Society of Automotive Engineers, Inc.
TWO PENNSYLVANIA PLAZA, NEW YORK, N.Y. 10001

AEROSPACE RECOMMENDED PRACTICE

ARP 1148

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Revised

GROUND ELECTRICAL POWER UNIT, TRANSPORTABLE 115/200 VOLT AC (NOMINAL) 400 HERTZ, 3-PHASE 4-WIRE (GROUNDED NEUTRAL) Y-CONNECTED SYSTEM

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1. SCOPE

This Recommended Practice outlines the general requirements for a transportable self-contained, continuous duty, diesel engine driven brushless alternator unit for supplying 400-Hertz electrical power to high performance commercial transport aircraft. It is intended to assist the airlines in standardardizing recommendations for various sizes and configurations of equipment and it is a guide for the preparation of detailed specifications by the purchaser. The unit is primarily intended to supply power to the aircraft during passenger loading and unloading, and during servicing operations at airports throughout the world. The combination of the equipment specified herein and the interconnecting cable(s) between the 400-Hertz alternator and the aircraft shall provide power characteristics at the aircraft receptacle which meet MIL-STD-704A requirements for Category "B" equipment. Other limits which are necessary to meet specific conditions must be specified by the purchaser.

2. APPLICABLE DOCUMENTS

The following documents shall form a part of this Recommended Practice to the extent specified herein. The applicable issue of each shall be that in effect on the date of this Recommended Practice unless otherwise specified in the purchaser's specifications. Supplementary specifications which by reference in any of the following publications are indicated to be part thereof, shall not be considered as effective except as specifically stated in the purchaser's specifications or as may be otherwise mutually agreed upon between the vendor and purchaser. In the event of conflicts between this Recommended Practice and the listed documents, this Recommended Practice shall apply:

DOCUMENT	TITLE
NEMA MG-1	NEMA Standards Publication - Motors and Generators
MIL-G-6099A	Generators and Regulators, Air-Cooled, A-C, Aircraft, General Specification For
MIL-I-26600	Interference Control Requirements, Aeronautical Equipment
MIL-I-0011683B	Interference Suppression, Radio Requirements for Engine Generators and Miscellaneous Engines
MIL-I-6181D	Interference Control Requirements, Aircraft Equipment
MIL-M-10304C	Meters, Electrical Indicating, Panel Type, Ruggedized, General Specification For
MIL-STD-461	Electromagnetic Interference Characteristics Requirements for Equipment
MIL-W-16878D	Wire, Electrical, Type B, 105 degrees C, 600 Volts, Insulated, High Temperature, Navy
MIL-W-5086A	Wire, Electrical, 600 Volt, Copper, Aircraft
MIL-STD-704A	Electric Power, Aircraft, Characteristics and Utilization of
ATA-Spec 101	Specification for Ground Equipment Technical Data
SAE-J680	Motor Truck Instrument Panel Grouping
SAE AIR-769	Ground Fault Protection on 400-Cycle Ground Power Units
SAE ARP-760	400-Cycle Ground Power Unit Provisions for Aircraft Electrical System Protection
SAE J919	Measurement of Sound Level at Operator Station
SAE J952a	Maximum Sound Levels for Engine Powered Equipment

3. REQUIREMENTS

3.1 Performance:

3.1.0.1 Recommended unit configurations shall be 60, 90, 160, and 200 KVA continuous at .8 to 1.0 power factor.

3.1.0.2 The ratings listed above shall be obtainable at the most stringent operating conditions cited in this specification.

3.1.0.3 The unit shall be capable of starting and producing its rated output and maximum overload at any ambient temperature ranging from -25 degrees F to +125 degrees F and at any ambient pressure encountered at elevations up to 4000 feet above sea level.

3.1.1 Operability: Also see Appendix

3.1.1.0.1 Each unit configuration shall be capable of continuous operation at rated output for a minimum of eight (8) hours under all operating conditions listed in this Recommended Practice.

3.1.1.0.2 The unit shall produce no noticeable smoke during operation. Fumes shall not be evident within 15 feet horizontally when operating in still air.

3.1.1.0.3 The unit prime mover shall be a diesel engine designed to operate on the widest spectrum of fuels possible.

3.1.1.0.4 Fuel consumption shall be minimal for all operating conditions.

3.1.1.0.5 Adequate fuel capacity shall be provided for eight (8) hours of continuous operation at rated output.

3.1.1.1 Reliability: Also see Appendix

3.1.1.1.1 Reliability is defined as the probability that a unit will perform its intended function for a specific period of time. The probability of no failures in t hours is expressed as R_t:

$$R_t = e^{-\lambda t}$$

$$\lambda = \text{Item Failure Rate} = \frac{1}{\text{MTBF}} \quad : \text{and } e = 2.718$$

3.1.1.2 Maintenance Requirements: Also see Appendix

3.1.1.2.1 Maintainability: See Appendix

3.1.1.2.2 Maintenance Repair Cycle:

3.1.1.2.2.1 An hourmeter shall be provided on the prime mover to facilitate compliance with scheduled maintenance and overhaul requirements. Scheduled maintenance checks shall not be required more often than every 150 hours of operating time.

3.1.1.2.3 Service and Access:

3.1.1.2.3.1 Equipment components and systems requiring routine and frequent inspection and maintenance shall be readily accessible. Suitable access doors or removable enclosures shall be provided for this purpose.

3.1.1.2.3.2 Major assemblies and components shall be easily disconnected and removed from the equipment without the necessity for extensive disassembly of other components. Lifting eyes, fork lift channels, or other devices shall be provided where required.

3.1.1.3 Total Life: Also see Appendix

3.1.1.3.1 "Total Life" is defined to be the hours of use from time of delivery of the equipment to the using activity until its identity is destroyed by classifying it as salvage and/or subject to cannibalization.

3.1.1.4 Environmental:

3.1.1.4.1 Unit performance or life shall not be affected by wind, sand, grit, salt air, precipitation, de-icing fluids, or other normally encountered airport atmosphere conditions. The entire unit shall start easily and operate satisfactorily under temperature conditions ranging from -25 F to +125 F.

3.1.1.5 Transportability: Also see Appendix

3.1.1.5.1 The unit shall have over-the-road capability and shall not exceed 96" in width and 120" in height when mounted on a vehicle chassis. Overall height including transporting vehicle for highway shipment shall not exceed 13 feet 6 inches.

3.1.1.6 Safety: Also see Appendix

3.1.1.6.1 Personnel Safety:

3.1.1.6.1.1 The load contactor(s) shall be interlocked with the aircraft electrical system so that the feeder cable(s) shall not remain energized except when engaged with the aircraft receptacles. As specified by the purchaser, the aircraft system provides a small transformer-rectifier on the airplane fed from the external power lines to provide 28 V DC that can be fed back to the unit. Ground power unit use of this 28 V DC airplane source should be limited to 1/2 ampere per cable.

3.1.1.6.2 Equipment Safety:

3.1.1.6.2.1 The overvoltage protective system shall disconnect the electrical system of the aircraft from the ground power alternator when the equivalent step function of the AC line-to-neutral voltage transient exceeds curve 1 of Figure 1 with full rated load removed. (Refer to MIL-STD-704A for calculations of the equivalent step function of a transient surge voltage.)

3.1.1.6.2.2 The undervoltage protective system shall disconnect the electrical system of the aircraft from the ground power alternator when the average line-to-neutral voltage drops below 102 V for longer than 4 seconds with full rated load applied. See curve 4 of Figure 1. (Refer to MIL-STD-704A for calculations of the equivalent step function undervoltage transient.)

3.1.1.6.2.3 The overfrequency protective system shall disconnect the electrical system of the aircraft from the ground power alternator when the alternator frequency exceeds 435 ± 5 Hertz.

3.1.1.6.2.4 The underfrequency protective system (manual reset) shall disconnect the electrical system of the aircraft from the ground power alternator when the alternator frequency drops below 370 ± 5 Hertz.

3.1.1.6.2.5 The overload protective system shall disconnect the electrical system of the aircraft from the ground power alternator when the output exceeds 125% rated current for five minutes. Overload protection must have an inverse time characteristic and should operate instantaneously if a short circuit occurs within the ground power unit. See paragraph 3.2.0.11 for additional requirements.

3.1.1.6.2.6 All components shall be fail-safe.

3.1.1.7 Noise and Vibration:

3.1.1.7.1 The maximum sound level for the equipment shall meet the requirements of SAE J952a. The measurement of the sound level shall be in accordance with SAE J919 paragraphs 1.1 through 3.5.

3.1.1.7.2 The unit shall be designed and constructed so that no parts will work loose in service. It shall be built to withstand the stresses, jars, vibrations, and other conditions incident to shipping, storage, installation and service.

3.2 Equipment Definition: Also see Appendix

3.2.0.1 Type of Mounting: The alternator with its prime mover and controls shall be tractor-mounted, truck-mounted, trailer-mounted, or self-propelled and shall have a self-supporting independent frame.

3.2.0.2 Prime Mover: The prime mover for driving the alternator shall be a diesel engine of sufficient horsepower to produce the rated KVA at .8 to 1.0 power factor and normal overload at the altitude and temperature range in which the equipment will be operated.

3.2.0.3 Alternator Speed: Alternator speeds shall be based on the acceptable continuous operating speed of the diesel engine.

3.2.0.4 Altitude: See paragraph 3.1.0.3.

3.2.0.5 Ambient Temperature: See paragraph 3.1.0.3.

3.2.0.6 Temperature Rise: Components of the alternator shall have insulating properties meeting NEMA MG1 Standards.

3.2.0.7 Dielectric Tests: The components of the alternator shall meet the requirements of paragraph 4.5.6 of MIL-G-6099A.

3.2.0.8 Alternator Rating: The recommended alternator ratings shall be 60, 90, 160, or 200 KVA continuous at any power factor from .8 to 1.0.

3.2.0.9 Overload Rating: The normal overload rating of all alternators shall be 125% of rated KVA at .8 power factor for 5 minutes. (See paragraph 3.2.0.40 for additional overload capabilities.)

3.2.0.10 Maximum Overload: The maximum overload required from the alternator shall be 125% of rated KVA at .8 power factor for 5 minutes.

3.2.0.11 Three/Unit Short Circuit Current: Three/unit short circuit current (not to exceed four per unit) shall be provided if a short occurs at the end of the output cable or within the aircraft. Time period shall be a minimum of 4 seconds and a maximum of 8 seconds.

3.2.0.12 Nominal Voltage Rating: The AC system shall be a 3-phase, 4-wire "Y" system with grounded neutral having a nominal voltage of 115/200 V. The grounded neutral shall be tied solid to the alternator frame with sufficient capacity in the tie to handle maximum ground fault current for a period of 10 seconds.

3.2.0.13 Regulated Voltage Range: The regulated voltage range shall be -15% to +15% of the nominal voltage rating line to line. This range shall be adjusted by the regulator rheostat. Range specified will permit checking overvoltage and undervoltage protective devices.

3.2.0.14 Type of Regulator: The regulator furnished with the alternator shall be a magnetic amplifier or solid state design.

3.2.0.15 Regulator Sensing: Regulator sensing shall be three phase averaging.

3.2.0.16 Highest Phase Voltage Limiting: A highest phase voltage limiting system shall be incorporated in the voltage regulator to limit the highest phase voltage of the alternator to 130 V during unbalanced load conditions.

3.2.0.17 Line Drop Compensation: A system of automatic line drop compensation shall be incorporated in the voltage regulator to provide constant voltage at the aircraft receptacle(s) irrespective of current and power factor. Minimum compensation capability shall be 5%.

3.2.0.18 Voltage Regulation: The voltage at the aircraft receptacle(s) will stay with ± 1% of the rated line-to-neutral voltage for all balanced loads (between receptacles and phases) up to 125% rated KVA at 0.8 power factor except during load switching.

3.2.0.19 Voltage Regulation Steady-State: The voltage at the end of the output cable(s) shall stay within ± 1% of the steady state voltage for all balanced loads (between receptacles and phases) up to and including 125% rated KVA at .8 power factor.

3.2.0.20 Voltage Transients: The equivalent step function of the AC voltage shall not exceed curves 2 and 3 of Figure 1 during full load application or removal. (Refer to MIL-STD-704A for calculations of the equivalent step function of the voltage transient.)

3.2.0.21 Voltage Transient Recovery: Output voltage transients shall recover to and stay within ± 1% of the steady state voltage in 200 milli-seconds with full rated load applied or removed from the ground power unit.

3.2.0.22 Voltage Modulation: The output voltage modulation shall not exceed .5% at any steady state condition within the rating of the machine.

3.2.0.23 Frequency of Voltage Modulation: The frequency components of the voltage modulation envelope wave form shall not exceed 100 CPS.

3.2.0.24 Phase Voltage Balance with Balanced Load: The maximum deviation of any of the three-phase voltages from the average of the three-phase voltages shall not exceed 1% with a balanced three-phase load. The voltages shall be measured at the alternator output terminals.

3.2.0.25 Phase Voltage Displacement with Balanced Load: The phase voltage displacement with a balanced load shall be within the limits of 120 degrees ± 1.5 degrees.

3.2.0.26 Phase Voltage Balance with Unbalanced Load: The maximum deviation of any of the phase voltages from the average of the three-phase voltages shall not exceed 4% with 1/3 rated current on any one phase and no load on the other two phases when measured at the alternator output terminals.

3.2.0.27 Phase Voltage Displacement with Unbalanced Load: The phase voltage displacement with a 1/3 rated current unbalanced load shall be within the limits of 120 degrees ± 4 degrees.

3.2.0.28 Individual Harmonic: The RMS value of any individual harmonic shall not exceed 2% of the fundamental (RMS) when measured from line to line and line to neutral at no load and rated KVA at .8 power factor with a harmonic analyzer.

3.2.0.29 Total Harmonic Content: The total harmonic content of the output voltage shall not exceed 3% of the fundamental (RMS) when measured from line to line and line to neutral at no load and rated KVA at .8 power factor with a distortion meter or calculated from the individual harmonics as measured with a harmonic analyzer. The total harmonic content of the output voltage shall not exceed 4% of the fundamental (RMS) when measured from line to line and line to neutral for a 1/3 rated current unbalanced load.

3.2.0.30 Crest Factor: The crest factor of the alternator shall not exceed 1.414 ± 0.07.

3.2.0.31 Frequency Regulation: The output frequency shall stay within 400 Hertz ± 5 Hertz at all steady state load up through full rated load.

3.2.0.32 Frequency Regulation Steady State: The output frequency shall stay within ± 1 Hertz of the steady state frequency for all loads up to and including full rated load.

3.2.0.33 Frequency Transients: The instantaneous frequency shall not be greater than 417.5 Hertz or less than 382.5 Hertz during full load application or removal.

3.2.0.34 Frequency Transient Recovery: Output frequency transients shall recover to and stay within 400 Hertz ± 5 Hertz in 2 seconds.

3.2.0.35 Frequency Modulation: The output frequency modulation shall not exceed .25% of the steady state frequency for all loads up to and including full rated load.

3.2.0.36 Frequency Modulation Rate: The rate of frequency change due to frequency modulation shall not exceed 13 Hertz per second.

3.2.0.37 Frequency Drift: Variation within steady state frequency limits due to drift shall not exceed ± 1 Hertz.

3.2.0.38 Frequency Drift Rate: Frequency variation due to drift shall not occur at a rate greater than 15 Hertz per minute.

3.2.0.39 Phase Rotation: Phase rotation shall be A-B-C.

3.2.0.40 Inrush Current Provisions: Units rated at 140 KVA or larger shall be capable of starting a 28 HP motor with an inrush current of 400 amps superimposed on a 50% rated KVA at .9 power factor lagging, steady state load. The 400-amp surge decays to a steady state value of 70 amps in 2 seconds, and is followed by a 160-amp inrush current in 4 seconds. The 160-amp surge decays to 30 amps in 2 seconds.

3.2.1 Interface Requirements: Also see Appendix

3.2.1.1 Each output feeder cable and plug assembly shall be compatible with an AN-3114 receptacle.

3.2.2 Customer Furnished Property List: Not applicable.

3.2.3 Manuals/Publications: Also see Appendix

3.2.3.1 Operating, illustrated parts, maintenance and overhaul manuals shall be provided.

3.2.3.2 All manuals shall be in accordance with ATA Spec 101.

3.2.4 Tools and Test Equipment: Also see Appendix

3.2.4.1 Only standard tools shall be required for maintenance of any parts of the equipment.

3.2.5 Training: See Appendix

3.3 Design and Construction:

3.3.1 General Design Features: Also see Appendix

3.3.1.1 The prime mover installation shall be complete with all normal accessories.

3.3.1.2 The fuel tank shall be equipped with a self-closing fill and vent fitting.

3.3.1.3 A gravity feed fuel system shall not be used.

3.3.1.4 The fuel tank fill port shall be accessible from ground level and shall be so located as to preclude a possibility of fuel impinging on electrical or engine components during filling operations.

3.3.1.5 The prime mover exhaust system shall be routed clear of fuel and electrical system components. If routed through areas where leakage of oil, grease, or fuel could occur, the exhaust system shall be shielded from direct contact by such leakage.

3.3.1.6 The exhaust pipe shall terminate a minimum of 18 inches above the ground.

3.3.1.7 The prime mover and alternator shall be in an in-line configuration joined together with a suitable flexible coupling. The coupling shall be replaceable without the need of special alignment jigs.

3.3.1.8 Provisions shall be made for lifting with a fork lift as well as providing a top mounted lifting eye with suitable supporting framework required to support the unit.

3.3.1.9 Control Panel:

3.3.1.9.1 The control panel shall have easy accessibility of controls and instruments and shall contain all equipment necessary for the operation and control of the diesel engine and alternator. The panel controls and instruments shall be suitably identified and distinctly divided between prime mover and alternator controls and instruments.

3.3.1.9.2 Instruments shall be per MIL-M-10304A or equal. The instruments shall be of the type easily read, and of a well known manufacture so that replacements are readily obtainable. All instruments and control panels shall be lighted so that they can be read at night.

3.3.1.9.3 The control panel for the alternator shall contain the following minimum equipment:

3.3.1.9.3.1 One ammeter of adequate range, and a switch to permit reading the current in each phase.

3.3.1.9.3.2 One voltmeter with 0-300 V scale and a switch to permit reading of line-to-line and line-to-neutral voltage on each phase.

3.3.1.9.3.3 A frequency meter with a range of 350 to 450 Hertz.

3.3.1.9.3.4 A load "on" green indication light.

3.3.1.9.3.5 "On-Off" pushbuttons for the alternator with indicating lights.

3.3.1.9.4 The control panel for the engine shall contain the following:

3.3.1.9.4.1 Starter pushbutton, throttle, oil pressure gauge, ammeter, engine hourmeter, and water or cylinder temperature gauge.

3.3.1.10 The wiring shall be brought to terminal blocks and each conductor identified in accordance with a wiring diagram. The wiring shall be formed and laced to give a neat appearance. Wiring shall meet the requirements of MIL-W-16878D Type B and MIL-W-5086A of their equivalent.

3.3.1.11 The unit or power package shall have the following features:

3.3.1.11.1 A suitable metal weatherproof housing.

3.3.1.11.2 Minimum overall dimensions of the unit and its housing consistent with adequate clearances, proper ventilation and accessibility for maintenance.

3.3.1.11.3 Capability of over-the-road travel without special permits.

3.3.1.11.4 A completely self-contained, light and compact as possible, and aesthetically pleasing package.

3.3.1.11.5 Provision to use the package as a means of access to aircraft electrical receptacles located up to 10 feet above ground level.

3.3.1.11.6 Adequate storage space for all the necessary output cables.

3.3.2 Materials, Parts, and Processes: Also see Appendix

3.3.2.1 All materials and components assembled or fabricated into the equipment shall be new and unused, of high grade quality, of current production, and free from all defects or imperfections which might affect the serviceability or appearance of the finished product.

3.3.2.2 Wire resistant and non-moisture absorbing materials shall be used wherever possible.

3.3.3 Standard and Commercial Parts:

3.3.3.1 Standard commercial parts shall be used wherever possible.

3.3.4 Moisture and Fungus Resistance: Also see Appendix

3.3.4.1 Equipment and controls that are exposed to the weather shall be weatherproof type.

3.3.5 Corrosion of Metal Parts:

3.3.5.1 Suitable and adequate corrosion protection shall be applied throughout the equipment.

3.3.6 Interchangeability and Replaceability:

3.3.6.1 All parts having the same manufacturer's part number shall be directly and completely interchangeable with each other with respect to installation and performance.

3.3.7 Workmanship:

3.3.7.1 High standards of workmanship and methods of fabrication shall be basic requirements. Welds shall exhibit good penetration and shall be clean and free from slag. Welds shall not be ground in order to improve appearance except on non-structural parts. Sheared or sharp metal edges shall be burred and broken. All exposed metal corners shall be removed and adequately radiused.

3.3.8 Electromagnetic Interference:

3.3.8.1 The unit shall meet radio suppression specifications MIL-I-26600. MIL-I-0011683B, MIL-I-6181D, and MIL-STD-461. It shall be capable of operating through the entire aircraft radio frequency range. Provisions shall be designed into the power unit to protect it from voltage fluctuations which might result from the operation of aircraft radio frequency equipment.

3.3.9 Identification and Marking:

3.3.9.1 All instruments and controls shall be suitably identified. Adequate operating instruction placards shall be permanently affixed in proximity to all control panels. Strip tape is not acceptable.

3.3.9.2 Wiring and plumbing schematic diagrams shall be permanently affixed in a convenient location. All controls and instruments shall be identified in like manner on the schematics as on the respective placards.

3.3.9.3 The contents of all fluid tanks shall be legibly identified by installing a permanent placard adjacent to the tank filler.

3.3.9.4 A metal nameplate shall be riveted to the equipment specifying vendor's name and/or trademark, vendor's part or model number, vendor's serial number, date of manufacture, and pertinent characteristics (such as rating).

3.3.10 Storage: See Appendix

3.3.11 Exterior Finish: Also see Appendix

3.3.11.1 The equipment shall be suitably primed and finished.

3.3.12 Product Support: See Appendix

3.3.13 Warranty: See Appendix

3.3.14 Performance Guarantee: See Appendix

3.3.15 Human Engineering:

3.3.15.1 The unit shall be easily operated by personnel possessing no special skills and given minimum training on the equipment. All operator controls and instruments shall be conveniently grouped at one location. Operation shall be easily accomplished while wearing foulweather clothing. The entire assembly shall require no maintenance skills beyond those normally provided by an automotive mechanic using standard tools.

4. QUALITY ASSURANCE PROVISIONS

4.1 Preliminary Qualification Tests: See Appendix

4.2 Formal Qualification Tests: See Appendix

4.2.1 Inspection: See Appendix

4.2.2 Analyses: See Appendix

4.2.3 Demonstrations: See Appendix

4.2.4 Tests: See Appendix

4.3 Reliability Test and Analyses: To be specified.

5. INSTRUCTIONS FOR SHIPMENT

5.1 Preparation for Shipment: See Appendix

5.2 Shipment: See Appendix

6. DEFINITIONS AND ABBREVIATIONS

This glossary of terms is included as a part of this specification for use in its interpretation.

Type of mounting is the means of mounting the alternator with its prime mover and controls.

Prime mover is the source of power for driving the alternator.

Unit refers to the complete power package such as the prime mover, alternator and all associated equipment and systems.

Alternator speed is the nominal speed at which the alternator operates to produce 400 Hertz.

Altitude is the maximum height in feet above sea level at which the unit must operate and maintain characteristics within recommended limits.

Ambient temperature is the temperature range in degrees Fahrenheit in which the unit must operate and maintain characteristics within recommended limits.

Temperature rise is the rise in degrees Centigrade above ambient for components of the 400 Hertz alternator.

Dielectric tests are the high voltages impressed between a component and the frame of the alternator. This test is used to check insulation characteristics.

Alternator rating is the full load value expressed in KVA at 0.8 to 1.0 power factor.

Overload rating is the normal overload value expressed in KVA at 0.8 power factor for a specified time.

Maximum overload is the maximum load expressed in KVA at 0.8 power factor that the alternator must produce for a specified time.

Three/unit short circuit current provides that the alternator under short circuit conditions must provide at least three times rated current. This feature will trip any overcurrent devices in the aircraft so that a fault may be isolated.

Nominal voltage rating is the root-mean-square line-to-neutral and line-to-line voltage at which the alternator is rated. The alternator is normally set such that output voltage is maintained at this value.

Regulated voltage range is the range in adjustment of the line-to-line voltage as controlled by the regulator rheostat.

Type of regulator refers to the system for controlling the output voltage of the alternator.

Regulator sensing is the means by which the voltage is sensed and fed to the voltage regulator.

Highest phase voltage limiting is a means of limiting the highest phase voltage of the alternator during any unbalanced load condition.

Line drop compensation is a system of increasing the alternator voltage in proportion to the current and power factor in the output cable(s) such that the voltage is held constant at the aircraft receptacle.

Remote sensing is a means of providing constant voltage at the aircraft receptacle by sensing the voltage at the receptacle with three separate leads in the output cable.

Voltage regulation is the band that the output voltage stays within except during transients.

Voltage regulation steady state is the band that the output voltage stays within with a fixed load.

Voltage transients are the maximum momentary deviation of the output voltage from the voltage regulation band.

Voltage transient recovery is the time required for the output voltage to recover to and remain within the prescribed limits after full load application or removal.

Voltage modulation is the cyclic variation about an average of the AC peak voltage during any steady state load. The modulation envelope is formed by a continuous curve connecting each sine wave peak to the successive sine wave peak. Voltage modulation in percent is calculated by taking maximum voltage minus minimum voltage times 100 and then dividing this value by maximum voltage plus minimum voltage.

Frequency characteristic of voltage modulation are the component frequencies which make up the modulation envelope wave form.

Phase voltage balance with balanced load is the maximum deviation of any of the three phase voltages from the average of the three phase voltages with a balanced three-phase load. The percent unbalance is calculated by taking maximum deviation of any one line-to-neutral voltage from the average of the three phase voltages times 100 divided by the average of the three phase voltages.

Phase voltage displacement with balanced load is the maximum deviation in degrees from 120 degrees between phases of the alternator voltages during balanced load conditions.

Phase voltage balance with unbalanced load is the maximum deviation of any of the three phase voltages from the average of the three phase voltages with a prescribed unbalanced load. Percent unbalance is calculated in the same method as under balanced load conditions.

Phase voltage displacement with unbalanced load is the maximum deviation in degrees from 120 degrees between phases of the alternator voltages during a prescribed unbalanced load.

Individual harmonic is the RMS value of any individual harmonic voltage when measured with a harmonic analyzer. This value is expressed as a percentage of the fundamental.

Total harmonic content is the total RM S voltage remaining when the fundamental component is removed. This value is determined by calculating the square root of the sum of the squares of the individual harmonics and expressing this value as a percentage of the fundamental.

Crest factor is the ratio of the peak voltage to the RMS voltage. This ratio with a true sine wave is 1.414.

Frequency regulation is the band that the output frequency stays within except during transients.

Frequency regulation steady state is the band that the output frequency stays within during any fixed load.

Frequency transients are the maximum instantaneous deviation of the output frequency from the frequency regulation band.

Frequency transient recovery is the time required for the output frequency to recover to and remain within the prescribed limits after full load application or removal.

Frequency modulation is the cyclic variation of instantaneous frequency about a mean frequency during any steady state load. Frequency modulation in percent is calculated by taking maximum frequency minus minimum frequency times 100 and then dividing this value by maximum frequency plus minimum frequency.

Frequency modulation rate is the rate of change of frequency due to frequency modulation when plotted against time.

Frequency drift is the slow and random variation in frequency within the steady state limits.

Frequency drift rate is the rate of change of frequency due to frequency drift when plotted against time.

7. APPENDIX - DETAILS FOR CONTRACTUAL NEGOTIATION

The following requirements peculiar to purchaser and vendor are enumerated below for specific use as the purchaser may require:

7.1 Operability:

7.1.1 Ratings based on a specific fuel shall be so designated and any fuel restrictions shall be specified by the purchaser.

7.1.2 Specific fuel consumption at rated power shall be specified by the vendor.

7.2 Reliability:

7.2.1 Mean time between failures (MTBF), assuming exponential distribution of times to failure, shall be computed by the vendor for the equipment major components.

7.2.2 The vendor shall compute and specify R_t for the equipment major components for a time period of t operating hours, equal to the vendor specified TBO, with a confidence factor of 90%.

7.2.3 The vendor shall determine and specify the total maintenance cost per TBO cycle as derived from his reliability calculations. This figure may be utilized in determining vendor responsibility regarding warranty as agreed upon by vendor and purchaser.

7.3 Maintenance Requirements:

7.3.1 Maintainability requirements in quantitative terms with tolerance e.g. mean time to repair, maintenance man-hours per operating hour, etc., shall be specified by the vendor.

7.3.2 The required number of operating hours for scheduled maintenance and for overhaul of the equipment and its components shall be specified by the vendor.

7.3.3 The man-hours to replace any major component shall be specified by the vendor.

7.4 Total Life:

7.4.1 "Total Life" of the equipment shall be specified by the vendor.

7.5 Transportability:

7.5.1 Limitations governing transportability shall be specified by the vendor.

7.6 Safety:

7.6.1 An optional phase sequence protective system if specified by the purchaser shall disconnect the electrical system of the aircraft from the ground power alternator if the phase rotation of the alternator output voltages are reversed. Proper phase rotation is A-B-C.

7.6.2 An optional feature providing for a more elaborate protective system similar to the Class II Protective System called out in ARP 760 paragraph 3.2 may be stipulated by the purchaser. This system would replace the protective system outlined in paragraphs 3.1.1.6.2.1, 3.1.1.6.2.2, 3.1.1.6.2.3, 3.1.1.6.2.4, and 3.1.1.6.2.5.

7.6.3 Optional devices to automatically shut down the prime mover when a hazardous or self-destructive condition exists during use may be specified by the purchaser.

7.6.4 An optional protective device that will disconnect the electrical system of the aircraft from the ground power alternator in the event of the neutral line going to open circuit may be specified by the purchaser.

7.7 Equipment Definition:

7.7.1 A semi-permanent skid-mounted unit may be specified by the purchaser.

7.7.2 Other maximum overload ratings may be stipulated by the purchaser if aircraft loadings demand a different value.

7.7.3 If measurement of phase voltage balance with balanced load is to be taken at other than the alternator output terminals, maximum deviation, output cable size and output cable length must be specified by the purchaser.

7.7.4 If measurement of phase voltage balance with unbalanced load is to be taken at other than the alternator output terminals, maximum deviation, output cable size and output cable length must be specified by the purchaser.

7.7.5 Output feeder cable length and size shall be specified by the purchaser.