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MILITARY SPECIFICATION

GENERATOR SYSTEM, 400 HERTZ ALTERNATING CURRENT, AIRCRAFT GENERAL SPECIFICATION FOR

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

1. SCOPE

1.1 This specification covers the general requirements for a 115/200 volt; 400 Hz, alternating current, 3 phase, 4 wire electric power generation system, consisting of a 400 Hz generator and generator controls. Detail requirements for specific systems are covered by detail specifications hereunder.

2. APPLICABLE DOCUMENTS

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

SPECIFICATIONS

MIL-P-116	Preservation, Methods of
MIL-D-1000	Drawings, Engineering and Associated Lists
MIL-M-3171	Magnesium Alloy, Processes for Corrosion Protection of
MIL-E-5272	Environmental Testing, Aeronautical and Associated Equipment General Specification for
MIL-E-5400	Electronic Equipment, Aircraft, General Specification for
MIL-S-7742	Screw Threads, Standard, Aeronautical
MIL-P-8879	Parts and Equipment Aeronautical. Preparation for Delivery
MIL-Q-9858	Quality Program Requirements

MIL-M-23618	Handbook, Aircraft Inspection Requirements
MIL-L-23699	Lubricating, Oil, Aircraft, Turbine Engine, Synthetic Base

STANDARDS

Military

MIL-STD-129	Marking for Shipment and Storage
MIL-STD-130	Identification Marking of U. S. Military Property
MIL-STD-143	Specifications and Standards; Use of
MIL-STD-210	Climatic Extremes for Military Equipment
MIL-STD-444	Nomenclature and Identification for Electronic Equipment
MIL-STD-454	General Requirement for Electronic Equipment
MIL-STD-461	Electromagnetic Interference Characteristics, Requirements for Equipment
MIL-STD-481	Configuration Control - Engineering Changes, Deviations and Waivers
MIL-STD-831	Test Reports, Preparation of
FED-STD-595	Aeronautical Standard Notice for Federal Std. No. 595 Colors
MS 33540	Safety Wiring, General Practices for
MS 33542	Criteria - Temperature and Altitude Range, Blast Cooled Electric Equipment
MIL-STD-1472	Human Engineering Design Criteria for Military Systems
MS 33543	Criteria - Temperature and Altitude Range, Self Cooled Electric Equipment
MS 33586	Metals, Definition of Dissimilar
MS 90415	Nut, Self Locking Steel 450°F with captivated washer

NAVAL AIR SYSTEMS COMMAND REQUIREMENTS

AR-5	Microelectronic Devices used in Avionics Equipment, Procedures for Selection and Approval of
AR-8	Versatile Avionic Shop Test System (VAST) Avionic System Compatibility, General Requirements for
AR-9	VAST Test Programs, General Requirements for
AR-10	Maintainability of Avionics Equipment and Systems, General Requirements for

(When requesting specifications, standards, drawings, and publications refer to both number and title. Copies of this specification and applicable specifications may be obtained upon application to the Commanding Officer, Naval Aviation Supply Depot, Code 105, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120)

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.

Institute of Electrical and Electronics Engineers (IEEE)

Test Code for Aircraft A-C Generators #80b

(Copies of IEEE Publications may be obtained from the Institute of Electrical and Electronics Engineers, 33 West 39th Street, New York, N.Y.)

3. REQUIREMENTS

3.1 Qualification - Qualification under this specification is required. The system furnished under this specification shall be a product which has been tested and has passed the qualification tests specified herein and approved for listing on the applicable Qualified Products List unless agreement is obtained in writing from the qualifying activity that no qualified product is practical for the application. In which case, a product which has been tested to and has qualified to a detail specification accepted in writing by the Qualifying Activity may be utilized. In either

case, each system delivered shall fully meet all the requirements of the detail specification and shall be capable of successfully completing the tests required by the detail specification for acceptance and for qualification verification or for any one of the qualification samples.

3.2 Precedence - The contract shall have precedence over any specification. Whenever the requirements of this specification and the detail specification or standard conflict, the requirements of the detail specification or standard shall govern. Any deviation from this specification or from subsidiary specifications or standards, where applicable, are subject to approval in writing of the Qualifying Activity.

3.3 Materials

3.3.1 Selection of Materials, Parts, and Processes - Materials, parts and processes shall conform to applicable Government specifications. Materials conforming to contractor's specifications may be used provided the specifications are approved by the Government and contain provisions for adequate tests.

The use of contractor's specifications will not constitute waiver of Government inspection. Military Standard parts shall be used wherever they are suitable for the purpose, and shall be identified on the drawing by their standard part number. In the event there is no suitable standard part in effect on the date of invitation for bids, commercial parts may be used providing the requirements of this specification are met.

3.3.2 Nonmetals - Nonmetals used, including plastics, fabrics, and protective finishes, shall be moisture resistant and shall not be adversely affected by weather, aircraft fluids, temperatures, and ambient conditions defined by the applicable specifications. Nonmetals may be treated to conform to this requirement.

3.3.3 Metals

3.3.3.1 Corrosion Resistance - Materials shall be of a corrosion-resisting type or suitably processed to resist corrosion. Any corrosion occurring during the testing provided herein, that causes malfunctioning of the equipment, shortening of life, impairment of use, or impairment of ease of replacement of parts shall cause for rejection.

3.3.3.2 Dissimilar Metals - Dissimilar metals as defined by Standard MS33586, when used in contact with each other, shall be protected against electrolytic corrosion, and the junction shall have a low impedance path to radio frequency currents.

3.3.3.3 Magnesium Alloy Parts - Magnesium alloy shall not be used in parts contacted directly by blast air or parts exposed directly to weather. Magnesium alloy parts used shall be processed in accordance with specification MIL-M-3171.

3.3.4 Toxic Material - Material which under any specified condition or fire produce toxic effects harmful to humans shall not be used.

3.4 Design and Construction - All system components shall conform to the applicable detail specification or drawing.

3.4.1 Workmanship - All machined surfaces shall have a smooth finish, and all details of manufacture, including the preparation of parts and accessories, shall be in accordance with the best practice of high quality electric equipment. Particular attention shall be given to neatness and thoroughness of soldering, wiring, impregnation of coils, markings of parts, plating, lacquering, riveting, clearance between soldered connections, removal of burrs and sharp edges, and ruggedness.

3.4.2 Environmental Requirements - All components shall operate in accordance with this specification when subjected to the following conditions.

3.4.2.1 Temperature and Altitude - The ambient temperature conditions for liquid cooled generators shall be as defined in the detailed specification or drawing. System components cooled with blast air shall fully support the system when supplied specified ram air within the temperature-altitude limits of MS 33543. Self cooled static system components shall operate continuously within the range defined by MS 33543, Curve I, to the maximum altitude required by the detail specification or drawing except that the ambient temperature will not exceed 55°C. Heat rejection and coolant delivery for these components shall not exceed the values specified in the detailed specification or drawing.

3.4.2.2 Humidity - As required by paragraph 4.5.25.

3.4.2.3 Salt Spray - As required by Specification MIL-E-5272, Procedure I, for control components and liquid cooled generators. As required by paragraph 4.5.20.2 for blast cooled generators and blast air cooled heat exchangers.

3.4.2.4 Fungus - As required by Specification MIL-E-5272, Procedure I.

3.4.2.5 Sand and Dust - As required by paragraph 4.5.22.

3.4.2.6 Shock - As required by paragraph 4.5.24.

3.4.2.7 Vibration - As required by paragraph 4.5.23.

3.4.2.8 Acceleration - The system components shall be capable of withstanding without failure the acceleration loads specified in the detail specifications.

3.4.3 Operating Positions - All system components except the generator shall operate in any position. The operating position of the generator shall be as required by the detail specification or drawing.

3.4.4 Simplification - Simplicity of design by use of identical parts in as many applications as possible is highly desirable. For example, two ball-bearing assemblies in a generator could be identical, and the same assemblies can be used in generators of several ratings.

3.4.5 Configuration - The system configuration shall be in accordance with the detail specification or drawings.

3.4.6 Consolidation of Control Components - Except for the current transformers which must be remotely located, all protection and control components shall be consolidated into one unit.

3.4.7 Manual System Control - Provision shall be made for manual control of the generating system, to be accomplished by means of one switch. This switch shall be a standard switch and shall perform the following control functions:

NORM - Generator automatically come on the bus when its electrical characteristics are within prescribed limits.

OFF-RESET - Generator deenergized and main line contactor open. Generator warning light "ON".

TEST - (Momentary) Generator energized, main line contactor open. Protective system operative. Generator warning light "OFF" if power is within prescribed limits, otherwise light is "ON". (The test function is required only if specifically required by the detail specification).

3.4.8 System Capacity (rating) - The system rating as specified by the detail specification or drawing shall be based on 115/200 volt, 400 Hz, 3 phase, 4 wire electric power. All system ratings are at the point of regulation which is the point at which each system is connected to its 400 Hz load bus. The generator shall be sized for a 5 volt drop in each feeder at rated load between the generator terminals and the point of regulation. All ratings defined in the following subparagraphs are applicable over the generator speed range and environmental conditions defined in the detail specification. If the system is defined with a slash rating it shall be capable of meeting all the requirements of this specification at either rating, except overload and short circuit capacity shall be based on the lowest specified continuous duty rating. The voltage limits of Figure 3 pertain.

3.4.8.1 Continuous Capacity - Each system shall be capable of continuously delivering its rated capacity over the specified generator speed range and at power factors of from 0.75 lagging to 1.00. When operation in parallel is required the electric load, both real and reactive, carried by any one system shall not deviate from the average by more than ten percent at any instant (transients at instant of paralleling excepted) or by 5 percent for any one minute period when measured line-to-neutral.

3.4.8.2 Overload Capacity - The system shall be capable of delivering 150 percent rated current at any power factor from 0.75 lagging to unity, for 5 minutes. It shall also be capable of supplying 200 percent rated current at any power factor from 0.75 lagging to unity, for 5 seconds. When operation in parallel is required the electric load, both real and reactive, carried by any one system during overload shall not deviate from the average by more than ten percent.

3.4.8.3 Short Circuit Capacity - Each system, when operated singly or in parallel, shall produce a minimum of 300 percent of rated load current into single phase, two phase, and three phase line-to-line and line-to-neutral short circuits for 5 seconds.

3.4.9 Generator Design

3.4.9.1 Mounting and Driving Provision - The means of generator mounting and driving shall be as specified in the detail specification.

3.4.9.2 Flexible Drive and Shear Section - Generators incorporating a bearing at the drive end of the rotor shall be equipped with a flexible drive coupling. A shear section shall be incorporated between the generator driving spline and the rotor, the strength of which shall be in accordance with the detail specification.

3.4.9.3 Electric Connections - The generators shall be supplied with suitable terminals for connection to external cable. Terminals shall be marked as shown on the applicable drawing. For three phase generators phase sequences shall be T_1, T_2, T_3. Neutral terminals for these three phases shall be T_4, T_5, and T_6 respectively. If a single neutral terminal is required, it shall be marked G. The main terminal block on the generator shall provide for output connections only. Terminations required in the generator control circuits shall be brought out as designated in the detail specification. All terminals shall be provided with nonflammable insulating protective covers. All terminal studs shall be steel RC 34 minimum hardness and a nut, MS 90415 or MS 3376 shall be used to secure external leads to the unit. The stud is not to be utilized as a conductor. Insulation materials shall not be utilized to establish and maintain the compressive forces required for electrical contact surfaces. The protective cover shall cover the main terminal block and all attached terminal lugs. The cover shall withstand normal handling and installation without damage.

3.4.9.4 Direction of Rotation - Unless otherwise specified, direction of rotation shall be counterclockwise when viewing the generator drive end. Direction of rotation shall be indicated on the generator.

3.4.9.5 Brushes - Brushes shall not be used

3.4.9.6 Cooling -

3.4.9.6.1 Air Cooling - When externally ducted air is required for cooling the generator, provisions for entrance and exit shall be provided by means integral with the generator. The inlet duct, if located radially, shall be positionable to at least four approximately equally spaced, radial positions.

3.4.9.6.1.1 Altitude Rating Chart - The generator manufacturer shall supply an altitude rating chart for air cooled generators (10,000 hour life) giving the safe allowable rating for the equipment based on MTBO (reference 3.4.9.7). This chart shall cover a range of altitude, temperature, and load as specified in Table II. The spacing and number of lines shall be selected to provide an accuracy of 10%. The rating chart shall be prepared for minimum rated lagging power factor loading. Generator minimum rated speed shall be used. Rating charts, Figure 2, shall be used as a guide. The chart shall cover ratings for both blast cooled and self cooled generators. Not required for liquid cooled generators.

3.4.9.6.2 Liquid Cooling - The generator shall operate continuously within specification limits when supplied with inlet oil conforming to MIL-L-23699 (or MIL-L-7808 if required by the detail specification) of temperatures from -40°C to 150°C, shall operate for 5 minutes when supplied this oil at temperatures between 150°C and 165°C, and when supplied no oil for an interval of one minute minimum. The maximum cooling oil pressure at the inlet port to the generator with respect to the generator ambient pressure, is 300 PSI at oil temperatures of -55°C and 150 PSI at 125°C. Maximum oil pressure, with respect to ambient pressure, at any other oil temperature is defined by a straight line through these two points. The flow of oil available to the generator will vary directly as the viscosity of MIL-L-23699 oil from none at -55°C to the maximum value shown by the detail specification. For oil temperatures of from 44°C to 100°C, a differential oil pressure of 55 ± 5 PSI will be maintained across the generator at the maximum value shown by the detail specification or drawing. At oil temperatures of 100°C to 165°C, the differential oil pressure will be maintained at 55 ± 5 PSI or the oil flow will be maintained at the maximum value of oil flow specified by the detail specification, whichever occurs first.

3.4.9.7 Life of Generator - Generators shall have a service life of 10,000 hours with no maintenance other than the following. Grease lubricated bearings may be replaced, relubricated, or have seals replaced at intervals not less than 2,000 hours. Grease lubricated splines may be relubricated at intervals not less than 750 hours or they may be replaced if readily detachable from the generator, at intervals not less than 750 hours. Oil lubricated bearings, bearing seals, and oil lubricated splines may be replaced at intervals not less than 5,000 hours.

3.4.9.8 Excitation - No source of excitation shall be required other than that supplied by the system.

3.4.10 Control Component Design - Control components shall conform to the requirements of specification MIL-E-5400 except where specific requirements are covered herein. The temperature-altitude requirements of paragraph 3.4.2.1, herein, shall pertain.

3.4.10.1 Voltage Setting - The voltage setting of the regulator shall be fixed during manufacture or overhaul. No adjustment shall be required at time of installation or between overhauls. There shall be no external adjustment means provided.

3.4.10.2 Slide Wire Devices - Slide wire devices using clamp or set screw type contacts shall not be used.

3.4.10.3 Life - System control components shall have a minimum of 5000 hours service life without overhaul or repair.

3.4.10.4 Mounting - Neither shock nor vibration mounts shall be used.

3.4.10.5 Modular Construction - The basic assembly may be subdivided into individual modules or packages which are completely encapsulated in potting compound. Such non-repairable modules are not to exceed a value of $150 to the Government, in production lots, without specific written approval of the qualifying activity. When used, microelectronic modular assemblies shall meet the requirements of AR-5.

3.4.10.6 Potting Compounds - Potting compounds shall be selected and used in accordance with MIL-STD-454, requirement 47.

3.4.11 Color - All system components shall be finished in a color conforming to Federal Standard 595, color number 17875 except that as an alternate the generator may be finished with a chemical film resulting in an aluminum or stainless steel color. The finishes shall be unaffected by the environmental tests specified by the detail specification or drawing.

3.4.12 Markings

3.4.12.1 Terminals - Markings of terminals shall be as specified in 3.4.9.3.

3.4.13 Identification of Product - Equipment, assemblies, and parts shall be marked as specified in Standard MIL-STD-130. The nomenclature appearing on the nameplate shall be as shown on the applicable detail specification.

3.4.13.1 Nomenclature - Nomenclature plate conforming to MIL-STD-444 shall identify the item and shall be securely attached to a fixed, accessable portion of each unit.

3.4.13.2 Use of MS Designations - MS designations shall not be applied to a product, unless specifically authorized by the procuring activity.

3.4.14 Installation Instructions - The contractor shall pack with each system component one printed copy of simple instructions, with illustrations and required diagrams covering installation. These instructions shall be protected to withstand and remain completely legible under the humidity and fungus requirements specified herein for control components. Prior to printing, two copies shall be furnished the qualifying activity for approval of content, presentation, and means of attachment.

3.4.15 Provisions for Maintainability - (Applicable to Navy Procurements)- Built-in test equipment, construction and packaging, and provisions for test points shall be as specified in Specification AR-10 excluding section 3.3. Equipment shall be compatible with VAST (Versatile Automatic Shop Test System) and shall meet the requirements of Specification AR-8. VAST Test Programs shall be furnished in accordance with Specification 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 Specification AR-9.

3.4.15.1 Overhaul - Complete overhaul of each system component in accordance with overhaul instructions approved by the qualifying activity shall not exceed the time specified by the detail specification when performed by personnel with the recommended skill level.

3.4.16 Maintainability - (Applicable to Air Force procurements) - The generating system shall meet the following maintainability requirements.

3.4.16.1 Scheduled Inspections - Schedule inspection maintenance requirements of the equipment shall be compatible with MIL-M-23618. Hourly postflight and periodic inspections will occur at a minimum number of flying hours as specifiedin the detail specification.

3.4.16.2 Scheduled Maintenance - Scheduled maintenance on the equipment shall not average more than the values specified in the detail specification for elapsed hours and maintenance manhours. Operating time between overhaul shall be in accordance with the detail specification.

3.4.16.3 Unscheduled Maintenance - Unscheduled maintenance shall not require more than the average manhours per operating hour as specified in the detail specification.

3.4.16.4 Maintenance Environment - The equipment design shall be such that "on-craft" maintenance tasks can be performed under any ground operating environment. Maintenance must be capable of being performed by personnel wearing clothing required by the particular environment.

3.4.16.5 Materials and Processes - No material or process required for flight line or shop maintenance shall require uncommon skills (Ref AFM 39-1), AGE, techniques, or excessive task times. Due consideration shall be given to the application of such materials and processes in austere base operating environments.

3.4.17 Reliability - The generating system shall have a mean time between failure (MTBF) as specified in the detail specification.

3.5 Performance - All characteristics specified herein are at the point of regulation. (See paragraph 6.2.2)

3.5.1 Voltage Limits - The transient and steady state voltage shall remain within the limits of Figure 3 for all balanced load conditions while the system is operating under all the environmental and load conditions defined herein.

3.5.2 Voltage Modulation -

3.5.2.1 Amplitude - The modulation of voltage shall not exceed an amplitude of 1.0 volts as measured peak to peak difference between the minimum and the maximum voltage reached during any one second.

3.5.2.2 Frequency Characteristics of the Voltage Modulation - The frequency characteristics of the voltage modulation shall be confined within the envelope of limits shown in Figure 4.

3.5.3 Phase Displacement and Voltage Unbalance - The displacement between phases and voltage unbalance shall be within the prescribed limits when the system is tested in conformance with paragraph 4.5.6.

3.5.4 Wave Form - The crest factor for each phase voltage wave form shall be 1.41 ± 5%. No single harmonic shall exceed 1.5% of the fundamental. The total harmonic content shall not exceed 3% for all normal operating conditions of the system.

3.5.5 Integral Control Power - The system shall provide control power which may be required for build up, operation of the protective equipment (under fault) and reset control of the system. Power for external use shall be furnished for maintaining contactors including conditions during short circuit. This power shall have the following characteristics: minimum volts DC; 20, maximum volts DC; 30, ripple; 2 volts peak to peak maximum, rated current output: 5 amps minimum continuous capacity.

3.5.6 System Build Up - The system shall provide build up without the aid of power which is external to the generating system.

3.5.7 Fault Clearing Characteristics

3.5.7.1 False Trips - No tripping of the system shall be caused by build up, load switching, input speed acceleration or deceleration, external fault application, or fault clearing.

3.5.7.2 Overvoltage - Overvoltage protection shall be provided by a static element which functions to disconnect the system from the load bus and

deenergize the generator before the voltage at the point of regulation exceeds the limits defined by the maximum overvoltage curve of Figure 6. Manual reset of this protective element shall be possible by putting the generator switch (see paragraph 3.4.7) in the "OFF RESET" position (then to "ON") if the output voltage of the system is less than that defined by the maximum overvoltage curve of Figure 6. There shall be no automatic reset of this protective element.

3.5.7.3 Undervoltage - Undervoltage protection shall be provided by a static element which functions to disconnect the system from the load bus and deenergize the generator within a period of from 3.5 to 5.0 seconds after any phase voltage (line-to-neutral) falls below 100 volts. Manual reset of this protective element shall be possible by putting the generator switch (see paragraph 3.4.7) in the "OFF RESET" position (then to "ON") if the voltage on each phase exceeds 110 volts. Reset shall be automatic when the system is shut down. After either automatic or manual reset, the undervoltage protection element shall provide for the system to be automatically reconnected to the load bus within 2 seconds after the lowest phase voltage exceeds 110 volts.

3.5.7.4 Underfrequency - Underfrequency protection shall be provided by a static element which functions to disconnect the system from the load bus within a period of from 1 to 3 seconds after the frequency falls below 375 Hz. Manual reset shall be possible by putting the generator switch (see paragraph 3.4.7) in the "OFF RESET" position if the output frequency of the system exceeds 385 Hz. After either automatic or manual reset the underfrequency protection shall provide for the system to be automatically reconnected to the bus within 2 seconds after the frequency exceeds 385 Hz.

3.5.7.5 Overfrequency - Overfrequency protection shall be provided by a static element which functions to disconnect the system from the load bus and deenergize the generator within a period of time 1 to 3 seconds after the frequency exceeds 425 Hz. Manual reset of this protective element shall be possible by putting the generator switch (see paragraph 3.4.7) in the "OFF RESET" position (then to "ON") if the output frequency of the system is less than 415 Hz. There shall be no automatic reset of this protective element on shut down of the system.

3.5.7.6 Feeder Fault - The system shall provide for the generator to be deenergized and disconnected from the load bus when the fault current on any phase exceeds 25 amperes.

3.5.7.7. Anti-Cycling - The system shall provide a means to prevent cycling the system when a fault exists. The control unit shall reset once after a fault upon activation of the control switch to the "OFF RESET" position, and if the fault remains, the unit shall trip and remain tripped until the control switch is reactivated to the "OFF RESET" position, (then to "ON").

3.5.8 Electromagnetic Interference - The system shall meet the requirements of MIL-STD-461, Class No. III-B for the generators and control equipment.

3.5.9 Automatic Paralleling - When required by the detail specification the system shall be capable of automatically paralleling with one or more similar systems.

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

3.7 Screw Threads - Screw threads shall conform to the requirements of Specification MIL-S-8879.

3.8 Safety Wiring and Staking - Accidental loosening of screws, screw parts, and connections shall be prevented by safety wiring, staking, or other approved methods. Safety wiring shall conform to Standard MS33540. Staking shall be used only when parts are permanently assembled.

4. QUALITY ASSURANCE PROVISIONS

4.1 Inspection Responsibility - The supplier is responsible for the performance of all inspection requirements as specified herein prior to submission for Government inspection and acceptance. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. Inspection records of the examinations and tests shall be kept complete and available to the Government.

4.2 Classification of Tests - The inspection and testing of electric power systems shall be classified as follows:

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

(b) Acceptance Test - Acceptance tests are those tests accomplished on generator systems manufactured and submitted for acceptance under a production contract.

(c) 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 meet all the requirements of the detail specification or drawing.

4.3.1 Qualification

4.2.1.1 Qualification - A system will be considered qualified and placed on the Qualified Products List if qualification test samples (as defined below) successfully complete the qualification tests designated by Table I in essentially the order listed and upon acceptance by the Qualifying Activity of a maintenance plan as defined in AR-10. System components will be retained in the Qualified Products List as long as the qualification verification samples are delivered as required below (paragraph 4.2.3) and continue to demonstrate conformance to the applicable detailed specification or drawing.

4.2.1.1.1 Qualification Test Sample - The qualification test sample shall consist of: (a) three (3) systems as described by the detailed specification or drawing; (b) a mating plug for every connector used on system components in the three systems; (c) two (2) sets of component wiring diagrams, detail assembly drawings, outline drawings, and operating instructions; and (d) three (3) copies of the material to be included in the installation instructions to be packaged with each production unit and an example of how this material is to be printed, protected, and attached to the unit. Sample system No. 1 shall be instrumented by the manufacturer to permit the measurement of critical component temperatures. The temperature instrumentation used and the location of the temperature measuring points shall be monitored throughout the qualification tests of Sample No. 1.

4.2.2 Qualification Testing - Qualification testing must be specifically authorized by the qualifying activity. The testing may be done by the manufacturer with approval by the qualifying activity. A test report, conforming to MIL-STD-831, covering such testing is required. At the option of the qualifying activity, any qualification test or all qualification tests (as required for any qualification sample) may be conducted on components submitted for qualification, for production acceptance, or on any system components delivered under a production contract for which conformance to this specification is required.

4.2.3 Qualification Verification of Production Systems - Each system component of the same part number delivered as a qualified item under this specification shall be numbered sequentially in essentially the order that it is submitted for Government acceptance regardless of the contract under which delivered or by whom purchased. To meet the delivery requirement for the first 50 components, 51 components must successfully complete the required acceptance tests; 50 of which are to be shipped as directed by the applicable contracts; and one component selected at random by the Government Inspector is to be forwarded to the Naval Air Test Center, (WST33) Patuxent River, Maryland. To meet the delivery for each succeeding 150 components, 151 components must successfully complete the required acceptance tests, 150 of which are to be shipped as directed by the applicable contract, and one component selected and forwarded as above. 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 1 for Qualification Verification or for any one of the qualification samples at

the discretion of the qualifying activity. Delivery of production components 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 qualification is officially rescinded. All qualification verification samples become Government property when accepted by the Government Inspector for shipment to the Naval Air Test Center.

4.2.4 Rejection and Retest of Qualification and Qualification Verification Samples - Components which have been rejected or returned to the manufacturer for any reason during qualification or qualification verification tests, may be reworked or have parts replaced to correct defects. Before resubmitting the components, full particulars concerning the rejection and the corrective action taken by the manufacturer must be submitted in writing by the manufacturer to the qualifying activity. Tests shall not be resumed until such a report is received. Where qualification tests are conducted under the auspicies of the manufacturer, the qualifying activity shall be advised upon failure of a qualification sample and of the action taken by the manufacturer with regard to failure.

4.3 Acceptance

4.3.1 Acceptance Requirements - Electric power systems or system components produced under this specification will be accepted if:

a. Qualified to this specification as amended by the detail specification or drawing and if the qualification is sustained in conformance with paragraph 4.2.3.

b. Acceptance tests of Table I are successfully completed.

c. Approved installation instructions are securely attached to each system component in such a way that they need not be removed for check out of the component prior to its installation on the aircraft.

d. A package holding one nut, MS90415-6, for each mounting hole in the generator flange is securely attached to each generator in such a way that it need not be removed for check out of the component prior to installation on the aircraft.

e. All changes to equipment have been processed in accordance with MIL-STD-481.

4.3.2 Rejection and Retest of Units Submitted for Acceptance - Units that have been rejected may be reworked or have parts replaced to correct the defects and resubmitted for acceptance. Before resubmitting full particulars concerning previous rejection and the action taken to correct

the defects found in the original shall be furnished the Government Inspector. Units rejected after retest shall not be resubmitted for repetition of tests without the specific approval of the Government Inspector.

4.4 Test Conditions - Unless otherwise specified, each test in this section shall be conducted under either condition more as described below.

4.4.1 Condition A - Under this test condition the following conditions as well as those specified by paragraph 4.4.2 pertain unless specifically amended by the test herein.

4.4.1.1 Mounting

4.4.1.1.1 Generator - The rotational axis of the generator shall be horizontal. Adequate thermal insulation shall be placed between the generator and the drive stand to reduce the heat transfer between them to a negligible value. The generator shall be driven at average rated speed.

4.4.1.1.2 Control Components - The control components shall be mounted with base down and horizontal. Adequate thermal insulation shall be placed between the control components and any objects with which it comes in contact to reduce heat transfer to a negligible value.

4.4.1.2 Generator Cooling -

4.4.1.2.1 Air cooled Generators - The generator inlet air temperature shall be kept within 5° of the temperature and altitudes specified by the individual tests. The generator cooling air flow shall be adjusted to supply whichever of the following criteria results in the smaller airflow

a. 11.0 inches + 0, -1.0 in. water

b. The airflow shown in Figure 5

4.1.2.2 Liquid Cooled Generators - The generator coolant temperature and pressure shall be maintained within the limits designated for the individual tests.

4.4.1.3.1 Generator Insulation - The external surface of the generator shall be covered with sufficient insulation to assure that the heat extracted by the specified air flow is not affected by the ambient of the surrounding air.

4.4.1.3.2 Control Components - The ambient air temperature and temperature of all surrounding objects shall be within ± 5°C of the values specified by the detail specification. The ambient air velocity shall be less than 5 knots actual airspeed.

a rated standard voltage, the total rms null voltage as well percent from

4.4.1.4 Generator Thermal Instrumentation - One of the generators submitted for qualification shall be instrumented by the manufacturer to permit measurement of critical temperatures. The instrumentation shall not change the electrical or thermal characteristics of the unit. The instrumentation used and location of the temperature measurement points shall be subject to approval by the qualifying agency.

4.4.2 Condition B - Under this test condition the following conditions as well as those specified by paragraph 4.4.3 pertain unless specifically amended by the test herein.

4.4.2.1 Mounting -

4.4.2.1.1 Generator - The rotational axis of the generator shall be horizontal and the unit driven at average speed.

4.4.2.1.2 Control Components - Control components shall be mounted base down and horizontal.

4.4.2.2 Environment - The generator inlet coolant temperature shall be 25°C ± 15°C. If a liquid coolant is employed for the generator the inlet temperature shall be 100 ± 5°C. System component ambient temperature shall be approximately room ambients.

4.4.2.3 Generator Cooling

4.4.2.3.1 Air Cooled Generators - The cooling airflow shall be adjusted to supply whichever of the requirements described below will result in the smaller mass flow. (This paragraph shall not be interpreted to establish pressure-airflow characteristics.)

a. Mass flow indicated in Figure 5.

b. 6.0 inches + 0-1 inches water

4.4.2.3.2 Liquid Cooled Generator - The flow of liquid coolant shall be in accordance with the detail specification.

4.4.3 General Test Conditions - The following are applicable to equipment tested under both condition A and B above.

4.4.3.1 Equipment Operation - The generator shall be controlled throughout all tests of this specification by the components with which it is to be qualified. System components shall be operated during all tests. The systems are not to be operated in parallel.

4.4.3.2 Warm Up - Unless otherwise specified, prior to each test the generator shall be operated at approximately average rated speed, delivering rated current at rated voltage sufficient time to reach a constant temperature. (See 4.4.3.4 and 4.4.3.5)

4.4.3.3 Voltage Measurement - Line-to-neutral value of the regulated system voltage shall be measured at the point of regulation.

4.4.3.4 Generator Feeder Voltage Drop - Tests shall be conducted with feeders between the generator and point of regulation sized to give a 5 volt drop per feeder when the generator is delivering full load current.

4.4.3.5 Load Power Factor - Rated minimum lagging power factor shall be used.

4.4.3.6 Phase Loading - The load per phase shall be balanced with 5 percent.

4.4.3.7 Speed - Unless otherwise specified, for constant speed generator (specified speed variation ± 5 per cent or less), all tests shall be run at average speed. For all other generators, the unit shall be operated at minimum average, and maximum rpm.

4.4.3.8 Component Operation - All system components shall operate throughout each test.

4.4.3.9 Altitude - The tests shall be run at approximately sea level (30 ± 3 in Hg).

4.4.4 Characteristic Data - Resistances, reactances, and time constants for the generator assembly shall be determined in accordance with the IEEE Test Code for aircraft AC generators or as approved by the qualifying activity. These data shall be included with the test report.

4.5 Test Methods -

4.5.1 Examination of Product -

(a) Qualification Test: Each system component and all parts submitted for qualification tests shall be examined as the Inspector may deem necessary to determine conformance to this specification and the applicable drawings with respect to material and workmanship, cleanliness, standard parts, simplification, mounting flange, coupling spline, lubrication, electric connections, excitation, connections, threaded parts, finish, interchangeability, marking, installation instructions, dimensions, weight, and color.

(b) Acceptance Test: Each system component subassembly and all parts submitted for acceptance shall be examined to determine conformance to this specification with respect to workmanship, cleanliness, lubrication, electric connections, voltage setting, threaded parts, finish marking, installation instruction, and color.

4.5.2 Maximum Speed for Regulation - The generator shall not be warmed up prior to this test. The generator shall be operated at a maximum speed for regulation as specified in the detail specification. The generator and regulator shall deliver rated voltage at no load. The first sentence of this paragraph shall not apply to Acceptance Test for regulators. This test may be conducted under condition A or B.

4.5.3 System Control

4.5.3.1 Qualification Test - Using a recording oscillograph determine conformance of the system to the following while operating under condition A.

(a) With all convection cooled system components mounted in an ambient of -55 ± 5°C and the temperature of the coolant to all system components maintained at -55 ± 5°C determine whether the transient response and steady state voltage regulation conforms to figure 3 at no load, one third load, two thirds load, full load, 150% rated load, and 200% rated load. Under each condition of loading, the determination of transient response and voltage regulation shall be made at minimum generator rpm, at rated (or average rated) generator rpm, and at maximum rated generator rpm. For each load condition the generator excitation shall be interrupted and closed to determine that the voltage output of the generator will build up and remain within the limits of Figure 3. For each load condition determine conformance of the feeder fault protective element to paragraph 3.5.7.6. Under any one of the loading conditions of this paragraph, conformance of all other protective functions of paragraph 3.5.7 are to be determined. When operation in parallel is required repeat the test with systems operating in parallel.

(b) Repeat the tests of 4.5.3.1(a) with component coolants at 25 ± 10°C.

(c) Repeat the tests of 4.5.3.1(a) with component coolants at 60 ± 5°C.

(d) Repeat the test of 4.5.3.1(a) with the systems component coolants at the maximum specified temperature.

4.5.3.2 Acceptance Tests

(a) Each unit submitted for acceptance shall be tested in an ambient of 25 ± 15°C and the coolant to all forced cooled components maintained at 25 ± 15°C. Tests shall be conducted to determine whether the transient response and steady state voltage regulation conforms to figure 3 at no load, half load, full load, and 150% load with the generator turning at rated (or average rated) rpm. During the test at full load the excitation circuit to the generator shall be opened and closed to determine that the generator will build up and remain within the limits of figure 3. Also, during the full load condition, conformance to all of the protective function requirements of paragraph 3.5.7 shall be demonstrated.

(b) One out of every 100 units presented for acceptance shall be subjected to the tests of 4.5.3.1(a) and 4.5.3.1(d). Units so tested shall not be submitted for qualification verification.

4.5.4 Overspeed

4.5.4.1 Qualification Tests - The generator shall demonstrate operation at the overspeed specified in the detail specification for 5 minutes without mechanical failure or impairing subsequent electrical performance. This test shall be made at no load, and the field circuit may be open. Test condition A pertains.

4.5.4.2 Acceptance Test - Conduct the test of paragraph 4.5.4.1 under test condition B on one unit out of every 100 submitted for acceptance.

4.5.5 Dielectric Strength - The generator shall withstand the following test voltage at commercial frequency, applied between winding and between each winding and frame, for the specified time. Control components shall be tested from each terminal to case. (Capacitors and electronic devices shall be disconnected if this test is likely to damage them). Test condition A pertains during qualification testing and condition B during acceptance testing.

(a) Circuits of 50V and less: 500V rms for 1 minute or 600V rms for 1 second.

(b) Circuits over 50V: Twice the rate voltage plus 1,000V for 1 minute, or 120 percent of the 1 minute voltage for 1 second.

(c) Capacitors and electronic devices prior to assembly shall be subjected to and shall withstand a ac test voltage of twice the maximum peak voltage encounted during normal operating conditions.

4.5.6 Exciter Polarity Reversal Test - The generator shall be operating at maximum rated speed, rated voltage, and no load condition. A three-phase fault (single-phase fault on single-phase generators) shall be applied to the terminals of the generator; and after 10 cycles (at the fundamental frequency), the polarity of the exciter shall have returned to and shall remain at a positive value. (Note: If the manufacturer can demonstrate to the satisfaction of the activity responsible for qualification that the generator is so designed as to preclude exciter reversal, this test need not be included as an Acceptance or Qualification Tests.

4.5.7 Warm Up - The generator and control components shall be soaked for at least 10 hours in an ambient temperature of $-55 \pm 5^{\circ}$ (not operating and with no circuits energized). With the generator operating at average rated speed, and no load, the generator and control components shall be energized and readings of the regulated voltage shall be recorded in increments of time close enough together to demonstrate the warm up characteristics for the first 5 minutes of operation unless the regulated voltage has stabilized in less than 5 minutes. The voltage during warm up shall be within 110 and 120 volts. This test may be conducted in connection with the test required by paragraph 4.5.3.1(a). When operation in parallel is required this test is to be repeated with systems operating in parallel.

integrating types specified value for

4.5.8 Phase balance (See paragraph 6.2.o)

4.5.8.1 Qualification Test - The effects of single phase and unbalanced three-phase loads on the balance of the three-phase voltage of the generator shall be determined as follows at unity power factor and at both minimum and maximum rated speeds:

(a) When the generator is carrying no load.

(b) When the generator is carrying no three-phase load, a single-phase line-to-neutral load equal to 1/6, 1/3, and 2/3 of the rated phase current shall be connected.

(c) When the generator is carrying 1/3 rated three phase load, a single phase line-to-neutral load equal to 1/6, 1/3, and 2/3 of the rated phase current shall be connected.

(d) When the generator is carrying 2/3 rated load, a single phase line-to-neutral load equal to 1/6 and 1/3, of the rated phase current shall be connected.

(e) When the generator is carrying 5/6 rated load, a single phase line-to-neutral load equal to 1/6 of the rated phase current shall be connected.

(f) When the generator is carrying a balanced 3 phase load.

(g) When operation in parallel is required, tests (a) through (g) above are to be repeated with the loads increased in each incidence by the number of systems in parallel.

The maximum unbalance of the phase voltage shall be 1, 2, and 4% respectively for the 1/6, 1/3 and 2/3 load unbalance conditions defined above. The phase angle between phases (excluding harmonics) shall be 120 $\pm$ 1°, 120 $\pm$ 2°, and 120 $\pm$ 4° respectively for the 1/6, 1/3, and 2/3 load unbalance condition. For zero and rated balanced three phase load, no phase output voltage (line-to-neutral) shall differ from the average of the 3 phase voltages by more than 0.5 percent and the phase angles shall be within 120 $\pm$ 0.6°.

4.5.8.2 Acceptance Test - For zero and rated balanced three phase load, unity power factor, measure each of the three phase voltages (line-to-neutral). No phase voltage shall differ from the average of the 3 phase voltage by more than 0.5 percent.

4.5.9 Efficiency - The combined efficiency of the generator and the control components shall be determined under the following conditions. At each loading during these tests with the exception of overload, the generator shall be run until its temperature is stabilized. Prior to conducting tests at over 100% rated load, the generator shall be operated at rated load until its temperature is stabilized. The load shall be increase to the desired overload

the environmental tests. It should be noted that the relationships ... each of

and shall remain for the specified time. At the end of the time period, the necessary readings shall be taken and then the overload removed. Test condition A pertains.

(a) Rated voltage

(b) In 1/4 load steps from 1/4 through 1 1/2 rated current

(c) Minimum rated lagging and unity power factor

(d) For generators having a speed range in excess of ± 5.0% maximum generator speeds.

The efficiency at full load shall not be less than that specified in the detail specification.

4.5.10 Short Circuit Capacity - During the course of other tests the ability of the generator and control components to deliver a short circuit current conforming to paragraph 3.4.8.3 shall be demonstrated.

4.5.11 Output- Voltage Modulation - Output voltage modulation is to be measured during the System control tests, paragraph 4.5.3.1, and shall not exceed 1.0 volt peak to peak.

4.5.12 Electromagnetic Interference - At no load and full load, both conducted and radiated electromagnetic interference measurements shall be taken on the complete system using the test procedures and applicable test instruments listed in MIL-STD-461. Measurements shall be made with maximum continuous integral control power being delivered. Tests shall be conducted at maximum and minimum rated generator speed. All systems shall comply with paragraph 3.5.8.

4.5.13 Wave Form - The crest factor and harmonic content, line-to-line and line-to-neutral, of the output voltage shall be determined under the following conditions:

(a) At minimum rated speed specified on the applicable drawing for no load, and in 20 percent load increments to rated load unity power factor.

(b) Condition (a) shall be repeated for minimum rated power factor.

(c) Conditions (a) and (b) shall be repeated at rated speed. The line-to-neutral crest factor obtained by the above test shall be 1.4 10± 5 percent. The value of any harmonic during the above test shall not exceed 1 1/2 percent of the fundamental. The total harmonic content shall not exceed three percent.

4.5.14 Endurance - Two cycles of the following test shall be conducted. When parallel operation is required one cycle shall be made with systems operating in parallel. Test condition A pertains.

(a) Sea Level - Operate 100 hours at sea level conditions. The load shall be suddenly removed and left off for five minutes every two hours. When self-cooling is specified on the detail specification or drawing, 40 hours at minimum rated speed, cooling condition B, except for pressure. The generator shall be loaded at 100 percent rated current at rated voltage.

(b) Intermediate Altitude - Operate for four continuous cycles of 24 hours each at two thirds the maximum altitude indicated by the detail specification. The dew point shall be less that -60°C. The system shall operate at least 1 hour, but no more than 2 hours, at sea level conditions between each cycle. If during changes in altitude, the temperatures, pressure, and flow rate can be brought to the correct values within 5 minutes no definite temperature and flow rate need be maintained.

(c) High Altitude Test - Two continuous cycles of 9 hours each at the maximum altitude specified by the detail specification shall be conducted. The dew point shall be less than -60°C. Between each cycle, sea level runs listed in part (b) shall be repeated.

(d) Low Temperature Test - The generator and control components shall be soaked for 24 hours and then operated for 50 hours at an ambient temperature of -55°C ± 5°C with the generator operating for alternate five hour periods at full load and no load.

(e) The generator and control components shall be operated continuously for 120 hours using the following 6 hours cycle. Following each cycle a 3 phase to neutral short circuit shall be applied.

1 - Full load - 2 hours

2 - No load - 5 minutes

3 - Full load - 2 hours

4 - No load - 5 minutes

5 - Full load - 1 hour, 50 minutes

During each part of this test, (a) through (e), the voltage regulation and modulation shall remain within limits. Following this test, the requirements of paragraph 4.5.3.1(b) shall be met.

4.5.15 Operating Position - During the course of other tests a 10-hour accumulation of time with the generator mounted vertically with no malfunctions shall be considered a sufficient demonstration of all attitude capability. Other components shall demonstrate that they are unaffected by position.

4.5.16 Switching Operation - The system shall be operated to determine compliance with paragraph 3.4.7.

4.5.17 Protective Operation - An analysis shall be made of the generating system to determine which faults, as defined in paragraph 6.2 will result in tripping of the protective devices, or could possibly result in the system not meeting the requirements of paragraph 3.5 of this specification. Sufficient tests shall be conducted to determine the validity of the analysis when operating singly or in parallel, when required. Samples of faluts shall be applied to the system to determine that the protective devices operate within the specified limits of paragraph 3.5.7 of this specification. By a combination of analysis and testing it shall be determined if the requirements of paragraphs 3.5.5 (Integral Control Power) and 3.5.7 (Loading and Fault Clearing Characteristics) of this specification are met. In the case of a feeder fault, it shall be applied between the generator terminals and the point of regulation.

4.5.18 Standard Performance - Control Components shall be tested in a generating system described in this specification or its equivalent. At rated speed no load, each of the electric protective devices shall be operated by application of a simulated fault and the protective device shall operate within the specified limits. When operation in parallel is required repeat the tests with systems operating in parallel. Test condition A pertains for qualification testing and test condition b pertains for acceptance testing.

4.5.19 Generator Fault Torque - Based on stabilized operating temperatures under the various required operating environments, an analysis shall be made of the generating system to determine maximum torque resulting from any fault as defined in paragraph 6.2.1. This maximum torque is to be determined analytically by allowing the external impedance between the generator and the short circuit to take on any value at any lagging power factor between zero and unity while the external balanced load is maintained at rated impedance and 0.75 power factor

When the fault impedance producing maximum torque has been determined, it is to be applied for a minimum of five seconds with transient and steady state torques recorded. Protective functions shall be deactivated during this test.

4.5.20 Salt Spray - Following each of the salt spray tests listed below the requirements of paragraph 4.5.3.1(b) shall be met.

4.5.20.1 Control Components, Installation Instructions, and Liquid Cooled Generators - The control components and liquid cooled generator shall be subjected to 50 hours of the Salt Spray Test specified in Specification MIL-E-5272, Procedure I.

4.5.20.2 Generators, Air Cooled and Blast Cooled Heat Exchangers - Air Cooled generators and blast cooled heat exchangers shall be put through the following tests:

(1) The generator shall first be subjected to the dielectric test of paragraph 4.5.5. This portion of the test is not applicable to heat exchangers.

(2) After the dielectric test each generator shall be immersed longitudionally in engine oil (MIL-L-23699) at 25 ± 10°C up to the bearings and the complete unit rotated in the oil approximately 60° every 15 minutes and 16 hours after which the generator is to be drained for one hour. Heat exchanges shall be submerged in engine oil (MIL-L-23699) at 25 ± 10°C for 16 hours and then drained.

(3) Subject the drained generator and heat exchangers to 25 four hour cycles during which engine oil (MIL-L-23699) shall be continuously injected into the cooling air at the rate of 5 milliliters per hour. During the first two hours of each cycle synthetic sea water formulated as follows shall be continuously introduced with the cooling air at the rate of 8.33 milliliters per minute:

COMPOUND	GRAMS PER LITER
Sodium Chloride	24.540
Magnesium Chloride	11.110
Sodium Sulphate	4.094
Calcium Chloride	1.159
Potassium Chloride	0.695
Sodium Bicarbonate	0.201
Potassium Bromide	0.101
Boric Acid	0.027
Strontium Chloride	0.042
Sodium Flouride	0.003

(Adjust the PH of this solution if necessary, to 8.2 with 0.1 normal sodium carbonate solution).

For the next ten minutes 150 milliliters of fresh water per minute shall be continuously injected into the cooling air. For the last one hour and 50 minutes of the cycle no water is to be injected into the cooling air. The loads on units under test shall be rotated as follows in successive cycles: No load, one half load, three quarter load, and full load.

(4) Conduct a dielectric test in accordance with paragraph 4.4.5. Demonstrate adequate cooling capacity of the cooler tested to cool the system at the maximum operating temperature specified by the detailed specification or drawing.

4.5.21 Fungus Resistance - All system components shall be subjected to the fungus resistance tests, Procedure I, of Specification MIL-E-5272 with the installation instructions and mounting nuts (as required by paragraph 4.3.1) attached. Following this test, the generator shall deliver rated load at average rated speed for 2 hours, the control components shall demonstrate their ability to meet the requirements of paragraph 4.5.3.1(b). Instructions are to be legible. Mounting nuts are to be unaffected and the package holding the nuts suitable for shipment. Components are not to operate during this test.

4.5.22 Sand and Dust - System components shall be subjected to the following test:

4.5.22.1 Particle Size - The sand and dust used in the test shall be of angular structure and shall be of the following particle size.

(a) 100 percent of the sand and dust shall pass through a 100-mesh screen, U. S. Standard Sieve Series.

(b) 98 ± 2 percent of the sand and dust shall pass through a 140-mesh screen, U. S. Standard Sieve Series.

(c) 90 ± 2 percent of the sand and dust shall pass through a 200-mesh screen, U. S. Standard Sieve Series.

(d) 75 ± 2 percent of the sand and dust shall pass through a 325-screen, U. S. Standard Sieve Series.

4.5.22.2 Chemical Content of Particles - Chemical analysis of the dust shall be as follows:

SUBSTANCE	PERCENT BY WEIGHT
$Si\ O_2$	97 to 99
$Fe_2\ O_3$	0 to 2
$Al_2\ O_3$	0 to 1
$Ti\ O_2$	0 to 2
Mg O	0 to 1
Inorganic Losses	0 to 2

4.5.22.3 PROCEDURE

4.5.22.3.1 Location of Specimens - Test specimens shall be placed in a test chamber equal to that specified in MIL- C-9436 and shall be positioned so as to insure the most uniform exposure, so that they do not contact each other, and so that they do not shield each other from the dust. Whenever practicable, the specimens shall be supported as in service.

4.5.22.3.2 Test Conditions

4.5.22.3.2.1 Part I - The internal temperature of the chamber shall be maintained at 25°C (77°F) with a relative humidity that shall not exceed 30 percent at anytime during the test. The sand and dust density shall be raised to and maintained at 0.1 to 0.25 gram per cubic foot within the test space. The sand and dust velocity through the test chamber shall be 2500 ± 500 feet per minute (fpm). The test specimen shall be operated no load but other applicable operating conditions such as rated voltage, frequency, speed, etc., shall be maintained. This portion of the test shall be continued for 2 hours.

Part II - Following this 2 hour period the chamber temperature shall be raised to and maintained at 71°C (160°F). The sand and dust velocity through the chamber shall be between 100 to 500 feet per minute (fpm). All other test requirements outlined in Part I shall be continued and this portion of the test shall be performed for 2 hours.

4.5.22.3.3 Removal of Dust - Upon completion of the exposure period, the test specimen shall be removed from the chamber and allowed to cool at room temperature. Accumulated dust shall be removed from the test item by brushing, wiping or shaking, and with care being taken to avoid the introduction of additional dust into the specimen. Under no circumstances shall dust be removed by either blast or vacuum cleaning.

4.5.22.3.4 Performance - After exposure and dust removal, the test of paragraph 4.5.3.1(b) must be successfully completed, and the test specimen shall be operated and measurements made as specified. Bearings, grease seals, relays, contacts, etc., shall then be carefully examined for the presence of sand and dust deposits. Deterioration or change in performance of any component which could in any manner prevent the equipment from meeting functional, maintenance, and service requirements during service life shall provide reason to consider the equipments as having failed to comply with the conditions of the sand and dust test.

4.5.23 Vibration

4.5.23.1 Qualification Test - Test condition A pertains.

4.5.23.1.1 Generator - The generator shall be vibrated in accordance with Procedure XII of MIL-E-5272 except the maximum temperature shall be the maximum sea level temperature as defined in the detail specification.

4.5.23.1.2 Control Components - Tests shall be performed in accordance with MIL-E-5272, Procedure XII, except that the vibration range shall be extended

from 500 Hz to 2000 Hz. Testing in the 5 to 500 Hz vibration range shall conform to MIL-E-5272, Procedure XII, Curve A. For tests in the 500 to 2000 Hz range, the vibration shall be at 0.036 inch double amplitude or an acceleration of ± 10g whichever is the lower value. During the testing, the control components shall control the generator operating at the maximum speed for regulation specified in the detail drawing or specification. The voltage modulation at any vibrating frequency shall be not greater than 1.0 percent due to vibration. Regulation within specified limits shall be demonstrated over the entire test. Protective functions shall be demonstrated during the vibration test. Following this test the control components shall demonstrate their ability to meet the requirements of paragraph 4.5.3.1(b). Any loosening of components or deterioration during this test will be cause for rejection.

4.5.23.2 Acceptance Test - No vibration test is required for generators at time of acceptance. All system control components shall be subjected to a vibration excursion from 5 to 2000 Hz and return to 5 Hz over a 15 minute period. The vibration shall be at 0.036 inch double amptitute or an applied acceleration of ± 10g whichever is the lower value. System components shall operate within specified limits during this test.

4.5.24 Shock - The control components shall be subjected to the following shock tests. Following the test the control components shall demonstrate their ability to meet the requirements of paragraph 4.5.3.1(b) at cooling condition B. The units need not be operable after the equipment crash-safety test of Specification MIL-E-5272.

4.5.24.1 Apparatus Calibration - The actual test item, a rejected item, or a dummy mass shall be used to calibrate the shock machine for conformance with the specified wave shape. When a dummy mass is used, it shall have the same center of gravity, the same rigidity, and the same mass as that of the test item and shall be installed in a manner similar to that of the test item.

4.5.24.2 Instrumentation

4.5.24.2.1 Frequency Response - The frequency response of the complete measuring system, from the accelerometer through the readout instrument, shall be as specified by figure 516.3 of MIL-STD-810B.

4.5.24.2.2 Accelerometer, Piezoelectric - When a piezoelectric accelerometer is employed as a shock sensor, the fundamental resonant frequency of the accelerometer shall be greater than 14,000 Hz, (resonant frequencies of 30,000 Hz or higher are recommended). For suitable low frequency response, the accelerometer and load (cathode follower, amplifier, or other load) shall have the following characteristics:

$$RC = 0.2$$

Where R = Load resistance (ohms)
C = Accelerometer capacitance plus shunt capacitance of cable and load (farads).

4.5.24.2.3 Accelerometer, Strain Gage - A strain gage accelerometer may be used, provided the undamped natural frequency is greater than 1,500 Hz with critical damping approximately 0.64 to 0.70 of critical.

4.5.24.2.4 Accelerometer Calibration - The accelerometer shall be calibrated against a standard transducer or by optical means.

4.5.24.2.5 Accelerometer Mounting - The monitoring accelerometer shall be rigidly attached to the test item support fixture at or near the attachment point of the test item.

4.5.24.3 Test Methods

4.5.24.3.1 Shock Pulse - The shock pulse shall be as shown in figure 516.2 of MIL-STD-810E. All points of the acceleration wave form obtained shall lie within the area enclosed by the tolerance limit lines of figure 516.2.

4.5.24.3.2 Mounting and Equipment Operation - The test item shall be rigidly attached to the shock machine in a manner that will simulate severice usage. Whenever possible, the test load shall be distributed uniformly on the test platform in order to minimize the effects of unbalanced loads. The system shall be operated in accordance with paragraph 4.5.2.1(b), and a record made to establish the criteria for satisfactory performance of the system at the conclusion of the test

4.5.24.3.3 Basic Design Test - Three shocks in each direction shall be applied along the three mutually perpendicular axes of the test item (total of 18 shocks). The shock pulse shape shall be in accordance with paragraph 4.5.24.3.1, of amplitude 15g, and time duration 11 milliseconds. At the conclusion of the test, the test item shall be tested for conformance with paragraph 4.5.14.3.1. Deterioration or change in performance of any component which could in any manner prevent the system from meeting functional, maintenance, and service requirements during service life shall be reason for rejection.

4.5.24.3.4 Crash Safety Test - This test is conducted to determine the structural integrity of equipment mounting means. The test item of dummy load shall be attached by its normal points of attachment. The test item or dummy load shall be subjected to two shocks in each direction along the three mutually perpendicular axes of the equipment (total of 12 shocks). The shock pluse shape shall be in accordance with paragraph 4.5.24.3.1, of amplitude 30g, and time duration 11 milliseconds. There shall be no failure of the mounting attachment and the test item or dummy load shall remain in place and not create a hazard. However, bending and distortion shall be permitted.

4.5.25 Humidity - All system components except those tested under paragraph 4.5.20.2 shall be subjected to the following test with required installation instructions and mounting nuts attached. Installation

instructions and mounting nuts, with containers, for those system components excluded from this test, shall also undergo this test. At the conclusion of this test, corrosion resulting in the malfunction of equipment, shortening of life, impairment of use, or difficulty of parts replacement will be cause for rejection. The instructions are to be legible, acceptable for shipment and for use by servicing personnel. Mounting nuts are to be unaffected and the package holding the nuts suitable for shipment.

4.5.25.1 Chamber - The chamber and accessories shall be constructed and arranged so as to avoid condensate dripping on the test item and vented to the atmosphere to prevent the buildup of vapor pressure. Relative humidity shall be determined from the dry bulb-wet bulb thermometer comparison method, or an equivalent method approved by the procuring authority. The velocity of the air throughout the test area shall not exceed 150 feet per minute. Distilled, demineralized, or deionized water at 23°C shall be used to obtain the specified humidity. Prior to starting the test, the ph of the water shall be measured and shall not be less than 6.0 or greater than 7.2.

4.5.25.2 Procedures - The test specimen shall be placed in the test chamber and set up to simulate installed service conditions. If more than one item is undergoing evaluation, the specimens shall be positioned so as to insure the most uniform exposure, so that they do not contact each other and so that they do not shield each other from the humidity. Prior to starting the initial test cycle, the specimen shall be dried at a temperature of 45°C ± 5°C and a relative humidity of 50% or less for at least two hours. Following the drying period, the temperature shall be reduced to 30°C ± 5°C and the relative humidity held at 50% ± 5%.

4.5.25.2.1 Duty Cycle - The test item shall be subjected, inoperative, to six 20 hour cycles, each cycle consisting of 12 hours at 60°C ± 5°C and approximately 8 hours at 30°C ± 5°C. The relative humidity shall be maintained at 95% or greater at both temperatures. The transitions between 30°C ±5°C and 60°C ± 5°C shall not exceed 1 1/2 hours and shall be accomplished as part of the 8 hour period. The relative humidity need not be controlled during the transition period. At the completion of the sixth cycle and with the chamber at 30°C ± 5°C, the test of paragraph 4.5.3.1(b) must be successfully completed.

4.5.26 Flexible Drive - The flexible drive test shall be conducted on a universal jount torsional vibration machine that has a fly-wheel of at least 20 times the amount of inertia as the rotor being tested. Testing procedure shall be as follows:

(a) 100 hours with ± 1 degree torsional amplitude input to drive shaft at critical frequencies.

(b) 50 hours with ± 2 degrees torsional amplitude input to drive shaft at frequencies of 20 to 24 Hz.

(c) 15 minutes of ± 2 degrees torsional amplitude input to drive shaft at critical frequencies.

During (a) above, the flexible drive shall limit the rotor amplitude within ± 5 degrees. During (b) and (c) above, the flexible drive shall limit the rotor amplitude within ± 7 degrees. If "dead band" or "clearance" is embodied in the drive elements, the amplitudes given above shall be increased by 1/2 the amount of the total angular clearance.

4.5.27 Drive Shear Section - Sufficient torsional force shall be applied to the drive shear section to result in its failure. The necessary torque indicating instruments shall be provided. Failure shall occur below the maximum torque limit shown on the detail specification or drawing. No electric overload or fault condition shall cause failure of the shaft.

4.5.28 Maximum Pressure Drop - While the blast air cooled generator or blast cooled heat exchanger is hot from previous high temperature operation, it shall be demonstrated that the generator will operate satisfactorily for 15 minutes when subjected to the pressure drop of 400 ± 15 minutes of water and inlet temperature of 140 ± 10°C.

4.5.29 Altitude Rating Chart - The altitude rating chart required by paragraph 3.4.9.6.1.1 shall be verified by tests conducted at the altitudes, loads, and temperatures specified in Table II and verification data submitted to the qualifying activity.

4.5.30 Acceleration - All system components except the generator shall be subjected to the acceleration test of Specification MIL-E-5272, Procedure III (paragraph 4.7.3). The deviation in system AC voltage and frequency produced by the acceleration shall be measured at 0 and 5 amp loads. Deviation in system voltages produced by the acceleration shall not exceed the limits of paragraph 3.5.1 and 3.5.2. There shall be no sign of instability.

4.5.31 Disassembly and Inspection - This test shall consist of disassembling the generator system and control components and inspecting for defects and wear. Such inspection of two (2) of the three qualification samples of each system component shall be done during overhaul in accordance with the overhaul instructions, by personnel with the designated skill levels to demonstrate compliance with paragraph 3.4.15. The contractor shall supply all necessary special support equipment for the demonstration. Equipment shall then successfully pass the Acceptance Test of Table I.

4.5.32 VAST Compatibility Demonstration - Each system control component shall demonstrate compatibility with VAST. (See paragraph 3.4.15). Tests shall be conducted as specifically designated by the Qualifying Activity.

4.5.33 Reliability and Maintainability Testing (Air Force)

4.5.33.1 Reliability Test - The generator reliability shall be demonstrated by testing the complete system for the number of MTFB periods or hours specified in the detail specifications. The test shall be conducted to a load schedule and conditions specified in the detail specification which shall be as representative of the application as practical.

4.5.33.2 Maintainability - Maintainability demonstrations shall be performed in accordance with the detail specification.

5. PREPARATION FOR DELIVERY

5.1 Preservation, Packaging, and Packing - The units shall be preserved and unit packaged in accordance with Specification MIL-P-7936 and MIL-P-116 as specified by the procuring activity.

5.2 Installation Instructions - The contractor shall attach one copy of installation instructions accepted at time of qualification to each system component shipped. Attachment shall be made as designated during specification.

5.3 Installation Hardware - A package holding one nut, MS90415-6, for each mounting hole in the generator flange shall be attached to each generator. Attachment shall be made as designated during qualification.

5.4 Marking of Shipments - In addition to any special marking required by the contract or order, unit packages, intermediate packages, and shipping containers shall be marked in accordance with Standard MIL-STD-129.

6. NOTES

6.1 Intended Use - The generators and control units covered by this specification are intended for use as continuous sources of AC electrical power on aircraft.

6.2 Definitions

6.2.1 Faults

6.2.1.1 Feeder Fault - Feeder faults shall be defined as those single phase line-to-neutral and line-to-line essentially zero impedance shorts applied to the feeders at any point between the generator terminals and the points of regulation.

6.2.1.2 System Faults - Distribution system faults are those single phase line-to-neutral and line-to-line faults occurring in the distribution and load system.

6.2.2 Point of Regulation - The point of regulation is that point at which the regulator senses and establishes system voltage. This point shall be at the line contactor input terminals. A five volt drop is permitted between the generator and the point of regulation under system full load conditions.

6.2.3 System Components - System components are those components (such as generators, control panels, and current transformers) which are mounted individually on the aircraft.

6.2.4 Phase Voltage - When the expression "phase voltage" is used in this specification or the detail specification drawing, it shall refer to the line-to-neutral voltage of the wye-connected generator.

6.2.5 Rated Current - Where specified, rated current shall be the rated current of the generator based upon the voltage rating and the KVA rating of the generator (see paragraph 3.4.8).

6.2.6 Phase Balance - The percent unbalance of the phase voltage for a three phase generator is defined as 100 times the maximum deviation of the phase voltage from the average of the three phase voltages divided by the average of the three voltages (see paragraph 6.2.4).

6.3 Ordering Data - The procuring activity should specify the detail specification or drawing.

6.4 Qualification - Awards will be made only for such products as have, prior to the bid opening date, been approved in accordance with paragraph 3.1. The attention of suppliers is called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Naval Air Test Center (Code WST33), Patuxent River, Maryland and information pertaining to the qualification of products under this specification may be obtained from that activity.

6.4.1 Re-submission of Qualification Samples - In case of failure of the sample or samples submitted, consideration will be given to the request of the manufacturer for additional tests only after it has been clearly shown that changes have been made in the product which the qualifying activity considers sufficient to warrant additional tests.

6.4.2 Supersession - This specification will supersede MIL-G-21480(AER) 7 July 1958 and Amendment 1 29 August 1969 for all new design. Cancellation of that specification will be delayed one (1) year from the date of this specification to allow time for the updating of all associated drawings and instructions. Also, to allow time for component manufacturers to bring all production items in line with the requirements of this specification wherever possible. The acceptance requirements of paragraph 4.3 and the requirement for qualification verification samples, paragraph 4.2.3 pertains as of the issue date of this specification.

Project No. 6115-N273.

PREPARING ACTIVITY
NAVAIR (AIR-5368)

TABLE I

TEST METHODS

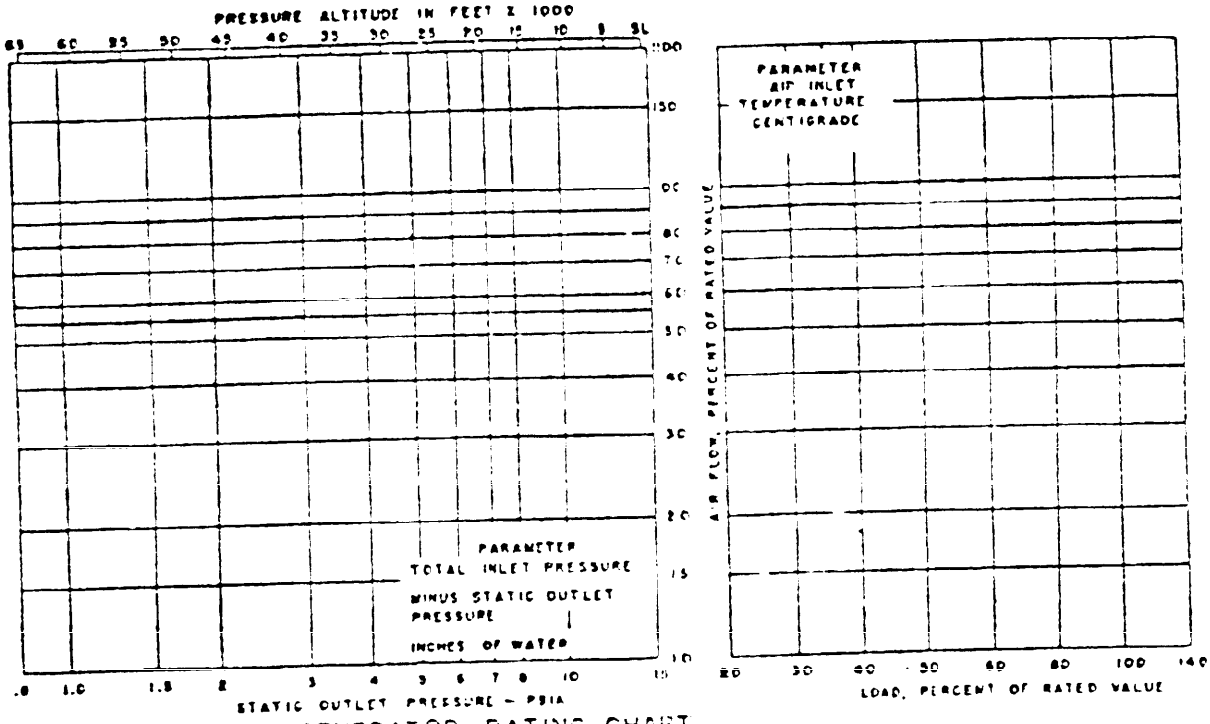
	Paragraph	Acceptance		Qualification Generator and Control Components			Qualification Verification
		Generator	Components	No. 1	No. 2	No. 3	
Examination of Product	4.5.1	X	X	X	X	X	X
Maximum speed for regulation	4.5.2			X	X	X	X
System Control	4.5.3.1			X	X	X	X
	4.5.3.2		X				
Overspeed	4.5.4.1			X	X	X	
	4.5.4.2	X					
Dielectric Strength	4.5.5	X	X	X	X	X	
Exciter Polarity - Reversal Test	4.5.6	X				X	X
Warm Up	4.5.7					X	
Phase Balance	4.5.8.1			X	X		X
	4.5.8.2	X					
Efficiency	4.5.9			X	X		X
Short-Circuit Capacity	4.5.10			X			X
Output-voltage modulation	4.5.11			X	X		X
Electromagnetic Interference	4.5.12			X	X		X

	Paragraph	Acceptance		Qualification			Qualification Verification
		Generator	Components	Generator and Control Components No. 1	No. 2	No. 3	
Wave Form	4.5.13			X	X		X
Endurance	4.5.14				X		X
Operating Position	4.5.15			X			X
Switch Operation	4.5.16			X			
Protective Operation	4.5.17			X		X	X
Standard Performance	4.5.18		X				
Generator Fault Torque	4.5.19			X		X	
Salt Spray	4.5.20			X			X
Fungus	4.5.21			X			
Sand Dust	4.5.22				X		X
Vibration	4.5.23.1				X		X
	4.5.23.2		X				
Shock	4.5.24				X		
Humidity	4.5.25					X	
Flexible Drive	4.5.26					X	
Drive Shear Section	4.5.27			X			
Maximum Pressure Drop	4.5.28				X		
Altitude Rating Chart	4.5.29			X			

	Paragraph	Acceptance: Generator	Acceptance: Components	Qualification Generator and Control Components No. 1	No. 2	No. 3	Qualification Verification
Acceleration	4.5.30			X			
Disassembly and Inspection	4.5.31			X	X	X	X
Vast Compatibility Demonstration	4.5.32					X	X
Reliability	4.5.33.1			X			
Maintainability	4.5.33.2			X			

Altitude Ft.	Load Per Cent Rated MVA	Inlet Air Temperature °C
0	120	120
		40
	100	140
		80
One half of the maximum altitude indicated by the detail specification.	120	40
	100	40
		0
	70	40
Maximum altitude indicated by the detail specification.	120	-40
	100	40
		-40
	70	40

TABLE II



GENERATOR RATING CHART
MANUFACTURER

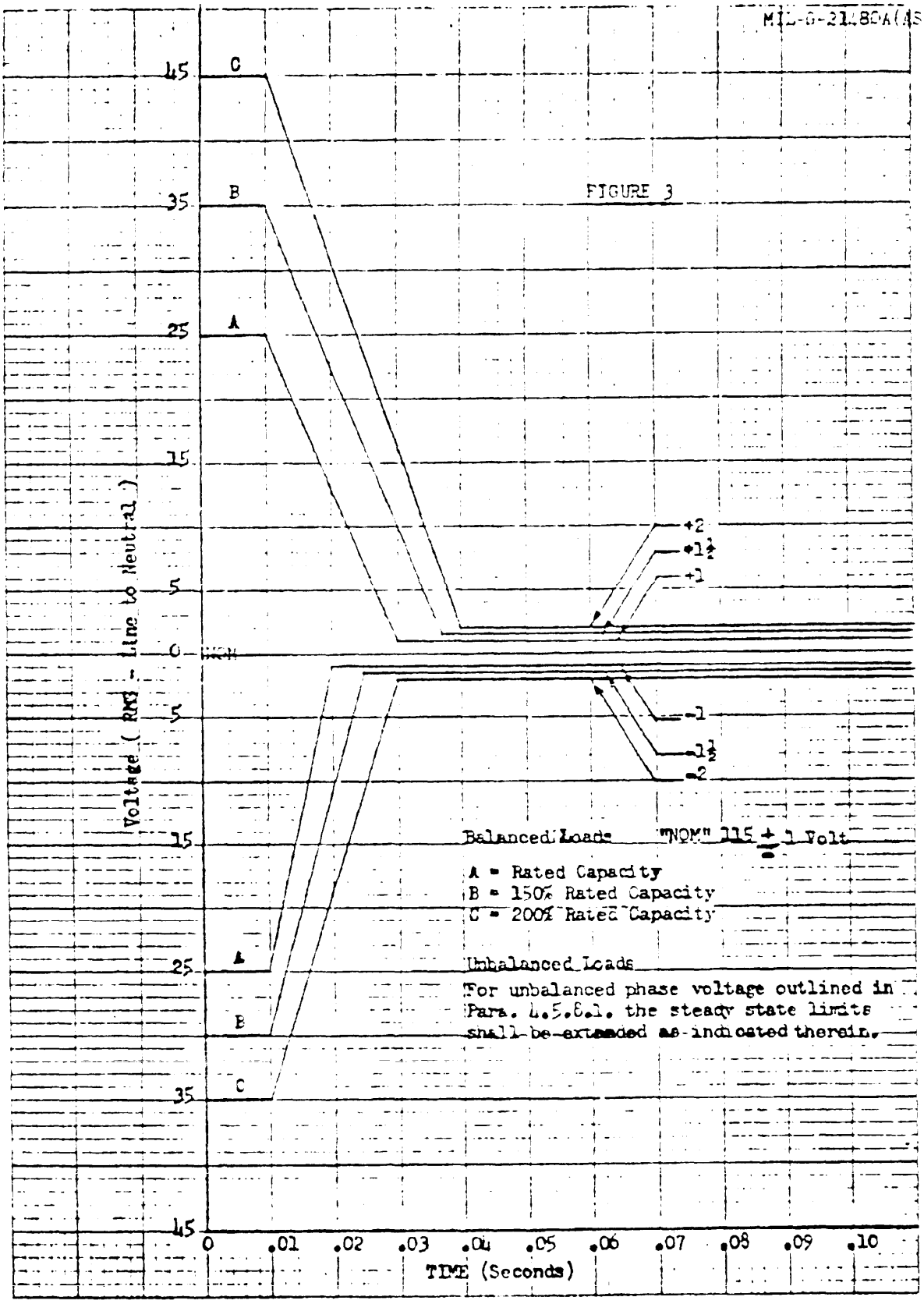
MANUFACTURER P/N:
SPECIFICATION NO:
AIR INLET CONFIGURATION:
RATED LOAD (KVA) AT VOLTS
SPEED
RATED AIRFLOW LB/MIN
OTHER DATA AND REPORTS

ASSY. DWG. NO
INST. NO
PF
PHASE

Note: This form not available through supply channels, must be reproduced locally.

FIGURE 2. Standard form of generator rating chart.

FIGURE 3



FREQUENCY CHARACTERISTICS
FOR
VOLTAGE MODULATION LIMITS

C.P.S.	VOD.
1.0	0.5
1.7	0.5
10.0	1.0
25.0	1.0
65.0	0.5
100.0	0.5

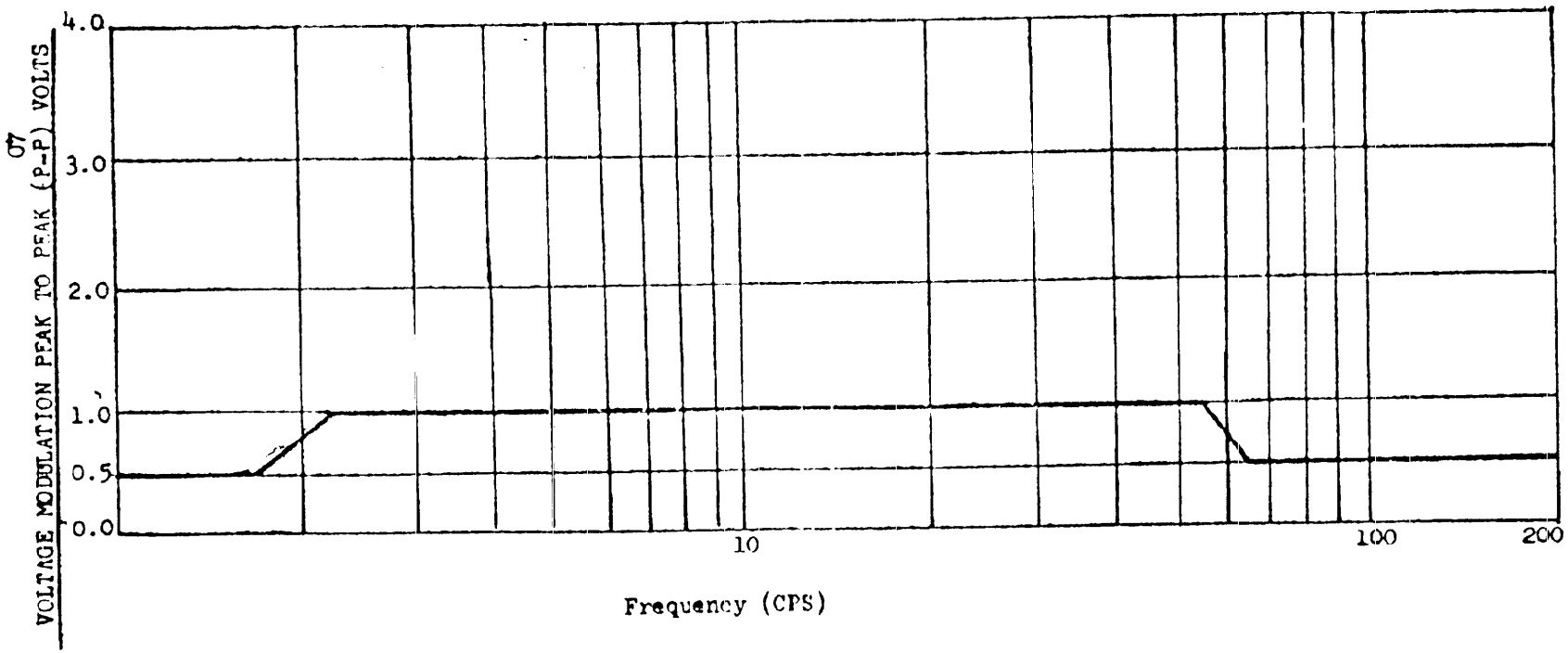
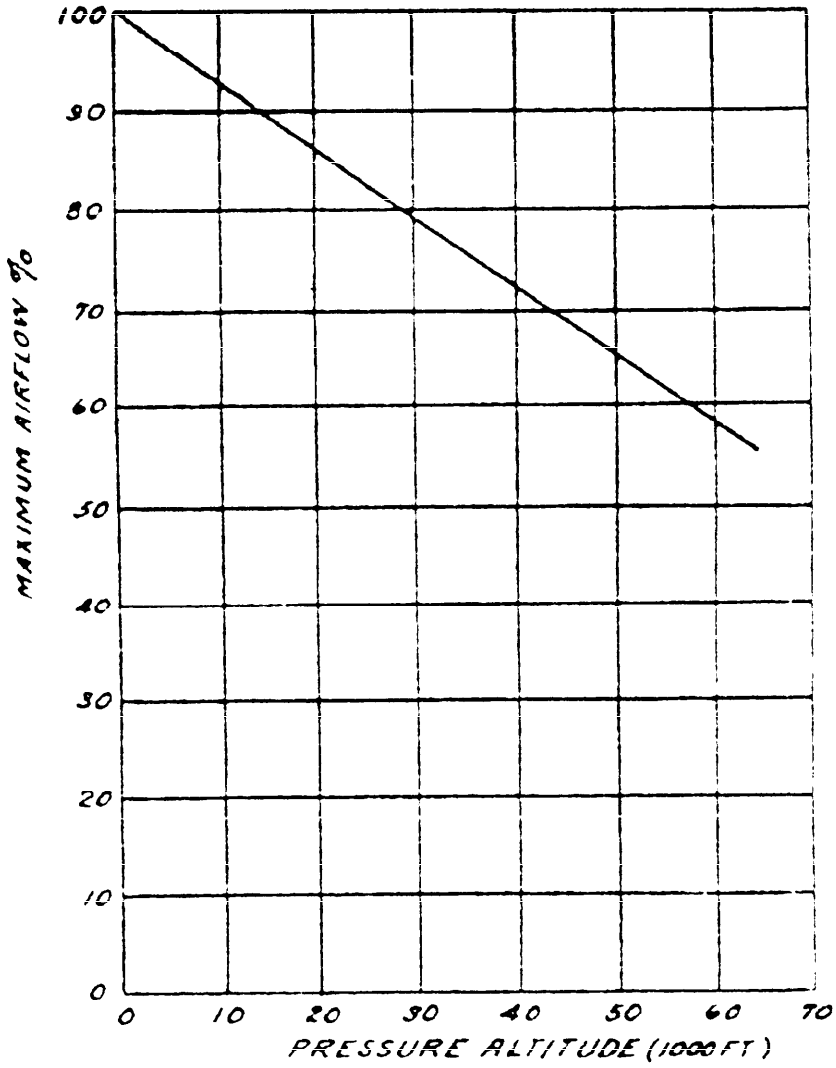


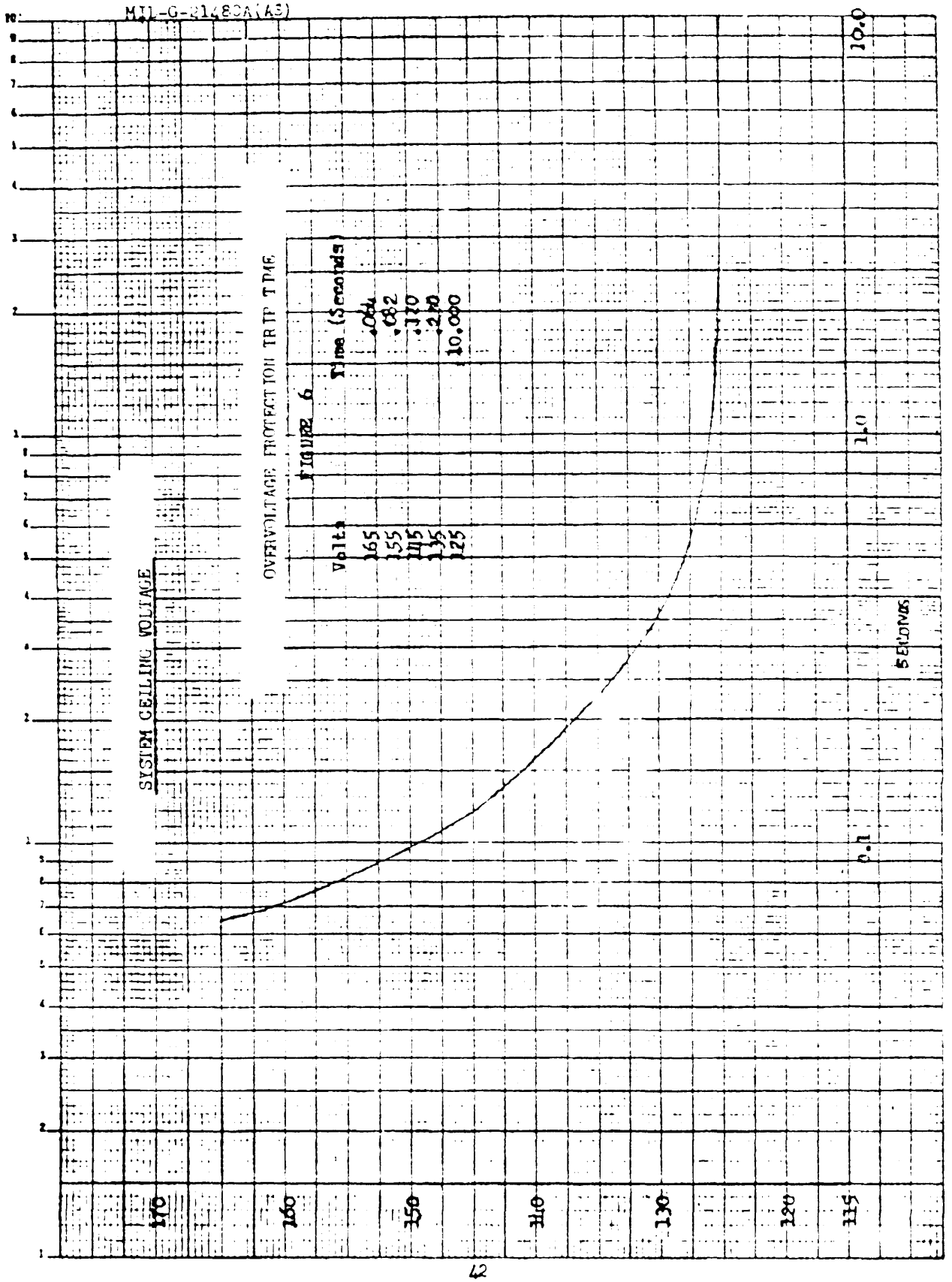
Figure 4



KVA	LBS/MIN
10	6.7
20	10
30	19
40	15
60	20
90	30
120	40
160	55

BASIC COOLING AIRFLOW FOR KVA OUTPUT APPLICABLE CONDITION 14.7 PSIA, INLET TEMP 120°C, MAXIMUM PRESSURE DROP 11.0 IN WATER.

FIGURE 5. MAXIMUM ALLOWABLE COOLING AIRFLOW FOR RATED LOAD



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a. Paragraph Number and Wording

b. Recommended Wording

c. Reason/Rationale for Recommendation

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