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MILITARY SPECIFICATION

ELECTRIC POWER GENERATING CHANNEL, VARIABLE INPUT SPEED, ALTERNATING CURRENT, 400 Hz, AIRCRAFT; GENERAL SPECIFICATION FOR

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

1. SCOPE

1.1 Scope. This specification establishes the general requirements for three phase, four wire, 115/200 volt, 400 Hz ac (alternating current) variable input speed electric power generating channels, herein referred to as the Generator Package for use on aircraft.

2. APPLICABLE DOCUMENT

2.1 Government documents.

* 2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation.

SPECIFICATIONS

Military

MIL-P-116	Preservation Methods of
MIL-W-5088	Wiring, Aerospace Vehicle
MIL-H-5606	Hydraulic Fluid, Petroleum Base Aircraft and Ordnance
MIL-S-7742	Screw Threads, Standard, Aeronautical

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Systems Engineering and Standardization Department (Code 53), Naval Air Engineering Center, Lakehurst, NJ 08733-5100, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 6115

SPECIFICATIONS (Continued)

Military (Continued)

MIL-L-7808	Lubricating Oil Aircraft Turbine Engine, Synthetic Base, NATO Code Number O-148
MIL-T-7928	Terminal, Lug and Splice, Crimp Style Copper; General Specification for
MIL-S-8879	Screw Threads, Controlled Radius Root with Increased Minor Diameter, General Specification for
MIL-L-23699	Lubricating Oil, Aircraft Turbine Engine, Synthethic Base
MIL-E-81910	Electrical Power Generating and Control Equipment, Aircraft, Testing; General Specification for

STANDARDS

Federal

FED-STD-595	Color

Military

MIL-STD-129	Marking for Shipment and Storage
MIL-STD-130	Identification Marking of U.S. Military Property
MIL-STD-454	Standard General Requirements for Electronic Equipment
MIL-STD-481	Configuration Control Engineering Changes, Deviations and Waivers
MIL-STD-704	Aircraft Electric Power Characteristics
MIL-STD-785	Reliability Program for Systems and Equipment Development and Production
MIL-STD-794	Parts and Equipment, Procedures for Packing and Packaging
MIL-STD-1515	Fastener Systems for Aerospace Applications

STANDARDS (Continued)

Military (Continued)

MIL-STD-1629	Procedures for Performing a Failure Mode, Effects and Criticality Analysis
DOD-STD-1686	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electricality Initiated Explosive Devices) (Metric)
MIL-STD-2068	Reliability Development Tests
MS 3376	Nut, Self-Locking; Reduced Height, Steel 450 degrees F, 12 Point Captive Washer
MS 14169	Circular Spline and Adapter Details, Engine Driven
MS 90415	Nut, Self-Locking; Steel, 160 KSI, 450 degrees F, 12 Point, Captive Washer

MILITARY HANDBOOKS

MIL-HDBK-217	Reliability of Electronic Equipment

(See Supplement 1 of this specification for a list of associated Military Detail Specifications.)

* 2.1.2 Other Government documents, drawings and publications. The following other Government documents, drawings and publications form a part of this specification to the extent specified herein. Unless specified, the issues shall be those in effect on the date of the solicitation.

NAVAL AIR SYSTEMS COMMAND DOCUMENTS

01-1A-17	Aviation Hydraulics Manual
AS-4613	Application and Derating Requirements for Electrical Components

DEPARTMENT OF DEFENSE

SD-6	Provisions Governing Qualifications

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

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

3. REQUIREMENTS

* 3.1 Specification Sheets. The individual item requirements shall be as specified herein and in accordance with the specification sheet. In the event of any conflict between the requirements of this specification and the specification sheet, the latter shall govern. (If a specific requirement specified herein is not required for an item, it shall be so indicated on the specification sheet (e.g. Shock - N/A.)).

3.2 Qualification. Channel or channel components furnished under this specification shall be products which are qualified for listing on the applicable qualified products list at the time set for opening of bids (see 4. and 6.).

3.3 Materials. Materials used in the manufacture of channel components shall be of high quality suitable for the intended purpose. Materials conforming to contractor's specifications may be used provided the specifications contain provisions for adequate tests and the required life, performance, reliability, and warranty period are achieved. The use of the contractor's specifications does not constitute waiver of Government inspection.

3.3.1 Metals.

3.3.1.1 Corrosion resistance. Materials shall be of a corrosion resisting type or suitably processed to withstand the environmental test requirements of MIL-E-81910.

3.3.2 Toxicity and fire resistance. Non-metallic materials used shall be flame resistant, shall not support combustion, and shall be nontoxic when exposed to flame as well as when used under all operating and environmental conditions herein.

3.4 Design and construction.

* 3.4.1 General design and construction. All channel components shall conform to the applicable specification sheet and shall be capable of demonstrating conformance to all the tests of Section 4 of this specification. Each channel shall provide two electrically independent sources of electric power: (1) an ac (alternating current) power source, the main source of power for general distribution to aircraft electrically powered equipment; and (2) a dc (direct current) power source, the power source for the control and monitoring functions within the channel and for electrical bus protection and control equipment external to the channel as specified in the applicable specification sheet.

3.4.1.1 Environmental. All channel components shall operate in accordance with this specification when subjected to the tests of MIL-E-81910, except that the minimum coolant temperature for start-up operation of any channel component shall be -40°C. After start-up the minimum coolant temperature shall be -40°C for the generator package and -55°C for all other channel components. The maximum altitude requirements shall be in accordance with the applicable specification sheet.

3.4.1.2 Channel control switch. Provisions shall be made so that the ac power source can be controlled by a switch by which the following control functions are performed in the positions indicated.

a. NORMAL - In this position the ac power source automatically energizes its bus when the electrical characteristics are within prescribed limits. A warning light shall be "ON" when the main power bus is not energized. Protective circuits shall be operative.

b. OFF-RESET - In this position the ac power source is electrically deenergized and the generator feeder contactor is open. Protective circuits shall reset. The warning light shall be 'ON'.

c. TEST - This is a momentary position, where the ac power source is energized with the generator feeder contactor open. Protective circuits shall be operative. The warning light shall be "OFF" if the power characteristics are within the protective limits for normal operation, otherwise the light shall be "ON".

* 3.4.1.3 Reliability. Reliability shall be considered in each phase of the channel design process. Techinques used to determine and evaluate the detailed design shall include a stress analysis with associated predictions and allocations in conformance with MIL-HDBK-217, sneak circuit and worst case analysis on all channel control and protective circuits in accordance with MIL-STD-785, Task 205 and 206, parts derating in accordance with the requirements of AS-4613 for class A equipment, a failure modes and effects analysis, thermal considerations, corrosion control, and electrostatic discharge control. The test program shall include the test, analyze and fix methods of MIL-STD-2068 during all required testing and provisions shall be made for the reporting, analysis, and correction of all failures occuring during the test program. Manufacturing screening of each channel component shall be provided by the random vibration and temperature cycling of the burn-in test.

3.4.1.4 Shock mounts. Shock mounts (or vibration isolators) shall not be used.

3.4.1.5 Electrostatic Discharge Control. The contractor shall establish and implement as applicable, an electrostatic discharge (ESD) control program in accordance with the requirements of DOD-STD-1686 when either Class 1 or Class 2 parts as identified in Table II, Appendix A of DOD-STD-1686 are used in the design and manufacture of these channel components.

3.4.1.6 Electric connections.

3.4.1.6.1 External electric connections. Channel components shall be so designed that external connections and wiring can be made in accordance with MIL-W-5088. No channel component structure shall be used as a current path except for radio noise shielding.

3.4.1.6.2 Terminal block design. Where terminals are used for the external connection to channel components they shall be of the stud-type and shall be designed so that the current is conducted by means of surface to surface contact and not through the stud threads. All studs shall be steel, corrosion resistant, C-34 to C-42 Rockwell hardness, .18 inches minimum diameter, and shall be of sufficient length to accommodate two MIL-T-7928 lugs. All nuts for studs by which external wiring is attached to engine or nacelle mounted channel components shall be furnished with the terminal block and shall conform to either MS 3376 or MS90415. There shall be no dielectric material in the compression buildup of a terminal. Terminal block shall be so designed that they can be removed and replaced on the component without the necessity for rebrazing or soldering. Barriers affording a positive separation of leads or terminals shall be provided on the terminal block. A durable, reusable, non conductive terminal cover shall be provided to cover terminal blocks and all attached terminal lugs used in making external connections to channel components. Terminal designations shall be marked durably, legibly, and prominently on the terminal block itself or on the generator package adjacent to the terminal block.

3.4.1.7 Dielectric. Insulation used for electrical isolation shall be adequate to prevent breakdown under all specified environmental conditions for the required life of the equipment.

3.4.1.8 Threaded parts. All threads shall conform to MIL-S-7742 or MIL-S-8879. All internal or external parts which are threaded shall be positively locked. Accidental loosening of threaded parts shall be prevented by self locking nuts, safety wiring, or other methods. Staking shall not be used. All removable parts externally screwed into the channel components (screws, bolts, caps, plugs, filters, fittings, etc.) shall to be screwed into steel inserts selected and applied in accordance with MIL-STD-1515, requirement 205. All externally accessible bolts and screws with the exception of those securing nameplates or electric receptacles shall be not less than 3/16 inch minimum in diameter for engine or gear box mounted equipments.

3.4.1.9 Adjustments. No provisions for external adjustments shall be provided and no adjustment or alignments shall be required during installation of any channel component. All adjustments shall to be made at the time of manufacture or when a component is being restored to a like new condition. If devices for making adjustments are installed within channel components, suitable means for locking and sealing shall be provided.

3.4.1.10 Mean Flight Hours Between Failure. While operating under specified conditions the minimum mean flight hours between failure (MFHBF) for the generator package shall be 3000 hours for its first 5.5 years of service life, including storage.

3.4.1.11 External openings in channel components. All case openings shall be protected by suitable means against passage of round objects of 3/16 inch or greater in diameter.

3.4.1.12 Color. Channel components shall be furnished in a color conforming to FED-STD-595, color number 17875, except that as an alternate they may be finished with a chemical film resulting in an aluminum or stainless steel color. The finishes shall be undamaged by the required environmental testing.

3.4.1.13 Failure mode and effects analysis (FMEA). A failure mode and effects analysis shall be performed in accordance with the requirements of MIL-STD-1629. Channel protective functions shall be independent of the control functions and no single fault or failure shall result in channel operation outside the protective limits specified herein.

3.4.1.14 Anti-cycling. The channel shall provide a means to prevent on/off cycling when the system trips on a protective function. The channel control shall reset once after the channel trips when the control switch is placed in the OFF-RESET position. If the cause of the trip still remains, the channel shall trip again when the control switch is placed in the NORMAL postion and remain tripped until the control switch is placed in the OFF-RESET position.

3.4.1.15 Maintainability. The generator package and all remote channel components shall meet the requirements of this specification for its complete 5.5 year service period, without the need for any routine servicing or maintenance actions. The channel design shall not include any provision for the disassembly or inspection of the generator package or channel components.

3.4.2 Generator package design and construction.

3.4.2.1 Brushes. No brushes shall be used.

* 3.4.2.2 Control circuitry. All circuitry for the conversion, regulation, and protection of the channel output power as well as that circuitry specified in the specifiation sheet for the protection and control of aircraft buses shall be contained in the generator package, with the exception of the channel control switch (see 3.4.1.2) and other remotely located channel components (such as current transformers) as specified in the specification sheet.

* 3.4.2.3 Cooling system. All heat dissipated by the generator package shall be removed by means of on external oil cooling system using either MIL-L-23699 or MIL-L-7808 oil. The internal oil within the generator package, resulting from external oil cooling system, shall not require any service, level adjustment or monitoring. Coolant leakage from either an operating or inoperative generator package shall not exceed 2CC per hour per rotating seal. Wetting of static seals by coolant oil is permissible providing no drops form. Prior to delivery and at the conclusion of the qualification inspection, the coolant used by the generator package shall meet contamination requirements in accordance with 4.6.15. The temperature of the external coolant at the inlet to the generator package for both continuous operation

and the five minute maximum temperature operation, plus the temperature, pressure, and flow characteristics of the coolant at the inlet and outlet of the package shall conform to the requirements of the specification sheet. Any coolant/lubricant other than the above used internal to the generator package shall be sealed to prevent leakage, have provisions within the package for the transfer of heat between internal and external coolants, and shall not require any service or replenishment in meeting any requirements of this specifications. All sealed coolant/lubricant generator packages shall have a warning device on the unit in accordance with the requirements of the specification sheet to provide an indication of the internal fluid level.

3.4.2.4 Input shaft.

3.4.2.4.1 Shaft speed. The generator package shall be capable of operating at the input shaft speeds and loads indicated by the specification sheet. Operation at overspeed shall be required for intervals of not more than five minutes and not more often than once in every five operating hours. The maximum acceleration and deceleration of the input shaft in rpm/sec shall be equal to the maximum speed of the shaft for the rated ac power output divided by six.

3.4.2.4.2 Shaft shear section. A shear section shall be provided in the input shaft which will cause it to break when the torque transmitted by the shaft is within the tolerances of the shear value indicated by the specification sheet. When the shaft breaks all rotating parts of the generator package shall be disconnected from the driving pad except the shaft end may be left in the driving spline. Removal of the input shaft either before or after breakage, shall not require other than minor disassembly of the generator package.

3.4.2.4.3 Shaft spline. The spline with which the generator package engages the driving shaft shall conform to MS-14169.

3.4.2.5 Quick attach - detach (QAD). A QAD as specified by the specification sheet shall be the only support to the generator package. If a "V" band is used, it shall be designed so that it can be installed or removed by tightening or loosening one self locking, integrally retained member. When loosened this member shall drive the "V" band open to free the generator package. The QAD shall not be supplied as a part of the generator package unless specified in the specification sheet.

3.4.2.6 Effects of fluids. The generator package shall show no deterioration at normal operating temperatures due to wetting from JP-4 or JP-5 fuel, Skydrol 500 hydraulic fluid, fluids conforming to MIL-L-23699, MIL-L-7808, or MIL-H-5606, and aircraft washing compounds.

3.4.2.7 Operating position. The generator package shall be capable of operating within any of the position-time limits indicated by Figure 6.

3.4.2.7.1 Component Operating position. All channel components, mounted remote to the generator package, shall meet the requirements of this specification while mounted in any position.

* 3.4.3 Repairability. The generator package and all remote channel components shall be non-repairable. Upon the expiration of all contractual warranty provisions, a channel component may be returned to its original manufacturer for restoration to a "like new" condition. A restored component shall be required to meet all requirements of this specification including the contractual warranty provisions referenced above.

3.4.4 Deleted.

3.4.5 Endurance. The channel shall meet the endurance tests as specified in 4.6.14.

3.5 Electrical performance. All electrical requirements specified 3.5.1 thru 3.5.7 are applicable at the POR (Point of Regulation) as defined in 6.5.7 while the channel is supplying any combination of specified linear ac and dc loads as defined by 3.5.1, over the generator package input shaft speed ranges, with specified cooling, and under any of the environmental conditions defined herein. No power, other than the shaft power delivered to the generator package, shall be required for channel start up, control, and operation. The channel shall not trip during build up, load switching, generator package input shaft speed acceleration or deceleration, nor the application and the clearing of any electric fault external to the channel. In addition, no channel component shall be damaged when the generator package input shaft is continuously rotated at speeds below that required for electrical output. In the event of a protective function trip, the channel shall not reset until the input speed to the generator package drops below the minimum speed specified for rated dc power or the channel control switch is placed into the Off-Reset position.

3.5.1 Channel capacity (rating). All ratings specified in 3.5.1 thru 3.5.7 shall be available at the POR, as defined by Figure 5, to electrically power equipment external to the channel.

3.5.1.1 Rating of the ac power source. The rating shall be as specified in the detail specification with nominal output of 115/200 volts (rms), 3 phase, 4 wire, 400 Hz electric power.

3.5.1.1.1 Continuous rating. The channel ac power source shall be capable of continuously delivering power from no load to full load with a load unbalance wherein the difference in the current delivered by any two phases does not exceed 15 percent of the phase current at rated channel output. Rated power factor is 0.75 to 0.95 lagging for loads from 0 to 70 percent of rated load and 0.85 to 0.95 lagging above 70 percent rated load.

3.5.1.1.2 Overload capacity. The channel ac power source shall be capable of delivering 125 percent of the rated current for five minutes and 150 percent of the rated current for five seconds to loads having power factors of from 0.85 to 0.95 lagging and having an unbalance wherein the difference in the current delivered by any two phases does not exceed 15 percent of the phase current at rated channel output.

3.5.1.1.3 Short circuit capacity. The channel ac power source shall produce a minimum of 225 percent and a maximum of 350 percent rated phase load current for five seconds from the faulted phase during any single phase short circuit, and from all faulted phases either simultaneously or sequentially during a two phase, or three phase short circuit, line-to-line or line-to-neutral. Subsequent specified performance of the ac power source shall not be impaired by any combination of feeder short circuits applied continuously, or until removed by the channel control package.

3.5.1.1.4 Motor starting. With any initial channel load from zero percent to 70 percent at any rated power factor, the channel ac power source shall be capable of supplying current for five seconds to simulated locked rotor motor representing 60 percent of rated channel current at 0.4 lagging power factor.

3.5.1.2 Rating of the dc power source. The dc power source shall be capable of delivering rated current as indicated by the specification sheet and 200 percent of this rated current for five seconds at the POR. Short circuit current shall not exceed 12 amps. Subsequent specified performance of the dc power source shall not be impaired by the continuous application of feeder short circuits.

3.5.2 Electrical performance of the ac power source. The characteristics of the electric power delivered by the ac power source shall be as defined in 3.5.2.1 thru 3.5.2.2.2. For each condition below requiring a protective function, 100 milliseconds shall be assumed as the generator line contactor operating time. Reset shall not be automatic. Reset shall be by means of the channel control switch (see 3.4.1.2) only.

3.5.2.1 Voltage.

3.5.2.1.1 Voltage regulation. The transient and steady state line-to-neutral voltages of each phase of the ac power source shall remain within the limits of Figure 1 under normal operating conditions.

3.5.2.1.2 Voltage protection. Any abnormal channel condition shall be cleared or the generator line contactor opened before the limits of Figure 2 are exceeded. The minimum time for such action after the onset of an abnormal operating condition resulting in undervoltage is 3.5 seconds. There is no minimum time requirement when an abnormal condition results in an overvoltage.

3.5.2.1.3 Wave form. Each phase voltage wave shall have a crest factor of 1.41 ± 0.07 under continuous and 1.41 ± 0.10 under overload conditions of 3.5.1.1.1 and 3.5.1.1.2 respectively. The distortion factor for the phase voltage wave form shall not exceed 0.05 under continuous and 0.08 under overload conditions. The limits of the ac distortion spectrum shall not exceed the envelope shown in MIL-STD-704. The dc content of the ac output voltage shall not exceed plus or minus 0.10 volts under any normal operating condition. Under abnormal conditions, protective functions within the channel shall operate to open the generator feeder contactor when the distortion factor exceeds 0.05 to 0.08 for a period of 3.5 to 5.0 seconds with loads up to 125 percent or before the dc content on any phase exceeds 2.0 volt-seconds above an ultimate trip point of 0.5 volts dc.

* 3.5.2.1.4 Faulted bus isolation. If a channel protective function is activated by other than undervoltage (3.5.2.1.2), dc content (3.5.2.1.3), or distortion factor (3.5.2.1.3) the ac power source shall be de-energized, the Generator Line Contactor (GLC) opened, and the load bus transferred without any delay by closing the Bus Tie Contactors (BTC) between buses. The channel protective functions for only the undervoltage, dc content, and distortion factor protection circuits shall inhibit the transfer of a faulted bus from its power source to an alternative/standby power source. Activation of such inhibited protective function logic shall result in the following sequence:

1. The Bus Inhibit Relay (BIR) shall be energized for a minimum of 100 ms prior to opening the G.L.C.

2a. If the fault is cleared during this 100 ms time delay the channel shall not trip and the bus transfer shall be inhibited by the BIR remaining energized.

2b. If the fault is not cleared after the BIR is energized the GLC shall be opened.

3a. If the fault clears after the GLC is opened, the bus shall be considered faulted and its transfer inhibited by the BIR remaining energized.

3b. If the fault remains after the GLC is opened, the ac power source shall be de-energized within a minimum of 1.5 seconds, the BIR de-energized, and the inhibited bus released by transfer to its alternate/standby power source.

4. After a bus transfer has been inhibited it shall remain inhibited without reset until the generator speed drops below the minimum speed specified for rated dc power not withstanding of any operation of either the channel control switch or the underspeed monitoring circuit.

3.5.2.1.5 Phase displacement and voltage unbalance. The phase displacement between phases shall be within 116° to 124° and voltage unbalance between phases shall not exceed 3 volts under continuous and overload conditions of 3.5.1.1.1 and 3.5.1.1.2.

3.5.2.2 Frequency.

3.5.2.2.1 Frequency regulation. Under normal operating conditions, the transient and steady frequency of the power output shall remain within the limits defined by Figure 3, the steady state frequency deviation shall stay within the limits of MIL-STD-704 and the frequency drift rate shall not exceed 15 Hz per minute.

3.5.2.2.2 Frequency protection. Any abnormal channel condition shall be cleared or the generator line contactor opened and the ac power source deenergized before either the maximum or minimum limits of Figure 3 are exceeded. The minimum time for such action after the onset of an abnormal

operation condition resulting in underfrequency shall be 0.8 seconds. There is no minimum time requirement when an abnormal condition results in an overfrequency.

3.5.3 Electrical performance of the dc power source. The dc power source shall be electrically independent of the ac power source and shall provide rated current at the POR over the input shaft speed range specified for dc power output. The transient and steady state dc voltage shall remain within the limits of Figure 4. The distortion factor, distortion spectrum, and ripple amplitude shall conform to the requirments of MIL-STD-704 for dc power at the POR as defined by Figure 5.

3.5.4 Underspeed monitor. When the generator package input shaft speed is below the minimum specified by the specification sheet, a normal monitoring function within the channel shall maintain the generator line contactor open and the ac power source deenergized. Operation of the monitoring function, under conditions of either increasing or decreasing shaft speed, shall occur at minimum shaft speed for rated ac power output plus five percent minus zero. No manual reset shall be required to resume normal operation of the channel when the generator speed returns to within the specified limits.

3.5.5 Feeder fault protection. When the rms fault current in any feeder carrying ac current from the generator package to the POR exceeds 20± 5 amperes or 15 percent of the rated line current, whichever is greater, a protective function within the channel shall within 50 milliseconds deenergize both the ac power source and the generator line contactor. Reset (3.4.1.2) shall be by means of the channel control switch only. No fault other than on a feeder shall cause the feeder fault protective circuits to function.

3.5.6 Heat rejection. The maximum heat rejection for each channel component at rated power output shall be as specified by the specification sheet. Heat rejection shall not be greater at any lesser power output than it is at rated load, and shall not increase by more than 50 percent under the 125 percent overload condition of 3.5.1.1.2.

3.5.7 Maximum torque requirement. The channel's mechanical demand from its driving source shall not exceed 300 percent of that required at rated load and minimum speed for ac power output, under any specified operating or fault condition.

* 3.6 Marking. Equipment, assemblies, and parts shall be marked as specified in MIL-STD-130 and the generator package nameplate shall include the following:

Warranty Expiration Date ---
Non-Serviceable, Non-Repairable Generator Package
Do Not Disassemble

3.7 Installation instructions. The contractor shall attach to each channel component one copy of simple instructions with illustrations and required diagrams covering its installation. These instructions shall be protected to remain completely legible and suitable for issue to maintenance

personnel after exposure to the humidity and fungus requirements specified herein for self cooled components. Prior to printing, two copies of the instructions shall be furnished to the qualifying activity for approval of content, presentation, and means of attachment to the applicable channel component.

3.8 Workmanship. Workmanship on all channel components shall be in accordance with MIL-STD-454, Requirement 9.

4. QUALITY ASSURANCE PROVISIONS

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

4.2 Classification of inspections. The inspection and test requirements specified herein (Table I) are classified as follows:

a. Qualification inspection (see 4.3, 6.5.8, and 6.5.9).

b. Quality conformance inspection (see 4.4, and 6.5.10).

4.3 Qualification. Qualification shall be in accordance with SD-6.

4.3.1 Qualification submittal. The submission for qualification shall consist of three complete channels as described by the applicable specification; one generator package input shaft; two sets each of component wiring diagrams, schematics, outline drawings, and operating instructions; two copies of the Reliability Prediction Report required by 4.6.3; two copies of the Failure Mode and Effects Analysis required by 3.4.1.13; two copies of the Sneak Circuit Analysis required by 3.4.1.3; two copies of the Worst Case Analysis required by 3.4.1.3; certificates required by 4.6.10(d), 4.6.11, and 4.6.13; and, two copies of the quality conformance inspection data (Table I) certified by the cognizant Government inspector or by an official of the supplying firm. Each channel shall be provided with the following:

a. A mating plug for every receptacle used on each channel component.

b. Installation hardware for each generator package.

c. Two copies of the material to be included in the installation instructions to be packaged with each channel component and an example of how the instructions are to be printed, protected, and attached to channel components before delivery.

4.3.2 Qualification inspections and tests. Qualification inspections and tests shall be conducted by the qualifying activity in essentially the order listed in Table I. At the option of the qualifying activity, any or all qualification inspections and tests required for any one of the qualification samples (tests listed under sample channel number 1, 2, or 3 of Table I) may be conducted on any channel or channel component submitted for qualification. In addition, the qualifying activity has the option to conduct inspections to verify conformance to any of the requirements that were satisfied by certification, or to increase the number of tests points, within specified limits, to further examine any area where marginal performance is observed during the tests herein. These options do not relieve the contractor from the responsibility of fully meeting all requirements of this specification and the specification sheet. The testing of any one channel will be restricted to four months elapsed time starting with the date a complete channel is received by the qualifying activity. Any period during which testing is stopped by the qualifying activity because of a channel failure, is to be added to the four months elapsed time. Channels and their components demonstrating satisfactory performance to the tests conducted during this period will be approved for qualification and listed on the appropriate qualified products list at the end of the four month period.

4.3.3 Qualification retention. Each channel 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 quality conformance inspection 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 quality conformance inspection, 50 of which are to be shipped as directed by the applicable contract(s), and one component, selected at random by the Government Inspector, is to be forwarded with copies of the required quality conformance inspection data, certified by the cognizant Government Inspector, to the Naval Air Test Center (SY60), Patuxent River, Maryland 20670, Attention: For NATC-4P7-101. To meet the delivery requirements for each succeeding 150 components, 151 components must successfully complete the required quality conformance inspection, 150 of which are to be shipped as directed by the applicable contract(s), and one component selected at random, forwarded as above. The span of serial numbers of the production channel components from which each qualification retention sample is selected shall be recorded and this information included with the sample. The sample, together with quality conformance inspection data certified by the cognizant Government Inspector, shall be shipped not later than the final channel components in the production group from which selected.

The channel components forwarded to the qualifying activity shall be inspected for similarity to the configuration which was qualified and tested for conformance to the applicable performance specifications. Tests for each qualification retention sample will be selected in rotation by the qualifying activity from those examinations and tests listed in Table I for the qualification samples. The qualifying activity shall select tests from those listed for qualification channel number 1, Table I, for the first qualification retention sample submitted; from those listed for qualification sample channel number 2, Table I, for the second qualification retention

sample submitted; from those listed for qualification sample channel number 3, Table I, for the third qualification retention sample submitted; and from those listed for qualification sample channel number 1, again for the fourth qualification retention sample, and so on. In addition, the qualifying activity has the option to conduct any inspections to verify conformance to any of the requirements that were previously satisfied by certification.

The testing of any one qualification retention sample component will be restricted to two months elapsed time from the time the component is received by the qualifying activity. Any period during which testing is stopped because of a channel component failure is to be added to the two months elapsed time. Channel components demonstrating satisfactory performance to the qualification retention tests conducted during this period will be approved in writing by the qualifying activity for retention on the applicable qualified products list. At the conclusion of testing a report of the Government test results will be forwarded to the contractor.

Acceptance of components submitted for quality conformance inspection shall not be delayed pending results of qualification retention inspection provided qualification retention samples from the most recent prior inspection lot having the same military part numbers met the qualification retention test requirements. Qualification is to be considered sustained as required under 4.4.(a) if qualification retention samples have been submitted in conformance to this paragraph and qualification has not been officially rescinded.

In addition to the qualification retention procedure specified above, the qualifying activity may at any time, test any component(s) delivered under a production contract to determine conformance to this specification.

4.3.4 Rejection and reinspection of channel components submitted for qualification and qualification retention. The contractual calender warranty period shall not be applicable to any channel component obtained for the primary purpose of laboratory accelerated life type qualification testing. Failed channel components which have been rejected or returned to the manufacturer during qualification or qualification retention may be reworked or have parts replaced to correct defects. Before resubmitting or replacing channel components which have failed, full particulars concerning the rejection and the corrective action taken by the manufacturer shall be reported in writing by the manufacturer to the qualifying activity. Inspections shall not be resumed until such a report is received. Channel components shall be disqualified if the manufacturer has not either corrected and returned the component to the qualifying activity with the required report or has not submitted a corrective program in writing acceptable to the qualifying activity within 30 days where qualification samples are concerned or 10 days where qualification retention samples have failed. Qualification tests may be discontinued at the discretion of the qualifying activity at any time a channel component fails to meet the requirements of this specification.

4.4 Quality conformance inspection. Each channel component produced under a contract requiring qualification to this specification will be accepted if:

(a) Qualified in accordance with this specification and the applicable specification sheet, and if the qualificiation is sustained in conformance with 4.3.3.

(b) The quality conformance inspections of Table I are conducted by the supplier and are successfully completed. Quality conformance inspection procedures and any changes to the quality conformance inspection described herein shall be subject to the written approval of the qualifying activity.

(c) Installation instructions, approved by the qualifying activity, 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) All changes to the equipment after qualification have been processed in accordance with MIL-STD-481.

4.4.1 Rejection and reinspection of channel components submitted for quality conformance inspection. Channel components that have been rejected may be reworked or have parts replaced to correct the defects and resubmitted for quality conformance inspection. Before resubmitting, full particulars concerning previous rejection and the action taken to correct the defects found shall be furnished in writing to the Government inspector.

4.5 Standard test conditions. Unless the test condition is specifically described for each test in 4.6 of this specification, the standard test conditions of 4.5.1 thru 4.5.9 shall apply:

4.5.1 Test sample. Tests are to be conducted on a complete single channel with channel components interconnected as shown by the detail specification. The ac and dc power feeders shall be tested in the configuration shown and with the length, size and number of feeders as specified in Figure 5. All other channel control leads shall be less than fifty feet in length and of a conductor size adequate to carry the required current, but with no conductor smaller than AWG No. 22. Channel control shall be by means of the channel control switch (see 3.4.1.2) which shall remain in the NORMAL position throughout each test unless RESET, TEST, or manual deenergizing of the ac power unit is specifically required.

4.5.2 Loading of the ac power source. The ac power source shall deliver rated three phase power at the POR (see Figure 5), wherein the current in each phase is balanced within three (3) percent of the average of the three phase currents, under test conditions wherein the generator package input shaft speed is within specified limits for rated ac power output.

4.5.3 Loading of the dc power source. The dc power source shall deliver rated power to the POR (see Figure 5), under inspection conditions wherein the generator package input shaft speed is within specified limits for rated dc current output.

4.5.4 Voltage and frequency measurements. Whenever channel output voltage and frequency measurements are required, they shall be made at the POR (Figure 5). Ac voltage measurements shall be true rms and shall be made line-to-neutral and line-to-line in each instance. All voltage measurements shall be accurate within 0.25 percent. Frequency measurements shall be accurate within 0.25 Hz.

4.5.5 Power factor. Loads shall be applied at 0.95 lagging power factor.

4.5.6 Channel component mounting. The generator package shall be mounted in the 0° roll position as shown by the detail specification, and with its rotational axis offset from the horizontal as shown by the detail specification. If the 0° roll position is not specified by the detail specification, the generator package may be inspected in any position of roll. If the horizontal position is not specified, it shall be tested with the rotational axis of the generator horizontal. All other channel components shall be mounted in a horizontal position with base down.

4.5.7 Thermal.

4.5.7.1 Thermal isolation of channel components. Thermal insulation shall be placed between channel components and any objects with which they come in contact to reduce heat transfer to a negligible value during thermal tests. Insulation is not required at the mounting face or input shaft of the generator package.

4.5.7.2 Channel component cooling. Air used in the cooling of channel components shall conform to the altitude-temperature requirements of MIL-E-81910 for standard conditions. Cooling oil temperature at the point it enters a channel component shall be maintained at 80 percent of the maximum specified in degrees C for continuous operation.

4.5.7.3 Warm up. Prior to each test the system shall be operated, delivering rated current at rated voltage, for sufficient time for the temperature of each system component to stabilize (see 4.5.7.4).

4.5.7.4 Temperature stabilization. The temperature of channel components shall be considered to have stabilized when the temperature at the points monitored changes less than 1°C during a period of 5 minutes.

4.5.8 Environment. Environment conditions shall conform to the standard conditions specified in MIL-E-81910, as modified by 3.4.1.1.

4.5.9 Generator package input shaft speed. The generator package input shaft speed shall be cruise speed if that speed is specified by the detail specification. If cruise speed is not identified, tests shall be conducted at 90 percent of the maximum shaft speed for rated ac power output. Minimum rated generator package input shaft speed for channel operation shall be as specified on the specification sheet.

4.6 Methods of inspection.

4.6.1 Examination of product.

4.6.1.1 Channel components submitted for qualification and qualification retention inspection. Each channel component and all parts thereof submitted for qualification or qualification retention inspection shall be examined as the Government inspector and qualifying activity deem necessary to determine conformance to the specification and detail specification with respect to materials and workmanship, cleanliness, simplification, mounting means, coupling spline, lubrication, electric connections, adjustable resistors, connections, threaded parts, finish, interchangeability, markings, installation instructions, dimensions, weight, and color.

4.6.1.2 Channel components submitted for quality conformance inspection. Each channel component and all parts submitted for quality conformance inspection will be examined by the Government inspector to determine conformance to this specification with respect to workmanship, cleanliness, lubrication, electric connections, adjustments, threaded parts, finish, marking, installation instructions, color, and consistency with qualification samples.

4.6.2 Dielectric inspection. The generator shall withstand the following test voltage at commercial frequency, applied between windings, and between each winding and frame, for the specified time. Control and monitoring components shall be tested from each terminal to case. (Devices shall be disconnected if this test is likely to damage them.) Wire wound electric components (motors, transformers, solenoids, etc.) having leakage currents exceeding 5 milliamps and all other components having leakage currents exceeding 3 milliamps shall be rejected. (All voltages applied shall be ± 1.0 percent.)

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

b. Circuits operated above 50V: twice the rated voltage plus 1,000 volts rms for 1 minute, or 120 percent of the 1 minute voltage for 1 second.

c. Devices disconnected during the above tests shall be subjected to and shall withstand a test voltage of twice the maximum peak voltage encountered during normal operating conditions or a minimum of 100 volts, whichever is greater.

If it is necessary to repeat a dielectric test, the voltage levels listed above shall be reduced to 75 percent of the values shown.

4.6.3 Mean Flight Hours between Failure. The manufacturer shall submit with the qualification samples a parts stress analysis. Analysis of electronic components shall be in conformance with MIL-HDBK-217, wherein conformance to 3.4.1.10 is demonstrated. It shall also include the various terms in the "part failure rate model" for each component derated at the most severe conditions.

4.6.4 Deleted.

4.6.5 Electrical performance for qualification inspection.

4.6.5.1 Electrical performance at standard temperatures. Determine channel performance under standard temperature conditions as follows:

a. Under conditions wherein the generator package input shaft is accelerated from a speed below the minimum specified for rated dc power output up to overspeed, held for five minutes, and then decelerated to a speed below that required for rated dc power output, determine (1) that the dc voltage regulation conforms to Figure 4 over the shaft speed range specified for rated dc power output; (2) that the ac voltage and frequency regulation conforms to Figures 1 and 3, respectively, over the shaft speed range specified for rated ac power output; and (3) that the channel underspeed monitoring function conforms to the requirements of 3.5.4. Tests shall be conducted with 10, 60 and 100 percent rated load on the ac power source and 50 and 100 percent rated load on the dc power source. Shaft acceleration and deceleration rates shall be maintained between 90 and 100 percent of the maximum specified in 3.4.2.4.1.

b. With the generator package input shaft at cruise speed and the ac power source delivering 10, 60, 100, 125 and 150 percent rated ac power output, determine conformance to the regulation and wave form requirements of 3.5.2.1.1, 3.5.2.2.1, and 3.5.2.1.3, except wave form measurement is not required at 150 percent rated power. In addition determine conformance of the ac power source to the electrical protection requirements of 3.5.2.1.2, 3.5.2.1.3, 3.5.2.2.2, and 3.5.5 at 10, 60, 100 and 125 percent of rated ac power output. All loads shall be suddenly applied, allowed to stabilize and then suddenly removed.

c. Repeat (b) except with the maximum ac load unbalance and at the maximum and minimum power factors specified by 3.5.1.1.1. Conduct the same tests with the generator package input shaft speed at the minimum and at the maximum speed for rated ac power output. Under each test condition determine conformance to the phase displacement and voltage unbalance requirements of 3.5.2.1.5. Unbalanced loading shall be accomplished such that no phase will be loaded higher than in (b) above at each load level. Each of three sequentially submitted channels shall have the high phase load applied to a different phase(s).

d. Determine conformance of the dc power output to the requirements of 3.5.3 at 50 and 100 percent rated dc current output with the generator package input shaft at cruise speed and at the minimum and maximum shaft speed for rated ac power output. Note: The tests of this paragraph (4.6.5.1(d)) need only be run at cruise speed for those channels wherein the generator from which the dc power is derived rotates at a constant speed, ±1.75 percent, over the entire generator package input speed range for rated dc power output.

4.6.5.2 Electrical performance at minimum temperatures. Determine channel performance under minimum temperature component cooling conditions as follows: All components of the channel shall be soaked at an ambient temperature of -55°C for 2 hours during which time no power shall be connected to any channel component. At the end of this period the ambient temperature around all channel components shall be raised to -40°C for at least 2 hours before starting test (a) below and then after startup reduced to -55°C and maintained at this temperature throughout this test. The temperature of the cooling oil entering the generator package shall be allowed to rise to 23±10°C during test (a) below and then shall be maintained at this temperature throughout tests (b) and (c).

a. With the generator package coolant at -40°C at the start, accelerate the generator input shaft speed from zero to the maximum speed for rated ac power output. The time to accelerate the shaft from zero speed to the minimum shaft speed specified in the detail specification for rated dc power output shall be 30±5 seconds. The rate of shaft acceleration from the minimum shaft speed for rated dc power output to the maximum speed for rated ac power output shall be between 90 and 100 percent of the maximum value specified by 3.4.2.4.1. Within 45 seconds after shaft acceleration is initiated from zero speed, the channel control shall cause the channel feeder contactor to close and connect rated ac load. At this time the ac voltage and frequency shall be within the limits of Figure 1 and the normal limits of Figure 3, respectivley, and the dc power source shall demonstrate its ability to deliver rated current with output voltage conforming to Figure 4. The generator package input shaft shall then be decelerated to zero speed at a rate between 90 and 100 percent of the maximum value specified by 3.4.2.4.1. Demonstrate that the underspeed monitoring function conforms to 3.5.4 during deceleration. It shall also be demonstrated that the maximum coolant pressure indicated by the specification sheet is not exceeded.

b. Repeat 4.6.5.1(c) at the stabilized ambient and coolant temperatures specified in 4.6.5.2.

   Repeat 4.6.5.1(d) at the stabilized ambient and coolant temperatures specified in 4.6.5.2.

4.6.5.3 Electrical performance at maximum temperatures. Determine channel performance under maximum temperature component cooling conditions as follows: All channel components shall be soaked at the maximum ambient temperature(s) indicated by the applicable specification sheet for four hours with no electrical power connected to any channel component. During the soaking period the generator package shaft shall be rotated at a speed adequate to insure coolant circulation through the package with inlet temperature of the coolant maintained at the maximum specified temperature for continuous operation. At the end of this period, the ambient temperature for all channel components shall be adjusted to the maximum specified continuous operating temperature and held at this temperature throughout this test. The coolant into the generator package shall be maintained at the maximum specified continous operating temperature.

a. Repeat 4.6.5.1(a) at the maximum ambient and maximum coolant temperatures for continuous operation specified in 4.6.5.3.

b. Repeat 4.6.5.1(c) at the maximum ambient and maximum coolant temperatures for continuous operation indicated in 4.6.5.3, except that at 100 percent ac load at maximum power factor and maximum generator package input shaft speed for rated ac power, the temperature of the coolant to the generator package shall be raised to the maximum coolant inlet temperature for five minute operation as shown on the detail drawing.

In addition determine conformance to the short circuit requirements of 3.5.1.1.3 at maximum generator package input shaft speed after the channel has thermally stabilized while delivering rated ac power. Single phase and two phase short circuit tests need only be conducted on one configuration of loading for each channel tested, however, the short circuit phase shall be varied so that each of three sequentially submitted channels have the single phase and two phase loads applied to different phases. The test shall be conducted by placing a zero impedence load across the terminals at the POR for five seconds or until disconnected by the channel control package.

c. Repeat 4.6.5.1(d) at the maximum ambient and maximum coolant temperatures for continuous operation specified in 4.6.5.3. In addition determine conformance to the short circuit requirements of 3.5.1.2 at maximum generator package input shaft speed for rated dc power. The test shall be conducted by placing a zero resistance load across the dc terminals at the POR.

* 4.6.6 Electrical performance for quality conformance inspection.

a. Conduct 4.6.5.1(a) except that the ac power source is only required to be loaded at 10 and 100 percent of its rating and with the acceleration and deceleration rates maintained within the broader limits of 40 to 100 percent of the maximum specified in 3.4.2.4.1.

b. Conduct (4.6.5.1(c) at 10 and 100 and 125 percent rated load on the ac power source ommitting inspections for wave form (see 3.5.2.1.3) phase displacement and voltage unbalance (see 3.5.2.1.4).

c. Conduct 4.6.5.1(d).

4.6.7 Motor starting.

a. The temperature of all channel components shall be stabilized with maximum specified continuous ambient and cooling oil temperatures at rated load, and with the generator package

input shaft at minimum rated speed for rated ac output. The load shall then be reduced to 70 percent of rated at .75 power factor and then a simulated motor starting load applied for 5 seconds. This simulated motor load shall be a 3 phase 0.4 lagging power factor load of 60 percent rated phase current per phase. The channel shall demonstrate the capability to provide this load for 5 seconds, and the voltage and frequency shall remain within the limits of Figure 1, Curve B and Figure 3, normal operation limits, respectively.

b. Repeat (a) with the channel delivering 20 percent rated power, standard cooling conditions, and maximum rated shaft speed for rated ac power output.

4.6.8 Heat rejection. Heat rejection for each channel component shall be determined. Tests shall be conducted while the channel is delivering 10, 60, and 100 percent rated ac load continuously, and 125 percent ac load for 5 minutes, with the generator package input shaft speed at cruise speed and at the minimum and maximum speed for rated ac power output. Tests shall be conducted at the specified environmental condition which produces the maximum heat rejection for that channel component. The heat rejection for each channel component shall not exceed the values specified by the detail specification and 3.5.6.

4.6.9 Maximum torque. For any load or fault condition specified by 3.5.1, determine load impedence which will result in the max torque demand by the generator package. This impedence shall be applied for five seconds with transient and steady state torques recorded. Protective functions shall be deactivated during this test. The maximum torque measured shall not exceed that specified in 3.5.7.

4.6.10 Environmental effects. Environmental tests shall be conducted in conformance to MIL-E-81910 as amended below:

a. The acceleration and burn-in test is deleted.

b. The dust test shall not be conducted on oil cooled channel components which are not vented to the environment.

c. During the temperature-altitude test, self cooled channel components shall be subjected to the requirements of MIL-E-81910 as amended by 3.4.1.1. For oil cooled channel components the specified range of coolant temperatures indicated by the applicable specification sheet apply over the entire altitude range.

d. The fungus test shall be deleted if a certificate, signed by an official of the supplying firm, indicating that channel components will not support the growth of fungus, is submitted. Installation instruction shall not be put through the fungus test if a similar certificate is submitted indicating that they will remain acceptable for use by service personnel after being exposed to the specified fungus test for ten (10) days.

e. During the humidity test, the applicable installation instructions shall be attached to each channel component and shall remain acceptable for use by service personnel after two cycles of the specified test.

f. During the electromagnetic susceptibility test, the ac and dc voltage regulation and frequency regulation shall remain within the normal limits of Figures 1, 3 and 4. Requirements concerning conducted electromagnetic interference do not pertain to conductors between channel components.

g. In conducting vibration testing, the generator package shall be considered as an engine mounted component and all other channel components as non-engine mounted components.

h. Where rated generator shaft speed is specified by MIL-E-81910, cruise speed shall be applied in accordance with 4.5.9 herein.

After environmental tests, except crash safety, the specified performance shall be demonstrated by completing the tests required by 4.6.6(b) and (c).

4.6.11 Toxicity and fire resistance of materials. In lieu of testing channel components for conformance to 3.3.2 a certificate signed by an offical of the supplying firm shall be submitted indicating that materials used in he production of channel components are flame resistant, will not support combustion, and are non-toxic when exposed to flame as well as under all operating and environmental conditions herein.

4.6.12 Position.

4.6.12.1 Generator package position. With the generator package in the positions and for the times listed in Table II, determine conformance of the ac and dc power sources to the regulation limits of Figures 1,3 and 4 while each power source delivers 50 and 100 percent rated load. These tests may be done in conjunction with other tests herein. All pitch angles apply to the horizontal position indicated by the specification sheet, or if none is indicated by the specification sheet, to the rotational axis of the generator. Roll angles are measured from the 0° roll angle identified by the specification sheet. If a position of 0° roll is not identified by the specification sheet, such a position shall be selected by the qualifying activity for this test.

4.6.12.2 Position inspection for channel components mounted remote to the generator package. During the testing conducted under 4.6.12.1, channel components mounted remote to the generator package shall first be tested with the component in a base down or other specified normal position and then periodically rotated clockwise 90, 180, and 270 degrees about each major axis except the verical axis. This positioning of remote mounted components shall not cause the channel performance to exceed specified regulation limits.

4.6.13 Effects of fluids. Testing to determine conformance of the generator package to the requirement of 3.4.2.6 shall be deleted if the manufacturer submits a certificate, signed by an official of the firm, indicating compliance to this requirement. If no such certificate is submitted, conformance to 3.4.2.6 shall be determined by conducting materials tests or by wetting a generator package over its entire external surface (flange surface excepted) a total of three times at three day intervals with each of the fluids listed, with no signs of deterioration.

4.6.14 Endurance. The channel shall be operated for 60 cycles of the test schedule shown by Table III. During each hour of the test the generator input shaft shall be operated at minimum rated input speed for rated ac power output the first 15 minutes, at cruise speed for the next half hour, and at maximum rated speed for rated ac power output the last 15 minutes. Changes in generator input shaft speed shall be within 10 percent of the maximum rate as specified by 3.4.2.4.1. The channel shall be shut down with the generator package input shaft speed reduced to zero for a minimum of ten minutes at the end of each cycle, and until all channel components have stabilized at 23±10°C after every 15 cycles. Before shutting down at the end of cycle 20 and cycle 40, the generator package shall be operated for one half hour with a load still connected to the load side of the generator bus contactor, with the generator input shaft at 30±5 percent of the minimum rated speed for rated ac power output, and with maximum continuous coolant temperature. The channel control switch is to be left in the NORMAL position except where reset is required. The generator contactor shall not close below minimum rated generator shaft speed for rated ac power output. Coolant leakage shall be observed throughout this test and conformance to 3.4.2.3 determined. Measure coolant pressure, pressure drop across the generator package, and flow rate under each temperature and input shaft speed condition to determine conformance to 3.4.2.3 and the applicable specification sheet. The following conditions shall be imposed randomly over the first 50 cycles of the test.

a. 150 percent ac load at 0.85 power factor and 200 percent dc load simultaneously for a duration of 5 seconds, a total of 10 times.

b. 125 percent ac load at 0.85 power factor for a duration of 5 minutes, a total of 10 times.

c. Single phase, two phase line-to-line, and three phase line-to-neutral short circuits shall be placed on the ac power source as well as short circuits on the dc power source, not simultaneously, each for a duration of 5 seconds. Each short circuit shall be imposed once during Steps 2, 3, and 9 of any cycle.

d. While the channel is under load and thermally stablized the generator package input shaft speed shall be increased to the overspeed condition indicated by the detail specification and held there for five minutes, 5 times. The channel shall continue to power the load throughout the test unless a channel protective function opens the generator feeder contactor.

The coolant into liquid cooled channel components shall be maintained at the specified flow rate and at the temperatures shown by Table III for liquid coolant. The ambient temperature indicated for each step of Table III shall be maintained around all air cooled channel components. The ambient temperature need not be maintained around liquid cooled channel components under test if thermal isolation is maintained (4.5.7.1).

If a part in a channel component fails during this test the supplier of the channel component shall submit a report to the qualifying activity identifying the failure, its cause, and proposed corrective action. The qualifying activity may, at its descretion, require that the failed component part(s) be replaced in all qualification test channel components. If a part fails during the last 10 cycles of this testing period, testing is to be resumed at the 51st cycle. Following the completion of the 60th cycle of this test, of which the last 10 cycles are failure free, the channel shall successfully complete tests of 4.6.6(b) and (c).

4.6.15 Fluid contamination. As the final quality conformance inspection, the generator package shall be operated for one hour and the coolant then checked for contamination in accordance with Naval Air Systems Command (NAVAIR), Aviation Hydraulics Manual 01-1A-17, Section III, using the contamination anaylsis Kit Part Number 57L414 (Figure 3-1 of the manual). The maximum acceptable particle level for this equipment is Class 5 as determined by NAVAIR Manual 01-1A-17. If the contamination level is unacceptable, the unit may be operated for a second one hour period with a clean filter. If the contamination level is again unacceptable, the unit shall be disassembled by the manufacturer and the source of contamination identified before resubmitting for test. This test shall be repeated at the conclusion of qualification testing. If disassembly and inspection is required after this test, it shall be accomplished by the manufacturer.

4.6.16 Input shaft shear. Using an uninstalled generator package input shaft determine conformance to 3.4.2.4.2.

5. PACKAGING

5.1 Preservation-packaging. Preservation-packaging shall be in accordance with MIL-STD-794 level A or C, as specified in contract or order (see 6.2).

5.1.1 Level A. For level A packaging, preservation shall be in accordance with MIL-P-116, Method II, without preservation compounds, using metal reusable containers unless otherwise specified.

5.1.2 Level C. For level C the channel components shall be preserved and packaged individually in accordance with the manufacturer's commercial practice.

5.2 Packing. Packing shall be in accordance with MIL-STD-794, level A, B or C as specified in the contract or purchase order.

5.3 Marking. Interior and exterior containers shall be marked in accordance wtih MIL-STD-794 and MIL-STD-129.

6. NOTES

6.1 Intended use. The channels qualifying to this specification are intended for use on aircraft as a primary continuous source of 400 Hz power and as a limited source of 28 volt dc power for use in electric power control and protective circuitry.

6.1.1 Aircraft power feeder configurations. The feeder impedance to the POR as provided in the actual aircraft installation for both the ac and dc power sources will not exceed the impedance provided by the test configuration specified in paragraph 4.5.1.

6.2 Ordering data. Acquisition documents should specify the following:

a. Title, number, and date of this specification.

b. Military Part Number. (See specification sheet)

c. Required level of packaging and packing. (5.1)

d. Type of container. (5.1.1)

e. Installation instructions (see 3.7) plus handbooks or manuals when required.

f. Qualification retention samples as specified in 4.3.3.

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time set for opening of bids, qualified for inclusion in Qualified Products List (QPL) whether or not such products have actually been so listed by that date. The activity responsible for this Qualified Products List is the Commanding Officer, Naval Air Engineering Center (SESD) (Code 53), Lakehurst, NJ 08733-5100, and the qualifying activity is the Naval Air Test Center, Patuxent River, Maryland. Information concerning qualification may be directed to the Commander, Naval Air Test Center, Attn: Code SY60, Patuxent River, Maryland 20670.

6.3.1 Qualification retention samples. For each quotation and based on all production contracts obtained, it will be the contractor's responsibility to inform the procuring activity of the exact number of qualification retention samples required for forwarding to the Qualifying Activity. If the proper number of retention samples is not itemized in the contract, then the contractor will, without additional cost to the Government, forward to the Qualifying Activity whatever number of retention samples is determined by the cognizant Government Inspector to be required by paragraph 4.3.3 of this specification.

6.4. Design guides. The following paragraphs contain design guidelines based on actual experience that should be addressed and considered by the Contractor when a variable input speed alternating current generating system is to be proposed/developed to this specification.

6.4.1 Castings. Castings should be in accordance with MIL-C-6021. All castings containing reinforced threaded holes should be classified Class 2, Grade C, in areas within three radii of the hole center-line for the depth of the hole.

6.4.2 Standard parts. Military standard parts, identified by their military part number, are desired. Commercial parts such as screws, bolts, nuts, washers, etc., may be used provided they possess suitable properties and are directly replaceable by military standard parts without equipment modification. When such commercial parts are used, the part number for the corresponding military standard part shall be referenced on the applicable parts list and on the contractor's drawings.

6.4.3 Semi-conductors and electron tubes. Transistors and diodes other than rotating rectifiers should be chosen and applied as outlined in MIL-STD-454, Requirement 30. Electron tubes of either the vacuum or gas filled types should not be used.

6.4.4 Internal electric connections. Channel component internal connections, except those made at the rotating equipment windings, should be made in accordance with MIL-STD-454, Requirements 1 and 69.

6.4.5 Adjustable resistors. Only sealed adjustable resistors conforming to MIL-R-39015 should be used.

6.4.6 Bearing retention. If bearing supports are nonferrous, the bearing should be inserted into a steel sleeve mechanically secured to the bearing supports. If bearing supports are made of steel, sleeves are not necessary. The outer bearing ring should be retained axially and should have a positive method to prevent rotation. The bearing inner ring should be provided with sufficient interference fit with the shaft to prevent rotation under operating speeds and temperatures.

6.4.7 Microelectronic devices. Microelectronic devices should be chosen, applied and reported in accordance with Requirement 64 of MIL-STD-454 and should be listed in MIL-STD-1562.

6.4.8 Capacitors. Capacitors should be chosen, applied and reported in accordance with MIL-STD-454 Requirement 2. The use of wet slug tantalum capacitors is not recommended.

6.4.9 Environmental stress screening. Environmental stress screening of electronic parts should be used where required to achieve the generator package mean flight hours between failures (MFHBF) as specified in 3.4.1.10.

6.5 Definitions. The definition of terms as listed in MIL-STD-704 will apply in addition to those cited in 6.5.1 thru 6.5.12.

6.5.1 Channel. The equipment and interconnecting wiring required to generate, regulate, monitor, and deliver electric power to the POR when driven mechanically by a variable speed shaft. If required by the applicable specification sheet, a channel used in single as well as multi-channel

installations shall include the logic necessary to control and protect the electric power buses (primary, monitored, and emergency), as well as delivering the power for controlling the power contactors. Unless otherwise specified in the applicable specification sheet or contract, the channel control switch (3.4.1.2), the generator bus tie contactor, and interconnecting wiring between channel components shall not be included in the equipment to be furnished under this specification.

6.5.2 Channel component. Any channel equipment removable from an aircraft as a unit.

* 6.5.3 Generator package. A channel component comprised of the generator plus all regulation, conversion, and monitoring functions of the channel as well as those functions required by the specification sheet for the monitoring and control of aircraft buses. The control switch (3.4.1.2) and any other channel control components identified by the detail specification for installation remote to the generator package are excepted.

6.5.4 Load. Load is measured by the current delivered by a channel as long as the voltage(s) at the POR(s) remains within the limits of Figure 1 and Figure 4 for ac and dc respectively. Rated ac phase load (or current) is equal to the KVA rating of the channel divided by 115 x 3.

6.5.5 Load unbalance. The maximum difference between ac current magnitudes for any two phases.

6.5.6 Normal operating conditions. Conditions wherein the channel is operated in specified environments (see 3.4.1.1), and positions (see 3.4.2.7 and 3.4.2.7.1), and at rated generator package input shaft speeds (see 3.4.2.4.1), including any combination of these. Under any of these conditions the channel shall be capable of delivering power for ac motor starting (see 3.5.1.1.4), ac loads from zero to specified overload, including load unbalance (see 3.5.1.1.1 and 3.5.1.1.2), and dc loads up to 200 percent overload (see 3.5.1.2).

6.5.7 Point of regulation (POR). That point at which channel voltage characteristics are measured. Typically this point for the ac power source will be where the channel feeders are attached to the contactor by which the channel is connected to the primary power bus. For the dc power source, these points are the terminals of the generator package. For the purpose of this specification, the POR is as shown by Figure 5.

6.5.8 Qualification inspection. Tests conducted on channels and channel components submitted for qualification.

6.5.9 Qualification retention inspection. Those inspections and tests run on production samples to verify that the design is identical to that previously qualified and that production components meet all the requirments of the specification.

6.5.10 Quality conformance inspection. Those inspections and tests accomplished on each channel component manufactured and submitted for acceptance under a production contract.

6.5.11 Standard test conditions. The conditions, as specified by 4.5.

6.5.12 Voltage unbalance. The maximum difference between ac phase voltage magnitudes for any two phases at the POR.

6.6 Specification sheet inclusions. The specfication sheet must include all areas where this specification does not define a parameter or where a variation to this specification is required. The following minimum information will be included in all specifications sheet referencing this document:

a. Rating, both ac and dc (3.5.1.1 and 3.5.1.2).

b. Envelope of all channel components, their mounting provisions, and all interfaces (electrical, mechanical, hydraulic, etc.).

c. Weight of each channel component and the overhung moment for all pad mounted channel components.

d. Temperature and altitude rating for each channel component.

e. Maximum heat rejection of each channel component (3.5.6).

f. The following coolant information is required for all oil cooled channel components:

   Temperature range for continuous operation.
   Maximum temperature for 5 minutes.
   Maximum system pressure.

g. Generator package rated input shaft speed range, speed range for rated channel ouputs, overspeed, direction of rotation, and shear section rating.

h. Generator package horizontal axis if not the generator's axis of rotation and the position of 0° roll.

6.7 Manufacturing requirements. The appropriate technical requirements contained in the following list of documents should be applied by the manufacture were applicable in order to achieve and maintain the Government's established policy requiring an acceptable level of manufacturing quality for all electrical/electronic equipment:

Document	Title
MIL-STD-454	Standard General Requirments for Electronic Equipment
MIL-STD-275	Printed Wiring for Electronic Equipment
MIL-P-55110	Printed Wiring Boards

WS-6536	Procedures and Requirements for Preparation and Soldering of Electrical Connections
NAV MAT-P-4855-1	Navy Power Supply Reliability
NAV MAT-P-9492	Navy Manufacturing Screening Program

*Indicates changes from previous issue.

Preparing activity
Navy - AS
(Project No. 6115-N505)

TABLE I. Inspection and test schedules.

Examination or Test	Requirement Paragraph	Method of Inspection Paragraph	Quality[7] Conformance Inspection	Qualification Inspection		
				Sample Channel No. 1	Sample Channel No. 2	Sample Channel No. 3
Examination of Product	3.4, 3.6 3.7, & 3.8	4.6.1.1 4.6.1.2	X	X	X	X
Dielectric	3.4.1.7	4.6.2	X			
MFHBF	3.4.1.10	4.6.3		X[1]	X[1]	X[1]
Electrical performance	3.5	4.6.5 4.6.6	X	X	X	X
Motor starting	3.5.1.1.4	4.6.7		X		
Heat rejection	3.5.6	4.6.8		X		
Maximum torque	3.5.7	4.6.9			X	
Environmental (except crash safety)	3.4.1.1	4.6.10		X[2]	X[2]	X[2]
Toxicity & fire resistance	3.3.2	4.6.11		X[3]	X[3]	X[3]
Position	3.4.2.7, 3.4.2.7.1	4.6.12			X	
Effects of fluids	3.4.2.6	4.6.13		X[4]	X[4]	X[4]
Endurance	3.4.5	4.6.14		X[5]	X[5]	X[5]
Shaft shear	3.4.2.4.2	4.6.16				X[6]
Fluid contamination	3.4.2.3	4.6.15	X	X	X	X
Crash safety	3.4.1.1	4.6.10		X[2]	X[2]	X[2]

Applicable notes are on next page.

TABLE I (Continued)

NOTES

1. The channel component MTBF analysis shall be submitted with the first channel submitted for qualification; not required for qualifiation retention.

2. Tests as scheduled by MIL-E-81910 as amended by 4.6.10 for each qualification test sample.

3. The suppliers certificate of conformance (4.6.11) shall be submitted with the first channel submited for qualification.

4. If a certificate is not received from the supplier for the effects of fluids test (4.6.13), tests may be conducted on any one generator package submitted for qualification.

5. The endurance test (4.6.14) shall be conducted on any two of the channels submitted for qualification.

6. Test to be done using a spare shaft furnished with channels submitted for qualification (4.3.1).

7. Test procedures to be used in the inspection of individual channel components, or subassemblies, shall be subjected to the approval of the qualifying activity.

TABLE II. Generator package attitude/time test (4.6.12).

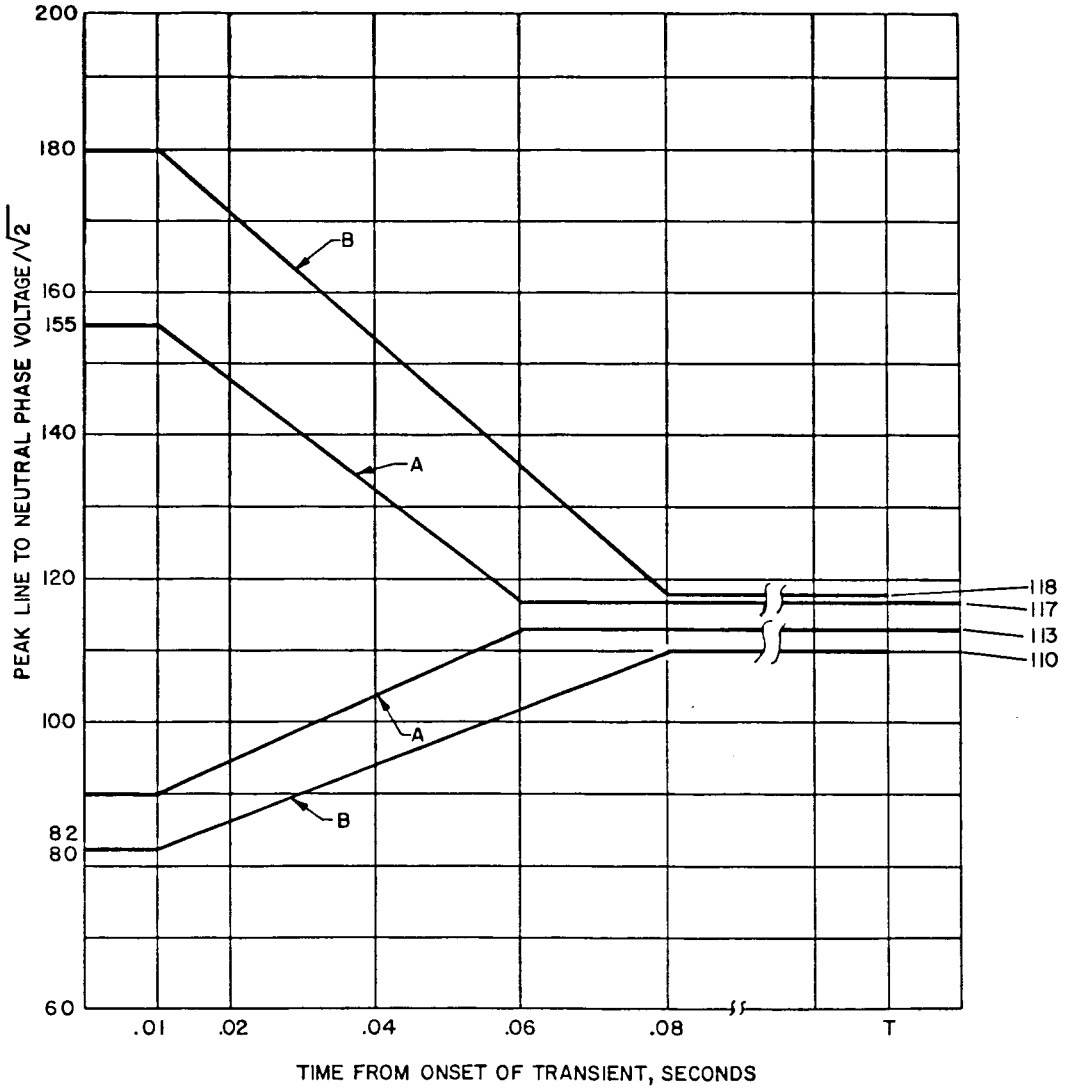
PITCH (±1°)	ROLL (±1°)	MINIMUM TIME
+15	+7.5	2 hour
+15	-7.5	2 hour
-7.5	+7.5	2 hour
-7.5	-7.5	2 hour
0	+15	5 minutes
0	-15	5 minutes
+60	+7.5	5 minutes
+60	-7.5	5 minutes
-45	+7.5	5 minutes
-45	-7.5	5 minutes
-90	0	30 seconds
+90	0	30 seconds
-30	+90	30 seconds
-30	-90	30 seconds
+30	+90	30 seconds
+30	-90	30 seconds
+105	0	30 seconds
0	Inverted	30 seconds

TABLE III. Endurance test schedule (see 4.6.14).

STEP	OPERATING TIME (minutes)	RATED AC LOAD (%)	RATED DC LOAD (%)	TEMPERATURE OF LIQUID COOLANT (°C)	AMB. AIR TEMPERATURE (°C)
1	120	100	100	max*	max*
2	120	50	50	30±10	23±10
3	120	70	75	max*	max*
4	120	10	50	30±10	23±10
5	5	100	100	max**	max**
6	120	40	50	30±10	23±10
7	120	90	75	max*	max*
8	120	20	50	30±10	23±10
9	120	100	100	max*	max*

*maximum specified temp for continuous operation

**maximum specified temp for 5 minutes



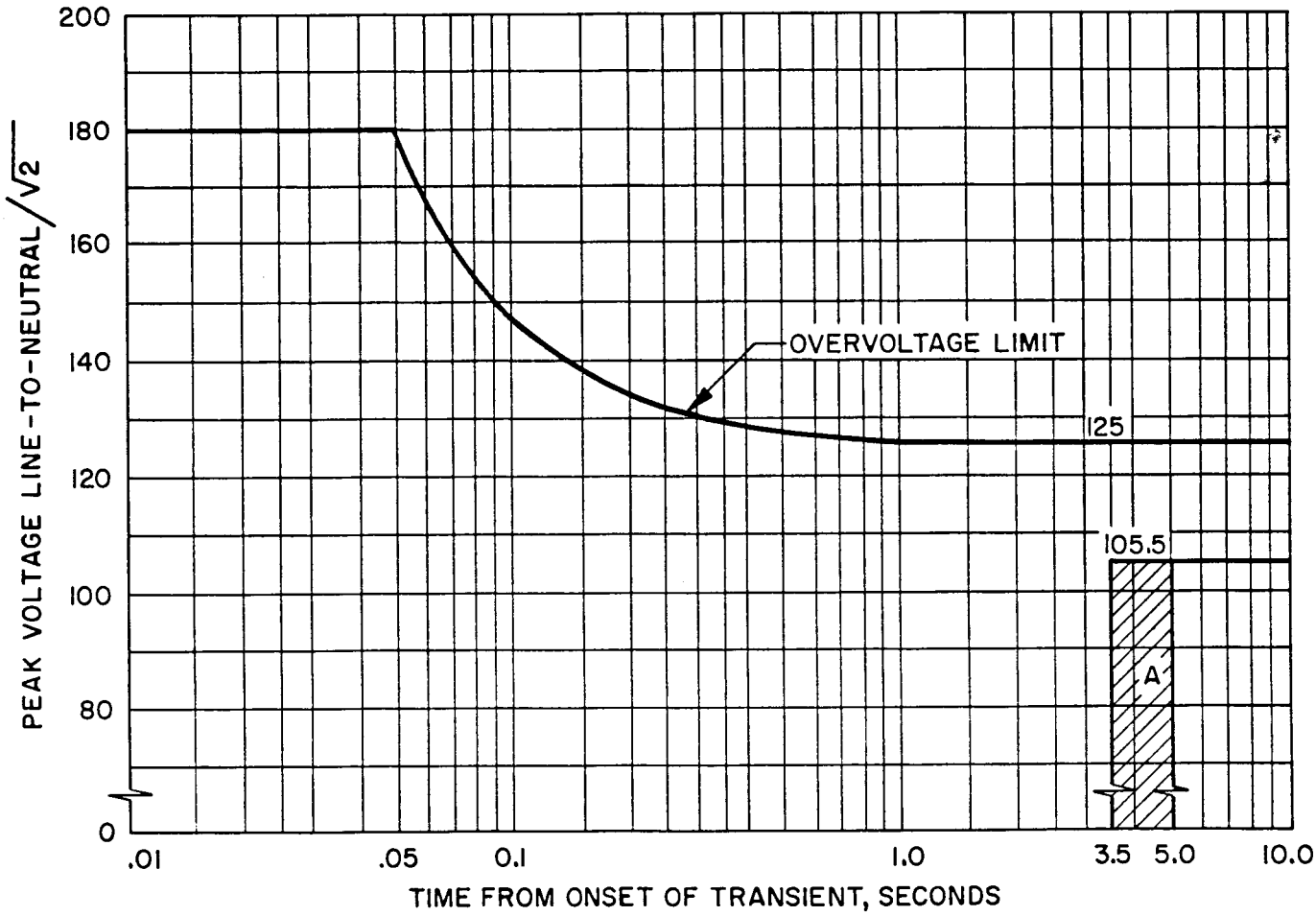
NOTES:

CURVE A. Maximum voltage transient upon application and removal of any load up to rated continuous load (3.5.1.1.1).

CURVE B. Maximum voltage transient upon application and removal of all overloads up to 150% (3.5.1.1.2). Time "T" is 5 seconds for 150% load or 5 minutes for 125% load.

Steady state limits are RMS values.

FIGURE 1. AC voltage regulation, normal operation (3.5.2.1.1).



NOTES:

a. Undervoltage protection shall operate within the shaded area (A) at any voltage below 105.5 ± 2.5 volts.

FIGURE 2. AC voltage limits during abnormal operation (3.5.2.1.2).

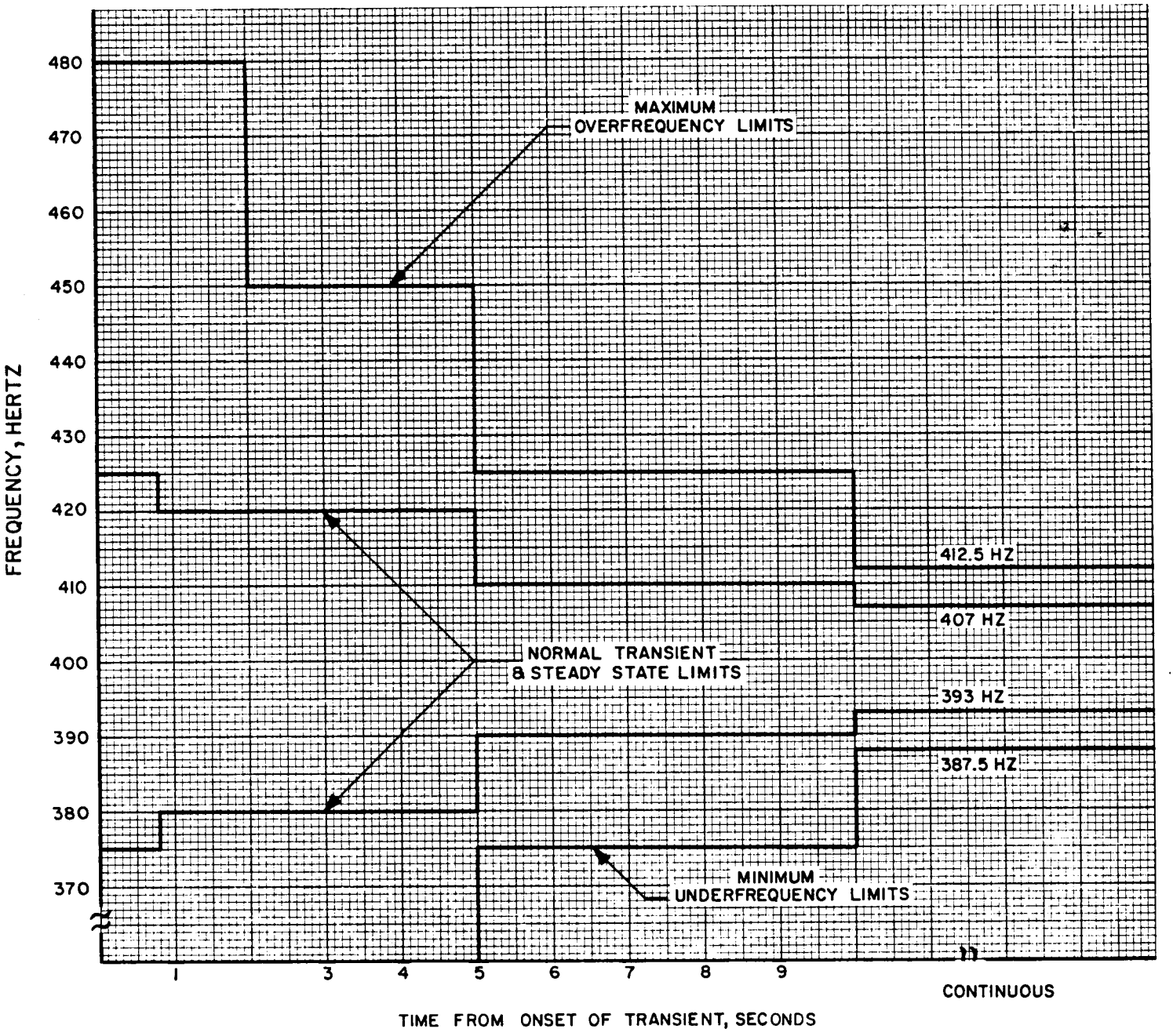
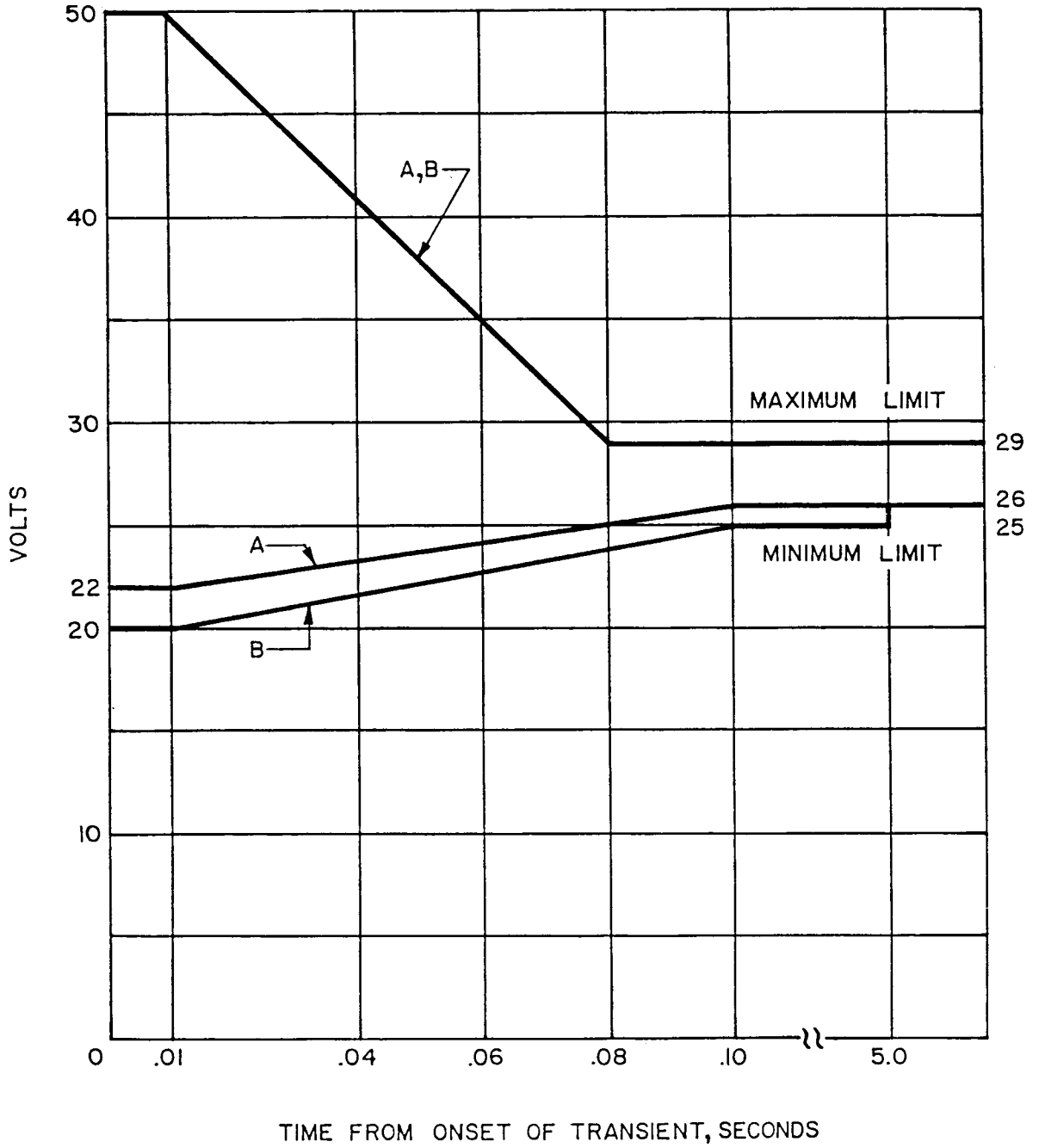


FIGURE 3. AC power, frequency limits (3.5.2.2.1 and 3.5.2.2.2).



NOTES:

A. Maximum voltage transient upon application and removal of any load from 50% to 100% of rated.

B. Maximum voltage transient upon application and removal of any overloads up to 200% of rated.

FIGURE 4. DC voltage regulation, normal operation (3.5.3).

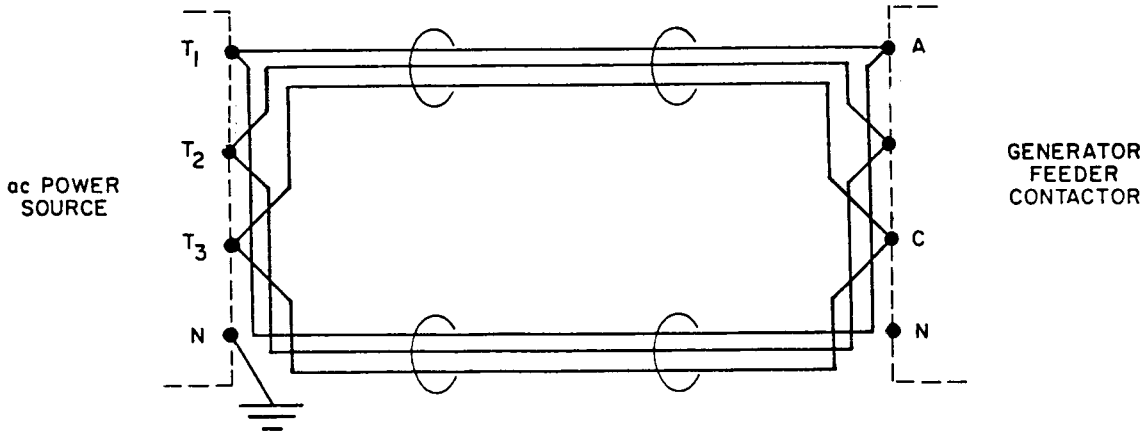


FIGURE 5a.

ac CHANNEL RATING (KVA)	ac FEEDER SIZE (AWG)	dc FEEDER SIZE (AWG)
20	12	18
30	10	18
40	8	18
60	6	18
75	4	18
90	2	18
120	1/0	18

FIGURE 5b.

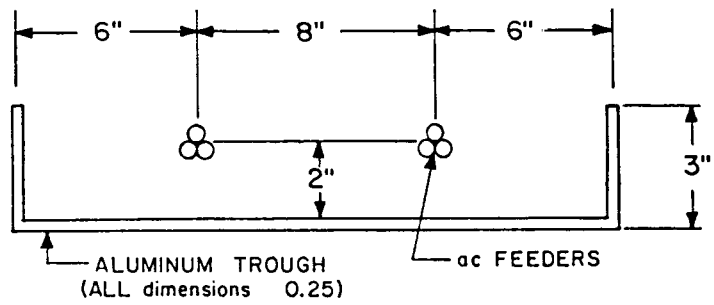


FIGURE 5c.

NOTES:

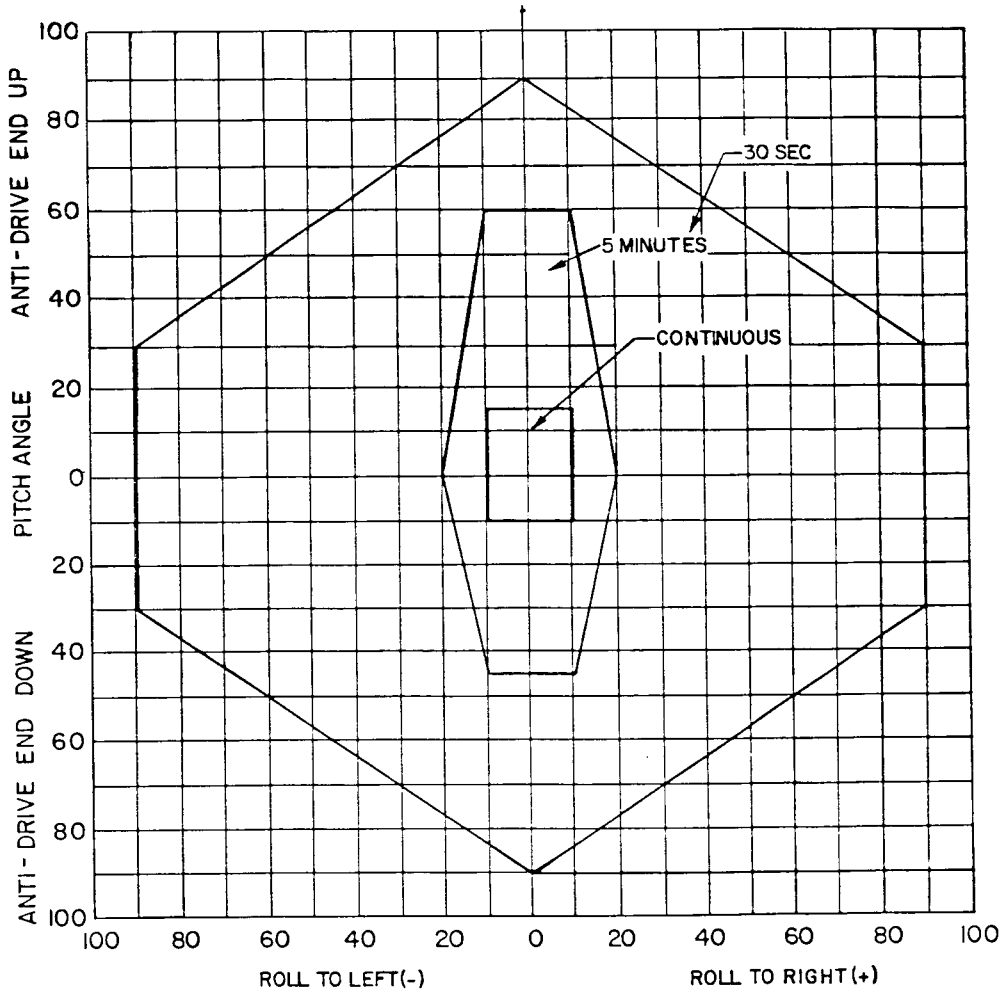
a. Feeder wire shall conform to MIL-W-22759 or MIL-W-81381.

b. The feeders for the ac power source of channels under test to determine conformance to this specification shall be connected as shown in Figure 5a, feeders shall be 50 ± 1 feet long, each feeder shall be sized as shown in Figure 5b, and positioned in an aluminum trough as shown by Figure 5c for their entire length. Feeder bundles are to be twisted once every 3 feet. The neutral connection of the ac power source shall be electrically grounded to the aluminum trough.

c. The feeder carrying the dc from the generator package terminals (POR) to the utilization equipment shall be sized as shown in Figure 5b. Its length, external to any channel components, shall be 50 ± 1 feet. The return circuit shall be through the ac neutral connections.

d. Points A, B and C are the POR for each phase of the ac power source.

FIGURE 5. Channel power feeder configuration during tests.



NOTES:

a. All dive and climb angles are with respect to the rotational axis of the generator. Roll angles are to be measured from the 0° roll angle identified by the detail specification.

b. This figure assumes only a gravitational force on the unit under test.

c. The total requirement includes 30 seconds in a zero gravity, negative 1G condition or inverted.

FIGURE 6. Generator package attitude (3.4.2.7).

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