

Submitted for recognition as an American National Standard

**EFFECTS OF NO-BREAK POWER TRANSFER ON 400 HZ  
AUXILIARY-POWER UNITS AND GROUND-POWER UNITS**

**FOREWORD**

Transferring 400 Hz aircraft load between aircraft auxiliary-power units and ground power units can create problems for the equipment if no-break power transfer (NBPT) methods are used unless they are properly specified and correctly executed. This SAE Aerospace Information Report describes how the power transfer is made and the possible detrimental effects on the aircraft auxiliary-power unit (APU) generator, the ground-power unit (GPU), and cable plugs and sockets.

Improper NBPT of 400 Hz power between aircraft APUs and GPUs can cause damage to either piece of equipment. Newer jet aircraft use this power transfer method to ensure that the on-board computer systems have uninterrupted power to prevent loss of data and increase reliability of onboard equipment by reducing exposure to interruptions due to power transfers. When these two power sources are connected together in a nonphase-locked condition, circulating currents can flow between them, which may cause damage to either the aircraft APU generator shafts or the GPUs.

**1. SCOPE:**

This SAE Aerospace Information Report (AIR) describes the characteristics and effects of using no-break power transfer (NBPT) methods when switching between auxiliary-power unit (APU) and ground-power unit (GPU). The GPU may be:

- a. Point-of-use solid-state frequency converter, engine-generator, or motor-generator
- b. Central system powered by motor-generator or solid-state frequency converter

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be reaffirmed, revised, or cancelled. SAE invites your written comments and suggestions.

Copyright 1992 Society of Automotive Engineers, Inc.  
All rights reserved.

Printed in U.S.A.

**SAE values your input. To provide feedback  
on this Technical Report, please visit  
<http://www.sae.org/technical/standards/AIR4651>**

## 2. REFERENCES:

- 2.1 Photocopies are available from the Engineering Society Library, 345 East 47th Street, New York, NY, (212) 705-7611. Breit, Joseph S. and Doty, James, H., "Aircraft No-Break Power Transfer Revisited", Book #1, Paper #410, NAECON '90, presented in Dayton, OH 1990

## 3. DISCUSSION:

NBPT is a method of providing an uninterrupted power source to a load when switching between two different power sources. This requires that for a brief time both power sources are connected together and to the load. Some modern aircraft such as the Boeing 747-400 and the McDonnell-Douglas MD-11 use this method to switch power between the aircraft APU and GPU. This is done to prevent loss of data stored in the computer memory.

There have been several reported instances of damage to both the aircraft APU generator shafts as well as damage to solid state GPUs, which have been attributed to the NBPT method of power transfer.

When two AC sources are connected together, there is a strong likelihood that the two sources will not be identically synchronized with each other, even though they are operating at the same frequency. Because of the phase angle difference, the instantaneous voltages of the two sources are at different levels. The voltage difference will force a circulating current, which is a function of the voltage difference, the cable and aircraft bus impedances as well as the GPU output impedances, to flow between the two sources.

The specifications supplied by the airframe manufacturers for the type of aircraft described will allow the NBPT power transfer to take place when the phase angle difference between the two sources is as much as 90°. Actual phase angle differences occur randomly up to this limit. Typical 400 Hz sources used are rated at 115/200 VAC, three phase, with a capability of delivering greater than 90 kV·A of power. A phase angle difference of this magnitude can result in initial circulating currents of up to 1400 amps, which may be in excess of the overload capability of some APUs and GPUs. Since the power transfer may take as long as 125 ms, these circulating currents can do damage to either the aircraft APU generator or the GPU. In addition, voltage transients may be introduced into both 400 Hz sources.

The data above represent a worst case scenario and illustrate the need for proper specification and execution of NBPT which can minimize the circulating currents and avoid potential detrimental effects.

## 4. EFFECT ON AIRCRAFT CABLE PLUGS AND RECEPTACLES:

There have been no reported failures of plugs, receptacles, or cables due to this circulating current. These programs should be monitored to determine if there are long-term effects.