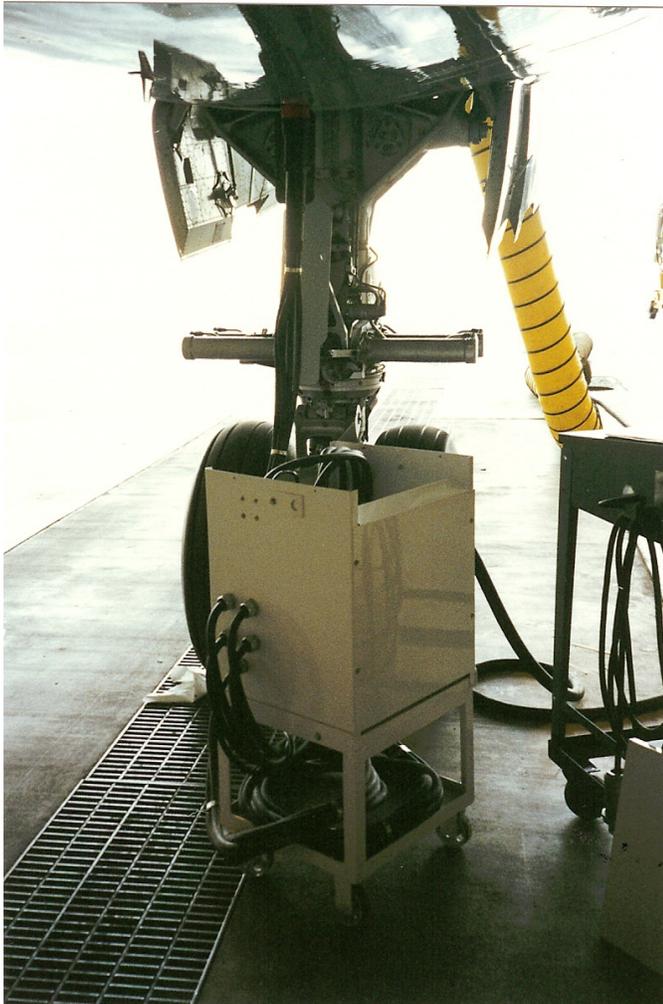


CASE STUDY

**Federal Express Corporation
Memphis, Tennessee**

Facility Description

FedEx Corporation is an American multinational courier delivery services company headquartered in Memphis, Tennessee. The name "FedEx" is a syllabic abbreviation of the name of the company's original air division, Federal Express, which was used from 1973 until 2000. The company is known for its overnight shipping service, but also for pioneering a system that could track packages and provide real-time updates on package location, a feature that has now been implemented by most other carrier services.



Challenge

In the summer of 1996, FedEx called on Power Quality International for assistance. They were experiencing dangerous airframe-to-ground arcing when supplying their aircraft from the hangar's 400Hz electrical power distribution system. Inside a hangar is considered an explosive environment. Arcing is an unacceptable hazard. Arcing results when zero-sequence harmonic currents, flowing through the zero-sequence impedance of the aircraft's metallic airframe, generate zero-sequence harmonic voltages ($E_h = I_h \times Z_H$). Any grounding of the airframe will cause arcing. Arcing occurred when the hangar's grounded hydraulic lines or static grounding cable came into contact with the aircraft. The zero-sequence current, which flows on the airframe, is generated by:

1. Single-phase, nonlinear loads, which generate third-order, zero-sequence harmonic currents
2. Unbalanced loading in the three-phase, four-wire system
3. Single-phase nonlinear loads, which generate unbalanced positive- and negative-sequence harmonic currents

In order to eliminate arcing, zero-sequence currents and arc voltage had to be eliminated. The measured arc voltage was 4.1 volts; sufficient to cause continuous arcing. The predominant arc frequency was 1200Hz, the 400Hz system's third harmonic.

The photograph to the left shows the 400Hz IoFilter™ designed by PQI. The 400Hz supply cable is plugged into the far side of the filter. The filter's output cable, partially coiled in the tray beneath the filter's enclosure, is plugged into the aircraft's input power receptacle.

Solution

PQI was able to eliminate arc voltage with the application of a 400Hz IoFilter™ (Zero-Sequence Harmonic Filter), shown here behind the aircraft's forward landing gear. The filter also improved the system's power quality by

- Reducing peak phase current
- Reducing average phase current
- Reducing source transformer losses
- Reducing system losses
- Reducing total harmonic distortion of current and voltage
- Improving power factor
- Improving phase current balance
- Improving phase voltage balance

Impact

The zero-sequence current at the aircraft was reduced by 95%. At this level, there is not enough current to sustain an arc should arc voltage increase. In addition, the arc voltage was reduced from 4.1 volts to less than 0.1 volts, a reduction of 97.6%.

The reduction of zero-sequence current and airframe-to-ground voltage was accomplished by applying an ultra-low zero-sequence impedance at the load or aircraft end of the three-phase, four-wire hanger power feeder circuit. The zero-sequence filter will shunt all zero-sequence currents, at its point of connection, in proportion to the zero-sequence impedance of the source and the filter.