

AEROSPACE RECOMMENDED PRACTICE

Submitted for recognition as an American National Standard

SAE ARP1480

REV.
A

Issued 1985-08
Revised 1991-04
Cancelled 1998-09

Ground Electrical Power Unit Brushless, Synchronous, Electric Motor-Driven 400 Hertz, 3-Phase Output

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1. SCOPE:

This recommended practice outlines the general requirements of a continuous duty, electric motor-driven brushless alternator unit for supplying 400 Hz electrical power to high performance commercial transport aircraft. This specification is for a single motor-generator set with one or two outputs. The generator set will generate at the aircraft voltage of 115/200 volts. This unit may be used in a central system of small size or in hangar or electronic shop applications. Power characteristics of this unit at the receptacle will meet MIL-Standard-704 requirements. 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 the recommended practice to the extent specified herein. The latest revision of each publication shall apply or as may be 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 otherwise be 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:

NEMA MG-1	NEMA Standards Publication - Motors and Generators
MIL-STD-461	Electromagnetic Interference Characteristic Requirements for Equipment
MIL-STD-704	Electric Power, Aircraft, Characteristics and Utilization of
ATA-Spec 101	Specification for Ground Equipment Technical Data
NBFI-70	National Electric Code
NEMA ICS 1	General Standards for Industrial Control and Systems
MIL-W-5086	Wire, Electric, Polyvinyl Chloride Insulated, Copper or Copper Alloy
MIL-G-6099	Generators and Regulators, Air-Cooled, AC, Aircraft, General Specification for
MIL-I-8500	Interchangeability and Replaceability of Component Parts for Aircraft and Missiles
MIL-W-16878	Wire, Electrical, Insulated, General Specification for
SAE J1175	

3. REQUIREMENTS:

3.1 Performance:

3.1.0.1 Units of small capacity - 6.25, 12.5, 18.75, and 37.5 KVA are commonly applied to electronic shops. The larger capacity units - 60, 75, 90, 125, 160, 200, 250, and 312 KVA sizes may be applied to central distribution of 400 Hz to multiple aircraft loads at Terminal gates or a Maintenance Base. All ratings are for continuous output at 0.8 power factor. All branch feeders shall be independently controlled to produce acceptable regulation at point of use.

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 °F (-32 °C) to +125 °F (52 °C) and at any ambient pressure encountered at elevations up to 10 000 ft above sea level. If the equipment is located in an enclosed space, ventilation of the room is required to hold the maximum upper ambient temperature to +125 °F (52 °C). De-rating of output of the unit at 2% for each EF over that limit is required.

3.1.1 Operability:

3.1.1.0.1 Each unit configuration shall be capable of continuous operation at rated output for 24 h per day under all operating conditions listed in this recommended practice.

3.1.1.0.2 The unit prime mover shall be a synchronous brushless electric motor.

3.1.1.1 Reliability: 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 failure in t hours is expressed as R_t :

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

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

3.1.1.2 Maintenance Requirements: 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 hour meter shall be provided on the unit to facilitate compliance with scheduled maintenance requirements. Scheduled maintenance checks shall not be required more often than every 2500 h of operation or 6 months elapsed time, whichever occurs first.

3.1.1.2.3 Service and Access:

3.1.1.2.3.1 Equipment components and systems shall be readily accessible.

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, forklift channels, or other devices shall be provided where required.

3.1.1.3 Total Life: See Appendix, Section 6.

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 conditions normally encountered in airport atmosphere conditions. The unit shall operate satisfactorily under temperature conditions ranging from -25 °F (-32 °C) to +125 °F (52 °C). (See 3.1.0.3) More severe operating requirements may dictate more extreme temperature ranges.

3.1.1.5 Safety:

3.1.1.5.1 Personnel Safety:

3.1.1.5.1.1 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 rectifier on the airplane fed from the external power lines to provide 28 VDC that can be fed back to the unit. Ground power unit use of this 28 VDC airplane source shall be limited to 1/2 ampere per cable. An aircraft test-bank switch may be provided as an option to facilitate testing of the system when not connected to an aircraft. This applies for non-central systems.

3.1.1.5.1.2 Each unit shall offer safety to personnel operating or in vicinity of an operating unit. Control panel doors shall be provided with locks to prevent entrance by others than authorized personnel. Only authorized personnel shall be capable of operating unit with control panel doors open. Inside the control panel, any voltage over 250 volts shall be specially shielded to prevent accidental contact.

3.1.1.5.1.3 All rotating or moving parts shall be shielded to prevent accidental contact while unit is in normal operating mode.

3.1.1.5.2 Equipment Safety:

- 3.1.1.5.2.1 The over-voltage protective system shall disconnect the electrical system of the aircraft from the ground power alternator distribution when the AC line-to-neutral voltage exceeds curve of Figure 1 at the generator output terminals.
- 3.1.1.5.2.2 The under-voltage protective system shall disconnect the electrical system of the aircraft affected from the ground power alternator distribution when the average AC line-to-neutral voltage drops below curve of Figure 1 at generator output terminals.
- 3.1.1.5.2.3 The under-frequency protective system, if required, shall disconnect the electrical system of the aircraft from the ground power alternator when the alternator frequency drops below 370 ± 10 Hz.
- 3.1.1.5.2.4 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 to protect the alternator if a short circuit occurs within the ground power unit or its distribution system.
- 3.1.1.5.2.5 Phase rotation required by all aircraft is A-B-C. Fixed single motor-generators must be checked for phase sequence at time of installation only. It is unlikely that the input power connections will ever be reversed.
- 3.1.1.5.2.6 The following motor protective devices shall be considered minimum equipment on a motor-generator unit.
 - a. Reduced inrush starting on units above 30 KW in capacity;
 - b. Automatically-timed and programmed field application;
 - c. Three-phase motor running protection.
- 3.1.1.5.2.7 All components shall be installed to provide fail-safe protection to the unit should malfunction in input power, load, or starting and running controls occur.
- 3.1.1.5.2.8 Output contactors or shunt trip breakers shall have ample capacity to interrupt the load, considered to be inductive, being carried at the time of overcurrent protection operation.