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MIL-M-19167(SHIPS)
29 November 1955

MILITARY SPECIFICATION

MOTOR-GENERATORS, AC TO DC, SHIPBOARD SERVICE

1. SCOPE

1.1 This specification covers alternating current (a.c.) to direct current (d.c.) motor-generator power supplies for Naval shipboard use on surface vessels.

2. APPLICABLE DOCUMENTS

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

SPECIFICATIONS

MILITARY

MIL-R-22 - Resistors, Variable (Wirebound, Power Type).
MIL-C-25 - Capacitors, Fixed, Paper-Dielectric, Direct-Current (Hermetically Sealed in Metallic Cases).
JAN-W-583 - Wire, Magnet.
MIL-S-901 - Shockproof Equipment, Class HI (High Impact) Shipboard Application, Test for.
MIL-E-917 - Electric Power Equipment, Basic Requirements for (Naval Shipboard Use).
MIL-D-963 - Drawings, Production (for Electrical and Mechanical Equipment for Naval Shipboard Use).
MIL-P-997 - Plastic-Material, Laminated, Thermosetting, Electrical-Insulating: Sheets, Glass Cloth, Silicone Resin.
MIL-V-1137 - Varnish, Electrical-Insulating (for Electro-Motive Equipment).
MIL-G-1140 - Glass Fiber: Yarn, Cordage, Sleeving, Cloth and Tape.
MIL-R-2033 - Relays for Naval Shipboard Electrical Service.
MIL-E-2036 - Enclosures for Electric and Electronic Equipment (Naval Shipboard Use).

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MILITARY (cont'd.)

MIL-M-2130 - Motor-Generators, General Purpose (Naval Shipboard Use).

MIL-C-2212 - Controllers, Motor Starter, and Master Switches-Alternating-Current, Naval Shipboard Use.

MIL-G-3111 - Generators, Electric, Direct-Current (Naval Shipboard Use).

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

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

MIL-T-15071 - Technical Manuals for Mechanical and Electrical Equipment.

MIL-R-15109 - Resistors and Rheostats, Shockproof (Naval Shipboard Use).

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

MIL-S-15291 - Switches, Rotary, Snap Action, Bureau Design.

MIL-P-16018 - Packaging of Switchboards, Controllers and Motor Starters (Over 40 Pounds).

MIL-M-16034 - Meters, Electrical-Indicating (Switchboard and Portable Types).

MIL-S-16036 - Switchboards and Switchgear Groups, Power, Electrical (Naval Shipboard Use).

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

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

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

MIL-M-17060 - Motors; Alternating-Current, Integral HP (Shipboard Use).

MIL-I-17205 - Insulation Cloth and Tape; Electrical (Glass-Fiber, Varnished).

MIL-C-17361 - Circuit Breaker, Air, Electric, Insulated Enclosure (Shipboard Use).

MIL-C-17588 - Circuit Breaker, Air, Electric, Insulated Enclosure, Low Voltage (125V) (Shipboard Use).

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

MIL-R-18281 - Rectifiers, Metallic: Selenium, Copper Oxide, and Magnesium-Copper Sulfide Types, Naval Shipboard Use.

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NAVY DEPARTMENT
General Specifications for Inspection of Material.

DRAWINGS

BUREAU OF SHIPS
S0103-73729 - Standard Drawing Format for Production Drawings Prepared by Contractor or Manufacturer for Approval by Government Agency.

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

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

AMERICAN STANDARDS
Z24.3 - Sound Level Meters for Measurement Noise and Other Sounds
Z24.7 - Apparatus Noise Measurement.

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

3. REQUIREMENTS

3.1 General. - The equipment shall consist of a motor-generator and control equipment necessary to make a complete power supply. Detailed requirements shall be as follows:

3.1.1 Enclosures. - The motor-generator and control equipment enclosures shall be dripproof protected in accordance with Specification MIL-E-2036.

3.1.2 Shock requirement. - The motor-generators and all associated control equipment shall be class HI shock resistant in accordance with Specification MIL-S-901 and all applicable equipment specifications.

3.1.3 Radio interference. - The motor-generators with associated control equipment shall be designed to produce no more than 5000 microvolts indicated quasi-peak conducted radio interference within the frequency range 150 kilocycles (kc.) to 20 megacycles (mc.) without the use of filters or condensers.

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3.1.4 Ambient temperature. - The ambient temperature of the motor-generator and associated control equipment shall be 50° Centigrade (C.).

3.1.5 Parallel operation. - When parallel operation of two motor-generators is specified (see 6.1) load sharing requirements shall be as follows. At any load between 20 and 125 percent of the combined kw. rating of the paralleled generators, the load current of either generator expressed as a percentage of its full load current shall not differ from the total system load current expressed as a percentage of the total rated full load currents of the connected generators by more than 7.5 percent.

3.1.6 Voltage regulation. - Voltage regulation of the generator output shall be in accordance with table I, as specified (see 6.1), with the generator operating at any load between no load and 125 percent of rated full load and with the motor operating under the conditions indicated.

Table I - Voltage regulation.

Regulation		Conditions				
		Motor input		Regulator or inherently	Parallel operation (see 3.1.5)	Test
		Voltage	Frequency			
A	2 percent bandwidth zero loop	± 10 percent	± 5 percent	Regulator	Cross current compensation	4.3.5.2
B	10 percent bandwidth zero droop	± 10 percent	± 5 percent	Inherent	Equalizers	4.5.1
C	+8 percent (decreasing load) -12 percent (increasing load)	Rated	Rated	Inherent	Without equalizers	4.5.2

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3.2 Motor-generators.- Each motor-generator shall be in accordance with type III of Specification MIL-M-2130, except as otherwise specified herein.

3.2.1 Mounting.- Each motor-generator shall be of the two bearing type with stationary component parts of each, the motor and the generator, rigidly coupled together in such a fashion that the combined unit will be capable of maintaining proper alignment without dependence upon the supporting structure of the ship, nor shall the unit require any additional structural bedplate. The rotating elements of both the motor and generator shall be mounted on a single one piece shaft. The motor-generator shall be as light and compact as possible consistent with specified performance and design.

3.2.2 Bearing.- Ball bearings shall be either of the prelubricated double seal, single row ball, double row width type or single shielded type. Ball bearings shall be replaced in shock tested motor-generators.

3.2.3 Degree of balance.- The motor-generators shall have precision balance.

3.2.4 Audio noise.- Motor-generators shall be designed to produce a minimum airborne noise. The maximum airborne noise level shall not exceed the limits specified in table II when measured using the flat network and weighing network for 70 decibels (db) in accordance with American Standard Z24.3. Measurements shall be made in accordance with procedure specified in American Standard Z24.7, except for the following:

(a) No observers or reflecting surfaces, other than the floor when necessary, should be less than 3 feet from either the microphone or the equipment being measured.

(b) In cases where the measurements cover a range of 10 db or more, or in the case of apparatus producing a highly directional noise, the individual ratings at each microphone location shall be reported and summarized in terms of power average together with the maximum and minimum values.

Table II - Audio noise limits.

Size of mg. (kw.)	Maximum noise level
5 kw. or less	75 db.
Above 5 kw. through 15 kw.	80 db.
Above 15 kw. through 60 kw.	85 db.
Above 60 kw. through 100 kw.	90 db.

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3.2.5 Dimensions and weight.- The physical dimensions (length, width and height) and the weight of the motor-generator may be less than but shall not exceed the limits specified (see 6.1). The mounting dimensions shall be as specified (see 6.1).

3.2.6 Motor.- The a.c. motor shall be in accordance with Specification MIL-M-17060, except as otherwise specified in Specification MIL-M-2130, and the following:

(a) Voltage - 440 volts.
(b) Duty - Continuous.
(c) R.p.m. - As determined by contractor.
(d) Design - B or F.
(e) Class of insulation - A, B, or H. Motor and generator insulation shall be the same class.
(f) Frame diameter - Not to exceed that specified (see 6.1).

3.2.7 Generator.- The d.c. generator shall be in accordance with Specification MIL-G-3111, except as otherwise specified in Specification MIL-M-2130, and the following:

(a) Voltage - 14, 28, 30, 120, 240, 120/240 as specified (see 6.1).
(b) Kilowatts - 2.5, 5, 10, 15, 30, 60 or 100 as specified (see 6.1).
(c) R.p.m. - As determined by contractor.
(d) Distribution system - 2 wire or 3 wire as specified (see 6.1).
(e) Frame diameter - Not to exceed that specified (see 6.1).
(f) Class of insulation - A, B, or H. Motor and generator insulation shall be the same class.

3.3 Control equipment.- Where voltage regulators are furnished (see 3.1.5) as a part of the control equipment, all the control equipment shall be contained within a control panel. Where voltage regulations are not furnished as a part of the control equipment, the control equipment shall be contained within a control panel or furnished as separate components, as specified (see 6.1).

3.3.1 Control panels.- Control panels shall be suitable for bulkhead or deck mounting, as specified (see 6.1), and shall include the following equipment and any other equipment necessary for satisfactory control of the motor generator:

(a) Motor controller.
(b) Voltage regulator (when furnished, see 3.1.6).
(c) Generator circuit breaker.
(d) Generator field rheostat.

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(e) Voltage regulator auto-manual transfer switch (when voltage regulator is furnished, see 3.1.6).
(f) Regulated voltage adjusting rheostat (when voltage regulator is furnished, see 3.1.6).
(g) Voltmeter for d.c. generator output.
(h) Ammeter for d.c. generator output.
(i) Start-stop push buttons.

3.3.1.1 General.- The control panel shall conform to Specification MIL-E-2036 and the following paragraphs of Specification MIL-S-16036: Switchboard structure and its compartmentation; Insulating panels, bases, and bus supports; Hinged and removable enclosing panels; Mounting of equipment; Insulation distances; Wiring of control and instrument circuits; Fuses and terminal blocks; Instruments, relays and instrument transformers; and Identification plates and marking. A copy of the complete schematic diagram, wiring diagram, and operating instructions shall be laminated in plastic and stowed in the control panel in accordance with paragraph covering protection of diagrams and instruction sheets specified in Specification MIL-E-2036.

3.3.1.2 Dimensions and weight.- The physical dimensions (depth, width and height) and the weight of the control panel complete as specified in 3.3.1 may be less than, but shall not exceed the limits specified (see 6.1).

3.3.1.3 Motor controller.- The a.c. motor controller shall be in accordance with Specification MIL-C-2212, with characteristics as specified in Specification MIL-M-2130, and the following:

(a) Operation - Magnetic.
(b) Type - Across the line.
(c) Duty - Continuous.
(d) Protection features - Emergency run feature not required; overload protection may be hand or automatic reset.
(e) Master switch - Local push button.

3.3.1.4 Voltage regulator (when furnished, see 3.1.6).- The voltage regulator shall be a static type (magnetic amplifier) and shall consist of a combined regulator and static excitation system.

3.3.1.4.1 Performance.- Voltage regulator performance shall be as specified in 3.1.6.

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3.3.1.4.2 Regulated voltage adjustment. - Provision shall be made to adjust the regulated voltage from 3.0 percent below to 7.0 percent above rated voltage in steps of not more than 0.5 percent of rated voltage at any load from no load to full load on the generator with generator fields cold and also with generator fields hot.

3.3.1.4.3 Manual voltage control. - Provision shall be made to obtain manual control of voltage. A rotary type switch shall be furnished to permit selection of automatic or manual operation.

3.3.1.4.4 Temperature limits. - The voltage regulator shall not exceed the temperature rises specified in table III, based on rated continuous load and an ambient temperature of 50°C. The temperature rises of other components shall be as specified in the applicable equipment specifications.

Table III - Maximum temperature rises.

Item	Name of part	Temperature rises in °C.
1	Bolted connections and terminal studs:	
1a	Not plated	50
1b	Silver plated	65
2	Coils:	
	Single layer series coils:	
2a	Class A insulation	45
2b	Class B insulation (measured by thermocouple on top of insulation)	65
	Shunt coils:	
2c	Class A insulation	50
2d	Class B insulation	70
2e	Class H insulation (measured by resistance) [1]	130
2f	Class A insulation	40
2g	Class B insulation	60
2h	Class H insulation (measured by thermometer)	110

[1]Preferable method.

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3.3.1.4.5 Insulation resistance.- The insulation resistance of the voltage regulator at normal operation temperatures shall be not less than 0.5 megohm (see 4.3.5.7).

3.3.1.4.6 Dielectric strength.- The voltage regulator shall withstand the dielectric test voltage specified in 4.3.5.8.

3.3.1.4.7 Rheostats.- Rheostats shall be in accordance with Specification MIL-R-15109 and shall be suitable for back of panel mounting, front of panel operation. A variable resistor conforming to Specification MIL-R-22 may be used in lieu of a rheostat for the regulated voltage adjustment control.

3.3.1.4.8 Rectifiers.- Rectifiers shall be in accordance with Specification MIL-R-18281, and of the selenium or copper oxide dry disk type. Each rectifier stack shall be given a moistureproof treatment to give protection from damp, salt atmospheric conditions.

3.3.1.4.9 Capacitors.- Capacitors for d.c. circuits shall be in accordance with Specification MIL-C-25. Capacitors for a.c. circuits shall be in accordance with either of the following:

(a) Specification MIL-C-25, except that the d.c. rating shall be reduced for a.c. as approved by the bureau or agency concerned.
(b) As approved by the bureau or agency concerned and in accordance with the requirements of section 3 of Specification MIL-C-25, except that the following paragraphs do not apply: Qualification, Dissipation factor, Life, Marking and Specification sheet for individual capacitor types.

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3.3.1.4.10 Reactors and transformer other than instrument transformers. - Materials and methods of manufacture shall conform to Specification MIL-E-917 and table IV.

Table IV - Minimum material requirements.

Item	Limitation	Material	Remarks
Electrical insulation as follows:	All sizes	Class A, B, or H	
Conductor	All sizes	As required	Spec. JAN-W-583 or MIL-W-16072
Ground	All sizes	Mica-glass	Spec. MIL-I-3505
Layer	All sizes	Varnished glass	Spec. MIL-I-17205
Tape	All sizes	Woven glass	Spec. MIL-G-1140
Tying cord	All sizes	Glass	Spec. MIL-G-1140
Cable support Terminal board Coil spacers Cable spacers	Where used	Glass melamine or glass silicone	Spec. MIL-P-15037, or MIL-P-17721 (class B) MIL-P- 7 (class H)
Varnish for treating and impregnating	All sizes	Organic-clear, baking or silicone clear baking	Spec. MIL-V-1137 Silicone varnish as approved by the bureau or agency concerned

3.3.1.4.11 Switches. - Control switches shall be in accordance with Specification MIL-S-15201. The switching of the voltage regulator from automatic to manual shall be such that the following conditions are met when in manual operation:

(a) Disconnect (for short out as necessary) all power inputs to the regulator.

(b) Isolate the regulator to prevent grounding of the motor or generator bus, except that potential transformer primary windings need only be disconnected.

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3.3.1.4.12 Shock. - The voltage regulator shall withstand the class HI shock tests specified in Specification MIL-E-901 when mounted in the control panel.

3.3.1.4.13 Compensation for parallel operation. - When parallel operation is specified (see 3.1.5) compensation for parallel operation shall be cross current compensation.

3.3.1.5 Circuit breaker. - The circuit breaker shall be either a type AQB and conform to Specification MIL-C-17361, or type ALB and conform to Specification MIL-C-17588 as specified (see 6.1). The instantaneous trip setting and thermal element rating shall be as specified (see 6.1).

3.3.1.6 Voltmeter. - A 4-1/2 inch 250-degree scale switchboard voltmeter conforming to Specification MIL-M-16034 shall be furnished. The meter scale shall be as specified (see 6.1) and have a red line scale mark at rated voltage.

3.3.1.7 Ammeter. - A 4-1/2 inch 250-degree scale switchboard ammeter conforming to Specification MIL-M-16034 shall be furnished. The meter scale shall be as specified (see 6.1) and have a red line scale mark at rated amperes.

3.3.1.8 Generator field rheostat. - A generator field rheostat in accordance with Specification MIL-R-15109 shall be furnished. The rheostat shall be suitable for back of panel mounting, front of panel operation, in a 1/8 inch panel.

3.3.2 Separate components. - The control equipment shall consist of the following components:

(a) Motor controller.
(b) Generator field rheostat.

3.3.2.1 Motor controller. - The motor controller shall be in accordance with 3.3.1.3. The enclosure shall be dripproof protected.

3.3.2.2 Generator field rheostat. - The generator field rheostat shall be in accordance with 3.3.1.8.

3.4 Onboard repair parts. - Onboard repair parts for the motor generators and associated control equipment shall be in accordance with the applicable specification for each component part. However, no repair armatures, field coils, or armature rewind material shall be furnished. One resistor, capacitor, and rectifier of each type used in the voltage regulator shall be furnished in each set of onboard repair parts. One voltage regulator transfer switch shall also be furnished in each set of onboard repair parts. Standard Navy stock numbers shall be obtained for all repair parts, whether furnished or not, in accordance with the procedure specified in

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Specification MIL-R-15137, except that the reproducible copy of NAVSHIPS 4372 and 4372A shall be submitted within 10 days after all equipment has been released for manufacture. A single copy of NAVSHIPS 4372 with additional copies of NAVSHIPS 4372A as necessary shall be submitted and list all replacement parts for the complete power supply. Submission of separate NAVSHIPS 4372 forms for each major component or piece meal submission of any of these forms will not be acceptable.

3.5 Drawings.- Master drawings shall be type I in accordance with Specification MIL-D-963 and shall contain information required by the applicable equipment specifications. The voltage regulator master drawing shall be in accordance with 3.5.1. In addition the contractor shall furnish an installation drawing for the motor generator and control equipment. These drawings shall conform to type II of Specification MIL-D-963. The drawings shall show all the information necessary for installing the equipment to include weights, overall dimensions (including clearance for removing parts), foundation bolting details, wiring details and center of gravity. A photographic tracing of the approved installation drawing shall be forwarded to the bureau or agency concerned prior to delivery of equipment. Certification data supporting all master drawings shall be submitted and contain all information required by applicable equipment specifications and conform to size A in accordance with Drawing S0103-73729.

3.5.1 The voltage regulator master drawing shall contain the following information:

(a) Descriptive data of voltage regulator set.
  (1) Type of control.
  (2) Enclosure.
  (3) Ambient temperature.
  (4) Shock classification.
  (5) Parallel (or nonparallel) operation.
  (6) Compensation for parallel operation.
  (7) Manufacturer's designation.
  (8) Mounting.

(b) Descriptive data of associated devices by piece number. The data applicable to the following parts shall be tabulated as follows:
  (1) Resistors
    a. Manufacturer's type and identification number.
    b. Resistance data including taps.
    c. Ampere rating.
  (2) Rectifier stack data:
    a. Type of rectifiers and manufacturer's identification number.
    b. Circuit (half wave or full wave).
    c. Cell size.
    d. Number of cells in series and parallel per arm.

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e. Current and voltage rating at the specified ambient and type of load.
f. Maximum operating temperature.
g. Identification as to where used.
h. Reverse current, average value (for magnetic amplifier application only).

(3) Capacitors
a. Type.
b. Voltage.
c. Capacity.

(4) Damping transformer.
a. Wire insulation.
b. Coil insulation.
c. Primary and secondary coil resistance.
d. Primary and secondary coil turns.
e. Primary and secondary wire size.

(5) Voltage adjusting rheostat.
a. Manufacturer's type and identification number.
b. Resistance in ohms.
c. Ampere rating.
d. Number of steps.

(6) Potential transformers
a. Frequency.
b. Volt-amperes, accuracy and thermal basis.
c. Voltage ratio.

(7) Reactors
a. Wire insulation.
b. Coil insulation.
c. Resistance of each winding.
d. Turns for each winding.
e. Wire size for each winding.

(8) Transfer switch
a. Type.
b. Amperes per contact.
c. Positions.
d. Stages.

(c) Weights. - The major assemblies should be listed and the weight for each given. Indicate the total weight for the regulator.

(d) Description of operation of regulator.

(e) Wiring and schematic diagram.

(f) Charts showing contact positions for transfer switch.

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(g) Curves or sufficient tabulated data showing transfer characteristics of each stage or circuit.

(h) Two representative views of equipment showing:

(1) Overall and principal dimensions of major assemblies.

(2) Drilling and mounting dimensions of major assemblies.

(3) Drilling and arrangement for parts.

3.6 Technical manuals. - Technical manuals shall conform to type B of Specification MIL-T-15071. Two manuals shall be packaged with each motor-generator. The arrangement of the text shall be as follows for cases where control panels are specified (see 6.1). This outline as applicable may also be used if a control panel is not specified:

- Cover
- Title page
- General data
  - Safety notices
  - Component list
    - Motor-generator
    - Control equipment
      - Voltage regulator
      - Motor controller
      - Generator field rheostat
      - Circuit breaker
- Table of contents
- List of illustrations and plans
- Introduction
  - General description
  - Power supply requirements and output
- Detailed description
  - Motor-generator
  - Control equipment
    - Voltage regulator
    - Motor controller
    - Rheostat
    - Circuit breakers

    (Note. - Reference to the motor controller, rheostat and circuit breaker inserts in the appendix are sufficient.)
- Installation instructions
  - Precautions
  - Preparation for use after storage
  - Mounting
  - Electrical connections

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Adjustments and tests
Principles of operation
    Motor generator
    Control equipment
        Basic magnetic amplifier principles
        Voltage regulator
        Motor-controller (reference to the controller insert is sufficient)
Operating instructions
Maintenance
Parts identification
Test data (include a complete set of combined unit test data not shown on master drawings)
Drawings
Appendix
    Motor controller insert
    Circuit breaker insert
    Rheostat insert

3.7 Reports. -

3.7.1 Progress reports. - A report shall be submitted each month, giving details of significant progress during the month. The first report shall include schedules of estimated completion dates for various phases of the programs for all component parts, such as basic design work, preparation of detail drawings, assembly, testing, and shipment. Subsequent reports shall indicate the percentage completion of the work under each of these items.

3.7.2 Test reports. - A complete set of test data shall be forwarded to the bureau or agency concerned for approval prior to shipment of equipment.

3.8 Special applications (see 6.1). -

3.8.1 Battery charging. - Where the power supply is to be used in whole or in part for battery charging the requirements below shall apply in addition to the foregoing requirements.

3.8.1.1 Regulated voltage adjustment. - In lieu of the range of adjustability specified in 3.3.1.4.2 the range of adjustment shall be 5 percent above and below rated voltage.

3.8.1.2 Reverse current protection. - The control panel shall contain a device which will disconnect the load when there is a 5 percent reversal of current. This may be accomplished either by a relay tripping the circuit breaker or a device which is capable of interrupting the current by itself. If a relay is furnished it shall be in accordance with Specification MIL-R-2033.

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4. QUALITY ASSURANCE PROVISIONS

4.1 Tests.- Sampling, inspection, and tests shall be in accordance with Specification MIL-M-2130 and with each individual equipment specification and as follows: Radio interference test, audio noise test and shock test shall also be conducted by the contractor.

4.2 Radio interference test.- The equipment shall be tested for radio interference in accordance with Specification MIL-I-16910. Tests shall be conducted on the motor generator alone if there is no voltage regulator. If there is a voltage regulator the tests shall be conducted with the voltage regulator operating. Conducted interference shall be measured from each line to ground at the power input and the power output. Tests shall be conducted at no load and full load. The test report shall include a complete set of the data obtained, and curves plotted from this data, including ambient values.

4.3 Voltage regulator.-

4.3.1 Each voltage regulator shall be subjected to the inspection and tests specified in 4.3.4, 4.3.5.1 and 4.3.5.8.

4.3.2 Voltage regulators shall be selected in accordance with table V and subjected to the inspection and tests specified in 4.3.4 and 4.3.5. One sample only shall be subjected to the shock test specified in 4.3.5.6.

Table V - Sampling for tests of voltage regulators.

Lot size, number of voltage regulators on the contract	Sample size, number of voltage regulators to be tested
1 to 15	1
16 to 40	2
41 to 65	3
66 to 110	4
111 to 150	5

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4.3.3 Acceptance of voltage regulator. - The first voltage regulator subjected to the tests specified in 4.3.5 shall be used to determine that the design is suitable for the particular application. Subsequent tests shall be used to determine that the units are satisfactorily duplicating the basic design. If the Government inspector determines under these subsequent tests that the voltage regulator does not comply with specification requirements the manufacturer shall correct the deficiency and demonstrate to the satisfaction of the Government inspector that all of the equipment is meeting the specification requirements. Tests shall be conducted with the voltage regulator operating at normal operating temperature rises.

4.3.4 Inspection. - A careful examination shall be made of the materials and workmanship to ascertain that they are of the quality specified herein and first class in every particular. The principal features of the design such as terminal connections, case construction, mounting, limiting dimensions, weight and identification plate data shall be checked for compliance with this specification.

4.3.5 Test procedures. -

4.3.5.1 Creepage clearance distances shall be demonstrated by actual measurement to be in accordance with Specification MIL-E-917.

4.3.5.2 Voltage regulation. - A total of 3 separate test runs shall be conducted to determine compliance with 3.3.1.4.1. With rated voltage and frequency applied to the motor, vary the generator load to 125 percent of full load in approximately 6 equal steps and back to no load in the same manner. The test shall be repeated with plus 10 percent rated voltage and plus 5 percent rated frequency applied to the motor, and again with minus 10 percent rated voltage and minus 5 percent rated frequency applied to the motor. No adjustments shall be made on the regulator between or during these tests. The generator load current and voltage and the motor voltage and frequency shall be recorded for each point. The voltages measured by this test shall be within the limits specified in table I.

4.3.5.3 Regulated voltage adjustment. - With rated voltage and frequency applied to the motor and the generator operating at no load under automatic operation, it shall be demonstrated that the voltage adjusting means will adjust the generator voltage within the limits and in the steps specified in 3.3.1.4.2 (or 3.8.1 if applicable). The test shall then be repeated with rated load applied to the generator. The maximum limits of adjustability at no load and full load shall be recorded.

4.3.5.4 Voltage recovery. - With the motor operating at rated voltage and frequency and the generator operating at no load, a load equal to 50 percent full load shall be suddenly applied. This test shall be repeated for sudden removal of the same load. The instantaneous voltages shall be measured during the transient period by means of an oscillograph or other equivalent means.

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4.3.5.5 Heating.- Heating tests shall be made on the voltage regulator equipment when operated under rated voltage and current conditions. The thermometer, thermocouple, or resistance method shall be used to determine the temperature rise on representative current carrying parts such as coils, reactors, transformers, resistors, rectifiers and terminals. Heating tests shall be made using the intended enclosure, with each item in its respective place. The maximum permissible temperature rise over a convenient room ambient (not less than 10°C.) shall not exceed the values specified in table III.

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

(a) The required type of shock test and weight designation of the shock test.- As required by the complete control panel.

(b) A definition of "failure to perform principal function".

(1) Breakage of any parts, including mounting bolts. Cracking or signs of cracking in parts vital to operation shall be considered breakage.

(2) Appreciable distortion or dislocation of any parts such as mounting feet, coils, or conducting terminals.

(3) A value of insulation resistance (corrected to 25°C.) less than that permitted by 3.3.1.4.5.

(4) Failure to withstand dielectric test voltage equal to 65 percent of that specified in 3.3.1.4.6.

(5) Failure to maintain the sensitivity specified in table I. The test shall be conducted with the regulator controlling the generator at any convenient load. The voltage of the generator shall be recorded before and after each blow. No adjustment shall be made between blows.

(c) Acceptable method of mounting.- The voltage regulator shall be shock tested within the control panel and mounted on the shock machine in a specified manner which simulated typical shipboard installations.

(d) Place at which shock test will be conducted.- Where a manufacturer is unable to conduct these tests at his own plant, he may arrange to have them conducted at a commercial laboratory approved by the bureau or agency concerned.

(e) Disposal of shock tested voltage regulator.

(1) Voltage regulators which have been subjected to the high-impact shock test and have failed to conform to the requirements will not be acceptable, either in whole or any of the parts.

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(2) Voltage regulators which have been subjected to the high-impact shock tests and have successfully passed this test may apply on a contract or order, provided the following post-shock tests are conducted and requirements satisfactorily met:

a. Voltage regulation.
b. Heating.
c. Dielectric.
d. Insulation resistance.

4.3.5.7 Insulation resistance. - The measurement of insulation resistance shall be made with all circuits of equal voltage above ground connected together. Circuits or groups of circuits of different voltage above ground shall be tested separately. Tests shall be made using a potential of 500 volts d.c. The temperature of the windings at the time of the insulation resistance measurement shall be recorded.

4.3.5.8 Dielectric test. - The dielectric test shall be made after all tests have been completed. The test shall be made upon the completely assembled unit and not upon an individual part; and exception is made in the case of repair parts which require dielectric tests, for example, repair coils. The voltage shall be applied both between circuits and between each circuit and ground. The dielectric test voltage shall be twice the rated voltage plus 1,000 volts but not less than 1,500 volts applied for a period of 1 minute. The frequency of the test voltage shall be not less than 60 cycles and shall be approximately a true sine wave.

4.4 Parallel operation test. - The following test shall be conducted on machines required to operate in parallel (see 3.1.5). With each motor generator connected to the same power supply, (voltage regulators in automatic operation) adjust the control equipment so that rated voltage is obtained and the kw. loads of each generator are equal for a combined load of 20 percent. No further adjustment of the control equipment shall be made for the remainder of the test. The total loads shall then be varied from 20 percent to 125 percent of the kw. rating of the parallel generators in five approximately equal steps and back to 20 percent load in the same manner. The voltage, current, kilowatt load, field voltage and field current of each generator at each load point shall be recorded.

4.5 Voltage regulation test (where no voltage regulator). -

4.5.1 Regulation "B" of table I. - Where the requirements for 10 percent bandwidth of table I apply the test shall be conducted as in 4.3.5.2. No adjustment of the generator field rheostat shall be made during the test.

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4.5.2 Regulation "C" of table I.- With the motor operating at rated voltage and frequency, and with the generator field rheostat so adjusted that the generator is operating at rated voltage and no load, load shall be applied in 6 approximately equal steps to 125 percent of full load. Under these conditions the voltage shall not drop more than 12 percent. With the same motor conditions, and with the generator field rheostat so adjusted that the generator is operating at rated voltage and 125 percent of full load, load shall be removed in 6 approximately equal steps to no load. Under these conditions the voltage shall not use more than 8 percent. At any point on the regulation curves there shall be no rise in voltage with increase in load, nor any drop in voltage with a drop in load.

4.6 Manual voltage control.- Generator field rheostat tests shall be as specified in Specification MIL-R-15109.

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

5. PREPARATION FOR DELIVERY

5.1 Preservation, packaging, packing and marking.- Motor generators, control equipment and associated repair parts shall be preserved, packaged, packed and marked for domestic shipment - immediate use, domestic shipment and storage or overseas shipment as specified (see 6.1), in accordance with Specifications MIL-C-2212, MIL-P-16018 and MIL-P-16298, as applicable.

5.2 Technical manuals.- Technical manuals, pamphlets and handbooks, as applicable shall be packaged and packed in accordance with Specification MIL-T-15071.

6. NOTES

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

(a) Title, number, and date of this specification.
(b) Whether parallel operation is required (see 3.1.5).
(c) Degree of regulation (see 3.1.6).
(d) Maximum dimensions, weight, and mounting dimensions for motor-generator (see 3.2.5).
    (1) Length.
    (2) Width.
    (3) Height including lifting provision.
    (4) Weight.
    (5) Distance between mounting bolt hole centers.
        a. Length.
        b. Width.
    (6) Size of mounting bolt holes.
    (7) Number of mounting bolt holes.

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(e) Maximum frame diameter for water (see 3.2.6 (f)).
(f) Generator voltage (see 3.2.7 (a)).
(g) Generator kw. (see 3.2.7 (b)).
(h) Whether distribution system is 2 wire or 3 wire (see 3.2.7 (d)).
(i) Maximum frame diameter for generator (see 3.2.7 (e)).
(j) If the degree of regulation is "B" or "C" of table I, whether control panel or separate components are required (see 3.3).
(k) Mounting of control panel, when furnished (see 3.3.1).
(l) Type and frame size of circuit breaker, when control panel is furnished (see 3.3.1.5).
(m) Circuit breaker thermal element rating and instantaneous trip setting when AQB breakers are required (see 3.3.1.5).
(n) Ammeter scale range when control panel is required (see 3 3.1.7).
(o) Voltmeter scale range when control panel is required (see 3.3.1.6).
(p) Maximum dimensions and weight for control panel (see 3.3.1.2).
  (1) Depth (including guard rail for deck mounted panels).
  (2) Width.
  (3) Height.
  (4) Weight.
(q) Special applications (see 3.8).
(r) Whether for domestic shipment - immediate use; domestic shipment and storage or overseas shipment (see 5.1).

6.2 This specification supplements Specification MIL-M-2130 for Bureau of Ships purchases of a.c./d.c. motor generator power supplies for surface vessels.

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

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SPECIFICATION ANALYSIS SHEET

Form Approved
Budget Bureau No. 119-R004

INSTRUCTIONS

This sheet is to be filled out by personnel either Government or contractor, involved in the use of the specification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity (as indicated on reverse hereof).

SPECIFICATION

ORGANIZATION (Of submitter) | CITY AND STATE

CONTRACT NO. | QUANTITY OF ITEMS PROCURED | DOLLAR AMOUNT $

MATERIAL PROCURED UNDER A

☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?

A. GIVE PARAGRAPH NUMBER AND WORDING.

B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES.

2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID

3. IS THE SPECIFICATION RESTRICTIVE?

☐ YES ☐ NO IF "YES", IN WHAT WAY?

4. REMARKS (Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)

SUBMITTED BY (Printed or typed name and activity) | DATE

DD FORM 1426 REPLACES NAVSHIPS FORM 4863, WHICH IS OBSOLETE C-8279