Wednesday,
February 1, 2006

Part V

Department of Transportation

Federal Aviation Administration

High-Intensity Radiated Fields (HIRF) Protection for Aircraft Electrical and Electronic Systems; Proposed Rule
DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Parts 23, 25, 27, and 29
[Docket No. FAA–2006–23657; Notice No. 06–02]
RIN 2120–AI06

High-Intensity Radiated Fields (HIRF) Protection for Aircraft Electrical and Electronic Systems

AGENCY: Federal Aviation Administration (FAA), DOT.
ACTION: Notice of proposed rulemaking (NPRM).

SUMMARY: The FAA proposes to add certification standards to protect aircraft electrical and electronic systems from high-intensity radiated fields (HIRF). This action is necessary due to the vulnerability of aircraft electrical and electronic systems and the increasing use of high-power radio frequency transmitters. The intended effect of this action is to create a safer operating environment for civil aviation by protecting aircraft and their systems from the adverse effects of HIRF.

DATES: Send your comments to reach us on or before May 2, 2006.

ADDRESSES: You may send comments, identified by Docket Number FAA–2006–23657, using any of the following methods:
• DOT Docket Web site: Go to http://dms.dot.gov and follow the instructions for sending your comments.
• Government-wide rulemaking Web site: Go to http://www.regulations.gov and follow the instructions for sending your comments.
• Mail: Docket Management Facility; U.S. Department of Transportation, 400 Seventh Street, SW., Nassif Building, Room PL–401, Washington, DC 20590–001.
• Fax: 1–202–493–2251.
• Hand Delivery: Room PL–401 on the plaza level of the Nassif Building, 400 Seventh Street, SW., Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.

For more information, see the SUPPLEMENTARY INFORMATION section of this document.

Privacy: We will post all comments we receive, without change, to http://dms.dot.gov, including any personal information you provide. For more information, see the Privacy Act discussion in the SUPPLEMENTARY INFORMATION section of this document.

Docket: To read background documents or comments received, go to http://dms.dot.gov at any time or to Room PL–401 on the plaza level of the Nassif Building, 400 Seventh Street, SW., Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.


SUPPLEMENTARY INFORMATION:

We Invite Your Comments
The FAA invites interested persons to participate in this rulemaking by submitting written comments, data, or views. We also invite comments relating to the economic, environmental, energy, or federalism impacts that might result from adopting the proposals in this document. The most helpful comments reference a specific portion of the proposal, explain the reason for any recommended change, and include supporting data.

We will file in the docket all comments we receive, as well as a report summarizing each substantive public contact with FAA personnel concerning this proposed rulemaking. The docket is available for public inspection before and after the comment closing date. If you wish to review the docket in person, go to the address in the ADDRESSES section of this preamble between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays. You may also review the docket using the Internet at the web address in the ADDRESSES section.

Before acting on this proposal, we will consider all comments we receive on or before the closing date for comments. We will consider comments filed late if it is possible to do so without incurring expense or delay. We may change this proposal in light of the comments we receive.

If you want the FAA to acknowledge receipt of your comments on this proposal, include with your comments a pre-addressed, stamped postcard on which the docket number appears. We will stamp the date on the postcard and mail it to you.

Readers should note that the FAA is publishing elsewhere in today’s Federal Register a notice of availability of a draft Advisory Circular. The Advisory Circular describes one way, but not the only way, to comply with the requirements contained in this NPRM. We also invite comments on the draft Advisory Circular. Refer to the notice of availability for instructions on how file comments on the draft Advisory Circular.

Privacy Act
Anyone is able to search the electronic form of all comments received into any of our dockets by the name of the individual submitting the comment (or signing the comment, if submitted on behalf of an association, business, labor union, etc.). You may review DOT’s complete Privacy Act Statement in the Federal Register published on April 11, 2000 (65 FR 19477–78) or you may visit http://dms.dot.gov.

Proprietary or Confidential Business Information
Do not file in the docket information that you consider to be proprietary or confidential business information. Send or deliver this information directly to the person identified in the FOR FURTHER INFORMATION CONTACT section of this document. You must mark the information that you consider proprietary or confidential. If you send the information on a disk or CD ROM, mark the outside of the disk or CD ROM and also identify electronically within the disk or CD ROM the specific information that is proprietary or confidential.

Under 14 CFR 11.35(b), when we are aware of proprietary information filed with a comment, we do not place it in the docket. We hold it in a separate file to which the public does not have access, and place a note in the docket that we have received it. If we receive a request to examine or copy this information, we treat it as any other request under the Freedom of Information Act (5 U.S.C. 552). We process such a request under the DOT procedures found in 49 CFR part 7.

Availability of NPRMs
You can get an electronic copy of this NPRM using the Internet by:
• Searching the DOT electronic docket Web page (http://dms.dot.gov/search);
• Visiting the FAA’s Regulations and Policies Web page at http://www.faa.gov/regulations_policies/;

You can also get a copy by sending a request to the Federal Aviation Administration, Office of Rulemaking, 800 Independence Avenue, SW., Washington, DC 20591; or by calling (202) 267–9680. Be sure to identify the docket number of this NPRM.

Authority for This Rulemaking
The FAA’s authority to issue rules regarding aviation safety is found in Title 49 of the United States Code.
Subtitle I, section 106 describes the authority of the FAA Administrator. Subtitle VII, Aviation Programs, describes in more detail the agency’s authority. This rulemaking is promulgated under the authority described in subtitle VII, part A, subpart III, section 44701(a)(1). Under that section the FAA is charged to promote safe flight of civil aircraft in air commerce by prescribing minimum standards in the interest of safety for appliances and for the design, material, construction, quality of work, and performance of aircraft, aircraft engines, and propellers. By prescribing standards to protect aircraft electrical and electronic systems from high-intensity radiated fields, this proposed regulation is within the scope of the Administrator’s authority.

Background

Statement of the Problem

The electromagnetic HIRF environment results from the transmission of electromagnetic energy from radar, radio, television, and other ground-based, shipborne, or airborne radio frequency (RF) transmitters. This environment has the capability of adversely affecting the operation of aircraft electric and electronic systems. Although the HIRF environment did not pose a significant threat to earlier generations of aircraft, in the late 1970s designs for civil aircraft were first proposed that included flight-critical electronic controls, electronic displays, and electronic engine controls, such as those used in military aircraft. These systems are more susceptible to the adverse effects of operation in the HIRF environment. Accidents and incidents on civil aircraft with flight-critical electrical and electronic systems have also brought attention to the need to protect these critical systems from high-intensity radiated fields.

On April 15, 1990, an Airship Industries Airship Model 600 Airship was driven by a highly directional RF broadcast from a Voice of America antenna and suffered a complete loss of power in both engines that resulted in a collision with trees and terrain during a forced landing in North Carolina. The National Transportation Safety Board stated in its investigation of the accident that the lack of HIRF certification standards for airships was a factor in the accident.

On March 2, 1999, a Robinson R-44 helicopter passed within 1,000 meters of the main beam of a high frequency (HF), high power broadcast transmission antenna in Portugal. The pilot reported strong interference in the aircraft’s communication systems, navigation radios, and intercom followed by illumination of the low rotor revolutions per minute (RPM) and clutch lights. He further noted that engine noise dropped to idle level and the engine and rotor RPM indicators dropped. The pilot entered autorotation and landed the helicopter successfully with damage only to the main rotor. Following landing, the pilot reported all cockpit indications were normal. The accident investigation division of Portugal’s Instituto Nacional da Aviação Civil stated that the probable cause of the incident was severe electromagnetic and RF interference.

The FAA has issued three airworthiness directives (ADs) in response to HIRF effects between 1991 and 1998. In AD 91–03–05, Airship Industries Skyship Model 600 Airships, the FAA required the installation of a modified ignition control unit because of the previously described dual-engine failure that occurred when the ignition control units were exposed to HIRF.

In AD 96–21–13, LITEF GmbH Attitude and Heading System Reference (AHRS) Unit Model LCR–92, LCR–92S, and LCR–92H, the FAA stated there are indications of an unusual AHRS reaction to certain RF signals that cause the AHRS to give misleading roll and pitch information. As a result, the FAA required either (1) the installation of a placard adjacent to each primary attitude indicator stating that flight is limited to day visual flight rules (VFR) operations only, or, if the primary attitude instruments have been deactivated, installation of a placard stating that flight is limited to VFR operations only, or (2) a modification and inspection of the AHRS wiring cables, a repetitive inspection of the cable shielding, and an insertion of a statement in the aircraft flight manual regarding unannounced heading errors that could occur after switching operation from DG to MAG or operation of the + switch in flight with any bank angle.

In AD 98–24–05, HOAC–Austria Model DV–20 Katana Airplanes, the FAA required the replacement of engine electronic modules to prevent electromagnetic interference in the modules. The FAA required the replacement of the modules because electromagnetic interference could cause the airplane’s engine to stop due to an interruption in the ignition system resulting in loss of control.

Concern for the protection of electrical and electronic systems in aircraft has increased substantially in recent years because of—

(1) A greater dependence on electrical and electronic systems performing functions required for the continued safe flight and landing of the aircraft;

(2) The reduced electromagnetic shielding afforded by some composite materials used in aircraft designs;

(3) The increase in susceptibility of electrical and electronic systems to HIRF because of increased data bus or processor operating speeds, higher density integrated circuits and cards, and greater sensitivities of electronic equipment;

(4) Expanded frequency usage, especially above 1 gigahertz (GHz);

(5) The increased severity of the HIRF environment because of an increase in the number and power of RF transmitters; and

(6) The adverse effects experienced by some aircraft when exposed to HIRF.

History

In 1987, the FAA contracted with the Department of Defense Electromagnetic Compatibility Analysis Center (ECAC) (currently the Joint Spectrum Center) to research and define the U.S. HIRF environment to be used for the certification of aircraft and the development of Technical Standard Orders. In February 1988, the FAA and the Joint Aviation Authorities (JAA) tasked the Society of Automotive Engineers (SAE) and the European Organization for Civil Aviation Equipment (EUROCAE) to develop guidance material and acceptable means of compliance (AMC) documents to support FAA and JAA efforts to develop HIRF certification requirements. In response, one SAE panel reviewed and revised the assumptions used for ECAC’s definition of a HIRF environment and published several iterations of that HIRF environment for fixed-wing aircraft based on revised assumptions. Another SAE panel prepared advisory material to support the FAA’s rulemaking efforts.

Because of efforts undertaken by the FAA and the JAA to harmonize the JAA’s airworthiness requirements and the FAA’s airworthiness regulations in the early 1990s, the FAA and the JAA agreed that the proposed HIRF certification requirements needed further international harmonization before a rule could be adopted.

As a result, the FAA established the Electromagnetic Effects Harmonization Working Group (EEHWG) under the Aviation Rulemaking Advisory Committee on Transport Airplane and Engine Issues (57 FR 58843, December 11, 1992) and tasked it to develop, in coordination with the JAA, HIRF certification requirements for aircraft.
The EEHWG expanded the existing HIRF environments developed by the ECAC with the SAE committee to include HIRF environments appropriate for aircraft certificated under parts 23, 25, 27, and 29.

In 1994, the FAA tasked the Naval Air Warfare Center Aircraft Division (NAWCAD) to conduct a HIRF electromagnetic field survey study to support the efforts of the EEHWG. The EEHWG also received HIRF electromagnetic environment data on European transmitters from European governments. The EEHWG converted the U.S. and European data into a set of harmonized HIRF environments, prepared draft advisory circular/ advisory material joint (AC/AMJ), and also prepared a harmonized FAA draft HIRF NPRM and JAA draft HIRF Notice of Proposed Amendment (NPA).

In November 1997, the EEHWG adopted a set of HIRF environments agreed on by the FAA, the JAA, and the industry participants. The HIRF environments contained in these proposed rules reflect the HIRF environments adopted by the EEHWG. In addition, the information contained in this NPRM is based on the draft NPRM/NPA document.

Current Requirements

Currently, §§23.1309, 25.1309, 27.1309, and 29.1309 provide general certification requirements applicable to the installation of all aircraft systems and equipment, but they do not include specific certification requirements for protection against HIRF. AC 23.1309–1C, “Equipped Systems, and Installations in Part 23 Airplanes,” states that § 23.1309 is not intended to include certification requirements for protection against HIRF. Because of the lack of specific HIRF certification requirements, special conditions to address HIRF have been imposed on applicants seeking issuance of a type certificate (TC), amended TC, or supplemental type certificate (STC) since 1986. Applicants have the option of demonstrating compliance using the external HIRF environment defined in HIRF special conditions or a system bench test level of 100 volts per meter (V/m), whichever is less. The FAA issued additional interim guidance for the certification of aircraft operating in High-Intensity Radiated Field (HIRF) Environments, dated April 2, 1998, with a cancellation date of April 2, 1999.

Development of the HIRF Environments

The HIRF environment was originally categorized into the rotorcraft severe, fixed-wing severe, certification, and normal HIRF environments. Each of these four HIRF environments was developed based on specific assumptions dealing with distance between the aircraft and transmitter, appropriate for the class of aircraft under consideration. The EEHWG investigated the likelihood that fixed wing aircraft and rotorcraft operate in the vicinity of high power transmitters. The EEHWG also investigated testing practicality and availability of test facilities for the HIRF environment levels. The EEHWG used these factors to select the levels for the HIRF environments used in the proposal.

In developing the U.S. HIRF environments, the EEHWG compared the U.S. and European HIRF environments and selected the transmitters with the highest field strength values for each of the 17 frequency bands for peak and average power.

The harmonized HIRF environments are based on the individual U.S. and European HIRF environments and form an estimate of the international electromagnetic field strength, in V/m, over a frequency range from 10 kHz to 40 GHz. The FAA, JAA, and other governmental and international agencies, such as the International Civil Aviation Organization (ICAO) and the International Telecommunications Union, plan to monitor the future growth of the harmonized HIRF environment.

The following general assumptions were used to develop the HIRF environments:

1. The HIRF environment was divided into 17 frequency bands, ranging from 10 kHz to 40 GHz.
2. The main-beam illumination and maximum-beam gain of the transmitting antenna were used.
3. The duty cycle of pulsed transmitters was used to calculate the average power; however, the modulation of a transmitted signal was not considered. The duty cycle was defined as the product of pulse width and pulse repetition frequency and applied only to pulsed systems.
4. Constructive ground reflections (direct and reflected waves) of HF signals were assumed to be in phase.
5. The noncumulative field strength was calculated; however, simultaneous illumination by more than one antenna was not considered.
6. Near-field corrections were used for aperture and phased-array antennas.
7. Field strengths were calculated at minimum distances dependent on the locations of the transmitting and the aircraft.
8. The field strength was calculated for each frequency band using the maximum field strength for all...
transmitters within that band for peak and average power, given in V/m. The field strength values were expressed in root-mean-square (rms) units measured during the peak of the modulation cycle, as many laboratory instruments indicate amplitude. The true peak field strength values will be higher by a factor of the square root of two.

(9) The peak field strength was based on the transmitter’s maximum authorized peak power, maximum antenna gain, and system losses. The average field strength was based on the transmitter’s maximum authorized peak power, maximum duty cycle, maximum antenna gain, and system losses.

(10) The average field strength was expressed in rms units measured at the transmitter site. Field strength values were expressed in rms units measured at the operating site. All values were expressed as the maximum field strength for all transmitters, on the basis of the transmitter’s authorized peak power, maximum antenna gain, and system losses.

(11) The aircraft’s altitude and the transmitter’s maximum antenna elevation were taken into account. The slant range was defined as the line-of-sight distance between the transmitter and the aircraft. The adjusted slant range was defined as the line-of-sight distance at which the aircraft encounters the maximum illumination from an elevation-limited antenna’s main beam. If the transmitter’s maximum antenna elevation angle was not available, 90 degrees was assumed.

(12) Transmitters located in prohibited areas, restricted areas, or warning areas (ICAO danger areas) were not included.

(13) Proposed special-use airspace (SUA) boundaries were defined for selected high-power transmitters. The size of the proposed SUA was derived from transmitter data and, therefore, varied from transmitter site to transmitter site. For transmitters located within a proposed SUA, the transmitter field strength was assessed at the boundary of the proposed SUA.

(14) Transmitters with experimental licenses and non-airport mobile tactical military transmitters were excluded.

### TABLE I.—SUMMARY OF TRANSMITTER LOCATIONS USED TO DEVELOP THE HIRF ENVIRONMENTS

<table>
<thead>
<tr>
<th>Geographic location of transmitter source</th>
<th>Transmitter distance from aircraft (feet, slant or adjusted (adj.) slant range)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rotorcraft severe</td>
</tr>
<tr>
<td><strong>Airport</strong>, <strong>heliport, and offshore platform</strong>&lt;sup&gt;2&lt;/sup&gt;: Fixed</td>
<td></td>
</tr>
<tr>
<td>Air route/Airport surveillance radar</td>
<td>300 adj. slant</td>
</tr>
<tr>
<td>All others</td>
<td>100 slant</td>
</tr>
<tr>
<td><strong>Mobile</strong></td>
<td></td>
</tr>
<tr>
<td>Aircraft weather radar</td>
<td>150 slant</td>
</tr>
<tr>
<td>All others</td>
<td>50 slant</td>
</tr>
<tr>
<td><strong>Land-based (other than airport and heliport)</strong>&lt;sup&gt;3&lt;/sup&gt;: HIRF SUA</td>
<td></td>
</tr>
<tr>
<td>All others (distance from facility):</td>
<td></td>
</tr>
<tr>
<td>&gt; 0–3 nautical miles (nm)</td>
<td>100 slant</td>
</tr>
<tr>
<td>3–5 nm</td>
<td>100 slant</td>
</tr>
<tr>
<td>5–10 nm</td>
<td>100 slant</td>
</tr>
<tr>
<td>10–25 nm</td>
<td>100 slant</td>
</tr>
<tr>
<td>&gt; 25 nm</td>
<td>100 slant</td>
</tr>
<tr>
<td><strong>Ship-based transmitters</strong>&lt;sup&gt;4&lt;/sup&gt;: All ships</td>
<td>500 slant</td>
</tr>
<tr>
<td><strong>Air-to-air</strong>&lt;sup&gt;5&lt;/sup&gt;: Interceptor</td>
<td>Not applicable</td>
</tr>
<tr>
<td>All others</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

1. The airport environment consisted of all fixed and mobile transmitters located within a 5-nm boundary around the airport. The fixed transmitters considered included the marker beacon, localizer, very-high-frequency omnirange (VOR) navigation, glide slope, tactical air navigation (TACAN), weather radar, telemetry, ground controlled approach radar, distance measuring equipment, microwave landing system (MLS), air surveillance radar, air route surveillance radar, ultra high frequency/very high frequency (UHF/VHF) communications, and air traffic control radar beacon system (ATCRBS) interrogator. The mobile transmitters considered included all the ground transmitters not in a fixed location, such as VHF radios on ground support equipment and the following aircraft transmitters: High frequency (HF)/UHF communication, TACAN, Doppler navigation radar, radio altimeter, weather radar, and ATCRBS beacon.

2. The heliport and offshore platform environments consisted of all transmitters, fixed and mobile, located on commercial heliport and offshore platforms. The transmitters considered included satellite, HF, and UHF/VHF communications, VOR navigation, homing beacons, weather radar, surface search radar, and MLS.

3. The land-based environment (other than the airport and heliport environments) consisted of all ground transmitters not located on an airport, heliport, or offshore platform. The transmitters considered included sonobuys, submarine and UHF/VHF communications, VOR navigation, homing beacons, weather radar, surface search radar, and MLS.

4. The ship-based environment consisted of all transmitters located on all commercial and military ships located at sea or in harbors near airports. The transmitters considered included air search radar, fire control radar, satellite, HF, and UHF/VHF communications, TACAN, weather radar, surface search radar, MLS, and ATCRBS interrogator.

5. The air-to-air environment consisted only of those transmitters on military aircraft because the transmitters on civilian aircraft were considered in the mobile airport environment. For military aircraft on intercept courses all non-hostile transmitters were assumed to be operational, and for all military aircraft on intercept courses all transmitters were assumed to be operational.
The fixed-wing severe and rotorcraft severe HIRF environments present worst-case estimates of the electromagnetic field strength in the airspace in which fixed-wing aircraft and rotorcraft operations, respectively, are permitted. The fixed-wing severe HIRF environment, as shown in table III, was used only to develop the certification HIRF environment. The rotorcraft severe HIRF environment, as shown in table IV, is identical to HIRF environment III as proposed in this notice.

The certification HIRF environment, as shown in table V (HIRF environment I as proposed in this notice) provides test and analysis levels to demonstrate that an aircraft and its systems meet HIRF certification requirements. HIRF environment I is based on likely aircraft separation distances and takes into account high peak power microwave transmitters that typically do not operate continuously at their maximum output levels. Based on statistical analysis of aircraft operations, the EEHWG determined that the assumptions used for calculating HIRF environment I were more appropriate for aircraft certification than the assumptions of the fixed-wing severe HIRF environment; therefore, the fixed-wing severe HIRF environment is not used in the proposed rules.

The normal HIRF environment, as shown in table VI (HIRF environment II as proposed in this notice) also provides test and analysis levels to demonstrate that the aircraft and its systems meet HIRF certification requirements. HIRF environment II is an estimate of the electromagnetic field strength in the airspace above an airport or heliport in which routine departure and arrival operations take place. HIRF environment II also takes into account high peak power microwave transmitters that typically do not operate continuously at their maximum output levels. The EEHWG determined that the assumptions used for HIRF environment II are most appropriate for aircraft operating in the vicinity of airports.
contained in current § 21.101  
Designation of applicable regulations  
(generally referred to as the “changed product rule”). Specifically, § 21.101  
would apply when an applicant intends  
to change a type certificate to obtain  
approval for the installation of an  
electrical or electronic system on an  
existing aircraft model. Accordingly,  
an electrical or electronic system that  
has previously met HIRF special conditions  
may require additional testing for it to  
be found in compliance with the HIRF  
environments specified in this proposal.  
The FAA specifically invites comments  
that discuss the effect (including any  
potential costs) of § 21.101 on the ability  
of applicants to comply with the  
proposed HIRF certification requirements.  

The hazard assessment conducted to  
show compliance with §§ 23.1309,  
25.1309, 27.1309, and 29.1309 then  
could be used to assist in determining  
the appropriate HIRF certification  
requirements for the aircraft electrical  
and electronic systems. HIRF  
certification requirements in the  
proposed rule would be established  
only for aircraft electrical and electronic  
systems whose failure would: (1)  
Prevent the continued safe flight and  
landing of the aircraft; (2) significantly  
reduce the capability of the aircraft  
or the ability of the flightcrew to respond  
to an adverse operating condition; or (3)  
reduce the capability of the aircraft  
or the ability of the flightcrew to respond  
to an adverse operating condition. This  
resulting failure classification would  
determine the appropriate HIRF environment  
the aircraft and/or electrical and electronic  
systems would be exposed to during  
certification testing.  

Under the proposed rule, electrical  
and electronic systems that perform a  
function whose failure would prevent  
the continued safe flight and landing of  
the aircraft must be designed and  
installed so that—  

(1) Each function is not affected  
adversely during and after the aircraft  
is exposed to HIRF environment I;  

(2) Each electrical and electronic  
system automatically recovers normal  
operation, in a timely manner, after the  
aircraft is exposed to HIRF environment  
I, unless this conflicts with other  
operational or functional requirements  
of that system; and  

(3) Each electrical and electronic  
system is not adversely affected during  
and after the aircraft is exposed to HIRF  
environment II.  

An example of an electrical or electronic  
system whose failure would prevent the  
continued safe flight and landing of the  
aircraft is a full authority digital  
electronic engine control (FADEC).  

In addition, rotorcraft would be  
required to meet additional HIRF  
certification standards because  
rotorcraft operating under VFR do not  
have to comply with the same minimum  
safe altitude restrictions for airplanes in  
§ 91.119 and, therefore, may operate  
closer to transmitters. Accordingly, for  
functions required during operation  
under VFR whose failure would prevent  
the continued safe flight and landing of  
the rotorcraft, the electrical and  
electronic systems that perform such a  
function, considered separately and in  
relation to other systems, would be  
required to be designed and installed so  
that each function is not adversely  
affected during and after the time  
the rotorcraft is exposed to HIRF  
environment III. Rotorcraft operating  
under instrument flight rules (IFR) have  
to comply with more restrictive altitude  
limitations and, therefore, electrical and  
electronic systems with functions  
required for IFR operations would be  
required to not be adversely affected  
when the rotorcraft is only exposed to  
HIRF environment I.  

The proposal would mandate that  
each electrical and electronic system  
that performs a function whose failure  
would reduce significantly the  
capability of the aircraft or the ability  
of the flightcrew to respond to an adverse  
operating condition be designed and  
installed so the system is not affected  
by the HIRF environment or equipment  
HIRF test level 1, 2, or 3. A  

system that is not adversely affected  
by any one of these test levels would  
be considered acceptable. Test levels 1 and  
2 have equivalent energy, but provide  
different modulation applications. This  
flexibility permits test laboratories to  
use existing test equipment. Test level 2  
allows an applicant to use equipment  
test levels developed for the specific  
aircraft being certificated. Any one of  
these test levels may be used to  
demonstrate HIRF protection. Examples  
of electrical and electronic systems  
whose failure would significantly  
reduce the capability of the aircraft  
or the ability of the flightcrew to respond  
to an adverse operating condition are  
instrument landing system (ILS)  
receiver or a VHF communications  
receiver.  

Lastly, under the proposed rule, each  
electrical and electronic system that  
performs a function whose failure  
would reduce the capability of the  
aircraft or the ability of the flightcrew  
to respond to an adverse operating  
condition must be designed and  
installed so the system is not affected  
adversely when the equipment  
providing these functions is exposed to  
equipment HIRF test level 4. An  
example of an electrical or electronic  
system whose failure would reduce the  
capability of the aircraft or the ability  
of the flightcrew to respond to an adverse  
operating condition is a cabin  
pressurization system.  

HIRF environments I, II, and III, and  
equipment HIRF test levels 1, 2, 3, and  
4 would be found in proposed  
appendixes to the affected parts.  

Compliance With HIRF Certification  
Requirements  

Acceptable operation of a system or  
equipment installation during exposure  
to a HIRF environment or equipment  
HIRF test level could be shown through  
similarity with existing systems,  
analyses, testing, or any combination  
acceptable to the FAA. However,  
certification by similarity could not be  
used for a combination of new aircraft  
design and new equipment design. In  
addition, service experience alone  
would not be acceptable because such  
experience may not include exposure to  
HIRF environments. Acceptable system  
performance could be attained by  
demonstrating that the system under  
consideration continued to perform its  
intended function. Deviations from the  
performance specifications of systems  
under consideration could be  
acceptable, but they would need to be  
assessed independently to ensure the  
effects of the deviations neither cause  
nor contribute to conditions that would  
affect adversely aircraft operational  
capabilities. When deviations in  
performance occur as a consequence of  
the system’s or equipment’s exposure to  
the HIRF environment or equipment  
HIRF test level, an assessment of the  
acceptability of the performance should  
be made. This assessment should be  
supported by data and analyses.  

Because aircraft control system  
failures and malfunctions could  
contribute more directly and abruptly to  
the continued safe flight and landing of  
an aircraft than display system failures  
and malfunctions, compliance with the  
proposed rule for systems performing  
display functions would not require  
aircraft level testing. Therefore, systems  
performing display functions could  
demonstrate compliance with the  
appropriate HIRF certification  
requirements in a laboratory using  
generic HIRF attenuation curves for that  
aircraft developed during previous HIRF  
aircraft level testing. The compliance  
should address instructions for  
continued airworthiness of the HIRF  
protection features.
Paperwork Reduction Act

In accordance with the Paperwork Reduction Act of 1995 (44 U.S.C. 3507(d)), the FAA has determined that there are no requirements for information collection associated with this proposed rule.

International Compatibility

In keeping with U.S. obligations under the Convention on International Civil Aviation, it is FAA policy to comply with International Civil Aviation Organization (ICAO) Standards and Recommended Practices to the maximum extent practicable. The FAA determined that there are no ICAO Standards and Recommended Practices that correspond to these proposed regulations.

Economic Evaluation, Regulatory Flexibility Determination, International Trade Impact Assessment, and Unfunded Mandate Assessment

Changes to Federal regulations must undergo several economic analyses. First, Executive Order 12866 directs that each Federal agency shall propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs. Second, the Regulatory Flexibility Act of 1980 requires agencies to analyze the economic impact of regulatory changes on small entities. Third, the Trade Agreements Act of 1979 (19 U.S.C. 2531–2533) prohibits agencies from setting standards that create unnecessary obstacles to the foreign commerce of the United States. In developing U.S. standards, this Trade Act requires agencies to consider international standards and, where appropriate, to be the basis of U.S. standards. Fourth, the Unfunded Mandates Reform Act of 1995 (Pub. L. 104–2) requires agencies to prepare a written assessment of the costs, benefits, and other effects of proposed or final rules that include a Federal mandate likely to result in the expenditure by State, local, or tribal governments, in the aggregate, or by the private sector, of $100 million or more annually (adjusted for inflation). This portion of the preamble summarizes the FAA’s analysis of the economic impacts of this NPRM. We suggest readers seeking greater detail read the full regulatory evaluation, a copy of which we have placed in the docket for this rulemaking.

In this proposed rule, the FAA has determined that this proposal: (1) Has benefits that justify its costs; (2) is not an economically “significant regulatory action” as defined in section 3(f) of Executive Order 12866; (3) is not “significant” as defined in DOT’s Regulatory Policies and Procedures; (4) would not have a significant economic impact on a substantial number of small entities; (5) is consistent with the Trade Agreements Act of 1979 in that it appropriately adopts international standards as the basis of U.S. standards; and (6) would not impose an unfunded mandate on state, local, or tribal governments, or on the private sector.

Who Is Affected By This Rulemaking

Manufacturers of transport category airplanes incur no incremental costs; manufacturers of transport category rotorcraft and non-transport category aircraft incur varying costs. Occupants in affected aircraft receive safety benefits.

Assumptions and Standard Values

- Discount rate: 7%.

Value of statistical fatality avoided: $3 million.

Benefits/costs are evaluated from two perspectives: (1) The “base case”—a comparison of the costs and associated benefits of current industry practice to those of the proposed rule, and (2) the “regulatory case”—a comparison of the costs and associated benefits of complying with current U.S. special conditions to those of the proposed rule.

Current industry practice for manufacturers of all airplanes certificated under part 25, for manufacturers of the majority of parts 23/29 aircraft, and for manufacturers of a sizeable minority of part 27 rotorcraft, is to comply with JAA’s (now EASA’s) HIRF interim standards (JAA’s version of special conditions), which are equivalent to those of the NPRM. On the other hand, manufacturers of the remaining aircraft (some part 23 and part 29 aircraft and most part 27 rotorcraft) currently meet only U.S. special conditions, which are not as stringent as those set forth in the NPRM. These affected aircraft manufacturers would experience additional costs under the proposed rule.

The proposed rule is assumed to be 100 percent effective in preventing HIRF-related accidents.

Alternatives Considered

Although earlier and current special condition levels of HIRF protection were considered, JAA’s HIRF standards were selected for this NPRM because of both the proven high levels of protection demonstrated and the potential cost savings resulting from harmonization of FAA and JAA/EASA requirements.

Costs and Benefits of This Rulemaking

Costs

In the first column (or, the base case, which reflects actual costs to industry), there are no additional HIRF-protection costs for manufacturers of part 25 airplanes and relatively low incremental costs for manufacturers of the majority of parts 23 and 29 aircraft, since U.S. manufacturers of these compliant aircraft currently meet JAA’s/EASA’s HIRF standards in order to market their aircraft in Europe. There are moderate incremental costs for manufacturers of the remaining portion of parts 23/29 aircraft and relatively lower costs for the majority of part 27 rotorcraft that do not currently meet JAA’s/EASA’s HIRF standards (equivalent to the requirements in this proposal) either...
because (1) their aircraft do not yet have complex electronic systems installed or (2) they have chosen not to market their aircraft abroad. This “current practice to proposed rule” is the base perspective in this analysis. The total estimated ten-year costs of $28.6 million (the sum of column one) represent the true incremental impact on the industry.

However, most manufacturers of parts 23, 25, 27, and 29 aircraft believe that U.S. special conditions afford sufficient protection from HIRF. Therefore, in the second column (or, the regulatory case, “special conditions to NPRM”), the FAA shows the incremental compliance costs between the current U.S. special condition levels (essentially equivalent to industry’s self-determined protection) and the NPRM’s more stringent requirements. These regulatory costs equal $409.5 million, and represent the costs for more robust HIRF protection that industry would not have voluntarily incurred.

**Benefits**

Estimated benefits of this proposal are the accidents, incidents, and fatalities avoided as a result of increased protection from HIRF-effects provided to electric and electronic systems. Quantified benefits are partly based on a study titled “High-Intensity Radiated Fields (HIRF) Risk Analysis,” by EMA Electro Magnetic Applications, Inc. of Denver, Co. (report DOT/FAA/AR–99/50, July 1999); the complete study is available in the docket for this rulemaking. Using the study’s risk analysis results for airplanes certificated under parts 23 and 25 and FAA accident/incident data for rotorcraft certificated under parts 27 and 29, the FAA calculated the difference between the expected number of accidents under the proposed standards versus those that could be expected if current U.S. special condition levels were maintained in the future in lieu of the proposed standards.

**Summary of Costs and Benefits**

The incremental costs of meeting the NPRM requirements versus current industry practice equal $28.6 million and the associated benefits are $88.1 million, for a benefit-to-cost ratio of 9.6 to 1. Alternatively, the incremental costs of meeting the NPRM requirements versus current U.S. special conditions equal $409.5 million and the benefits are $3,940.4 million, for a benefit-to-cost ratio of 9.6 to 1. From either perspective, the proposed rule is clearly cost-beneficial.

**Regulatory Flexibility Determination**

The Regulatory Flexibility Act of 1980 (RFA) establishes “as a principle of regulatory issuance that agencies shall endeavor, consistent with the objective of the rule and of applicable statutes, to fit regulatory and informational requirements to the scale of the business, organizations, and governmental jurisdictions subject to regulation.” To achieve that principle, the Act requires agencies to solicit and consider flexible regulatory proposals and to explain the rationale for their actions. The Act covers a wide-range of small entities, including small businesses, not-for-profit organizations and small governmental jurisdictions. Agencies must perform a review to determine whether a rulemaking action will have a significant economic impact on a substantial number of small entities. If an agency determines that it will, the agency must prepare a regulatory flexibility analysis as described in the Act. However, if an agency determines that a proposed or final rule is not expected to have a significant economic impact on a substantial number of small entities, section 605(b) of the 1980 act provides that the head of the agency may so certify and a regulatory flexibility analysis is not required. The certification must include a statement providing the factual basis for this determination, and the reasoning should be clear.

The proposed rule would affect manufacturers of parts 23, 25, 27, and 29 aircraft produced under future new type-certificates. For manufacturers, a small entity is one with 1,500 or fewer employees. None of the part 25 or part 29 manufacturers has 1,500 or fewer employees; consequently, none is considered a small entity. There are, however, currently about four part 27 (utility rotorcraft) and ten part 23 (small non-transport category airplanes) manufacturers, who have fewer than 1,500 employees and are considered small entities.

With respect to the part 27 entities, the incremental costs of this NPRM are estimated at $875 per new-production rotorcraft. Part 27 rotorcraft at the small
end generally sell for about $200,000; thus the incremental cost would represent only a fraction of one percent of each unit’s sales price and clearly less than one percent of the typical small manufacturer’s annual revenues. Consequently, the FAA does not consider the incremental cost to constitute a significant economic impact. Further, most utility rotorcraft are engaged in specialized activities such as logging, offshore oil drilling, construction, etc., the demand for which is highly price-inelastic; the manufacturers can readily pass on the relatively low incremental costs to purchasers of these highly-specialized rotorcraft.

The FAA contacted the ten part 23 small airframe manufacturers actively producing airplanes. The majority of these manufacture piston-engine airplanes, most of which do not include sophisticated electrical systems. Six of the ten companies are in the initial stages of developing new airplane models that will include full-authority-digital-engine-controllers (FADEC). About one-half of these, however, could not yet estimate new development costs. One manufacturer, sufficiently into the pre-certification process, did provide estimates of incremental costs related to the FADECs (costs were based on data received from the engine supplier). Additional non-recurring design/testing costs for engines in the new model would total $170,000 (recurring costs were not specified and thus assumed not significant). Annualizing the cost at 7% over a 10-year production period equals $24,200. The company expects to produce 100 airplanes annually, each selling for $130,000; expected annual sales revenue therefore equals $13,000,000. Thus, the $24,200 total annual incremental cost attributable to HIRF represents less than two-tenths of one percent of annual sales ($24,200/$13,000,000), which does not constitute a significant economic impact.

Based on there being no small manufacturers of part 25 or part 29 aircraft, and based on the described expense/revenue relationships for the part 23 and part 27 small manufacturers, the FAA certifies that this proposed rule would not have a significant economic impact on a substantial number of small entities. The FAA invites comments on the estimated small entity impact from interested and affected parties.

International Trade Impact Assessment

The Trade Agreements Act of 1979 prohibits Federal agencies from engaging in any standards or related activities that create unnecessary obstacles to the foreign commerce of the United States. Legitimate domestic objectives, such as safety, are not considered unnecessary obstacles. The statute also requires consideration of international standards and where appropriate, that they be the basis for U.S. standards.

In accordance with the above statute, the FAA has assessed the potential effect of this proposed rule for aircraft produced under the affected parts. This rulemaking is consistent with the Trade Agreements Act in that it adopts international standards as the basis of U.S. standards.

Unfunded Mandates Reform Act

The Unfunded Mandates Reform Act of 1995 (the Act) is intended, among other things, to curb the practice of imposing unfunded Federal mandates on State, local, and tribal governments. Title II of the Act requires each Federal agency to prepare a written statement assessing the effects of any Federal mandate in a proposed or final agency rule that may result in an expenditure of $100 million or more (adjusted annually for inflation) in any one year by State, local, and tribal governments, in the aggregate, or by the private sector; such a mandate is deemed to be a “significant regulatory action.” The FAA currently uses an inflation-adjusted value of $120.7 million in lieu of $100 million. This proposed rule does not contain such a mandate. The requirements of Title II do not apply.

Environmental Analysis

FAA Order 1505.1E identifies FAA actions that are categorically excluded from preparation of an environmental assessment or environmental impact statement under the National Environmental Policy Act in the absence of extraordinary circumstances. The FAA has determined this proposed rulemaking action qualifies for the categorical exclusion identified in paragraph 308(c)(1) and involves no extraordinary circumstances.

Executive Order 13132, Federalism

The FAA has analyzed this NPRM under the principles and criteria of Executive Order 13132, Federalism. We have determined that this action would not have a substantial direct effect on the States, on the relationship between the national Government and the States, or on the distribution of power and responsibilities among the various levels of government, and therefore would not have federalism implications.

Plain English

Executive Order 12866 (58 FR 51735, Oct. 4, 1993) requires each agency to write regulations that are simple and easy to understand. We invite your comments on how to make these proposed regulations easier to understand, including answers to questions such as the following:

- Are the requirements in the proposed regulations clearly stated?
- Do the proposed regulations contain unnecessary technical language or jargon that interferes with their clarity?
- Would the regulations be easier to understand if they were divided into more (but shorter) sections?
- Is the description in the preamble helpful in understanding the proposed regulations?

Please send your comments to the address specified in the ADDRESSES section.

Regulations That Significantly Affect Energy Supply, Distribution, or Use

The FAA has analyzed this NPRM under Executive Order 13211, Actions Concerning Regulations that Significantly Affect Energy Supply, Distribution, or Use (May 18, 2001). We have determined that it is not a “significant energy action” under the executive order because it is not a “significant regulatory action” under Executive Order 12866, and it is not likely to have a significant adverse effect on the supply, distribution, or use of energy.

List of Subjects

14 CFR Part 23

Air transportation, Aircraft, Aviation safety, Certification, Safety.
PART 23—AIRWORTHINESS STANDARDS: NORMAL, UTILITY, ACROBATIC, AND COMMUTER CATEGORY AIRPLANES

1. The authority citation for part 23 continues to read as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701, 44702, 44704.

2. Add §23.1308 to subpart F to read as follows:

§23.1308 High-intensity Radiated Fields (HIRF) Protection.

(a) Each electrical and electronic system that performs a function whose failure would prevent the continued safe flight and landing of the airplane must be designed and installed so that—

(1) The function is not adversely affected during and after the time the airplane is exposed to HIRF environment I, as described in appendix J to this part;

(2) The system automatically recovers normal operation, in a timely manner, after the airplane is exposed to HIRF environment I, as described in appendix J to this part, unless the system’s recovery conflicts with other operational or functional requirements of the system; and

(3) The system is not adversely affected during and after the time the airplane is exposed to HIRF environment II, as described in appendix J to this part.

(b) Each electrical and electronic system that performs a function whose failure would significantly reduce the capability of the airplane or the ability of the flightcrew to respond to an adverse operating condition must be designed and installed so the system is not adversely affected when the equipment providing the function is exposed to equipment HIRF test level 4, as described in appendix J to this part.

3. Add appendix J to part 23 to read as follows:

Appendix J to Part 23—HIRF Environments and Equipment HIRF Test Levels

This appendix specifies the HIRF environments and equipment HIRF test levels for electrical and electronic systems under §23.1308. The field strength values for the HIRF environments and equipment HIRF test levels are expressed in root-mean-square units measured during the peak of the modulation cycle.

(a) HIRF environment I is specified in the following table:

### TABLE I.—HIRF ENVIRONMENT I

<table>
<thead>
<tr>
<th>Frequency (cycles/second)</th>
<th>Field strength (volts/meter)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Peak</td>
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<tr>
<td>10 kHz–2 MHz ............</td>
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<tr>
<td>2 MHz–30 MHz ............</td>
<td>100</td>
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<tr>
<td>30 MHz–100 MHz ..........</td>
<td>50</td>
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<tr>
<td>100 MHz–400 MHz ..........</td>
<td>100</td>
</tr>
<tr>
<td>400 MHz–700 MHz ..........</td>
<td>700</td>
</tr>
<tr>
<td>700 MHz–1 GHz ...........</td>
<td>700</td>
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<tr>
<td>1 GHz–2 GHz .............</td>
<td>2,000</td>
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<tr>
<td>2 GHz–6 GHz .............</td>
<td>3,000</td>
</tr>
<tr>
<td>6 GHz–12 GHz ............</td>
<td>1,000</td>
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<tr>
<td>8 GHz–12 GHz ............</td>
<td>3,000</td>
</tr>
<tr>
<td>12 GHz–18 GHz ..........</td>
<td>2,000</td>
</tr>
<tr>
<td>18 GHz–40 GHz ..........</td>
<td>600</td>
</tr>
</tbody>
</table>

(b) HIRF environment II is specified in the following table:

### TABLE II.—HIRF ENVIRONMENT II

<table>
<thead>
<tr>
<th>Frequency (cycles/second)</th>
<th>Field strength (volts/meter)</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Peak</td>
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<tr>
<td>10 kHz–500 kHz ..........</td>
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<tr>
<td>2 MHz–30 MHz ............</td>
<td>100</td>
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<tr>
<td>30 MHz–100 MHz ..........</td>
<td>10</td>
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<tr>
<td>100 MHz–200 MHz ..........</td>
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</tr>
<tr>
<td>200 MHz–400 MHz ..........</td>
<td>10</td>
</tr>
<tr>
<td>400 MHz–1 GHz ...........</td>
<td>700</td>
</tr>
<tr>
<td>1 GHz–2 GHz .............</td>
<td>1,300</td>
</tr>
<tr>
<td>2 GHz–4 GHz .............</td>
<td>3,000</td>
</tr>
<tr>
<td>4 GHz–6 GHz .............</td>
<td>3,000</td>
</tr>
<tr>
<td>6 GHz–8 GHz .............</td>
<td>400</td>
</tr>
<tr>
<td>8 GHz–12 GHz ............</td>
<td>1,230</td>
</tr>
<tr>
<td>12 GHz–18 GHz ..........</td>
<td>730</td>
</tr>
<tr>
<td>18 GHz–40 GHz ..........</td>
<td>600</td>
</tr>
</tbody>
</table>
at a minimum of 0.15 mA at 10 kHz, increasing 20 dB per frequency decade to a minimum of 7.5 mA at 500 kHz.

(2) From 500 kHz to 400 MHz, use conducted susceptibility tests at a minimum of 5 V/m.

(3) From 100 MHz to 8 GHz, use radiated susceptibility tests at a minimum of 5 V/m.

PART 25—AIRWORTHINESS STANDARDS: TRANSPORT CATEGORY AIRPLANES

4. The authority citation for part 25 continues to read as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701, 44702, 44704.

5. Add § 25.1317 to subpart F to read as follows:

§ 25.1317 High-intensity Radiated Fields (HIRF) Protection.

(a) Each electrical and electronic system that performs a function whose failure would prevent the continued safe flight and landing of the airplane must be designed and installed so that—

(1) The function is not adversely affected during and after the time the airplane is exposed to HIRF environment I, as described in appendix K to this part;

(2) The system automatically recovers normal operation, in a timely manner, after the airplane is exposed to HIRF environment I, as described in appendix K to this part, unless the system’s recovery conflicts with other operational or functional requirements of the system; and

(3) The system is not adversely affected during and after the time the airplane is exposed to HIRF environment II, as described in appendix K to this part.

(b) Each electrical and electronic system that performs a function whose failure would significantly reduce the safety or landing of the airplane or the ability of the flightcrew to respond to an adverse operating condition must be designed and installed so the system is not adversely affected when the equipment providing the function is exposed to HIRF test level 4, as described in appendix K to this part.

6. Add appendix K to part 25 to read as follows:

Appendix K to Part 25—HIRF Environments and Equipment HIRF Test Levels

This appendix specifies the HIRF environments and equipment HIRF test levels for electrical and electronic systems under §25.1317. The field strength values for the HIRF environments and equipment HIRF test levels are expressed in root-mean-square units measured during the peak of the modulation cycle.

(a) HIRF environment I is specified in the following table:

<table>
<thead>
<tr>
<th>Frequency (cycles/second)</th>
<th>Peak</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 kHz–2 MHz ............</td>
<td>50</td>
<td>50</td>
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<tr>
<td>2 MHz–30 MHz ...........</td>
<td>100</td>
<td>100</td>
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<tr>
<td>30 MHz–100 MHz ..........</td>
<td>50</td>
<td>50</td>
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<tr>
<td>100 MHz–400 MHz .......</td>
<td>100</td>
<td>100</td>
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<tr>
<td>400 MHz–700 MHz .......</td>
<td>700</td>
<td>50</td>
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<tr>
<td>700 MHz–1 GHz ...........</td>
<td>700</td>
<td>100</td>
</tr>
<tr>
<td>1 GHz–2 GHz ............</td>
<td>2,000</td>
<td>200</td>
</tr>
<tr>
<td>2 GHz–6 GHz ............</td>
<td>3,000</td>
<td>200</td>
</tr>
<tr>
<td>6 GHz–8 GHz ............</td>
<td>1,000</td>
<td>200</td>
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<tr>
<td>8 GHz–12 GHz ...........</td>
<td>3,000</td>
<td>300</td>
</tr>
<tr>
<td>12 GHz–18 GHz ...........</td>
<td>2,000</td>
<td>200</td>
</tr>
<tr>
<td>18 GHz–40 GHz ...........</td>
<td>600</td>
<td>200</td>
</tr>
</tbody>
</table>

(b) HIRF environment II is specified in the following table:

<table>
<thead>
<tr>
<th>Frequency (cycles/second)</th>
<th>Peak</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 kHz–500 kHz ...........</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>500 kHz–2 MHz ............</td>
<td>30</td>
<td>30</td>
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<tr>
<td>2 MHz–30 MHz ............</td>
<td>100</td>
<td>100</td>
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<tr>
<td>30 MHz–100 MHz ...........</td>
<td>10</td>
<td>10</td>
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<tr>
<td>100 MHz–200 MHz ...........</td>
<td>10</td>
<td>10</td>
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<tr>
<td>200 MHz–400 MHz ...........</td>
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<td>10</td>
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<tr>
<td>700 MHz–1 GHz ...........</td>
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<td>1 GHz–2 GHz ............</td>
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<tr>
<td>2 GHz–4 GHz ............</td>
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<tr>
<td>4 GHz–6 GHz ............</td>
<td>3,000</td>
<td>160</td>
</tr>
<tr>
<td>6 GHz–8 GHz ............</td>
<td>400</td>
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</tr>
<tr>
<td>8 GHz–12 GHz ............</td>
<td>1,230</td>
<td>230</td>
</tr>
<tr>
<td>12 GHz–18 GHz ...........</td>
<td>730</td>
<td>190</td>
</tr>
<tr>
<td>18 GHz–40 GHz ...........</td>
<td>600</td>
<td>150</td>
</tr>
</tbody>
</table>

(c) Equipment HIRF Test Level 1. (1) From 10 kilohertz (kHz) to 400 megahertz (MHz), use conducted susceptibility tests with continuous wave (CW) at a 1 kHz square wave modulation with 90 percent depth or greater. The conducted susceptibility current must start at a minimum of 0.6 milliamperes (mA) at 10 kHz, increasing 20 decibels (dB) per frequency decade to a minimum of 30 mA at 500 kHz.

(2) From 500 kHz to 400 MHz, the conducted susceptibility current must be at least 30 mA.

(3) From 100 MHz to 400 MHz, use radiated susceptibility tests at a minimum of 20 volts per meter (V/m) peak with CW and 1 kHz square wave modulation with 90 percent depth or greater.

(4) From 400 MHz to 8 gigahertz (GHz), use radiated susceptibility tests at a minimum of 150 V/m peak with pulse modulation of 0.1 percent duty cycle with 1 kHz pulse repetition frequency. This signal must be switched on and off at a rate of 1 Hz with a duty cycle of 50 percent.

(5) From 400 MHz to 8 GHz, use radiated susceptibility tests at a minimum of 28 V/m peak with 1 kHz square wave modulation with 90 percent depth or greater. This signal must be switched on and off at a rate of 1 Hz with a duty cycle of 50 percent.

(d) Equipment HIRF Test Level 2. (1) From 10 kHz to 400 MHz, use conducted susceptibility tests with CW and 1 kHz square wave modulation with 90 percent depth or greater. The conducted susceptibility current must start at a minimum of 0.6 mA at 10 kHz, increasing 20 dB per frequency decade to a minimum of 30 mA at 500 kHz.

(2) From 500 kHz to 400 MHz, the conducted susceptibility current must be at least 30 mA.

(3) From 100 MHz to 400 MHz, use radiated susceptibility tests at a minimum of 20 V/m peak with 1 kHz square wave modulation with 90 percent depth or greater.

(4) From 400 MHz to 8 GHz, use radiated susceptibility tests at a minimum of 50 V/m peak with pulse modulation of 4 percent duty cycle with a 1 kHz pulse repetition frequency. This signal must be switched on and off at a rate of 1 Hz with a duty cycle of 50 percent.

(e) Equipment HIRF Test Level 3. Test level 3 is HIRF environment II in table II of this appendix reduced by acceptable aircraft transfer function and attenuation curves. Testing must cover the frequency band of 10 kHz to 8 GHz.

(f) Equipment HIRF Test Level 4. (1) From 10 kHz to 400 MHz, use conducted susceptibility tests, starting at a minimum of 0.15 mA at 10 kHz, increasing 20 dB per frequency decade to a minimum of 7.5 mA at 500 kHz.

(2) From 500 kHz to 400 MHz, use conducted susceptibility tests at a minimum of 7.5 mA.
PART 27—AIRWORTHINESS STANDARDS: NORMAL CATEGORY ROTORCRAFT

7. The authority citation for part 27 continues to read as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701, 44702, 44704.

8. Add § 27.1317 to subpart F to read as follows:

§ 27.1317 High-intensity Radiated Fields (HIRF) Protection.

(a) Each electrical and electronic system that performs a function whose failure would prevent the continued safe flight and landing of the rotorcraft must be designed and installed so that—

(1) The function is not adversely affected during and after the time the rotorcraft is exposed to HIRF environment I, as described in appendix D to this part; and

(2) The system automatically recovers normal operation, in a timely manner, after the rotorcraft is exposed to HIRF environment I, as described in appendix D to this part, unless this conflicts with other operational or functional requirements of that system;

(3) The system is not adversely affected during and after the time the rotorcraft is exposed to HIRF environment II, as described in appendix D to this part; and

(4) Each function required during operation under visual flight rules is not adversely affected during and after the time the rotorcraft is exposed to HIRF environment III, as described in appendix D to this part.

(b) Each electrical and electronic system that performs a function whose failure would significantly reduce the capability of the rotorcraft or the ability of the flightcrew to respond to an adverse operating condition must be designed and installed so the system is not adversely affected when the equipment providing these functions is exposed to equipment HIRF test level 4, as described in appendix D to this part.

(c) Each electrical and electronic system that performs a function whose failure would reduce the capability of the rotorcraft or the ability of the flightcrew to respond to an adverse operating condition, must be designed and installed so that the system is not adversely affected when the equipment providing these functions is exposed to equipment HIRF test level 4, as described in appendix D to this part.

9. Add appendix D to part 27 to read as follows:

Appendix D to Part 27—HIRF Environments and Equipment HIRF Test Levels

This appendix specifies the HIRF environments and equipment HIRF test levels for electrical and electronic systems under § 27.1317. The field strength values for the HIRF environments and laboratory equipment HIRF test levels are expressed in root-mean-square units measured during the peak of the modulation cycle.

(a) HIRF environment I is specified in the following table:

<table>
<thead>
<tr>
<th>Frequency (cycles/second)</th>
<th>Peak</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 kHz–2 MHz .............</td>
<td>50</td>
<td>50</td>
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<tr>
<td>2 MHz–30 MHz .............</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>30 MHz–100 MHz ..........</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>100 MHz–400 MHz ..........</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>400 MHz–700 MHz ..........</td>
<td>700</td>
<td>50</td>
</tr>
<tr>
<td>700 MHz–1 GHz ...........</td>
<td>700</td>
<td>100</td>
</tr>
<tr>
<td>1 GHz–2 GHz .............</td>
<td>2,000</td>
<td>200</td>
</tr>
<tr>
<td>2 GHz–6 GHz .............</td>
<td>3,000</td>
<td>200</td>
</tr>
<tr>
<td>6 GHz–8 GHz .............</td>
<td>1,000</td>
<td>200</td>
</tr>
<tr>
<td>8 GHz–12 GHz ..........</td>
<td>3,000</td>
<td>300</td>
</tr>
<tr>
<td>12 GHz–18 GHz ..........</td>
<td>2,000</td>
<td>200</td>
</tr>
<tr>
<td>18 GHz–40 GHz ..........</td>
<td>600</td>
<td>200</td>
</tr>
</tbody>
</table>

(b) HIRF environment II is specified in the following table:

<table>
<thead>
<tr>
<th>Frequency (cycles/second)</th>
<th>Field Strength (Volts/Meter)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 kHz–500 kHz ...........</td>
<td>20 20</td>
</tr>
<tr>
<td>500 kHz–2 MHz .............</td>
<td>30 30</td>
</tr>
<tr>
<td>2 MHz–30 MHz .............</td>
<td>100 100</td>
</tr>
<tr>
<td>30 MHz–100 MHz ..........</td>
<td>10 10</td>
</tr>
<tr>
<td>100 MHz–200 MHz ..........</td>
<td>30 10</td>
</tr>
<tr>
<td>200 MHz–400 MHz ..........</td>
<td>10 10</td>
</tr>
<tr>
<td>400 MHz–1 GHz ...........</td>
<td>700 40</td>
</tr>
<tr>
<td>1 GHz–2 GHz .............</td>
<td>1,300 160</td>
</tr>
<tr>
<td>2 GHz–4 GHz .............</td>
<td>3,000 120</td>
</tr>
<tr>
<td>4 GHz–6 GHz .............</td>
<td>3,000 160</td>
</tr>
<tr>
<td>6 GHz–8 GHz .............</td>
<td>1,000 170</td>
</tr>
<tr>
<td>8 GHz–12 GHz ..........</td>
<td>1,230 230</td>
</tr>
<tr>
<td>12 GHz–18 GHz ..........</td>
<td>730 190</td>
</tr>
<tr>
<td>18 GHz–40 GHz ..........</td>
<td>600 150</td>
</tr>
</tbody>
</table>

(c) HIRF environment III is specified in the following table:

<table>
<thead>
<tr>
<th>Frequency (cycles/second)</th>
<th>Field Strength (Volts/Meter)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 kHz–100 kHz ..........</td>
<td>150 150</td>
</tr>
</tbody>
</table>

(d) Equipment HIRF Test Level 1. (1) From 10 kilohertz (kHz) to 400 megahertz (MHz), use conducted susceptibility tests with continuous wave (CW) and 1 kHz square wave modulation with 90 percent depth or greater. The conducted susceptibility current must start at a minimum of 0.6 milliamperes (mA) at 10 kHz, increasing 20 decibels (dB) per frequency decade to a minimum of 30 mA at 500 kHz.

(2) From 500 kHz to 400 MHz, the conducted susceptibility current must be at least 30 mA.

(3) From 100 MHz to 400 MHz, use radiated susceptibility tests at a minimum of 20 volts per meter (V/m) peak with CW and 1 kHz square wave modulation with 90 percent depth or greater.

(4) From 400 MHz to 8 gigahertz (GHz), use radiated susceptibility tests at a minimum of 150 V/m peak with pulse modulation of 0.1 percent duty cycle with 1 kHz pulse repetition frequency. This signal must be switched on and off at a rate of 1 Hz with a duty cycle of 50 percent.

(5) From 400 MHz to 8 GHz, use radiated susceptibility tests at a minimum of 28 V/m peak with 1 kHz square wave modulation with 90 percent depth or greater. This signal must be switched on and off at a rate of 1 Hz with a duty cycle of 50 percent.

(e) Equipment HIRF Test Level 2. (1) From 10 kHz to 400 MHz, use conducted susceptibility tests with CW and 1 kHz square wave modulation with 90 percent depth or greater. The conducted susceptibility current must start at a minimum of 0.6 mA at 10 kHz, increasing 20 dB per frequency decade to a minimum of 30 mA at 500 kHz.

(2) From 500 kHz to 400 MHz, the conducted susceptibility current must be at least 30 mA.

(3) From 100 MHz to 400 MHz, use radiated susceptibility tests at a minimum of 20 V/m peak with CW and 1 kHz square wave modulation with 90 percent depth or greater.
(4) From 400 MHz to 8 GHz, use radiated susceptibility tests at a minimum of 150 V/m peak with pulse modulation of 4 percent duty cycle with a 1 kHz pulse repetition frequency. This signal must be switched on and off at a rate of 1 Hz with a duty cycle of 50 percent.

(f) Equipment HIRF Test Level 3. Test level 3 is HIRF environment II in table II of this appendix reduced by acceptable aircraft transfer function and attenuation curves. Testing must cover the frequency band of 10 kHz to 8 GHz.

(g) Equipment HIRF Test Level 4. (1) From 10 kHz to 400 MHz, use conducted susceptibility tests, starting at a minimum of 0.15 mA at 10 kHz, increasing 20 dB per frequency decade to a minimum of 7.5 mA at 500 kHz.

(2) From 500 kHz to 400 MHz, use conducted susceptibility tests at a minimum of 7.5 mA.

(3) From 100 MHz to 8 GHz, use radiated susceptibility tests at a minimum of 5 V/m.

PART 29—AIRWORTHINESS STANDARDS: TRANSPORT CATEGORY ROTORCRAFT

10. The authority citation for part 29 continues to read as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701, 44702, 44704.

11. Add §29.1317 to subpart F to read as follows:

§29.1317 High-intensity Radiated Fields (HIRF) Protection.

(a) Each electrical and electronic system that performs a function whose failure would prevent the continued safe flight and landing of the rotorcraft must be designed and installed so that—

(1) The function is not adversely affected during and after the time the rotorcraft is exposed to HIRF environment I, as described in appendix E to this part;

(2) The system automatically recovers normal operation, in a timely manner, after the rotorcraft is exposed to HIRF environment I, as described in appendix E to this part, unless this conflicts with other operational or functional requirements of that system;

(3) The system is not adversely affected during and after the time the rotorcraft is exposed to HIRF environment II, as described in appendix E to this part; and

(4) Each function required during operation under visual flight rules is not adversely affected during and after the time the rotorcraft is exposed to HIRF environment III, as described in appendix E to this part.

(b) Each electrical and electronic system that performs a function whose failure would significantly reduce the capability of the rotorcraft or the ability of the flightcrew to respond to an adverse operating condition must be designed and installed so the system is not adversely affected when the equipment providing these functions is exposed to equipment HIRF test level 1, 2, or 3, as described in appendix E to this part.

(c) Each electrical and electronic system that performs a function whose failure would reduce the capability of the rotorcraft or the ability of the flightcrew to respond to an adverse operating condition must be designed and installed so the system is not adversely affected when the equipment providing these functions is exposed to equipment HIRF test level 4, as described in appendix E to this part.

12. Add appendix E to part 29 to read as follows:

Appendix E to Part 29—HIRF Environments and Equipment HIRF Test Levels

This appendix specifies the HIRF environments and equipment HIRF test levels for electrical and electronic systems under §29.1317. The field strength values for the HIRF environments and laboratory equipment HIRF test levels are expressed in root-mean-square units measured during the peak of the modulation cycle.

(a) HIRF environment I is specified in the following table:

<table>
<thead>
<tr>
<th>Frequency (cycles/second)</th>
<th>Field strength (volts/meter)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 kHz–2 MHz</td>
<td>50</td>
</tr>
<tr>
<td>2 MHz–30 MHz</td>
<td>100</td>
</tr>
<tr>
<td>30 MHz–100 MHz</td>
<td>50</td>
</tr>
<tr>
<td>100 MHz–400 MHz</td>
<td>100</td>
</tr>
<tr>
<td>400 MHz–700 MHz</td>
<td>700</td>
</tr>
<tr>
<td>700 MHz–1 GHz</td>
<td>700</td>
</tr>
<tr>
<td>1 GHz–2 GHz</td>
<td>2,000</td>
</tr>
<tr>
<td>2 GHz–6 GHz</td>
<td>3,000</td>
</tr>
<tr>
<td>6 GHz–8 GHz</td>
<td>1,000</td>
</tr>
<tr>
<td>8 GHz–12 GHz</td>
<td>3,000</td>
</tr>
<tr>
<td>12 GHz–18 GHz</td>
<td>2,000</td>
</tr>
<tr>
<td>18 GHz–40 GHz</td>
<td>600</td>
</tr>
</tbody>
</table>

(b) HIRF environment II is specified in the following table:

<table>
<thead>
<tr>
<th>Frequency (cycles/second)</th>
<th>Field strength (volts/meter)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 kHz–500 kHz</td>
<td>20</td>
</tr>
<tr>
<td>500 kHz–2 MHz</td>
<td>30</td>
</tr>
<tr>
<td>2 MHz–30 MHz</td>
<td>100</td>
</tr>
</tbody>
</table>

(d) Equipment HIRF Test Level 1. (1) From 10 kilohertz (kHz) to 400 megahertz (MHz), use conducted susceptibility tests with continuous wave (CW) and 1 kHz square wave modulation with 90 percent depth or greater. The conducted susceptibility current must start at a minimum of 6 milliamperes (mA) at 10 kHz, increasing 20 decibels (dB) per frequency decade to a minimum of 30 mA at 500 kHz.

(2) From 500 kHz to 400 MHz, the conducted susceptibility current must be at least 30 mA.

(3) From 100 MHz to 400 MHz, use radiated susceptibility tests at a minimum of 20 volts per meter (V/m) peak, with CW and 1 kHz square wave modulation with 90 percent depth or greater.

(4) From 400 MHz to 8 gigahertz (GHz), use radiated susceptibility tests at a minimum of 150 V/m peak with pulse modulation of 0.1 percent duty cycle with 1 kHz pulse repetition frequency. This signal must be switched on and off at a rate of 1 Hz with a duty cycle of 50 percent.

(5) From 400 MHz to 8 GHz, use radiated susceptibility tests at a
minimum of 28 V/m peak with 1 kHz square wave modulation with 90 percent depth or greater. This signal must be switched on and off at a rate of 1 Hz with a duty cycle of 50 percent.

(e) Equipment HIRF Test Level 2. (1) From 10 kHz to 400 MHz, use conducted susceptibility tests with CW and 1 kHz square wave modulation with 90 percent depth or greater. The conducted susceptibility current must start at a minimum of 0.6 mA at 10 kHz, increasing 20 dB per frequency decade to a minimum of 30 mA at 500 kHz.

(2) From 500 kHz to 400 MHz, the conducted susceptibility current must be at least 30 mA.

(3) From 100 MHz to 400 MHz, use radiated susceptibility tests at a minimum of 20 V/m peak with CW and 1 kHz square wave modulation with 90 percent depth or greater.

(4) From 400 MHz to 8 GHz, use radiated susceptibility tests at a minimum of 150 V/m peak with pulse modulation of 4 percent duty cycle with a 1 kHz pulse repetition frequency. This signal must be switched on and off at a rate of 1 Hz with a duty cycle of 50 percent.

(f) Equipment HIRF Test Level 3. Test level 3 is HIRF environment II in table II of this appendix reduced by acceptable aircraft transfer function and attenuation curves. Testing must cover the frequency band of 10 kHz to 8 GHz.

(g) Equipment HIRF Test Level 4. (1) From 10 kHz to 400 MHz, use conducted susceptibility tests, starting at a minimum of 0.15 mA at 10 kHz, increasing 20 dB per frequency decade to a minimum of 7.5 mA at 500 kHz.

(2) From 500 kHz to 400 MHz, use conducted susceptibility tests at a minimum of 7.5 mA.

(3) From 100 MHz to 8 GHz, use radiated susceptibility tests at a minimum of 5 V/m.


Dorenda D. Baker,
Acting Director, Aircraft Certification Service.

[FR Doc. 06–895 Filed 1–31–06; 8:45 am]

BILLING CODE 4910–13–P