



AEROSPACE INFORMATION REPORT

AIR5387™

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Airport Electrical Power System Harmonics

RATIONALE

AIR5387 has been reaffirmed to comply with the SAE Five-Year Review policy.

INTRODUCTION

Quality of the airport electrical power is receiving increased attention due to the increased use of critical equipment such as computers and other equipment that demand high quality power. Much of the new equipment being installed today in airports causes harmonic distortion of the electrical power. At the same time, other new equipment being installed requires electrical power with little or no harmonic distortion. This document will explore the polluting effects of certain electrical equipment that degrade power quality and suggest some solutions. Poor power quality manifests itself in many ways:

- a. Overheated neutral conductors, transformers, and other electrical distribution equipment that can bring on premature failures.
- b. High voltage distortion.
- c. Neutral to ground voltage.
- d. Poor power factor.

In extreme cases, poor power quality can be a direct contributor to subsequent problems with equipment such as:

- a. Computer operational problems.
- b. Hardware component failures and reduced equipment life expectancy.
- c. Motor burnouts.
- d. Generator voltage regulation and frequency control problems.
- e. Uninterrupted power supply (UPS) and generator overheating.
- f. Failure of power factor (PF) correction capacitors.

In nearly every case, the loads themselves, not the supply, produce the voltage distortion found in the electrical distribution system. Normally the generators that are found in utility companies, as well as those in use for stand-by power around airports, all produce clean, high quality sinusoidal AC power. Alternating current (AC) in its purest form, follows a sine wave as it alternates 50 or 60 times per second (50 or 60 Hz) (see Figure 1).

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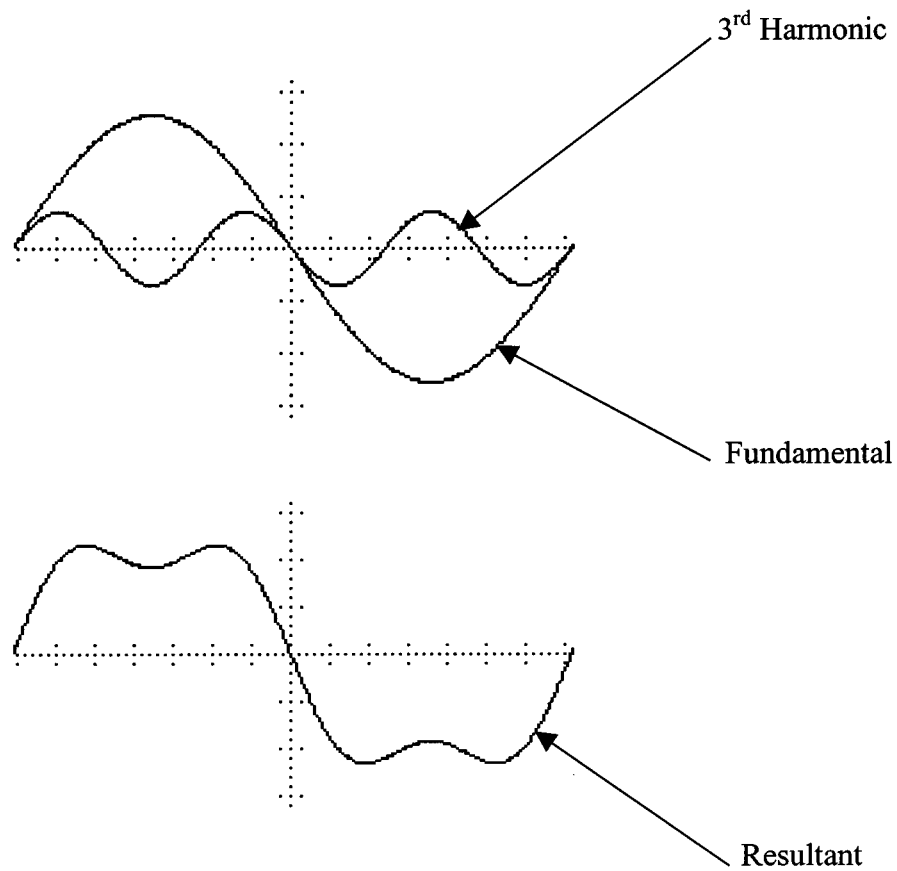


FIGURE 1 - Effect of Third Harmonic on a Sine Wave

1. SCOPE:

This SAE Aerospace Information Report (AIR) is intended to cover all airport 50 or 60 Hz electrical systems as well as all electrical utilization equipment that is attached to those systems.

1.1 Purpose:

This document is intended to instruct users about electrical power system problems caused by harmonic distortion of the electrical current. This distortion is generated by certain pieces of electrical utilization equipment commonly found in use on airports.

2. REFERENCES:

- 2.1 A. H. (Tony) Hoevenaars, P.E., Taming the Rogue Wave: Techniques for Reducing Harmonic Distortion, EC&M, June 1997.
- 2.2 Thomas Landers, P.E., Are Harmonics Overheating Your Neutrals and Panel Boards?, Power Quality Assurance, September/October 1997.
- 2.3 Marina Dishel, P.E. and John R. Nasto, P.E., Meeting IEEE 519 THD Limitations: A Case Study, EC&M, December 1997.
- 2.4 Richard Redl, Paolo Tenti, J. Daan Van Wyk, Power Electronics' Polluting Effects, IEEE Spectrum, May 1997.
- 2.5 IEEE-519-1992 Recommended Practices and Requirements for Harmonic Control on Electrical Power Systems.
- 2.6 IEC 1000 3-2 Limits for harmonic current emissions (equipment input current ≤ 16 A per phase).

3. ORIGIN OF POLLUTION:

- 3.1 More of the electrical equipment in use today is nonlinear, meaning it consumes current in a nonsinusoidal manner. According to Ohm's Law, when a voltage is applied across an impedance, current will flow that is equal to the voltage divided by the impedance. Until recently, electrical loads were essentially linear, offering constant impedance that caused little fluctuation to the current flow. This meant that the current flow through the electrical power system was essentially a continuous unpolluted 50 or 60 Hz sinusoidal wave. Nonlinear electrical loads are placed on the system by much of today's energy saving equipment such as:

3.1.1 Adjustable speed drives.

3.1.2 Battery chargers.

3.1.3 Computer and other electronic equipment power supplies.