Low Level Continuous Wave Lightning Test

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Submitted by

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This STA is required to conduct testing necessary to validate the lightning protection design on aircraft components. The test data will be scaled and transformed to obtain estimates of the peak voltage and current transients that can be expected on the aircraft systems as specified by the following:

1. FAA issue paper SE-2, “Lightning Protection Requirements.”

2. JAA document JAR25X899, Electrical Grounding and Protection Against Lightning and Static Electricity.”

3. FAA issue paper SE-1, Protection from High Intensity Radiated Fields (HRIF).”

4. JAA HIRF Certification Review Item D-5 – Stage 2, Special Condition Protection from External High Intensity Radiated Fields.”

5. FAA Special Condition #25-ANM-25, Boeing 747-400 & 747-400F, “Boeing 747-400 Lightning and Radio Frequency Energy Protection.”

6. JAA Special Condition AAB7747-400F/02, Boeing 747-400F, “Lightning Protection Indirect Effects.”

7. JAA Special Condition AAB7747-400F/01, Boeing 747-400F, “High Intensity Radiated Fields (HIRF).”

The tests to be conducted are low level, swept continuous wave tests on production aircraft components. This test will evaluate a section of the aircraft fuselage, or similar aircraft component to ensure compliance with FAA testing specifications. The testing will be conducted in two phases, and will use a vector network analyzer, an HP 3577B or equivalent to inject low level swept CW currents, from DC to 1 MHz.

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The first test is a direct drive, swept CW, transfer function. The test requires driving a transmission line formed by the aircraft component section within a wire return grid. Refer to Figure 1. RF Current is driven onto the test article by directly attaching the output of a 50 watt RF amplifier to one end of the aircraft component. A stepped swept test is required in order to measure as many aircraft component resonances as possible. Testing using widely spaced discrete frequencies would miss critical resonant frequencies.

The frequency range to be swept during the first test is 50 Hz to 1MHz. The dwell time per frequency point will be a maximum of 75 milliseconds, based on 401 points in a 30 second maximum sweep. The maximum number of sweeps per test will be 64, with a minimum time between tests of 2 minutes.

The second test is a pulse test, which injects short lived transient pulses of up to 500 milliseconds. Application of the transient will occur at up to 20 locations over the external surface of the test article. The configuration is shown in figures 1 and 2. Data of currents and voltages generated on the test article will be collected and analyzed with an oscilloscope. There will be a minimum 15 minute interval between each transient test.

This testing is very similar to the lightening testing which is conducted on a completed aircraft, except that we use the ground return wiring instead of the chicken wire ground plane mesh. The return network will consist of between 10 and 20 coaxial cables running the length of the test article, and equally spaced around the component. See figure 2.

The return grid will be isolated from the test article by approximately 18 inches, using either wooden or plastic brackets. The signal will be injected through the test article and the return will be through the coaxial ground.

As shown in the diagrams, the test is a direct drive non-intentional radiator. At best, the test set-up is a very inefficient antenna, and the direct drive testing generates no intentional fields outside the return network. Additionally, the test will be conducted inside of a metal building, with all doors closed. The structure provides an additional 30 dB of attenuation. Boeing has conducted this same test in the past, at this same location, with no interference issues noted.

The inputs to the HP 3577B Network Analyzer are from a current probe, and through a fiber optic transmitter and optical receiver. A computer is used to read the measurements and plot the test results.

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The occupied bandwidth of the emission shall not extend beyond the band limits. The frequencies, emissions and RF power are as follows:

- 50 Hz to 1MHz
- CW N0N
- Maximum of 50 watts RF power into the test article. Note: this is not radiated power, as this is a non-intentional radiator.

The tests will be conducted periodically from April 1, 2008 through April 1, 2010.

The “Stop Buzzer” is James W Daniels, telephone 206-200-5284.

Equipment List and Transmitter Locations

RF Equipment Used
RF Sources
Agilent/HP 3577B Vector Network Analyzer or equivalent
RF Amplifiers
RF Power Labs M125L 25 Watt CW Amplifier or equivalent
Amplifier Research, 50WD1000 or equivalent
Transmitter Information
Location 1
9-101 Building, Everett, WA
Lat/Lon: N 47° 30' 52" W 122° 17' 50"
Antenna Height: Highest point on aircraft is approximately 30 feet
Location 2
3-390 building, Seattle, WA
Lat/Lon: N 47° 32' 03" W 122° 19' 12"
Antenna Height: Highest point on aircraft is approximately 30 feet

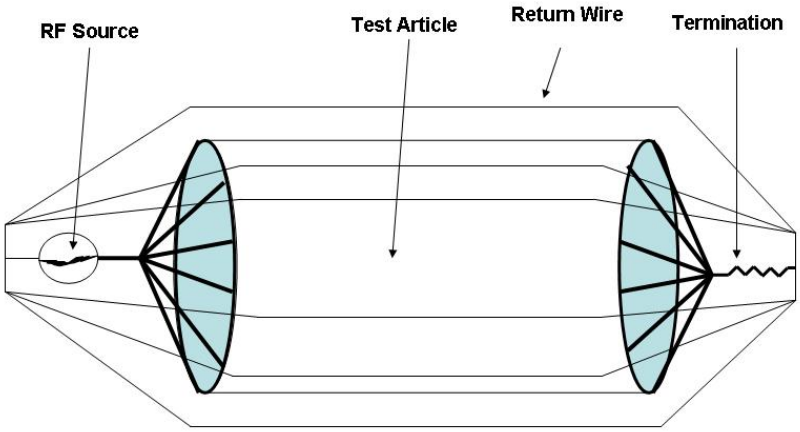

Figure 1 – Side View of Return Structure

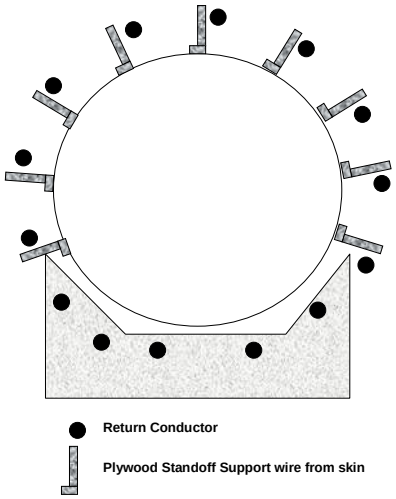

Figure 2 - End View of Ground Plane Details