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SUPERSEDING
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MILITARY SPECIFICATION

REGULATORS, VOLTAGE, AND CONTROL PANELS AIRCRAFT DIRECT CURRENT GENERATOR, GENERAL SPECIFICATION FOR

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

1. SCOPE

1.1 Scope - This specification covers solid state direct current voltage regulators or control panels used to regulate, control and protect aircraft engine driven direct current generators.

* 1.2 Classification - The regulators and control panels shall be of the following classes as specified:

Class A - Regulators and control panels that are operable under the temperature and altitude conditions of Curve II of MS33543.

Class B - Regulators and control panels that are operable under the temperature and altitude conditions of Curve I of MS33543 to a maximum temperature of 85°C.

Class C - Regulators and control panels that are operable under the temperature and altitude conditions of Curve I of MS33543.

2. APPLICABLE DOCUMENTS

2.1 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

QQ-P-416 Plating, Cadmium (Electrodeposited)

FSC 6110

SPECIFICATIONS

Military

MIL-P-116	Preservation-Packaging, Methods of
MIL-D-1000	Drawings, Engineering and Associated Lists
MIL-M-3171	Magnesium Alloy; Processes for Pretreatment and Prevention of Corrosion on
MIL-E-5400	Electronic Equipment, Airborne, General Specification for
MIL-C-5541	Chemical Conversion Coatings on Aluminum and Aluminum Alloys
MIL-G-6162	Generator, 30 Volts, Direct Current, Aircraft Engine Driven, General Specification for
MIL-S-7742	Screw Threads, Standard, Optimum Selected Series, General Specification for
MIL-A-8625	Anodic-Coatings, for Aluminum and Aluminum Alloys
MIL-S-8879	Screw Threads, Controlled Radius Root with Increased Minor Diameter, General Specification for
MIL-P-15024	Plate, Tags and Bands for Identification of Equipment

STANDARDS

Military

MIL-STD-129	Marking for Shipment and Storage
MIL-STD-130	Identification Marking of U.S. Military Property
MIL-STD-143	Standards and Specifications, Order of Precedence for the Selection of
MIL-STD-454	Standard General Requirements for Electronic Equipment

STANDARDS

Military (Continued)

MIL-STD-461	Electromagnetic Interference Characteristics Requirements for Equipment
MIL-STD-462	Electromagnetic Interference Characteristics, Measurement of
MIL-STD-749	Preparation and Submission of Data for Approval of Non Standard Parts
* MIL-STD-781	Reliability Tests: Exponential Distribution
MIL-STD-794	Parts and Equipment, Procedures for Packaging and Packing of
MIL-STD-810	Environmental Test Methods
MIL-STD-889	Dissimilar Metals
MS33543	Criteria Temperature and Altitude Range Self-Cooled Electric Equipment

PUBLICATIONS

NAVAIR AR (Aeronautical Requirements)

AR-8	Versatile Avionics Shop Test System/ Avionics System Compatibility, General Requirements for
AR-9	Test Program Sets, General Requirements for
AR-10	Maintainability of Avionics Equipment and Systems, General Requirements for

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

3. REQUIREMENTS

3.1 Qualification - The regulator or control panel furnished under this specification shall be a product which has been tested and passed the qualification tests specified herein and has been approved for listing on the applicable qualified products list.

3.2 Specification sheets - The individual regulator or control panel requirements shall be as specified herein and in accordance with the applicable detail specification sheet. In the event of any conflict between requirements of this specification and the detail specification sheet, the latter shall govern.

* 3.3 Design and construction - The voltage regulator or control panel shall conform to the requirements specified on the applicable detail specification sheet and this specification. The voltage regulator shall be completely solid state and shall have no moving parts. Component parts, design and construction shall enable the regulator or control panel to have a minimum shelf life of five years. Performance and reliability requirements shall be met after storage. The voltage regulator or control panel shall not use any liquid, gas or vacuum, or device which depends upon elevated temperature for operation.

3.3.1 Materials - Materials shall be of a corrosion resistant type or suitably processed to resist corrosion.

3.3.1.2 Dissimilar metals - Dissimilar metals, as defined by MIL-STD-889, shall not be used in contact with each other. Where such contact is unavoidable, the metals shall be protected against electrolytic corrosion. When protection is used, it shall be of such a type that a low impedance path is offered to radio frequency currents.

3.3.1.3 Non-metallic materials - Non-metallic materials used including plastics, fabrics, and protective finishes shall be moisture resistant and shall not support fungus growth. Materials shall not be adversely affected by weather, sunlight, aircraft fluids, temperatures, and ambient conditions encountered during operation of the aircraft.

3.3.1.4 Flammable materials - Materials which will support combusion shall not be used. Definitions and restrictions on the use of flammable materials shall be in accordance with MIL-STD-454 Requirement 3.

3.3.2 Finish -

3.3.2.1 Aluminum alloy parts - Aluminum alloy parts shall be anodically treated in accordance with MIL-A-8625 or shall receive an approved chemical film in accordance with requirements of MIL-C-5541. The films deposited by these treatments shall be removed from the actual contact area of all surfaces required to act as a path for electrical power and from the local areas under screws, nuts, or the like used for assembly or mounting purposes, to provide an adequate bonding connection.

3.3.2.2 Magnesium alloy parts - Magnesium alloy parts shall not be used without approval of the procuring activity. When approved for use magnesium alloy parts shall be surface treated in accordance with MIL-M-3171 to provide protection against corrosion.

3.3.2.3 Plating - Cadmium plating shall be in accordance with QQ-P-416.

3.3.3 Parts, materials, and processes -

3.3.3.1 Use of standard parts - Standard parts shall be used wherever they are suitable for the fulfilment of the design objectives and shall be identified on drawings by their standard part number.

3.3.3.2 Selection of standard parts - Parts, materials, and processes shall be selected from documents which are specified as standards in MIL-E-5400. Where there is no suitable document specified in MIL-E-5400 the contractor shall use other specifications, standards and drawings selected in the order of precedence set forth in MIL-STD-143. Parts, materials, and processes selected from other than those covered by documents specified in MIL-E-5400 are not considered standard and nonstandard part approval must be obtained prior to their use in the regulator or control panel.

3.3.3.3 Approval of nonstandard parts - Requests for approval of nonstandard parts shall be in accordance with MIL-STD-749. The activity responsible for reviewing requests for approval of nonstandard parts is the Qualifying Activity.

3.3.3.4 Commercial utility parts - Commercial utility parts such as screws, bolts, nuts and cotter pins may be used without approval provided they possess suitable properties and are replaceable by standard parts, without alteration. The corresponding standard part numbers shall be referenced in the parts list and on the drawings.

3.3.4 Screw threads - Screw threads shall conform to MIL-S-7742. For applications requiring high strength capability, threads conforming to MIL-S-8879 shall be used.

3.3.5 Interchangeability - All parts having the same manufacturer's part number shall be directly and completely interchangeable with each other with respect to installation and performance. Changes in manufacturer's part numbers shall be governed by the drawing number requirements of MIL-D-1000.

3.3.6 Simplicity - A design objective shall be the use of the same parts for as many applications as possible.

3.3.7 Safety wiring and staking - Accidental loosening of screws and screw parts and other connections shall be prevented by safety wiring (0.032-inch minimum outside diameter, where practical), staking, or other approved methods. Washers and cotter pins, where used, shall be assembled in a manner which prevents rotation of washers and movement of cotter pins under conditions of vibration.

* 3.3.8 Electrical connections and wiring -

* 3.3.8.1 Electrical connections - Aluminum studs and washers shall not be used for regulator or control panel connections. The electrical connections of the voltage regulator shall be as shown in Figure 1. The regulator shall be constructed so that a single regulator can control a single generator with only L+, L-, G+ and F+ terminals connected to the generator. Unless otherwise specified no connection shall be required to any other regulator terminal for this condition of operation.

* 3.3.8.2 Electrical wiring - Electric wire shall be compatible with the designed maximum operating temperature of the regulator or control panel. Wiring practices shall be consistent with the intended application. Those circuits which supply control and indication power to the starter or generator system shall be protected internally by a diode to prevent power back feed.

3.3.9 Dielectric strength - Dielectric strength tests shall be conducted on components and subassemblies, as necessary, before final assembly to determine the parts' ability to meet all specified dielectric requirements.

3.3.9.1 Circuits - Circuits which operate at voltages no greater than 50 volts shall be tested at 500 volts (rms), 60 Hz for one (1) minute or 600 volts (rms), 60 Hz for one (1) second. Circuits operating in excess of 50 volts dc shall be tested at a minimum of 10 times the nominal rated potential for 1 second.

3.3.9.2 Capacitors - Capacitors shall be tested for one minute at a voltage equal to twice the voltage and at the pulse repetition rate expected to be encountered in the intended application (see paragraph 6.3.1).

3.3.10 Operating position - The regulator or control panel shall be capable of operating in any position.

3.3.11 Size and weight - The physical dimensions, weight, and envelope configuration shall be as specified in the detail specification sheet.

3.3.12 Provisions for maintainability - (Applicable to Navy Procurements) Built-In test equipment, construction and packaging, and provisions for test points shall be as specified in AR-10 excluding section 3.3. Equipment shall be compatible with VAST (Versatile Automatic Shop Test System) and shall meet the requirements of AR-8. VAST Test Programs shall be furnished in accordance with AR-9. If changes to the equipment are made which will affect the fault diagnosis procedure, changes to the existing Test Program shall be prepared as part of the equipment changes in accordance with AR-9.

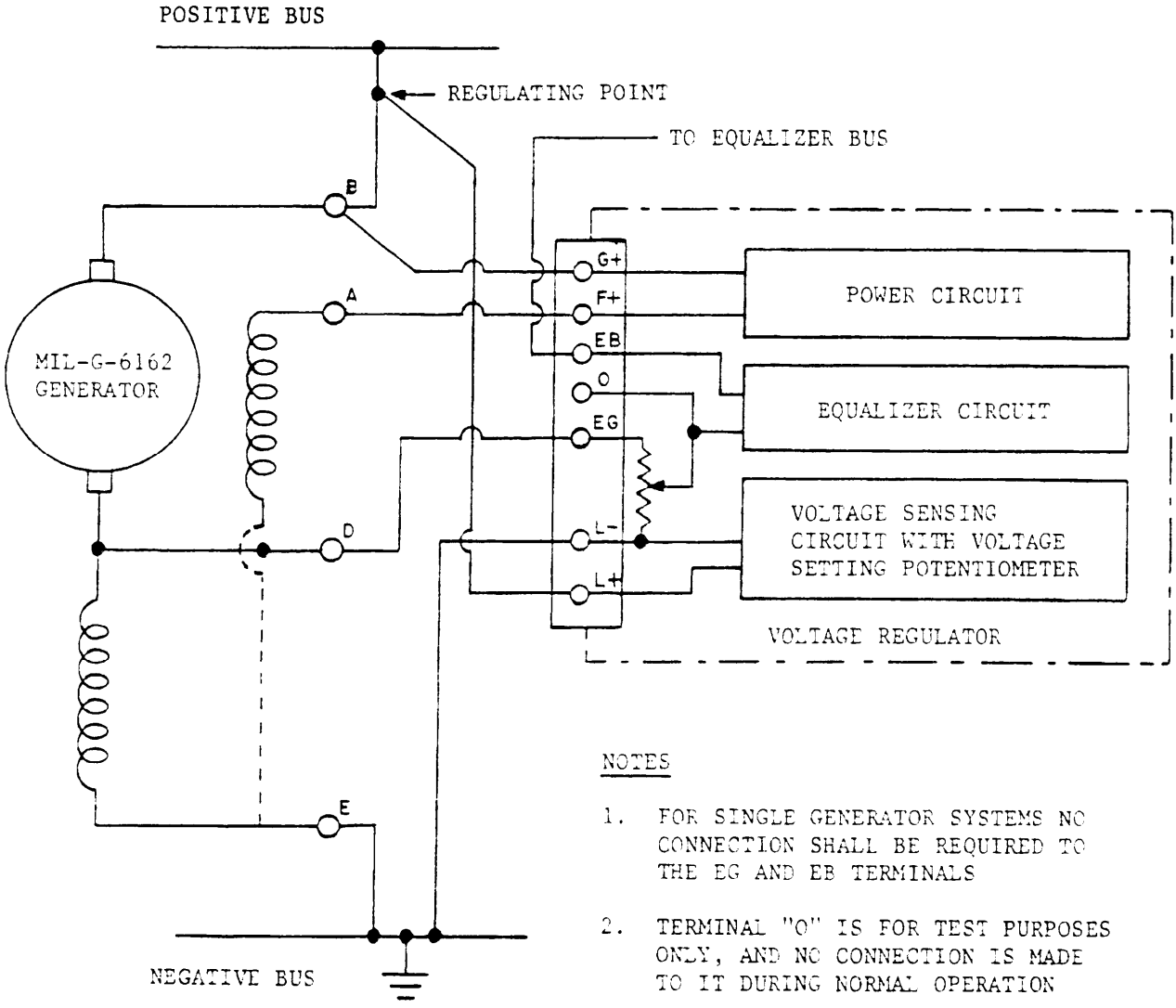

Figure 1 - Voltage Regulation Schematic Wiring Diagram

3.3.13 Marking - Regulator and control panel subassemblies shall be marked with the manufacturer's part number. Markings shall be in accordance with MIL-STD-130.

3.3.13.1 Nameplate - All regulators and control panels shall contain a standard size type A, B, or H metal nameplate in accordance with MIL-P-15024, securely attached to the unit. The nameplate shall contain the following information. Abbreviations are permissible.

Regulator, Voltage D.C. Generator } As Applicable
Control Panel D.C. Generator }
Volts and Field Amperes (as specified on applicable drawing)
Military Part No.
Manufacturer's Part No. or Model No.
Manufacturer's Name or Trademark
Serial No.
Federal Stock No.
Date of Manufacturer
Acceptance Stamp

3.3.13.1.1 Part number on nameplate - The manufacturer's part number indicated on the nameplate shall be the number of the contractor's assembly drawing which includes subassembly ordering data.

3.3.13.1.2 Restriction on size of trademark - The manufacturer's name or trademark shall be in letters not larger than other letters appearing on the nameplate.

3.3.13.2 Terminal marking - Terminal marking shall be clear and visible, and shall be in accordance with the detail specification sheet. Terminal protective covers, when installed, shall not obscure the terminal markings.

3.3.14 Use of MS or MIL designations - MS or MIL designations shall not be applied to a product, nor referred to in correspondence of sales material, until notification has been received that the product has been approved for use.

3.4 Performance -

* 3.4.1 Pulse width - Regulators controlling the voltage of generators through pulse width modulation of the field voltage shall have a minimum pulse width less than a 15 percent duty cycle and a maximum pulse width capable of producing the specified overload field current. The transition from minimum to maximum pulse width shall be smooth and stable and shall not cause modulation or fluctuations of the regulated voltage.

* 3.4.2 Buildup - The regulator shall be capable of effecting generator buildup under the conditions specified herein when furnished with a minimum residual voltage of 0.65 volt.

3.4.3 Voltage regulation - Unless otherwise specified, voltage regulation shall be accomplished through pulse width modulation of the field voltage pulse, from a duty cycle of 5 percent to specified overload current. The modulated field pulse shall not cause excessive ripple or ramping of the generated voltage.

3.4.4 Voltage setting - Unless otherwise specified, the voltage regulator shall be designed and constructed to permit the regulated voltage to be set to any value between plus 8 percent and minus 8 percent of the nominal voltage setting in increments of not more than 0.25 percent of the nominal setting. The voltage setting adjustment shall be accessible from the top of the regulator. The setting means shall be so designed and constructed that it will not be displaced by vibration or shock under any of the test conditions.

* 3.4.4.1 Maximum voltage setting - The regulator shall be capable of controlling the regulated voltage at a minimum of the nominal value with the voltage setting at the maximum. This test shall be performed with the generator at full load at both minimum and maximum speeds.

3.4.5 Protective and control functions - The following protective and control functions shall be provided as specified in the contract or detail specification sheet.

Protective functions

Reverse current protection
Overvoltage
* Feeder fault
* Open generator rectifier protection
Reverse polarity
* Current limiting (generator)

Control functions

* Field weakening
* Automatic cutout
Field flash
* Indication (generator failure)

*For inclusion in control panels only.

* 3.4.5.1 Protective functions - The components of the protective circuits of the regulator or control panel shall be separate and distinct from the control circuit components such that a failure of a control function will not impair the protective functions. After activation of one of the following protective functions the generator control panel concerned must be capable of being reset from a dead bus (i.e., without the use of power external to the system).

3.4.5.1.1 Reverse current protection (brush type generator) - The regulator or control panel shall be capable of automatic control of the line contactor. Reverse current cutouts shall be used in conjunction with regulators. The specified current flowing from the bus to the generator shall automatically trip the contactor thereby removing it from the bus. The reverse current required for activation shall be a minimum of 20 amperes and a maximum of 40 amperes. Activation shall not occur within the limits of cyclic load transfer specified herein. Sensing for reverse current protection shall be as specified on the detail specification sheet.

3.4.5.1.2 Overvoltage - When specified in the contract or detail specification sheet, the overvoltage protection shall respond and clear an overvoltage within the time specified on the detail specification sheet. In clearing an overvoltage the protective function shall automatically de-energize the generator and remove or isolate it from the bus. Overvoltage protection shall respond to only regulator or control panel induced overvoltages. The overvoltage protection shall be free of nuisance tripping and shall not respond to overvoltages external to its generating system. The overvoltage protection shall provide a means of manually resetting the protection for normal operation once an overvoltage has occurred and has been cleared. A manual means of resetting the protection shall be as specified on the detail specification sheet for the regulator or control panel.

3.4.5.1.3 Feeder fault - When specified in the contract or detail specification sheet, feeder fault protection shall automatically de-energize the generator and disconnect it from the bus whenever a feeder fault occurs. In multiple feeder systems the feeder fault protection shall permit a current difference of 5 percent of the generator rating between feeders without activation. Unless otherwise specified on the detail specification sheet, feeder fault protection shall activate at a fault current value of 125 amperes maximum. The detail specification sheet will specify the number and size of feeders to be protected.

3.4.5.1.4 Open generator rectifier protection (brushless type generator) - When rectifier protection is specified in the contract or detail specification sheet the protective function shall automatically de-energize the generator and remove or isolate it from the bus when a generator output rectifier becomes open circuited. The detail specification sheet may specify a manual override switch for rectifier protection. The override switch shall return the generator to the bus only if the other generators of a parallel system are not operating. The control panel shall provide visual indication of an open rectifier activation for maintenance purposes. The detail specification sheet will define the specific details.

* 3.4.5.1.5 Reverse polarity protection - The regulator or control panel shall prevent reverse polarity buildup of the generator and shall not be damaged by reverse polarity voltage (maximum 10 volts).

3.4.5.1.6 Current limiting (generator) - Unless otherwise specified by the detail specification sheet the regulator or control panel shall limit the current of the assisting generator during cross start to 150 percent of the generator rating.

* 3.4.5.1.7 Start cycle - When the control panel controls the start cycle of a shunt type starter-generator, the control panel shall insure that the shunt field circuit is closed prior to the line contractor closing. The shunt field circuit shall remain closed for the entire start cycle.

* 3.4.5.2 Control functions - The control functions shall be so designed that a fault which disables a control function shall not disable any protective function.

* 3.4.5.2.1 Field weakening - When specified in the detail specification sheet, the control panel shall weaken the field of the starter-generator during the start cycle to achieve the specified starter torque cutout speed.

3.4.5.2.2 Automatic starter cutout - When specified in the contract or detail specification sheet, the control panel shall automatically terminate the start cycle within the tolerances of the specified cutout speed and automatically initiate generator operation. Speed sensing shall be accomplished through a speed sensing device located in the starter-generator. Details of the speed sensing device shall be as specified in the detail specification sheet.

3.4.5.2.3 Field flash - When specified in the contract or detail specification sheet, the regulator or control panel shall provide a field flashing network capable of producing correct generator polarization prior to generator operation. The flashing current shall be limited to a maximum value of one-half ampere.

3.4.5.2.4 Indication (generator failure) - The control panel shall furnish at nominal voltage, one ampere continuous output for remote visual indication of generator failure. The indicator output shall be energized whenever the equipment bus is energized and the generator is isolated from the bus.

* 3.4.6 Equalizer circuit - The regulator or control panel shall be provided with an equalizer circuit for obtaining equal division of the load carried by two or more generators operated in parallel. The circuit shall have a fixed gain. The circuit shall be capable of withstanding an applied potential of 50 percent of the nominal voltage setting with respect to ground for 5 seconds. The effect of the equalizer circuit shall be determined on both a single generator system and a parallel system.

3.4.6.1 Equalizer operation - Control panels shall complete the equalizer circuit to the equalizer bus when the generator is energized and connected to the equipment bus.

* 3.4.7 Parallel operation - The regulator or control panel shall be designed to regulate the output voltage of generators or starter-generators designed to MIL-G-6162. During single generator and parallel operation (4 units or generators maximum), the regulated voltage shall remain within regulation limits stable and free from sustained modulation or oscillation. When controlling similar generators in parallel the generators may be of different manufacture or model number, and the regulators may also be of different manufacture or model number. During parallel operation, it is anticipated that the system will have a minimum busload equivalent to 10 percent of the system capacity. For regulators, if the the permanent busload is reduced below the 10 percent value, one generator may drop from the bus but under no circumstances shall the peak cyclic load transfer current be in excess of 10 percent of the rating of one generator, nor shall the generators cycle on and off the bus. For control panels if the permanent busload is reduced below the 10 percent value the generators shall remain in parallel and under no circumstances shall the peak cyclic load transfer current be in excess of 10 percent of the rating of one generator.

3.4.8 Time of recovery - With the generator operating between minimum and maximum speed, the voltage controlled by the regulator or control panel during load changes between full load and no load, shall be capable of recovering to and remaining within 10 percent of its steady state condition, within 0.05 seconds.

3.4.9 Heat dissipation - The regulator or control panel shall meet the voltage regulation requirements at room ambient, without adjustment, after being tested for heat dissipation in accordance with 4.6.10.

3.4.10 Ripple voltage - With the generator operating between minimum and maximum speed, the peak-to-peak ripple voltage shall not exceed 10 percent of the nominal voltage, with a maximum allowable excursion from the dc level of 7 percent of the nominal voltage.

3.4.11 Transient voltage - The regulator or control panel shall withstand a 200 percent nominal dc transient placed between the L+ and L- terminals of the regulator or control panel, for 10 seconds, when tested in accordance with 4.6.13.

3.4.12 Overlaod current - The regulator or control panel shall meet specified performance requirements when operated at the overload conditions specified in the detail specification sheet.

3.4.13 Endurance - The regulator or control panel shall be capable of operation for 200 hours under the conditions specified in 4.6.15.

3.4.14 Radio interference - The regulator or control panel conducted and radiated radio interference shall be within the limits specified in MIL-STD-461 when tested in accordance with MIL-STD-462.

3.5 Environmental -

3.5.1 Temperature - The regulator or control panel shall be capable of operation without degradation in specified performance at the ambient air temperature range specified in the detail specification sheet and when tested in accordance with 4.6.17.1.

3.5.2 Temperature-altitude - The regulator or control panel shall be capable of operation without degradation in specified performance at temperature-altitude conditions within the range specified by curve 1 of MS33543.

3.5.3 Vibration - The regulator or control panel shall be capable of operation without degradation in specified performance during and after being subjected to the vibration test of 4.6.17.3.

3.5.4 Shock - The regulator or control panel shall be capable of operation without degradation in specified performance during and after being subjected to the shock test of 4.6.17.4.

3.5.5 Humidity - The regulator or control panel shall show no evidence of corrosion, peeling, pitting, blistering, or cracking of the finish after being subjected to the humidity test of 4.6.17.5. At the conclusion of the test, at room ambient, the regulation shall be within the limits specified in the detail specification sheet.

3.5.6 Salt fog - The regulator or control panel shall show no evidence of corrosion, peeling, pitting, blistering, or cracking of the finish after being subjected to the salt fog test of 4.6.17.6. At the conclusion of the test, the overload current test and room ambient voltage regulation shall be within the limits specified in the detail specification sheet.

3.5.7 Sand and dust - The regulator or control panel shall be capable of operating within specified limits during and after being subjected to the sand and dust test of 4.6.17.7. At the conclusion of the test, at room ambient, the voltage regualtion shall be within the limits specifed in the detail specification sheet.

3.5.8 Fungus - The regulator or control panel shall show no evidence of fungus growth on any surface after being subjected to the fungus test of 4.6.17.8. At the conclusion of the test, at room ambient, the voltage regulation shall be within the limits specified in the detail specification sheet.

3.5.9 Explosion - The regulator or control panel shall not ignite an explosive mixture when tested in accordance with 4.6.17.9.

* 3.5.10 Reliability - Regulators and control panels shall have a minimum MTBF of 2000 hours when tested in accordance with paragraph 4.6.17.10.

3.6 Workmanship - Workmanship shall be in accordance with MIL-STD-454 requirement 9.

3.7 Installation instructions - The contractor shall pack with each regulator or control panel one approved printed copy of simple instructions, with illustrations and diagrams if necessary, covering the installation and adjustment of the regulator assembly. The instructions shall be protected to withstand and remain legible under the humidity and fungus requirements specified herein. Prior to printing, two copies shall be furnished the qualifying activity for approval of content, presentation and means of attachment.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection - Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier 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 Classification of tests - The inspection and testing of voltage regulators or control panels shall be classified as follows:

(a) Qualification Tests - Qualification tests are those tests accomplished on samples submitted for qualification as a satisfactory product.

(b) Qualification Verification Tests - Qualification verification tests are those tests conducted on production samples to verify that the design is identical to that qualified and that production units meets all of the requirements of this specification.

(c) Quality Conformance Inspections - Quality conformance inspections are those tests accomplished on voltage regulators or control panels manufactured and submitted for acceptance under contract.

4.2 Qualification tests - Qualification tests shall be conducted by the qualifying activity. When specified, the contractor may be authorized to test for qualification. When authorization has been granted, qualification test reports shall be submitted for qualification approval (see 6.2).

4.2.1 Sampling instructions - Qualification test samples shall consist of:

(a) Four (4) voltage regulators or control panels

(b) Reproducible copies of outline and assembly drawings

(c) Four (4) copies of installation and adjustment instructions

(d) Two (2) copies of internal schematic and parts list and, if applicable, a mating connector.

Samples shall be forwarded to the agency designated in the Letter of Authorization from the qualifying service (see 6.2). Samples shall be plainly identified by securely attached durable tags marked with the following information:

Sample for Qualification Test
Regulator, or Control Panel, Voltage, Direct Current Generator
Military Part No.
Manufacturer's Part No.
Date of Manufacture
Submitted by (name) (date) for qualification test in accordance with the requirements of MIL-R-23761 under authorization (reference authorizing letter).

4.2.2 Tests - The qualification tests shall consist of the tests specified in Table I and shall be conducted in the order listed for each sample. In addition, these tests may, at the option of the qualifying service, be supplemented with any other tests specified herein or with tests under actual service conditions which the qualifying service considers necessary to determine conformance with the requirements of this specification. Samples failing to meet the requirements do not qualify.

4.2.2.1 Disassembly and inspection - At the conclusion of the qualification tests, the voltage regulators or control panels shall be disassembled and inspected for defects.

4.3 Qualification verification tests -

4.3.1 Qualification verification - Each regulator or control panel of the same part number delivered as a qualified item under this specification shall be numbered sequentially in the order that it is submitted for Government acceptance regardless of the contract under which delivered or by whom purchased. In order to retain qualification status, the manufacturer is responsible for providing one qualification verification sample out of the first 51 unit production lot and an additional sample out of each additional 151 unit production lot. These samples which are to be provided at the manufacturer's own expense are to be selected at random by the Government Inspector and forwarded to the Naval Air Test Center (WST33), Patuxent River, Maryland 20670 (Attention: Work Unit NATC-8P7-101). The sample shall be shipped no later than halfway of the production lot from which selected. The span of serial numbers of the production units from which each qualification verification sample was selected shall be recorded and this information included with the sample. The units forwarded to Naval Air Test Center will be inspected and tested for conformance to the applicable detail specification. Tests will be conducted as shown by Table I for any one of the qualification samples at the discretion of the qualifying activity. Delivery of production units is not to be delayed pending result of any tests conducted on qualification verification samples. Once qualified, production components successfully passing the acceptance tests are to be accepted until the Government Inspector is notified that the qualification verification sample did not pass any test. After notification, no units are to be accepted for shipment pending resolution of the test failures. If production units are not corrected to the satisfaction of the qualifying activity, then qualification will be officially rescinded. The sample units and copies of Government test results may be obtained upon completion of the required testing by directing request to the above address.

4.3.2 Tests - Regulators or control panels may be subjected to any or all requirements and tests of this specification to assure continued compliance with the qualification requirements. Samples which are found to be defective for any reason shall be returned to the manufacturer for rework or parts replacement. Full particulars concerning the manufacturer's analysis of the defect and the corrective action required shall be submitted in writing by the manufacturer to the qualifying activity. The manufacturer shall also immediately inspect and test regulators or control panels currently in production and those awaiting shipment and certify that the deficiency has been corrected prior to further shipment. In addition, the manufacturer shall rework all the regulators or control panels in the production lot represented by the qualification verification test sample provided

TABLE I

QUALIFICATION TESTS

TESTS	REQ. PARA.	TEST PARA.
SAMPLE NO. 1		
Examination of Product (Voltage Regulation at Room Ambient)		4.6.1
Voltage Regulation	3.4.3	4.6.4
Protective & Control Functions (if applicable)	3.4.5	4.6.6
Generator Buildup	3.4.2	4.6.3
Pulse Width	3.4.1	4.6.2
Radio Interference	3.4.14	4.6.16
Vibration	3.5.3	4.6.17.3
Fungus	3.5.8	4.6.17.8
Salt Fog	3.5.6	4.6.17.6
Reliability	3.5.10	4.6.17.10
SAMPLE NO. 2		
Examination of Product (Voltage Regulation at Room Ambient)		4.6.1
Generator Buildup	3.4.2	4.6.3
Pulse Width	3.4.1	4.6.2
Operating Position	3.3.10	4.6.12
Temperature	3.5.1	4.6.17.1
Temperature - Altitude	3.5.2	4.6.17.2
Equalizer Circuit	3.4.6	4.6.7
Parallel Operation	3.4.7	4.6.8
Shock	3.5.4	4.6.17.4
Humidity	3.5.5	4.6.17.5
Reliability	3.5.10	4.6.17.10

TESTS	REQ. PARA.	TEST PARA.
SAMPLE NO. 3		
Examination of Product (Voltage Regulation at Room Ambient)		4.6.1
Equalizer Circuit	3.4.6	4.6.7
Parallel Operation	3.4.7	4.6.8
Maximum Voltage Setting	3.4.4.1	4.6.5
Ripple Voltage	3.4.10	4.6.11
Endurance	3.4.13	4.6.15
Explosion	3.5.9	4.6.17.9
Reliability	3.5.10	4.6.17.10
SAMPLE NO. 4		
Examination of Product (Voltage Regulation at Room Ambient)		4.6.1
Time of Recovery	3.4.8	4.6.9
Protective & Control Functions (if applicable)	3.4.5	4.6.6
Heat Dissipation	3.4.9	4.6.10
Overload	3.4.12	4.6.14
Transient Voltage	3.4.11	4.6.13
Sand and Dust	3.5.7	4.6.17.7
Reliability	3.5.10	4.6.17.10

that these regulators or control panels are returned to the manufacturer within one year of the date of manufacture, This requirement shall in no way prejudice the Government's position with respect to any other warranty stated or implied under the terms of the contract.

4.3.2.1 Disassembly and inspection - At the conclusion of the verification tests, the voltage regulators or control panels may be disassembled and inspected for defects.

4.4 Qualify conformance inspections - The contractor shall furnish all samples and shall be responsible for accomplishing the tests specified herein. When inspection is conducted at the contractor's plant, all inspection and testing shall be subject to the approval of the Government Inspector. Contractors not having laboratory testing facilities satisfactory to the Government shall engage the services of a commercial testing laboratory acceptable to the procuring activity. The contractor shall furnish test reports, showing the results for all tests required by this specification, and signed by an authorized representative of the contractor or laboratory as applicable. Acceptance or approval of material during course of manufacture shall in no case be construed as a guarantee of the acceptance of the finished product.

4.4.1 Sampling - Each voltage regulator or control panel manufactured and submitted for acceptance under contract shall be subjected to the acceptance tests specified herein.

* 4.4.2 Tests - The acceptance tests shall consist of the tests specified below and described under 4.6 "Test methods".

Examination of product (room ambient)
Voltage regulation (maximum and minimum specified ambient)
Protective and control functions (if applicable) (maximum specified ambient)
Equalizer circuit (maximum specified ambient)

In addition, the voltage regulator or control panel shall be subjected to any other tests specified herein which the Government Inspector considers necessary to determine conformance with the requirements of this specification. At the conclusion of the acceptance testing, the regulated voltage shall be set at the nominal voltage and the equalizer potentiometer (if specified) shall be placed in the fully counterclockwise position.

4.5 Test conditions - Unless otherwise specified, each test in this section shall be made under the following conditions.

4.5.1 Generator used - Unless otherwise specified the regulator or control panel shall control generators designed in accordance with MIL-G-6162. Unless otherwise specified the generator shall have a field resistance between 1.5 and 2.4 ohms (when measured at 25°C), a time constant between 35 milliseconds and 60 milliseconds and less than a 0.5 millisecond delay in response to a step field input measured at buildup.

4.5.2 Position - The regulator or control panel shall control voltage within specification limits when operated in any position.

4.5.3 Auxiliary equipment - No additional equipment, except that indicated by the manufacturer as necessary to meet the requirements of this specification and included in the weight and dimensions of the applicable detail specification sheet shall be used.

4.5.4 Standard test conditions - Unless otherwise specified, all tests shall be conducted in still air at a barometric pressure of 725 + 50 - 115 MM of mercury. The ambient temperature shall be maintained at 23° ± 10°C and the relative humidity shall be 50 ± 40%.

4.5.5 Warmup - No warmup shall be required.

4.5.6 Voltage setting - The regulated voltage shall be set at the nominal voltage at 125 percent of the generator minimum speed for regulation with no load on the generator prior to the following tests:

Voltage Regulation
Factors Affecting Voltage Regulation
Ripple Voltage

4.5.6.1 Voltage setting for parallel tests - Prior to paralleling tests, the regulators or control panels shall be adjusted as follows:

(1) While not in parallel, the voltages shall be adjusted in accordance with paragraph 4.5.6.

(2) With the equalizer potentiometers in the fully counterclockwise position and with the system at full load, the regulator of the generator carrying the smallest load current shall be adjusted for equal division.

4.5.7 Voltage measurement - The regulated voltage shall be measured between the "L+" and "L-" terminals.

* 4.5.8 Point of regulation - For the purpose of this specification, the point of regulation shall be located 2.5 to 5% of the nominal voltage line drop from a fully loaded generator.

4.6 Test methods -

4.6.1 Examination of product - Each regulator or control panel, subassembly, and part shall be examined as the Government Inspector may deem necessary to determine conformance with this specification and the detail specification sheet with respect to materials, electrical connections, threaded parts, finish, interchangeability, marking, instructions, dimensions, weight, and workmanship.

4.6.2 Pulse width -

* 4.6.2.1 Minimum pulse width - The minimum pulse width of the field voltage that the regulator or control panel is capable of producing shall be determined while controlling a generator at the maximum speed for regulation and no load. If the minimum pulse width is not produced under the above load and speed condition, the regulated voltage shall be lowered by adjustment of the voltage setting until the minimum pulse width is produced. Measurements shall be made with an oscilloscope. Time and voltage calibrated photographs of the oscilloscope display shall be submitted with the qualification report. The minimum field pulse shall not represent a duty cycle of more than 15 percent.

$$\text{Percent duty cycle} = \frac{\text{pulse width} \times 100}{\text{total pulse interval}}$$

* 4.6.2.2 Maximum pulse width - The generator shall be operated at minimum speed and full load; if the maximum pulse width or full on condition is not produced under these conditions, the speed shall be reduced until the maximum pulse width or full on condition is obtained. In performing this test, care shall be exercised not to exceed the overload current value of the regulator or control panel. There shall be no modulation or instability of the generator output voltage.

* 4.6.3 Generator buildup - When furnished with a minimum residual voltage of +0.65 volt, the regulator or control panel shall be capable of effecting generator buildup. If the 0.65 volt residual is not obtainable by varying the speed of the generator, the residual voltage shall gradually be adjusted by flashing the field of the generator until +0.65 volt is reached. Care shall be exercised not to reverse the residual or reduce it below the +0.65 volt level. With minimum residual voltage, the regulator or

control panel shall be capable of effecting generator buildup under all of the operating temperatures specified herein. Failure to effect generator buildup with the minimum value of residual voltage shall be cause for rejection.

4.6.4 Voltage regulation - The regulated voltage shall be measured under the following conditions:

(1) At room ambient the following shall be performed:

(a) At minimum speed for regulation specified on the generator drawing, the load shall be varied from no load to full load. The load shall be suddenly removed and applied for each observation (shock loaded).

(b) At the average rated generator speed, the preceding test shall be repeated.

(c) At maximum rated generator speed, the test of (1) (a) above shall be repeated.

(2) Repeat (1) with the regulator or control panel at -55°C.

(3) Repeat (1) with the regulator or control panel at 71°C, 85°C, or 120°C, as applicable.

For each ambient temperature condition, the voltage shall remain within the limits specified on the applicable detail specification sheet over the generator speed and load range (minimum speed for regulation to maximum rated speed) except that to expedite testing the measured voltage can be above both limits by as much as 3 percent provided the overall variation does not exceed the difference between the fixed ambient limits specified on the applicable detail specification sheet.

4.6.5 Maximum voltage setting - The maximum voltage setting shall be obtained at full load conditions by setting the voltage adjustment to the maximum stop position at minimum speed for regulation. The regulator shall be capable fo controlling the regulated voltage at a minimum of the nominal value under these conditions.

* 4.6.6 Protective and control functions - Operation of protective and control functions shall be within the limits specified herein and by the detail specification sheet. Operation of protective and control functions shall be tested at the temperature extremes specified. Testing of protective and control functions may be accomplished concurrently with the temperature testing 4.6.17.1.

* 4.6.6.1 Protective functions - Protective function circuits shall be operable in the event of control circuit failures. To demonstrate this the protective functions shall respond when the power output device of the regulator or control panel is short circuited.

4.6.6.1.1 Reverse current protection (brush type generator) - To test reverse current protection of control panels the regulated voltage of one generator of a parallel system shall be lowered until the reverse current protection activates. The amount of current required for activation shall be measured. Activation of the reverse current protection shall not be affected by generator speed or system load.

4.6.6.1.2 Overvoltage - Overvoltage protection shall be tested as follows:

(1) With the voltage at the nominal regulated setting, a full generator capacity shock load shall be applied and removed. The test shall be performed at minimum and maximum speed for regulation. Where applicable, the above tests shall be repeated for a 150 percent and a 200 percent generator load. Activation of the overvoltage protection shall be cause for rejection.

(2) With the regulator or control panel controlling the generator at the minimum speed for regulation and no load, the L+lead of the regulator shall be opened. Failure to achieve overvoltage protection within the time specified shall be cause for rejection. If the design of the regulator is such that an overvoltage does not occur due to opening the L+lead, the manufacturer shall advise the qualifying agency of a suitable means to simulate an overvoltage due to regulator malfunction. Simulated failure (open or shorted) of any component shall not result in overvoltage for longer than the time specified.

4.6.6.1.3 Feeder fault - The feeder fault protection shall be tested as follows:

(1) A 125 amp load shall be connected between the approximate mid-point of the positive feeder and ground. When the load is activated the protective function shall automatically de-energize the generator and remove or isolate it from the bus.

(2) With the feeder fault load circuit of (1) open circuited initially, the feeder fault shall be applied in twenty-five (25) ampere increments. When the feeder fault reaches approximately 125 amperes the protection function shall activate and automatically de-energize the generator or isolate it from the bus.

(3) Once the generator system has been subjected to and has cleared a feeder fault with the fault load remaining, an attempt shall be made to reset the generator. The generator control unit shall de-energize the generator before a maximum of 1 volt appears across the generator equalizer.

Steps (1), (2), and (3) shall be repeated at a minimum and maximum speed for regulation and at 10 percent, 50 percent, 75 percent and full generator load.

4.6.6.1.4 Open generator rectifier protection (brushless type generator) - The rectifier protection shall be tested as follows:

(1) A switch shall be placed in series with one of the output rectifiers and left in the closed position.

(a) With the generator at the minimum speed and 10 percent generator load the switch shall be opened. The rectifier protection shall de-energize the generator and remove it from the bus within two seconds.

(b) Repeat (1)(a) with the generator at full load.

(c) Repeat (1)(a) with the generator at 10 percent load and the specified overspeed.

(d) Repeat (1)(a) with the generator at full load and the maximum speed for regulation.

4.6.6.1.5 Reverse polarity protection - To test the reverse polarity protection, the residual voltage of the generator shall be reversed by flashing the field in the reverse direction; once reversed, the regulator or control panel shall be connected to the generator and an attempt made to energize the generator. The generator shall not build up in the reverse direction and there shall be no damage to the regulator or control panel.

4.6.6.1.6 Current limiting (generator) - Operation tests shall be conducted and measurements made to insure that the current of the assisting generator is limited to 150 percent of the generator rating during cross start.

4.6.6.2 Control functions -

4.6.6.2.1 Field weakening - To test for field weakening, the field shall be weakened in such a manner as to maximize the torque delivered by the starter-generator over the specified speed range.

4.6.6.2.2 Automatic starter cutout - Operation tests shall be conducted and measurements made to insure that the control panel automatically terminates the start cycle within the tolerances of the specified cutout speed and automatically initiates generator operation.

4.6.6.2.3 Field flash - Measurements shall be made to insure that the field flashing network produces correct generator polarization with a flashing current of 1/2 ampere or less.

4.6.6.2.4 Indication (generator failure) - Measurements shall be made to insure that the nominal voltage "1" ampere continuous output for remote generator failure indication is operating as required.

* 4.6.7 Equalizer circuit - The regulator terminal "EG" shall not be connected for this test. The circuit shall lower the control voltage by 9 ± 1 percent when 1.0 percent nominal voltage is applied between terminal "O" and terminal "EB" with terminal "O" negative to terminal "EB". The equalizer circuit shall be tested as follows:

(1) A battery or power supply of sufficient capacity and a voltage divider network shall be used to energize the circuit. When not energized, the equalizer circuit shall not cause any increased modulation of the regulated voltage. The gain of the equalizer circuit shall be determined at no load, 50 percent load and full load. Measurements shall be made across the speed range with the gain determined every 1,000 RPM from the minimum speed for regulation to maximum speed for regulation.

(2) With the regulator disconnected from the generator, the equalizer circuit shall withstand a signal of 50 percent nominal voltage applied between terminal "EG" and terminal "L-". Terminal "EG" shall be positive with respect to terminal "L-" and the potential shall be applied for 5 seconds. After this test the equalizer circuit shall be allowed to return to room ambient and meet the requirements of paragraph 4.6.7(1).

4.6.8 Parallel operation - The regulators or control panels shall control respective generator voltages when two or more generators operate in parallel. Prior to testing, the regulators or control panels shall be adjusted in accordance with paragraph 4.5.6.1. The bus voltage shall be stable and the voltage regulation shall be within the limits specified in the applicable detail specification sheet. Instability of the output voltage, failure to meet the cyclic load transfer, steady state load division or voltage regulation requirements during parallel operation shall be cause for rejection.

4.6.8.1 Cyclic load transfer - While operating in parallel, a recording oscillograph shall be connected to monitor the load currents. Sensitivity and speed of the oscillograph shall be adequate to observe small deviations in the generator load currents. There shall be no peak cyclic load transfer nor load swapping greater than 10 percent of the rating of a single generator. Cyclic load transfer for the parallel system shall be determined under the following conditions:

(1) With both generators at the minimum speed for regulation and permanent system load equal to 10 percent of the rating of one generator, shock loads of 50, 100, and 150 percent system capacity shall be applied and removed. The speed of one generator shall be raised in increments of not more than 500 RPM until the maximum speed for regulation is reached. At each new speed, the shock loads shall be applied and removed.

(2) Repeat (1) starting with the fixed speed generator at the average speed for regulation.

(3) Repeat (1) with the fixed speed generator at the maximum speed for regulation.

Shock loads shall be maintained on the bus for a sufficient period of time (2 minutes maximum) for cyclic load transfer to be established. In addition to the above, removal of the loads shall not cause any sustained cyclic load transfer between the generators. The regulators or control panels shall not develop any sustained electrical oscillations under any of these load changes.

4.6.8.2 Steady state load division - Steady state load division shall be within 10 percent of the rating of one machine from 15 percent to full system load. Load division shall be checked at 15 percent, 25 percent, 50 percent and full system load. During this test the voltage regulation shall remain within the specified limits. The generator speeds of paragraph 4.6.8.1(1) and (3) shall be used to check the steady state load division.

4.6.9 Time of recovery - With the generator operated at minimum, maximum and average speeds, a recording oscillograph shall be used to measure the voltage transient when full rated load is applied and removed. The voltage controlled by the voltage regulator or control panel during load changes between full and no load shall recover to and remain within 10 percent of its steady state condition within 0.05 second. Tests shall be conducted on both single generator and parallel generator systems.

4.6.10 Heat dissipation - The voltage regulator or control panel shall be operated under the following conditions:

(1) The generator shall be operated at full rated load and a speed which will require the regulator or control panel to supply its full rated field current. Excess cooling air shall be provided to the generator to prevent damage during this test.

(2) The generator shall be operated at a speed and load condition which will require the regulator or control panel to produce its minimum pulse width.

During this test the voltage regulator or control panel shall be operated in a maximum ambient temperature of 71°C, 85°C, or 120°C, as applicable, for each of the above conditions. There shall be no forced ventilation of the regulator or

control panel or the immediate surrounding area. Test condition (1) shall be maintained for a period of 8 hours immediately after which the regulator or control panel shall be subjected to test condition (2) for one hour. The regulator or control panel shall be returned to room ambient and meet the requirements of the voltage regulation test at room ambient, paragraph 4.6.4(1), without adjustment.

4.6.11 Ripple voltage - Ripple voltage shall be measured at 10 percent, 25 percent, 50 percent and full load while the generator is operated at minimum, average and maximum speeds. The peak-to-peak ripple voltage shall not exceed 10 percent of the nominal voltage with a maximum allowable excursion from the dc level of 7 percent nominal voltage. Measurements shall be made with an oscilloscope (10 megahertz minimum bandwidth). Any modulation of the output voltage shall be included in and counted as ripple. The test shall be conducted with the regulated voltage set at the nominal voltage and without a battery or external filter. Ripple measurements shall be made at the point of regulation.

4.6.12 Operating position - Prior to the operating position test the regulated voltage shall be adjusted as specified in 4.5.6. The regulator or control panel shall be rotated by increments of no more than 90 degrees from the normal horizontal position, 360 degrees about each major axis except the vertical axis. If any of the operating positions are found to affect heating or voltage regulation, the worst position shall be used for the remaining sections of this test. In each of the positions, the regulator or control panel shall be capable of effecting generator buildup.

4.6.13 Transient voltage test - While controlling a generator set at nominal voltage, minimum speed for regulation and full load, a 200 percent nominal dc transient shall be placed between the L+ and L- terminals of the regulator or control panel for 10 seconds. A separate generator or power supply shall be used for the 200 percent volt source (if required for protection purposes, a diode shall be placed in the positive line). For this test the lead between the "G+" terminal of the regulator or control panel and the "B" terminal of the generator shall be removed and the "L+" and "G+" terminals of the regulator or control panel shorted. A diode shall also be placed in the lead between the "L+" terminal of the regulator or control panel and the "B" terminal of the generator to isolate the controlled generator from the transient. During the transient period it is permissible for the regulator or control panel to stop regulating; however, protective or control functions shall not activate. The above transient shall be applied 30 times at a rate not greater than one per two minutes. Following this test the regulator or control panel shall meet the requirements of the voltage test at room ambient, paragraph 4.6.4(1) without resetting any protective or control function.

4.6.14 Overload current - The speed and load of the generator shall be adjusted so the regulator or control panel produces the overload current specified on the detail specification sheet. The regulator or control panel shall deliver the overload current for one hour after which it shall be inspected for damage and shall pass the voltage regulation test of paragraph 4.6.4(1) without resetting any protective or control functions. During this test the generator shall be provided with excess cooling air.

4.6.15 Endurance - The regulator or control panel shall be operated for 200 hours to control a generator operating at a speed which will cause the greatest variation in field current when full generator load current is switched on and off. Once the variation in field current has been established, a simulator may be used for the generator provided that the minimum and maximum values of field current are the same as those obtained with the generator. The load shall be switched on for 5 seconds and off for 5 seconds. Sufficient readings shall be taken to determine compliance with the requirements of this test. During the test the regulated voltage shall not drift more than 1 percent of the nominal voltage during any 25 hour period nor more than 2 percent of the nominal voltage during the entire test. No voltage adjustment shall be permitted during the test. Following the endurance test, the regulator or control panel shall meet the voltage regulation requirements, paragraph 4.6.4(1); the time of recovery requirements, paragraph 4.6.9; and the equalizer requirements, paragraph 4.6.7(1). Failure to meet any of these requirements shall be cause for rejection.

4.6.16 Radio interference - Both the generator and regulator or control panel shall be located within a shielded enclosure. The field current supplied by the regulator or control panel shall be made to vary through generator speed and loading to cause approximately 10, 50, 75 and 100 percent maximum rated regulator current to flow in the generator field. When the regulator or control panel does not have a fixed pulse repetition rate, the generator speed and load shall be varied to obtain a good cross section of pulse repetition rates between the minimum and maximum rate. If any one pulse repetition rate appears critical with respect to radio interference, tests shall be conducted at this rate. If the generator, when tested with a rheostat, does not meet the requirements of MIL-STD-461 when tested in accordance with MIL-G-6162, then the generator regulator or generator control panel combination shall not be required to comply with the requirements in that frequency band; however, the combination shall not exceed those values obtained on the generator. The generator and regulator or control panel lead lengths shall be six feet.

4.6.16.1 Conducted interference - Conducted interference shall be within the limits of MIL-STD-461 for test requirements CE03 and CS01. When conducting test procedures CE03, the only measurement required shall be on the positive feeder of the generator. Measurements shall be made in accordance with the specified techniques of MIL-STD-462.

4.6.16.2 Radiated interference - Radiated interference shall be within the limits of MIL-STD-461 for test requirements RE02 and RS01. Measurements shall be made in accordance with the specified techniques of MIL-STD-462.

4.6.17 Environmental tests - The regulator or control panel shall be subjected to the following environmental tests in accordance with the specified methods of MIL-STD-810 except where noted. Upon completion of each environmental test, the regulator or control panel shall be required to pass the requirements of paragraph 4.6.4(1) voltage regulation for room ambient conditions. Failure to meet the requirements of voltage regulation or other requirements as specified in the individual environmental tests shall be cause for rejection.

4.6.17.1 Temperature tests - Prior to the temperature tests the regulated voltage shall be adjusted as specified in 4.5.6.

4.6.17.1.1 Low temperature - The regulator or control panel shall be soaked for at least 10 hours in an ambient temperature of -55°C (not operating and with no circuits energized). Following this, it shall be connected to immediately build up and control a generator operating at the average speed for regulation and full load. Readings of regulated voltage shall be recorded immediately and every two minutes until the voltage stabilizes. The regulated voltage shall remain within the regulation limits.

4.6.17.1.2 High temperature - The ambient temperature shall be decreased from 25°C to -55°C and then increased to 71°C, 85°C, or 120°C, as applicable. Each temperature shall be held until the regulated voltage stabilizes as indicated by the readings taken at 10-minute intervals. Tests will be made at any other ambient temperature between the limits specified, at the option of the qualifying service. The regulated voltage shall remain within the regulation limits for all conditions specified on the detail specification sheet. At the conclusion of the high temperature regulation portion of the test, the regulator or control panel shall be de-energized and allowed to soak at the applicable maximum temperature for a period of 5 hours after which it shall be capable of effecting generator buildup.

4.6.17.2 Temperature-altitude - Prior to the temperature-altitude tests the regulated voltage shall be adjusted as specified in 4.5.6. The temperature and altitude shall be varied within the limits specified in MS33543 with the exception that the lower temperature limit shall be considered to be a constant -55°C. The upper temperature altitude limit shall be in accordance with the upper temperature range of the regulator or control panel, 71°C, 85°C, or 120°C, as appropriate. The regulator or control panel shall be operated at each of the following conditions:

(1) At -55°C and 65,000 ft. pressure altitude.

(2) At the appropriate maximum pressure altitude per Curve I or Curve II of MS33543, as applicable.

(3) At sea level and the applicable maximum temperature, 71°C, 85°C, or 120°C.

The regulator or control panel shall be operated at each condition for a minimum of one hour. The regulated voltage shall remain within the regulation limits for all temperature-altitude conditions specified in MS33543. Tests may be made at intermediate altitudes, within the altitude temperature limits specified, at the option of the qualifying service.

* 4.6.17.3 Vibration - The vibration test shall be conducted in accordance with Method 514, Procedure I, Category (a), Curve AT of MIL-STD-810. During the test, the regulator or control panel shall control a generator running at average speed and 50 percent rated load. The regulated voltage shall remain within the specified limits during the test. The regulator or control panel shall be mounted directly on the vibration table unless a mounting device is an integral part of the regulator or control panel. Mechanical damage due to vibration, or failure to remain within the regulating limits during or after the vibration test, shall be cause for rejection.

* 4.6.17.4 Shock - The regulator or control panel shall be subsubjected to the shock test in accordance with Procedure I and III, Method 516 of MIL-STD-810. The shock pulse shall conform to the configuration and tolerance limits of Figures 516-2 of MIL-STD-810. The regulator or control panel shall control a generator operating at any speed within regulation limits and no load during this test. An oscilloscope or oscillograph shall be used to monitor the regulated voltage. Failure to remain within the specified regulation limits shall be cause for rejection.

4.6.17.5 Humidity - The regulator or control panel shall be subjected to a humidity test in accordance with Procedure II, Method 507 of MIL-STD-810.

4.6.17.6 Salt fog test - The regulator or control panel shall be subjected to the salt fog test in accordance with Procedure I, Method 509 of MIL-STD-810 for a period of 48 hours. Upon completion of this test, any salt deposits shall be brushed form the regulator or control panel prior to being air dried for a period of 48 hours at 25°C±3°C. Upon completion of the drying period, the regulator or control panel shall meet the requirements of the overload current test, paragraph 4.6.14, prior to the room ambient voltage regulation requirements of paragraph 4.6.4(1).

4.6.17.7 Sand and dust - The regulator or control panel shall be subjected to the sand and dust test in accordance with Procedure I, Method 510 of MIL-STD-810.

4.6.17.8 Fungus - The regulator or control panel shall be subjected to the fungus test in accordance with Procedure I, Method 508 of MIL-STD-810.

4.6.17.9 Explosion - The explosion test shall be conducted in accordance with Method 511, Procedure I of MIL-STD-810 on those regulators or control panels equipped with overvoltage protection. Immediately after introduction of the explosive mixture, the regulator or control panel shall be energized and control a generator or suitable simulated load. At the conclusion of step 3 of Procedure I, the overvoltage protection of the regulator or control panel shall be activated (mechanically or electrically) to simulate an overvoltage. Ignition of the explosive mixture shall be cause for rejection.

* 4.6.17.10 Reliability - For qualification, reliability testing shall be accomplished after all other testing is completed. The reliability qualification demonstration shall be in accordance with Test Plan I, Test Level A-1 of MIL-STD-781. Reliability acceptance test shall be in accordance with Test Plan I, Test Level F of MIL-STD-781. The generator simulator employed for endurance testing may also be utilized for reliability testing.

4.6.18 VAST compatibility demonstration - Each regulator or control panel shall demonstrate compatibility with VAST (see 3.3.12). Tests shall be conducted as specifically designated by the Qualifying Activity.

5. PREPARATION FOR DELIVERY

5.1 Application - The packaging, packing and marking requirements specified herein apply only to direct purchases by or direct shipments to the Government.

5.2 Preservation and packaging -

5.2.1 Level A - The regulator or control panel shall be packaged in accordance with MIL-STD-794. Preservation shall be in accordance with MIL-P-116, Method II without preservation compound. One regulator or control panel shall be packed per container.

5.2.2 Level C - The regulator or control panel shall be preserved and packaged individually in accordance with the manufacturer's commercial practice.

5.3 Packing -

5.3.1 Level A - Unless otherwise specified, regulators or control panels shall be packed in accordance with MIL-STD-794. Shipping containers shall be exterior export type conforming to Tables II and III of MIL-STD-794.

5.3.2 Level B - Unless otherwise specified, regulators or control panels shall be packed in accordance with MIL-STD-794. Shipping containers shall be exterior domestic type conforming to Tables II or III of MIL-STD-794.

5.3.3 Level C - Shipping containers shall meet the requirements of MIL-STD-794 for Level C packing.

5.4 Marking and labeling - Each package and shipping container shall be durably and legibly marked in accordance with the requirements of MIL-STD-129.

5.5 Acceptance stamp - Each package and shipping container shall be durably and legibly marked in accordance with the requirements of MIL-STD-129. In addition, two opposite sides of each shipping container or exterior packing shall be marked with the Government acceptance stamp.

6. NOTES

6.1 Ordering data - Procurement documents should specify the following:

(a) Title, number and date of this specification.
(b) Title, number and date of the applicable Military Standard or specification sheet.
(c) Levels of preservation and packaging and packing (5.2).
(d) Required protective and control functions not covered by the detail specification sheet
3.4.5.1.2 Overvoltage
3.4.5.1.3 Feeder fault
3.4.5.1.4 Open generator rectifier
3.4.5.1.5 Reverse polarity protection
3.4.5.2.1 Field weakening
3.4.5.2.2 Automatic starter cutout
3.4.5.2.3 Field flash

6.2 Provisions for qualification tests - The right is reserved to reject any bids on regulators or control panels covered by this specification which have not been subjected to the required qualification tests and found satisfactory for inclusion on a Qualified Products List. The attention of suppliers is called to this requirement. Request for authorization for qualification tests of the proposed regulators or control panels shall be made to the Naval Air Systems Command, Washington, D.C. 20361 or the activity responsible for the qualification.

6.2.1 Engineering changes to a qualified item - Once a manufacturer's part number has been placed on the Qualified Products List, the manufacturer is responsible for any changes to the regulator or control panel which affect its physical or performance characteristics. No changes shall be made to a qualified regulator or control panel without the specific approval of the qualifying agency. The manufacturer shall allow sufficient lead time for the qualifying agency to repeat the qualification tests if necessary.

6.3 Miscellaneous notes -

6.3.1 Dielectric strength - The dielectric strength test for capacitors described in Section 3 is not a test of ultimate dielectric strength and is not intended to be a design criterion for capacitors. The purpose of this test is to assure the satisfactory performance of individual capacitors under operating conditions. Capacitors used shall be suitable for the purpose and shall conform to applicable Government specifications.

6.3.2 Mounting - Care shall be exercised with respect to the physical mounting of the regulator or control panel in the aircraft to assure the vibration and shock conditions specified herein are not exceeded.

6.3.3 Electrical terminal function - For purposes of this specification, the electrical terminal designation and function are as follows:

Designation	Function
L+	Positive voltage sensing
G+	Input power
F+	Output (generator field)
EG	Equalizer input (from generator)
EB	Equalizer bus
L-	System ground
O	Test point for equalizer circuit, not required for normal generator operation

Terminal connections, connector pin designations and functions other than those shown above will be specified on the applicable Military Standard or specification sheet.

6.3.4 Aircraft wiring - Normal aircraft installation will insure that separate L+ and G+ leads are provided to the regulator or control panel. For installation other than normal, approval of the aircraft procuring activity must be obtained.

6.4 Precedence - When the requirements of the contract, this specification, or applicable subsidiary specification or applicable equipment drawing are in conflict, the following precedence shall apply:

(1) Contract - The contract shall have precedence over any specification or drawing.

(2) Military Standards and specification sheets - Applicable Military Standards or specification sheets shall govern when the applicable drawings are in conflict with this specification.

(3) This specification - This specification shall have precedence over all subsidiary specifications.

(4) Referenced specifications - Any referenced specification shall have precedence over all applicable subsidiary specifications referenced therein. All referenced specifications shall apply to the extent specified.

6.5 Supersession data - This issue of MIL-R-23761 supersedes the previous issue of MIL-R-23761, for new designs. The previous issue shall remain in effect to cover the reprocurement of voltage regulators previously required. MIL-R-23761 qualification approval granted prior to the issue date of this specification applies to the previous issue and certification to this issue will require requalification.

* 6.6 Changes from previous issue - The margins of this specification are marked with an asterisk to indicate where changes from the previous issue MIL-R-23761A(AS), were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

Custodians:

Army - AV
AF - 11

Preparing Activity:

Navy - AS

Project No. 6110-0182

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

OMB Approval
No. 22-R255

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DOCUMENT IDENTIFIER AND TITLE
MIL-R-23761B Regulators, Voltage, and Control Panels, Aircraft Direct Current Generator, General Specifications For

NAME OF ORGANIZATION AND ADDRESS

CONTRACT NUMBER

MATERIAL PROCURED UNDER A
☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

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   A. GIVE PARAGRAPH NUMBER AND WORDING.

   B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES

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