessary limit required to remove the armature.
(10) Lifting means.

(p) Detailed drawing of sleeve-bearing shell and liner showing all dimensions.

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

ement ball bearings by standard bearing number. If
MIL-ring, all replacement bearings shall be identified
and identification numbers.
nber and type of the applicable bearing puller. If
lers are not suitable, the note shall so state and
brand, and catalog number of a suitable bearing

xciters, bearing oil seals and shaft air seals.
ngs of brush rigging, brush-holders, and brushes.

Drawings for propulsion auxiliaries shall contain
le specification.

Certification data sheets shall include the
d field circuit.

requirements of the data ordering documents (see
he information specified in 3.8.2.1 through 3.8.2.2.

clude a set of drawings containing the information

ure has been validated, revalidation is required
arrangement of parts has been changed. Revalidation
s been changed is not required. The contractor
dation prior to submission of preliminary manuals

ining.

ding wire.

ing.

and alternate
number.

to ___°C set at

etermined from actual

n to include in kW

s.
friction loss.

erature) of:

-holder and brush retaining mechanism.
s giving brush form or type, top bevel, bottom
including length of pigtail and slot of terminal.
ards.
ature.
pression equipment including rating of resistors,
ils, and other accessories.
nsulation data shall be included on each master
the drawing previously approved by the command or agency
s shown on a separate drawing covering insulation
machines, the Government drawing of the insulation
ter to on each applicable master drawing. This data
all inculation used, indicating the materials,
nce of winding and insulating operations, number of
6.2 lapping of tape applications, limiting voltages and
mber and types of thinner to be used, temperature
eatments, vacuum and pressure employed during
spe shall contain complete detailed information on
ly including:
and turn insulation.
onl including slot and end turn insulation of each
whe ground insulation, coil turn separators, coil
sha ion, and support pads between coils and armature
piece.
h type of winding showing a cross section of the
lative location and identification, by piece numbers,
aterials shown.
nd data are necessary to show method of manufacture
l forming) of each winding. These sketches should
ls as the direction and overlap of the various tape
ands, conductors, turns, and coils, the distance
oil slot insulation and slot armor extend beyond
on and the original and final shape of conductors
e and after each insulation process.
r (3) and (4) should be identified as to the type
otor and the type of winding. The sketches should

load.
nding and descending

ent, field current,

ent, field current,

. report - frequency

at normal load:

wire.

for acceptance. Where such validation is not completed, correspondence forwarding preliminary manuals shall show the portions of the manual which have not been validated. Validation shall be completed prior to printing of final manuals.

3.8.2.3 Items requiring validation. The following items require validation. The validation of subcontractor furnished items may be accomplished at the subcontractor's plant where such validation is not affected by equipment furnished by the contractor or other subcontractors. For example, validation of the procedure for adjusting generator brush-holders, brush spring tension and replacement of brushes may be accomplished at the generator manufacturer's plant provided the location of other units on the completely assembled generator set does not change the procedure.

(a) Procedure for determining whether the generator set or motor is properly alined.
(b) Procedure for examination and replacing all journal bearings (including checking bearing clearance).
(c) Procedure for examination, determining clearances, and replacement of all seals.
(d) Procedure for taking thrust clearance, installing thrust locking device, examination and replacement of thrust shoes, and for taking total float clearance on thrust bearings.
(e) Procedure for examination, replacement, and setting of parts in all mechanical control assemblies.
(f) Procedure for examination of controls and linkages including setting instructions.
(g) Procedures for balancing the rotating elements of the generator set or motor.
(h) Procedure for adjusting generator or motor brush-holder, brush spring tension and replacement of brushes, as applicable.
(i) Confirm the lubrication characteristics and procedures (pressures, temperatures, areas to be lubricated, and frequency of lubrication, as applicable) agree with information in the technical manual.
(j) Wave forms, oscilloscope traces, voltages, and currents involved in the trouble shooting procedures for voltage regulator, static type excitation systems and the electric speed and load sensing type governor, as applicable.
(k) Procedures for validating installation criteria specified in 3.8.2.2.

3.9 Workmanship.

3.9.1 General. Workmanship shall be in accordance with the requirements herein applicable to soldering, marking of parts and assemblies, wiring, welding and brazing, plating, riveting, finishes, machine operations, screw assemblies, and freedom of parts from burrs, sharp edges, or any other damage or defect that could make the part (or equipment) unsatisfactory for the purpose intended.

3.9.2 Threaded parts or devices. Screws, nuts, and bolts shall show no evidence of cross threading, mutilation, or detrimental or hazardous burrs.

3.9.2.1 Tightness. Screw-type fasteners shall be tight. The word tight means the screw shall be firmly secured and that there shall be no relative movement possible between the attached parts.

3.9.3 Wiring. Insulated wire shall be formed into cables or ducted wherever practicable. Wires and cables shall be positioned or protected to avoid contact with rough or irregular surfaces and sharp edges.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, 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.

4.1.1 Inspection system. The contractor shall provide and maintain an inspection system acceptable to the Government for supplies and services covered by this specification. The inspection system shall be in accordance with MIL-I-45208 (see 6.2.1).

4.2 Classification of inspection. The inspections required herein are classified as follows:

(a) First article inspection (see 4.3).
(b) Quality conformance inspection (see 4.4).

4.3 First article inspection. First article inspection shall consist of the examination and tests specified in table IV.

TABLE IV. Tests.

Description of test	Requirement paragraph	First article inspection	Quality conformance inspection
Air gap measurements	3.4.20	4.6.4	4.6.4
Resistance	3.4.27.3 and 3.4.29	4.6.5	4.6.5
Airborne noise	3.4.14	4.6.6	4.6.6
Internally excited vibration	3.4.8, 3.4.9, and 3.4.10	4.6.7	4.6.7
Commutation	3.4.32	4.6.8	4.6.8
Voltage regulation	3.4.7.1	4.6.9	4.6.9
No-load saturation	3.4.7	4.6.10	4.6.10
Lubrication	3.4.39	4.6.11	4.6.11
Overspeed	3.4.12	4.6.12	4.6.12
Insulation resistance (cold)	3.4.17	4.6.13	4.6.13
Dielectric tests	3.4.18	4.6.14	4.6.14
Speed regulation	3.4.7.2	4.6.15	4.6.15
Effectiveness of enclosure	3.4.40	4.6.16	------
Heating	3.4.3	4.6.17	------
Insulation resistance (hot)	3.4.3.1	4.6.18	4.6.18
Reversal	3.4.6.1	4.6.19	------
Ripple voltage	3.4.16	4.6.20	------
Efficiency	3.4.6.2	4.6.21	------
Weight	3.4.48	4.6.22	------
Shock	3.4.13	4.6.23	------
Inclined operation	3.4.37	4.6.24	------
Parallel operation	3.4.19	4.6.25	------
Operation with one field coil disconnected	3.4.29.1	4.6.27	------
Cooler water side flow tests	3.4.41	4.6.29	------
Breakaway torque	3.4.6.1	4.6.31	------
Operational tests	3.4.6	4.6.30	------
Maintainability demonstration	3.4.1.4	4.6.2	------
Reliability demonstration	3.4.1.3	4.6.3	------
Magnetic tests	3.4.3.1	4.6.26	------
Rheostat data	3.4.6	4.6.28	------

4.4 Quality conformance inspection. Quality conformance inspection shall be performed on all units, and shall consist of the applicable tests specified in table IV.

4.5 Additional tests. The first article inspection shall be repeated after any change in design which affects performance characteristics. If quality conformance data reveal variations beyond normal manufacturing tolerances, the Government may require that any or all of the first article tests be made on a particular item to demonstrate that it will meet the requirements of this specification.

4.6 Tests.

4.6.1 Repair parts.

4.6.1.1 Coil tests. Resistance readings at normal room temperature shall be made upon repair field coils and the results checked against the values obtained for the coils of the machine. If the resistances are materially different from those of the machine coils the repair coils shall be rejected. Repair coils shall be subjected to the dielectric test specified in 4.6.14.

4.6.1.2 Armature tests. The tests on repair armatures shall comprise those routine tests normally made on the machine itself. Any armature that has been routine tested in the frame of any machine of the size and design specified in the contract or order may be

designated as the repair armature. In cases where repair armatures are ordered on subsequent contracts or orders and for which suitable frames are not available, the following tests shall be made:

(a) General examination. The armature shall be subjected to a thorough examination to ascertain that the material, workmanship, dimensions, and design are in conformance with the requirements of this specification.
(b) Internally excited vibration. The armature shall be dynamically balanced.
(c) Bar-to-bar voltage drop test. This test may be made with any suitable test equipment.
(d) Insulation resistance. See 4.6.13.
(e) Dielectric strength. See 4.6.14.

4.6.2 Maintainability demonstration test. A maintainability demonstration test shall be conducted to verify achievement of the quantitative value of predicted maintainability specified in 3.4.1.4.2.

4.6.2.1 Test plan. The contractor shall prepare a detailed maintainability test plan in accordance with MIL-STD-471. Demonstration test shall be performed in accordance with phase II, method 4 of MIL-STD-471. This plan shall be formulated so that it will apply to a basic design or designs and any known modifications thereto. Once this plan has been accepted it shall be used on generators or motors furnished, except where a new basic design or modifications to the original basic designs have been incorporated in the generator or motor sets and are not covered by the original plan. In this case, the manufacturer shall submit a demonstration plan for the new basic design or modification, as applicable, to NAVSEC for acceptance. As a minimum, the following items shall be covered in the demonstration plan:

(a) Preventive maintenance tasks shown in table V.
(b) Corrective maintenance tasks as follows:
    (1) Replacement of journal bearings.
    (2) Replacement of seals.
    (3) Replacement of thrust bearings.
    (4) Replacement of parts in the overspeed trip assembly.
    (5) Replacement of all recording devices (thermometers, gages, and so forth) mounted on the generator package. Also check accessibility of these devices to verify that readings can be easily observed by operating personnel.
    (6) Replacement of generator brush-holders, springs, and brushes. This requirement also applies to rotating type exciters where furnished.
    (7) Check accessibility of terminals and terminal boards to verify that wiring to these boards can be conveniently disconnected and connected by maintenance personnel without removing units or parts on the machine other than removal of access covers for these terminals and terminal boards.
    (8) Replacement of parts in the voltage regulator (where applicable).
    (9) Replacement of parts in the static type exciter, where furnished.
    (10) Replacement of resistance temperature sensing elements (RTD's).

TABLE V. Preventive maintenance tasks.

Item	Action	Frequency
D.c. propulsion motor	Clean the electrostatic filter	Monthly
	Clean and examine commutator and brush assembly	Quarterly
	Clean air filters	Quarterly
	Measure journal bearing clearance, ball bearing (anti-friction)	Quarterly
	Clean and examine blower motor	Quarterly
	Lubricate blower motor	Annually
	Clean electrostatic collector cells	Annually
	Clean and examine propulsion motor	Annually
	Measure insulation resistance	Accomplish weekly when in port
	Measure thrust bearing clearance	Quarterly
	Renew air filter media	Accomplish as directed by air filter examination
D.c. propulsion generator	Clean and examine commutator and brush assembly	Quarterly
	Examine air filter	Quarterly
	Clean and examine propulsion generator	Once during operational cycle between the scheduled overhaul
	Clean electrostatic filter collector cells	Annually
	Measure insulation resistance	Accomplish weekly when in port
	Renew air filter media	Accomplish as directed by air filter examination
	Examine exciter	Weekly
	Clean and examine exciter	Monthly
	Measure and adjust brushes and brush rigging	Monthly
	Lubricate generator bearings	Semi-monthly
	Examine generator and exciter terminal boxes	Quarterly
	Measure bearing clearance	Quarterly
	Renew lube oil in bearing sump, examine slinger rings	Semi-annually
	Clean and examine bearing assembly	Once during operational cycle between the scheduled overhaul

4.6.2.2 Maintainability test conditions. The maintainability test shall be performed with the equipment or system installed in a manner which simulates, to the satisfaction of the contracting activity, the shipboard dimensional envelope as specified (see 6.2.1). The access envelope shall be simulated with panels and screens. Test equipment, tools, repair parts, and maintenance literature, at least in the form of preliminary manuscripts of manuals covering maintenance instructions shall be made available for the performance of the tests. Test team, facilities, and support material shall represent the normal shipboard resources as defined in the manuals prepared for this equipment. Test mechanics shall be given no outside assistance. The following shall be recorded, monitored or certified by the DCASMAR during the test:

(a) Data collected, including man-hours, clock-hours, maximum number of active mechanics, part identification, documentation of the specified maintenance tasks in 4.6.2.1.
(b) Factors which influenced the data.
(c) Identification of other intervening parts removed or moved to replace the part for which a replacement time has to be demonstrated.
(d) Computation or measurement of the required replacement times.
(e) Deficiencies.
(f) Recommendations.
(g) Results of retest, if applicable.
(h) Certification by the DCASMAR of the data obtained and whether or not the replacement time requirements have been met.

4.6.2.3 The training and skill levels of manufacturer's shop personnel who perform the maintenance tasks of the demonstration test shall be commensurate with Navy personnel who will maintain the motors or generators.

4.6.2.4 Simulation of faults or failures by introducing defective parts is not required.

4.6.2.5 The activity acquiring the generators or motors and NAVSEC shall be notified at least 30 days in advance of scheduled maintainability demonstration tests so that arrangements can be made to witness the demonstration if desired. Such notice shall contain complete identification of the equipment involved.

4.6.3 Reliability demonstration. A plan for formal demonstration of achieved reliability at specified milestones, including planned number of test articles, accept/reject criteria, discrimination ratio, or the associated confidence or risk levels, shall be prepared as specified by the contracting activity (see 6.2.2). MIL-STD-785 shall be used as a guide.

4.6.3.1 Life (endurance). Direct testing is not required. Any temperatures or wear rates above those specified, or evidence of failure to meet the MTBF, shall be treated as failure to meet this requirement.

4.6.4 Air-gap measurements. The air gap shall be measured by steel "feelers" or gages. Measurements shall be made at the centerline at all main poles and interpoles at each end. Where it is physically impossible to measure the air gaps directly as specified, indirect measurements may be taken by optical methods.

4.6.4.1 Acceptance criteria. The air gaps shall be uniform. Allowable air gap variations shall be consistent with the required noise level (see 3.4.14.1.1).

4.6.5 Resistance. The resistance of the armature and all fields and the temperature at which they are measured shall be taken and recorded.

4.6.5.1 Acceptance criteria. Resistance of armature and fields shall be within 10 percent of calculated value when corrected to 25°C.

4.6.6 Noise test. Motors and generators shall be airborne and structureborne noise tested under normal operating conditions to duplicate shipboard installation and subjected to the requirements of 3.4.14, table I, and MIL-STD-740. Prior to testing, the contractor shall submit for Navy review a detailed drawing of the test set-up. Detailed test requirements contained in MIL-STD-740 shall apply, with reports provided in accordance with the data ordering documents (see 6.2.2).

4.6.7 Vibration test. Motors and generators shall be vibration tested under normal operating conditions to duplicate shipboard installation and subjected to the requirements of MIL-STD-167-1, type I, environmental vibration, up to and including 50 Hz, and the requirements of MIL-STD-167-1, type II, internally excited vibration. A detailed description with drawings of the test set-up shall be submitted for Navy review prior to testing. Detailed test requirements contained in MIL-STD-167-1 shall apply and reports shall be provided in accordance with the data ordering documents (see 6.2.2).

4.6.8 Commutation.

4.6.8.1 The observation of commutation shall be made in conjunction with and during the progress of other tests.

4.6.8.2 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, that this setting is permanently marked, and that the brushes are well seated on the commutator. During the progress of the tests, the brushes and the commutator shall remain untouched. The motor commutators shall have a smooth and uniformly colored surface. The condition of the generator commutator surface shall be observed and recorded on the test data sheet (see 6.2.2).

4.6.8.3 It shall be ascertained that commutation is attained by correct interpole field strength and not by brush shift from the neutral or by interpole shunts. Brush shift from neutral or the use of shunts across the interpole field terminals is not acceptable. Proper correction of interpole strength shall require a change in the interpole air gap or the interpole winding.

4.6.8.4 Observation of the commutation shall be made at varying loads throughout the service range. Also, at shutdown, the armature shall be rotated slowly by hand, and any irregular markings or lack of uniform coloration or polish on the surface of the commutator covered by the brushes shall be carefully noted.

4.6.8.5 Successful commutation is defined as that not resulting in accumulated injury or permanent damage to the brushes and commutator, and does not require undue commutator maintenance to meet required performance. The absence of visible sparking is not essential to acceptable commutation. It is desired that the commutator show a tendency to polish rather than to blacken, burn, or pit. The most satisfactory commutator film is uniformly colored, between straw to dark brown, with neither a high glaze nor an extremely dull finish. For normal operating conditions, from 0 to 100 percent load, the sparking at the brushes shall not exceed grade 1-1/4 as follows:

(a) Grades of commutation.

1	Black. No sparking.
1+	Band limits. Considered as the point on the buck boost curve at which sparking is first observable.
1-1/4	Slight sparking on a few brushes. The point where an increase in the number of brushes that spark is noticeable after band limits.
1-1/2	Slight sparking on half of the brushes. Half of the brushes spark or half of the total edge of the brushes are covered with yellow sparks.
2	Sparking on most brushes. Sparking on practically all brushes, but no streamers.
3	Continuous heavy sparking with occasional to heavy streamers.

4.6.9 Voltage regulation (generators only). With the field rheostat so adjusted that the machine is operating at rated-voltage, rated r/min, and no-load, the load shall be applied in 20-percent steps up to the rated-output to determine if the machine performance conforms to 3.4.7.1. With the field rheostat so adjusted that the machine is operating at rated-voltage, rated r/min, and rated-load, the load shall be reduced to 0 in 20-percent steps to determine if the machine performance conforms to 3.4.7.1. Following each initial setting for these two tests, there shall be no readjustment of the field rheostat for the remainder of the test.

4.6.10 No-load, 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 first article tests (see 6.2.2). The readings for one curve shall always be taken with increasing values on 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:

(a) Four below 60 percent of rated voltage.
(b) One between 60 and 90 percent.
(c) One at rated voltage.

Readings of line voltage, field current, field voltage, and speed shall be taken and recorded. The machine shall be driven by any convenient prime mover.

4.6.11 Lubrication. Unless otherwise specified (see 6.2.1), lubrication tests shall be conducted as follows:

(a) By a careful observation and general examination of the parts, it shall be determined that the performance of the lubricating system is satisfactory with the generator or motor in normal horizontal position. Test shall be observed during the progress of the other tests, or by special tests as the circumstances may warrant. Lubricant similar to that required for service operation shall be used. The quality conformance test reports (see 6.2.2) 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.

4.6.12 Overspeed. Each machine shall be subjected to an overspeed test at a speed 25 percent greater than the rated-speed for a period of 30 minutes unless otherwise specified by the command or agency concerned. For generators, 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. Observe for noise, mechanical balance, and smoothness of running during the test, and for 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.

4.6.13 Insulation resistance (cold). Test shall be made before and after the dielectric tests (see 4.6.14). Prior to the application of the test voltage, the windings of the machine shall be thoroughly discharged. 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 ohmmeter conforming to MIL-O-16485. The time of test voltage application shall be not less than 60 seconds. The temperature of the machine windings at the time of the test shall be measured and recorded. Insulation resistance measurements shall be corrected to 25°C. Unless otherwise specified in the contract or order (see 6.2.1), corrections shall be made on the basis of insulation resistance doubling for each 15°C decrease in temperature. Unless otherwise specified (see 6.2.1), the insulation resistance test may be conducted at any convenient ambient temperature. The relative humidity at the time ot the test shall be measured and recorded.

4.6.14 Dielectric tests.

4.6.14.1 General. The dielectric test shall be made after all other quality conformance 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. Spare coils shall be tested assembled on the poles. If a pole is not available for test, the test shall be conducted using a simulated pole made from steel.

4.6.14.2 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 Hz. The voltage wave shall approximate a sine wave. The testing voltage shall be applied continuously for a period of 60 seconds.

4.6.14.2.1 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.

4.6.14.2.2 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.

4.6.15 Speed regulation. For submarine motors, the speed of the motor shall be recorded as the load is varied from full-load to no-load in 25-percent steps with the voltage held constant. The percent regulation shall be approximately the same for both directions of

rotation (see 3.4.7.2 for limits). Alternatively, starting with rated-load, gradually decrease the load current to no-load and then increase the load current to the desired overload in approximately 25-percent steps to rated-load.

4.6.16 Effectiveness of enclosure. Test for effectiveness of enclosure shall be conducted as follows:

(a) The frame of the first complete machine with or without armature(s) installed, but with field coils installed and with shaft openings masked off shall be subjected to a stream of water from a hose having 1-inch nozzle diameter under a head of 35 feet from a distance of about 10 feet. The stream of water shall be directed to successfully cover all external surfaces of the machine for a total period of time of not less than 5 minutes.
(b) The test in (a) shall be repeated with the shaft seals installed, a dummy shaft or real shaft to fill up the two shaft openings, and no additional masking around the shaft openings. Any leakage into the machine shall drain to the sumps or bottom access doors.
(c) The criteria of acceptability for (a) is as follows: Leakage shall not exceed 1/2 cup (4 U.S. fluid ounces) in any main portion of the machine enclosure. Main portions are the forward end commutator area, aft end commutator area, and the area between armatures. In no case shall leakage be permitted on any current carrying part.

4.6.17 Heating tests.

4.6.17.1 Conditions. The heating test shall be made at rated-load and rated-speed of the machine. In addition, heating tests shall be made at other values of speed and load corresponding to operating conditions which would result in higher total temperature of any part of the machine than would occur at rated-load and rated-speed. Tests shall be conducted with the cooling water adjusted to specified inlet temperature and rated gallons per minute (gal/min). For the generator tests, cooling water at specified temperature should be utilized for both the generator and the bearing coolers, provided that bearing operating temperature technical manual limits are not exceeded. If less than rated cooling water temperature is supplied to the generator, shutdown temperatures should be adjusted to reflect the conditions that would exist if rated cooling water temperature were supplied. Heating tests shall be conducted on the machine completely assembled with enclosures and heat exchanger.

4.6.17.1.1 The conditions in the testing room shall be such that the room temperature adjacent to the machine will not vary greatly during test. A variation of 10°C or more during a period of 6-hours or a proportional change for runs of shorter duration shall in no case be exceeded. If the room temperature is very irregular during the run or changes rapidly at the end, the test shall be repeated.

4.6.17.1.2 No heat runs shall be undertaken on machines which have recently been brought from a place varying in temperature by 5°C or more from that in which the test is to be made; or where the temperature of the room in which machines under test have stood varied 5°C or more during the preceding 2-hour period.

4.6.17.2 Duration. Normal load heat runs shall be continued until steady final temperatures have been attained in all parts of the machine. To abridge the long heating period in the case of large machines, reasonable overloads of current during the preliminary periods are permissible. It shall be considered that steady final temperatures have been reached when at least four consecutive readings taken at 15-minute intervals show a slope of less than 1°C per hour in the temperature rise of any part of the machine. Temperature rise shall be determined using air leaving cooler as a reference.

4.6.17.3 Measurement of temperatures. Temperature measurements shall be taken during the progress of the heat run at each of the following points:

(a) Water entering cooler.
(b) Water leaving cooler.
(c) Air entering cooler.
(d) Air leaving cooler.
(e) Shunt field.
(f) Compensating field.
(g) Commutating field.
(h) Series field.
(i) Bearings.
(j) Frame.

(k) Room.
(l) Commutator (if feasible).
(m) Armature windings (at hottest end).
(n) Armature coil (at hottest end).
(o) Armature banding wire (if applicable).
(p) Armature riser.
(q) Shunt field (at hottest end).
(r) Compensating field (at hottest end).
(s) Commutating field (at hottest end).
(t) Series field (at hottest end).

4.6.17.3.1 Shutdown temperatures. Shutdown temperatures shall be taken for each of the following:

(a) Commutator (at two or more points).
(b) Armature windings (at hottest end).
(c) Armature core (at hottest end).
(d) Armature banding wire (if applicable).
(e) Armature riser.
(f) Shunt field (at hottest end).
(g) Compensating field (at hottest end).
(h) Commutating field (at hottest end).
(i) Series field (at hottest end).

4.6.17.4 Method of measuring temperatures.

4.6.17.4.1 Only one method (see MIL-E-917) of temperature determination shall be required for any particular part. Commutators, bearings and mechanical parts shall be measured by method I of MIL-E-917. Method of measurement for all other parts is optional with the contractor.

4.6.17.4.2 Where thermometers are furnished for permanent measurements of bearings in the case of ring and disc 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 examination hole at the top of the bearing cap and touching and bearing shell.

4.6.17.4.3 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 line.

4.6.17.4.4 On shutdown, thermocouples or preheated thermometers or embedded detectors shall be placed on the armature commutator, core and windings, and banding wire. Every precaution should be taken to reduce to a minimum the period of time elapsing between the time of removal of the load from the machine and the application of the thermometers or thermocouples. A curve should be plotted 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. The temperature by resistance measurement method may be used in lieu of the thermocouple-thermometer method.

4.6.18 Insulation resistance (hot). Immediately following the heat run, measurements of insulation resistance shall be taken (see 4.6.13).

4.6.19 Reversal test. When specified (see 6.2.1), submarine emergency propulsion motors (EPM) shall be subjected to a reversal test. For this test, the EPM shall be assembled together with all other propulsion shaft components (turbines and reduction gear) and controlled by its EPM controller. Capability of the motor to reverse from full-power and r/min ahead to full-power and r/min astern in specified time interval without malfunction or damage shall be shown.

4.6.20 Ripple voltage. The measurement of ripple voltage shall be accomplished with an instrument which is satisfactory to the command or agency concerned.

4.6.21 Efficiency.

4.6.21.1 General. When the efficiency of a machine is stated without specific reference to the load conditions, rated-load shall always be understood. The efficiency shall correspond to, or be corrected to, conditions of rated-voltage, current, and speed. The

efficiency shall be determined and recorded for 50, 75, and 100 percent of rated-load at rated-voltage and speed. The loss tests specified in 4.6.21.2 through 4.6.21.6 shall be made so as to obtain sufficient data to allow calculations of efficiencies at all operating conditions.

4.6.21.2 I^2R losses. The armature and field I^2R losses shall be separately calculated as the product of the square of the current at the load for which the loss is to be computed and the measured resistance of the circuit corrected to 90°C for class B, 120°C for class F, and 125°C for class H insulation, of MIL-E-917.

4.6.21.3 Friction and windage losses. The machine shall be driven at rated-speed by an independent motor, the output of which shall be determined when driving the machine with its brushes in contact but not excited. The motor output, when driving the machine under test, represents the friction and windage loss.

4.6.21.4 Core losses. Machine 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 machine 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.

4.6.21.5 Brush contact loss. Two volts total drop shall be considered as the standard drop corresponding to the brush contact loss for electrographic and graphite brushes with pigtails attached. Metal graphite brushes shall be considered as special and hence require an actual determination of the drop in each case.

4.6.21.6 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.

4.6.22 Weight. The weights of the d.c. machine and the repair parts shall be taken and recorded. A weight report (see 6.2.2), shall be submitted to the contracting agency containing actual weighed weights.

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

(a) The required type of shock test. Type A.
(b) The weight designation of the shock test. As required by the equipment to be tested if the shaft in application will be required to support a heavy weight such as an exciter armature, the shock test shall be conducted with the shaft so loaded.
(c) Principal functions of the equipment or apparatus. Electric propulsion.
(d) A definition of "failure to perform principal functions":
    (1) Breakage of any parts, including mounting bolts.
    (2) Appreciable distortion or dislocation of any parts such as mounting feet, poles, coils, brushes, and bearings.
    (3) A value of insulation resistance lower, when corrected to 25°C, than that permitted by this specification.
    (4) An unbalance of more than two times the value of unbalance specified herein.
    (5) A bearing temperature rise in excess of that permitted in table II.
    (6) Objectionable noise. Any noticeable increase or decrease in noise of the machine 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 examination specified in item (8).
    (7) Low dielectric strength. The machine shall be operated to obtain approximately rated temperature rise of iron and windings, then disconnected from its load or from its source of power and a dielectric strength test made to check the condition of the insulation. This dielectric strength test shall be made in accordance with 4.6.14, except that it shall be made with an applied voltage equal to 65 percent of that specified in 4.6.14. Under these conditions, insulation failures shall be cause for rejection.
    (8) Failure to pass examination. The machine shall be disassembled after examination of performance specified in item (1) to (7), inclusive, and examined 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 of designation of acceptable method of mounting the equipment on the shock testing machine. The mounting adapters shown on the following figures of MIL-S-901 shall be used:
  (1) Figure 4c for machine to be tested on the shock-testing machine for light-weight equipment.
  (2) Figure 7A for machine to be tested on the shock-testing machine for medium-weight equipment.
  (3) For heavy-weight equipment, the method of mounting shall be as specified in MIL-S-901.

(f) The place at which the shock test will be conducted. Unless otherwise specified (see 6.2.1), shock tests will be conducted at the contractor's plant. Where a contractor is unable to conduct these tests at his own plant, he may arrange to have them conducted, at his own expense, at a commercial or Government laboratory suitably equipped to conduct tests. Where shock tests are conducted at a Government laboratory, a copy of the applicable master drawing shall accompany the machine.

(g) Disposal of shock tested machines.
  (1) Machines which have been subjected to the high-impact shock test and have failed to meet the requirements shall not be acceptable, either in whole or any of their parts. They shall not apply on a contract or order.
  (2) Machines which have been subjected to the high-impact shock test and have successfully passed this test shall be considered acceptable and shall apply on contract or orders provided the following conditions are met:
    a. Mounting flanges connecting directly to the prime mover or propeller shafting shall be replaced in the event of minor deformation. Minor deformations affecting alinements, including alinements with the prime mover, shall be corrected. Minor deformations shall be defined as those which do no cause unqualified rejection of the design under the high-impact shock test but which are in excess of the dimension tolerances specified on the applicable drawings.
    b. Prior to acceptance, all ball bearings from machines which have successfully passed the high-impact shock test shall be removed from the machines and subjected to the following procedure: Single-shielded and single-sealed bearings shall be cleaned thoroughly with a solvent such as kerosene or Stoddard solvent and immediately flushed with lubricating oil to inhibit corrosion. The bearing shall then be examined for obvious defects by visual examination and by manual rotation. Bearings shall be repacked with the correct amount of the proper lubricant and reinstalled in the machine.
    c. Double-shielded and double-sealed bearings shall not be flushed with cleaning solvent or lubricating oil but shall be examined as specified above and shall be reinstalled in the machine.

4.6.24 Inclined operation test. Inclination tests shall be made as follows unless specifically waived (see 6.2.1):

(a) For surface ship applications:
  (1) Shaft inclined 15 degrees, front end low.
  (2) Shaft inclined 15 degrees, rear end low.
  (3) Shaft horizontal, base tilted 30 degrees clockwise.
  (4) Shaft horizontal, base tilted 30 degrees counterclockwise.

(b) For submarine application, tests shall be made in two positions:
  (1) Shaft inclined 30 degrees, one end low.
  (2) Shaft horizontal, base tilted 15 degrees to the right or left.

4.6.24.1 The direction of inclination or tilt for submarine machines shall be determined by the DCASMAR as the most likely to cause oil leakage.

4.6.24.2 In each of the positions specified in 4.6.24, the machine shall be run for a period of not less than 30 minutes. During progress of the test it shall be ascertained that there is no sudden increase in bearing temperatures or evidence of oil leakage either

external or internal. The test shall be run at no-load and maximum speed. There shall be no noticable increase in noise during this test. A special stub shaft and thrust bearing shall be provided by the contractor for this test.

4.6.25 Parallel operation. When specified (see 6.2.1), submarine propulsion generators, assembled with their prime movers shall be tested for parallel operation sufficiently to demonstrate that any one of a set for installation on one submarine will operate satisfactorily in parallel with any other unit of the set throughout a range of 25-percent to 100-percent of the combined rated-load. When the load is varied by means of either generator rheostats or engine governors clutched together through this load range from 25 percent to 100 percent or from 100 percent to 25 percent, the maximum difference in the current supplied by any one generator from that supplied by any other generator shall not exceed 15 percent of the rated current of one generator.

4.6.26 Magnetic tests. Tests shall be run as specified (see 6.2.1) to determine compliance with the special magnetic requirements of 3.4.31.

4.6.26.1 Acceptance criteria. When magnetic tests are required, acceptance criteria shall be as specified (see 6.2.1).

4.6.27 Operation with one shunt field coil disconnected. A 5-minute observation run shall be conducted on submarine-generator at rated-speed, current, and voltage with one shunt field coil disconnected under the following conditions:

(a) Maximum flux (maximum speed to maximum voltage).
(b) Maximum speed (at maximum voltage).

Commutation shall be closely observed for evidence of sparking.

4.6.27.1 Acceptance criteria - motor and generator. After completion of the test specified in 4.6.27, the commutator and brushes shall be examined for evidence of permanent damage. Permanent damage shall include:

(a) Any obvious damage to the brushes, brush-holders, or commutator.
(b) Any distorted or high commutator bars.
(c) Any evidence of severe commutator threading or grooving.
(d) Any significant reduction in the surface area of the brush seat.

Evidence of slight burning or discoloration on the trailing edge (side or seat), and pitting on the seat of the brush shall not be cause for rejection.

4.6.28 Submarine propulsion motor-rheostat data tests (see 6.2.2). When specified (see 6.2.1), data shall be obtained by test to enable accurate calculation of the motor characteristic curves as follows:

(a) A plot of speed versus field current for motor operation from the battery at average discharge voltages covering the complete range.
(b) A plot of speed versus field current for motor operation from fixed voltages as specified.

4.6.29 Cooler water side flow tests. Each air cooler shall be flow tested on the water side to develop a calibration curve of flow versus pressure drop through the coolers. Flow measurements shall be made using the inlet and outlet pressure taps supplied on each water side connection. The contractor shall supply a curve showing pressure drop versus flow for each cooler supplied for flow rates up to the maximum allowable flows permitted by specifications.

4.6.30 Operational tests. Machine shall be subjected to the tests specified in 4.6.30.1 through 4.6.30.5. Testing may be performed using the pump-back or back-to-back setup.

4.6.30.1 Preliminary run. The motor or generator shall be operated at full-load and rated-speed to bring the components up to operating temperature. During this period the general operation of the unit shall be observed and any necessary adjustment shall be made.

4.6.30.2 One-hour continuous run at full-load. Immediately following the preliminary run, the motor or generator shall be operated at full-load and rated-speed for 1-hour. At 1/4-hour intervals during this run, the following data shall be recorded:

(a) Time.
(b) Ambient temperature.

(c) Field voltage and current.
(d) Armature voltage and current.
(e) Frame termperature.
(f) Bearing coil, cooling water and air temperatures.
(g) Cooling water flows.
(h) Field RTE's.

4.6.30.3 Fifty-hour continuous test. Motor and generator shall be operated continuously for 50-running hours in the ahead direction only, at various loads and r/min including at least 10-hours continuous at rated-conditions. Data shall be recorded as specified in 4.6.30.2. The contractor may perform any of the applicable tests during this test so long as continuous operation is not interrupted (by not more than one 5-minute period).

4.6.30.4 Astern test. For submarine propulsion motors, an additional astern test shall be conducted immediately following the 50-hour continuous test, for 10-continuous hours at rated conditions. The generators need not be operated in the astern direction.

4.6.30.5 Acceptance criteria. More than one shutdown, a shutdown or more than 5 minutes duration, failure to meet temperature limits, or failure of any part or assembly during the 60-hour test period shall constitute failure of the test.

4.6.31 Breakaway torque test. When specified (see 6.2.1), submarine emergency propulsion motors shall be subjected to a starting torque test. Testing procedure shall be as specified (see 6.2.1). The capability of the motor to provide specified starting torque in both directions of rotation without malfunction or damage shall be shown. Field and starting currents shall be recorded and included in the test reports.

4.7 Final examination. Equipment shall be given a thorough general examination in accordance with the applicable specification prior to delivery to determine that the equipment is satisfactory in all respects. Special attention should be given to the following items:

(a) Cleanliness (external and internal as visible through examination ports).
(b) Bolting made up properly, including locking devices secured.
(c) Identification plates installed and according to plan.
(d) Critical external dimensions checked for plan conformance.
(e) Piping connections properly located and of the correct size and standard.
(f) In judging the final condition of treated windings, the method specified in MIL-E-917 of trying to separate varnish layers with a fingernail or knife from a flat surface, with 1/2 inch considered excessive is not acceptable.
(g) In addition to the requirements of MIL-E-917, finish cuts on rotors may be done after varnishing. All machining after varnish treatment should be limited to finishing operations and removal of metal should not exceed 0.016 inch. Insulated windings should be protected as much as is practicable.

4.8 Inspection of preparation for delivery. Preservation-packaging, packing, and marking shall be inspected for compliance with section 5 of this document.

5. PREPARATION FOR DELIVERY

(The preparation for delivery requirements specified herein apply only for direct Government acquisitions. For the extent of applicability of the preparation for delivery requirements of referenced documents listed in section 2, see 6.4.)

5.1 Preservation-packaging, packing, and marking.

5.1.1 Equipment. Each equipment (generator, motor, or propulsion auxiliary) with accessories shall be preserved-packaged level A or C, packed level A, B, or C as specified (see 6.2.1), and marked in accordance with MIL-E-16298.

5.1.2 Repair parts and tools. Repair parts shall be preserved-packaged, packed, and marked in accordance with MIL-E-16298 or MIL-E-17555, as applicable, and modified in accordance with MIL-STD-758 for submarine applications in accordance with the level specified for the intended use and destination as follows:

Destination	Level	
	Preservation-packaging	Packing
Onboard	A	C
Stock	A	B
Immediate use	C	C

Unless otherwise specified (see 6.2.1), repair parts shall be packaged one part per unit package, except that all parts comprising a single set or assembly shall be individually protected and packaged together as a single unit.

5.1.2.1 Repairables. Repair parts subject for return to a repair facility for restoration and reissue shall be packaged and packed in materials and containers capable of reuse. Unless otherwise specified (see 6.2.1), packaging shall be in accordance with MS 90363. Repairables requiring reusable containers, such containers shall be in accordance with the guidelines of MIL-E-17555. Containers shall be marked: "REUSABLE DO NOT DESTROY". Packaging and transportation support data shall be furnished for items falling in this category (see 6.2.2).

5.1.2.2 Semiconductors or solid-state devices. Semiconductors such as diodes, transistors, intergrated circuits as well as circuit boards or chassis in which they are incorporated, shall be individually packaged in a barrier bag conforming to class E, style 1, type I or II, or class F, style 1, type I of MIL-B-117. MIL-B-117 bag material shall employ aluminum foil as a laminate of the bag barrier material. Bag closure shall be effected by heat sealing. Leads and terminals shall be protected from damage by means of the container (carrier) design, die cut inserts, or by the use of non-corrosive cushioning material. Leads and other projecting parts may be used for positioning but shall not be subjected to loads or other stresses such as bending or twisting that can damage the entry seals. For level C preservation-packing, semiconductor or solid-state devices subject to electromagnetic degradation shall be protected with a wrap of aluminum foil or a barrier bag employing aluminum foil as a laminate of the bag material. Leads and terminals shall be protected as specified herein.

5.2 Cushioning, dunnage, and wrapping materials.

5.2.1 Level A preservation-packaging and levels A and B packing. Use of all types of loose-fill materials for packaging and packing applications such as cushioning, filler or dunnage is prohibited for materials destined for shipboard installation/stowage.

5.2.2 Level C preservation-packaging and packing. When loose fill type materials are used for packaging and packing applications such as cushioning, filler and dunnage, all containers (unit, intermediate and shipping) shall be marked or labelled with the following information.

"CAUTION

Contents cushioned etc., with loose-fill material. Not to be taken aboard ship. Remove and discard loose-fill material before shipboard stowage. If required, recushion with cellulosic material, bound fiber, fiberboard, or transparent flexible cellular material."

5.2.3 Cushioning, filler, dunnage, and wrapping materials selected, whenever available, shall exhibit improved performance for resistance to fire.

5.3 Technical manuals. Technical manuals, which accompany shipments that are packed level A or B, shall be packaged in a transparent waterproof plastic bag, minimum 4 mil thick. Closure shall be by heat sealing. Technical manuals shall not be placed within any flexible sealed barrier enclosing components. The copy(s) of the manual shall be placed in the shipping container housing the main unit. Packing lists shall indicate which container contains the technical manual(s) and shall also state the approximate location therein. For ease of removeability the location of the manual shall be such that it is readily accessible when the container is opened. Technical manuals, when shipped in bulk quantities, shall not be individually wrapped, but shall be packed in accordance with the requirements of the applicable technical manual specification or packed in containers conforming to the requirements for level A, B, or C, as specified (see 6.2.1).

5.4 Special requirements. Equipment, tested and certified (see 3.5.3 and 4.6.6), shall have their shipping containers marked in accordance with MIL-STD-740 in addition to the marking requirements of 5.1.1.

5.5 Unpacking. Unpacking instructions shall be provided for complex equipment or systems and floating bag type packs, the instructions shall contain the following information:

"To unpack remove the top and sides, leaving the unit resting on the bottom of the packing case. Remove the packing case and slip the unit off the base. In unpacking the item, the following precautions shall be observed to prevent possible damage:

(a) Observe the arrows marked on the shipping container. These point to the cover which can be removed most readily.
(b) Remove nails with a nail-puller only.
(c) Remove screws with a screwdriver only.
(d) Never pound or hammer the shipping container.
(e) Keep all levers and crowbars away from the interior of the container."

5.5.1 These instructions shall be placed in a sealed waterproof envelope prominently marked "UNPACKING INSTRUCTIONS" and firmly affixed to the outside of the shipping container in a protected location, preferably adjacent to the identification marking. If the instructions cover a set of equipment packed in multiple containers, the instructions shall be affixed to the number one container of the set or system.

5.6 Data (see 6.2.2). Data shall be prepared for delivery in such a manner as to insure the required information is protected against deterioration, physical damage or loss during shipment from the contractor to the receiving activity. Packages or shipping containers shall as a minimum conform to the level C requirements of 5.1 herein.

6. NOTES

6.1 Intended use. Equipment described by this specification will be a permanent installation on military ships, and is used to transmit propulsive power to the propellers. Failure may immobilize and thereby endanger the ship.

6.2 Ordering data.

6.2.1 Acquisition requirements. Acquisition requirements should specify the following:

(a) Title, number and date of this specification.
(b) Minimum material requirements (see 3.2).
(c) Class of insulation (see 3.2.3).
(d) Engineering services (see 3.3).
(e) Specific limits required (see 3.4.1.1).
(f) When overload is required (see 3.4.5.1).
(g) Rating required (see 3.4.6).
(h) Special performance requirements (see 3.4.6.1).
(i) Efficiencies and losses (see 3.4.6.2).
(j) Structureborne vibration range (see 3.4.8.2).
(k) Limits for deviation from true roundness (see 3.4.8.2.1).
(l) Shockproofness (see 3.4.13).
(m) Special shock requirements for submarines (see 3.4.13).
(n) Electromagnetic interference (see 3.4.15).
(o) Parallel operation (see 3.4.19 and 4.6.25).
(p) When feet are not bolted to prime mover bedplate (see 3.4.22.1).
(q) When jacking gear is not required (see 3.4.30.3).
(r) When stub shaft is not required (see 3.4.30.4).
(s) Special magnetic requirements (see 3.4.31.3).
(t) When terminal lugs for connecting generator and motor leads to power cables should be supplied (see 3.4.34.3).
(u) When heaters are not required (see 3.4.35.1).
(v) If sleeve bearing are not to be provided for propulsion generators and motors (see 3.4.38).
(w) Number of bearings required (see 3.4.38.1).
(x) If bearing design is other than specified (see 3.4.38.1.1).
(y) Number of bearings for motors if other than two (see 3.4.38.2).
(z) When motor bearings should be designed to carry propeller thrust (see 3.4.38.2(d)).
(aa) Bearing lubrication (see 3.4.39).
(bb) When sump should not be provided (see 3.4.40.2).
(cc) Direction of flow if other than specified (see 3.4.43).
(dd) Weights not to be exceeded (see 3.4.48).
(ee) Type of exciter drive or submarine battery characteristics (see 3.5.2.1).

(ff) Motor-generator type and voltage of exciter driving motor (see 3.5.3.1).
(gg) When low noise level is specified (see 3.5.4).
(hh) Blower motor characteristics and shock test (see 3.5.4.2).
(ii) Repair parts and special tools to be furnished (see 3.6).
(jj) When repair parts boxes are required (see 3.6.1).
(kk) When repair field coils should be furnished for submarine application (see 3.6.1.1(e)).
(ll) When repair parts and special tools are not to be furnished for stowage (see 3.6.1.3).
(mm) If additional drawing data is required (see 3.8.1.2.1).
(nn) Quality assurance requirements (see 4.1.1).
(oo) Shipboard dimensional envelope for maintainability (see 4.6.2.2).
(pp) If lubrication tests are conducted other than as specified (see 4.6.11).
(qq) If temperature corrections are to be made other than as specified (see 4.6.13).
(rr) If insulation resistance test is to be conducted at other than a convenient ambient temperature (see 4.6.13).
(ss) When reversal test is required (see 4.6.19).
(tt) Where shock test is to be conducted (see 4.6.23(f)).
(uu) If inclined operation test is waived (see 4.6.24).
(vv) If parallel operation test is required (see 4.6.25).
(ww) Magnetic test and acceptance criteria (see 4.6.26 and 4.6.26.1).
(xx) Rheostat data tests (submarine) (see 4.6.28).
(yy) Breakaway torque (see 4.6.31).
(zz) Testing procedure (see 4.6.31).
(aaa) Applicable levels of preservation, packaging, packing and marking required (see 5.1.1, 5.1.2, and 5.3).
(bbb) Repairables packaging other than specified (see 5.1.2.1).

6.2.2 Data requirements. When this specification is used in a contract which invokes the provision of the "Requirements for Data" of the Defense Acquisition Regulation (DAR), the data identified below, which are required to be developed by the contractor, as specified on an approved Data Item Description (DD Form 1664), and which are required to be delivered to the Government, should be selected and specified on the approved Contract Data Requirement List (DD Form 1423) and incorporated in the contract. When the provisions of the "Requirements for Data" of the DAR are not invoked in a contract, the data required to be developed by the contractor and required to be delivered to the Government should be selected from the list below and specified in the contract.

Paragraph	Data requirements	Applicable DID	Option
3.4.1.3	Plan, reliability program	DI-R-2113	------
3.4.1.3.1	Report, reliability prediction	DI-R-2117	------
3.4.1.3.2	Report, failure mode effects and analysis (FMEA)	DI-R-2115	------
3.4.1.4.1	Plan, maintainability demonstration	UDI-R-23564	------
3.4.1.6	Reliability and maintainability allocations, assessments, and analysis report	DI-R-3535	------
3.4.1.7.2	Plan, system safety program (SSPP)	UDI-H-23390	------
3.4.8.1.3	Reports, test	DI-T-2072	------
3.4.13	Report, shock dynamic design analysis	UDI-F-23122	------
3.6	Provisioning parts list	DI-V-2078	------
3.8.1	Drawings, engineering and associated lists	DI-E-7031	Level 3 (production) Design activity designation - contractor Design activity drawing numbers - contractor
3.8.2	Manual, technical, preliminary	DI-M-2043	Type I of MIL-M-15071
	Manual, technical, standard	DI-M-2044	Type I of MIL-M-15071
4.6.3	Plan, reliability test and demonstration	UDI-R-23562	------

Paragraph	Data requirements	Applicable DID	Option
4.6.3	Reports, reliability test test and demonstration	UDI-R-23563	------
4.6.6	Report, noise measurement	UDI-R-22578	------
4.6.7	Report, vibration testing	UDI-T-23762	------
4.6.8.2, 4.6.10, 4.6.11, 4.6.22, and 4.6.28	Reports, test	DI-T-2072	------
5.1.2.1	Packaging and transportation support data	UDI-P-23508	------

(Copies of data item descriptions required by the contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.)

6.2.2.1 The data requirements of 6.2.2 and any task in section 3, 4, or 5 of the specification required to be performed to meet a data requirement may be waived by the contracting/acquisition activity upon certification by the offeror that identical data were submitted by offeror and accepted by the Government under a previous contract for identical item acquired to this specification. This does not apply to specific data which may be required for each contract regardless of whether an identical item has been supplied previously (for example, test reports).

6.3 First article inspection. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection as to those bidders offering a product which has been previously acquired or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract.

6.4 Subcontracted material and parts. The preparation for delivery requirements of referenced documents listed in section 2 do not apply when material and parts are acquired by the contractor for incorporation into the equipment and lose their separate identity when the equipment is shipped.

6.5 Changes from previous issue. The symbol "¶" is not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Preparing activity:
Navy - SH
(Project 6115-N362)

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

OMB Approval
No. 22-R255

INSTRUCTIONS: The purpose of this form is to solicit beneficial comments which will help achieve procurement of suitable products at reasonable cost and minimum delay, or will otherwise enhance use of the document. DoD contractors, government activities, or manufacturers/ vendors who are prospective suppliers of the product are invited to submit comments to the government. Fold on lines on reverse side, staple in corner, and send to preparing activity. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements. Attach any pertinent data which may be of use in improving this document. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity.

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   B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES

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