News from the Hill

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New Standards Established for HIRF Environments

Electronic systems subject to design approval must comply with new High-Intensity Radiated Field testing standards

As the number of wireless signal transmitters increases and electronic devices become more essential to flight operations, civil aircraft are more susceptible to electromagnetic interference than ever before. As a result of the FAA's recent amendment to the airworthiness certification standards, avionics suppliers, manufacturers and repair stations will need to ensure certain new or modified electrical systems can effectively function under the new standards established for high-intensity radiated field environments.

The new standards cover all type-certificated aircraft and rotorcraft, requiring that the vehicle's flight-critical electronic systems must not be adversely affected by exposure to certain HIRF environments and must recover normal function after exposure to certain electromagnetic emissions.

Furthermore, the standards, which took effect Sept. 5, 2007, provide HIRF operating requirements for electrical systems whose failure would significantly reduce the airplane's capability or the crew's ability to respond to an adverse situation.

At first glance, the new standards do not appear to entail major changes for already-certificated aircraft and equipment. Since 1987, the FAA has been releasing special conditions to spell out the HIRF-resistance requirements for individual systems, and a multitude of electrical systems have been approved under these conditions.

However, this first glance might be deceiving, as there are new requirements that might impose compliance burdens on repair stations installing certain equipment.

HIRF Background

HIRF radiation is the result of energy transmissions from television, radio, radar and other transmitters used on the ground, in the air, or at sea. Such emissions vary in frequency and can have a variety of impacts on an aircraft's electrical systems — anything from static on a display screen to the complete shutdown of critical components, such as the full-authority digital-engine control.

While aircraft have been exposed to HIRF emissions for more than 50 years, in the 1970s, civil aircraft designs incorporated flight-critical electronic systems that could be threatened by the HIRF environment.

In addition to an increased dependence on flight-critical electronic systems, modern civil aircraft also rely on composite materials, which can provide less protection from HIRF fields than those used previously. Furthermore, electronic equipment installed in aircraft today has greater sensitivity than in the past.

Following the first special conditions issued to protect electrical systems from high-intensity electromagnetic environments in the late 1980s, the FAA began to work with Europe's JAA to harmonize requirements for protection from such radiation. The Electromagnetic Effects Harmonization Working Group's findings were submitted for legal review and economic analysis in the late 1990s, and an NPRM was issued in February 2006.

The final rule is intended to harmonize U.S. standards with European standards currently implemented by the European Aviation Safety Agency.

Billy Martin, principal engineer and HIRF expert with Cessna Aircraft Co., said standardizing the regulations is preferable to issuing special conditions. He said the private avionics sector has been taking steps to protect electrical systems against HIRF for more than a decade.

The New Rule

The new rule divides electrical and electronic components into four separate categories for the purpose of applying testing standards:

• The first category comprises electrical and electronic systems that perform a function whose failure would prevent the continued safe flight and landing of the airplane. These systems will be subjected to the most stringent HIRF-compatibility tests to ensure HIRF is unlikely to cause an adverse safety condition with respect to these systems.

• The second category comprises electrical and electronic systems that perform a function whose failure would significantly reduce the capability of the airplane or the ability of the flight crew to respond to an adverse operating condition. These are important systems, but not as important as the safety-critical systems in the first category. Therefore, the testing standards applying to these systems are lower; specifically, the recovery requirement does not exist for them. Nonetheless, there are testing standards associated with these systems.

• The third category comprises electrical and electronic systems that perform a function whose failure would reduce the capability of the airplane or the ability of the flight crew to respond to an adverse operating condition. The difference between these systems and category No. 2 systems is this category includes all systems whose failure could reduce the capability of the airplane or the ability of the flight crew in any way — even if the reduction is insignificant. This sort of equipment must meet HIRF test level three standards, which means they must not fail under "worst-case" standards.

• The fourth category comprises electrical and electronic systems that perform a function whose failure would not reduce the capability of the airplane or the ability of the flight crew to respond to an adverse operating condition. These systems might be important to the aircraft owner and there might be other safety-of-flight issues associated with them (such as drawing power from the main power bus making improper wiring dangerous), but if one of these systems failed as a consequence of HIRF, the failure would not have any adverse effect on safety. An example of one of these systems might be a passenger entertainment system. No HIRF testing is required of these systems.

New electrical and electronic systems subject to design approval on or after Sept. 5, 2007, must comply with the new HIRF-testing standards. Repair stations needing design approval for installation, such as a supplemental type certificate, will need to pay attention to these testing standards.

Installation Concerns

When installing electrical and electronic systems, 14 CFR § 43.13(b) requires the repair station to return the aircraft to a condition at least equal to the original or properly altered condition.

An aircraft type certificate issued before Sept. 5, 2007, continues to be valid; therefore, installing electrical and electronic systems for repair purposes in accordance with the type design will be acceptable.

Repair stations should expect hurdles if they intend to perform a major change to type design — such changes require supplemental type certificates. Under 14 CFR §§ 21.115 and 21.101, the applicant for an STC generally must demonstrate compliance to the airworthiness standards in effect on the date of the application for the STC (except for certain insignificant changes and changes to certain small aircraft).

The new certification basis for electrical and electronic systems is the new HIRF testing standards. There is an exception for certain systems.

If the system meets the following conditions, it could be considered exempt from the new HIRF testing rules:

1) The system in question has previously been shown to comply with certain special conditions for HIRF. Such special conditions have been prescribed under 14 C.R § 21.16. The special conditions must have been issued before Dec. 1, 2007. Although many modern avionics pieces will meet these requirements, some older items may not meet this requirement because they predate applicable special conditions.

2) The HIRF immunity characteristics of the system have not changed since compliance with the special conditions was demonstrated. If there have been any alterations to the aircraft — even unrelated ones — since the original HIRF analysis, it is possible these changes might interact with the system in question to change its HIRF characteristics since compliance with the special conditions was demonstrated. Remember, changes to HIRF characteristics are not always adverse changes to HIRF resistance. Positive changes increasing the system's resistance to HIRF-related impairment are changes, too, and such changes would invalidate an attempt to use this exception.

3) The party seeking to rely on the prior HIRF compliance findings (the data used to demonstrate compliance) must provide the data originally used to demonstrate compliance with the special conditions. This implies a special relationship with the OEM — a relationship in which the OEM is willing to share arguably proprietary data with the supplicant who seeks FAA approval. Many repair stations will not be able to meet this third element if they are not able to obtain the origi-

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nal data from the original testing.

This exception runs out after approximately five years; so, as of Dec. 1, 2012, it could be difficult to install electrical and electronic systems on aircraft when the original equipment/system was tested under a special condition and not under the new rule — because *all* systems will need to be subject to testing under the new rule.

FAA Spokesperson Alison Duquette said the new rule standardizes HIRF requirements for all systems, rather than requiring a different set of criteria for different components.

After September, the FAA is no longer issuing special conditions, and anyone seeking certification from the FAA for a flight-critical electronic component or to modify an existing type design is subject to the new HIRF requirements.

While the previous special conditions only addressed flight-critical systems, the new amendment imposes requirements on systems that would have an impact on the aircraft in an adverse situation. Manufacturers and repair stations should be aware of this additional burden when seeking certification or approval. The testing guidelines for such systems, along with flight-critical systems, are listed in the final rule.

The Testing

If the equipment you intend to install has not yet been subjected to the appropriate testing, it will need to be tested according to the parameters of the new rule. Generally, this will entail a three-part test:

• First, you must test to ensure the functions of the electrical/electronic system are not adversely affected during and after the time the aircraft is exposed to a specifically designated HIRF environment, known as HIRF environment I. HIRF environment I represents the range of electromagnetic field strengths an aircraft could encounter during its operational life.

• Second, you must ensure the electrical/electronic system will automatically recover normal operation in a timely manner after the aircraft is exposed to HIRF environment I. Obviously, recovery is unnecessary when recovery conflicts with other operational or functional requirements of the system.

• Third, the tester needs to ensure each electrical/electronic system is not adversely affected by exposure to the less severe, but more commonly encountered, HIRF environment II. HIRF environment II is an estimate of the electromagnetic field strengths more likely to be encountered in the airspace above an airport or heliport at which routine departure and arrival operations take place.

There will be a fourth element to the testing for rotorcraft electrical/electronic systems, which must meet the requirements of a defined HIRF environment III.

The new regulations establish parameters for testing to the HIRF environments I and II (and III for rotorcraft). These parameters are listed as appendices to the airworthiness standards (Parts 23, 25, 27 and 29).

Compliance Advice

Components already approved under the existing conditions may still be distributed and installed on aircraft without any additional testing or other actions as long as the installation is covered under the original type certificate or a pre-existing supplemental type certificate. This means existing systems can be repaired as long as the repair does not affect the original certification characteristics.

When it comes to flight-critical electrical systems, manufacturers only need to comply with the new standards if the modification or creation of a new part is not covered under a previous certificate. This means the new standard would primarily impact manufacturers of new equipment if application for the design approval (TC, TSOA, STC) was made after Sept. 5, 2007, as they will need to show flight-critical electronic components are in compliance with the new standards through well-defined testing parameters.

Any repair station modifying a previously certificated system or adding new equipment to a type-certificated aircraft needs to be especially careful regarding its regulatory obligations. If the installation requires an STC, the changed product rule applies and the applicant must be prepared to ensure the HIRF compliance of any equipment not previously conformed to the HIRF rule.

If the manufacturer complied with a prior HIRF special condition and there is no data for compliance to the new HIRF rules, the repair station must either provide the data originally used to demonstrate compliance with the special conditions as part of its package, or it must perform the testing necessary to demonstrate compliance to the new rule.

Al Ingle, president of Capital Avionics and treasurer of the AEA board of directors, said while he has heard of electromagnetic interference adversely affecting aircraft electronic systems, he has never seen severe damage caused by HIRF. Nonetheless, he said uniform standards for HIRF protection help to clearly establish aircraft safety.

"With the standards, you're all done," Ingle said. "The manufacturer gets the type certificate and you know for the future that the system is protected."

These amendments are integrated into the Federal Aviation Regulations as airworthiness standards. ❑