[4910-13]

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Parts 23, 25, 27, and 29

[Docket No. ; Notice No.]

RIN 2120-

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 for aircraft electrical and electronic systems because of their increased use in aircraft and vulnerability to high intensity radiated fields (HIRF). The proposed rule would define specific HIRF certification requirements to provide protection against HIRF effects that would apply to any applicant seeking issuance of a type certificate, amended type certificate, or supplemental type certificate for the initial approval of a new type of aircraft design or a change in aircraft type design.

DATES: Comments must be received on or before *[Insert date 90 days after date of publication in the Federal Register.]*

ADDRESSES: Comments on this document should be mailed or delivered, in duplicate, to: U.S. Department of

Transportation Dockets, Docket No. [ ], 400 Seventh Street SW., Room Plaza 401, Washington, DC 20590. Comments may be filed and examined in Room Plaza 401 between 10 a.m. and 5 p.m. weekdays, except Federal holidays. Comments also may be sent electronically at anytime to the Dockets Management System (DMS) at the following Internet address: http://dms.dot.gov/. Commenters who wish to file comments electronically should follow the instructions on the DMS web page.

FOR FURTHER INFORMATION CONTACT: John P. Dimtroff, Avionics Systems Branch, Aircraft Engineering Division, AIR-130, Federal Aviation Administration, 800 Independence Avenue SW., Washington, DC 20591; telephone (425) 227-1371; electronic mail: John.Dimtroff@faa.gov.

SUPPLEMENTARY INFORMATION:

Comments Invited

Interested persons are invited to participate in the making of the proposed action by submitting such written data, views, or arguments as they may desire. Comments relating to the environmental, energy, federalism, or economic impact that might result from adopting the proposals in this document also are invited. Substantive comments should be accompanied by cost estimates. Comments must identify the regulatory docket or notice

number and be submitted in duplicate to the DOT Rules Docket address specified above.

All comments received, as well as a report summarizing each substantive public contact with FAA personnel concerning this proposed rulemaking, will be filed in the docket. The docket is available for public inspection before and after the comment closing date.

All comments received on or before the closing date will be considered by the Administrator before taking action on this proposed rulemaking. Comments filed late will be considered as far as possible without incurring expense or delay. The proposals in this document may be changed in light of the comments received.

Commenters wishing the FAA to acknowledge receipt of their comments submitted in response to this document must include a pre-addressed, stamped postcard with those comments on which the following statement is made: "Comments to Docket No. [ ]." The postcard will be date stamped and mailed to the commenter.

Availability of NPRMs

An electronic copy of this document may be downloaded using a modem and suitable communications software from the FAA regulations section of the FedWorld electronic bulletin board service (telephone: (703) 321-3339) or the Government

Printing Office (GPO)'s electronic bulletin board service (telephone: (202) 512-1661).

Internet users may reach the FAA's web page at http://www.faa.gov/avr/arm/nprm/nprm.htm or the GPO's web page at http://www.access.gpo.gov/nara for access to recently published rulemaking documents.

Any person may obtain a copy of this document by submitting a request to the Federal Aviation Administration, Office of Rulemaking, ARM-1, 800 Independence Avenue SW., Washington, DC 20591, or by calling (202) 267-9680. Communications must identify the docket or notice number of this NPRM.

Persons interested in being placed on the mailing list for future rulemaking documents should request from the above office a copy of Advisory Circular No. 11-2A, Notice of Proposed Rulemaking Distribution System, which describes the application procedure.

Background

Statement of the Problem

The electromagnetic HIRF environment exists because of the transmission of electromagnetic energy from radar, radio, and television transmitters, and other ground-based, shipborne, or airborne radio frequency (RF) transmitters. 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 since the mid-1970s. Accidents and incidents on civil aircraft with flight-critical electrical and electronic systems have brought attention to the need to provide HIRF protection for these critical systems.

On April 15, 1990, an Airship Industries Airship-600 traversed the beam of 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 the 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 at the time of the airship's certification was a factor in the accident.

More recently, on March 2, 1999, a Robinson R-44 helicopter passed within 1,000 meters of the main beam of a high frequency (HF), high energy broadcast transmission antenna in Portugal. The pilot reported strong interference in the intercommunication and communication systems and navigation radios, followed by illumination of the low rotor revolutions per minute (RPM) and clutch lights. He further noted the engine noise dropped to idle level and the engine and rotor RPM indicators dropped. The pilot entered autorotation and landed the helicopter successfully with

only damage to the main rotors. Following landing, the pilot reported all cockpit indications were normal. The accident investigation division of Portugal's Instituto Nacional da Aviação Civil stated in its investigation of the incident that the probable cause 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 could 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, stating 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 from DC 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 engine electronic module. 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 being 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 the 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 No. 23.1309-1C, "Equipment, 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 HIRF environments in FAA Notice No. N8110.71, 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. [The FAA has issued [insert additional interim guidance.] **REMOVE SENETENCE IF NO GUIDANCE IS AVAILABLE BEFORE PUBLICATION.]**

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. The EEHWG investigated the likelihood that fixed wing aircraft and rotorcraft operate in the vicinity of these 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 proposed rules.

The U.S. HIRF environments were calculated by the NAWCAD based on the assumptions agreed on by the EEHWG, using unclassified and classified data on government and civilian transmitters, such as electromagnetic effects data bases, technical manuals, and information provided by transmitter operators.

In developing the U.S. rotorcraft severe, fixed-wing severe, certification, and normal HIRF environments, the NAWCAD reviewed the Joint Spectrum Center's HIRF data and updated the transmitter information to ensure the most current licensed and authorized transmitters were used. A

subset of data was created that contained the licensing information and equipment descriptions on the 25 highest radiated power transmitters in each of the following 17 HIRF frequency bands for each of the HIRF environments: 10 to 100 kilohertz (kHz), 100 to 500 kHz, 500 kHz to 2 megahertz (MHz), 2 to 30 MHz, 30 to 70 MHz, 70 to 100 MHz, 100 to 200 MHz, 200 to 400 MHz, 400 to 700 MHz, 700 MHz to 1 GHz, 1 to 2 GHz, 2 to 4 GHz, 4 to 6 GHz, 6 to 8 GHz, 8 to 12 GHz, 12 to 18 GHz, and 18 to 40 GHz.

The NAWCAD then selected the five transmitters with the highest peak and the five transmitters with the highest average radiated power in each frequency band. To select each of these transmitters, the NAWCAD performed further analysis and investigation to confirm the transmitters were operating and producing the radiated power indicated in the licensing information. If one of the transmitters was located in prohibited or restricted airspace, the NAWCAD noted that information, removed the transmitter from consideration as a potential HIRF transmitter, and selected the next lower radiated power transmitter not in prohibited or restricted airspace. Once the five highest peak and five highest average power transmitters were identified and confirmed operational, the NAWCAD recalculated their electromagnetic field strengths, in V/m. Finally, the NAWCAD created each U.S. HIRF environment using the

transmitters with the highest calculated field strength in each of the 17 frequency bands for peak and average power. JAA-member nations undertook similar efforts to develop the European HIRF environments.

To create the harmonized 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, the 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 transmitter 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.

(10) The average field strength was based on the transmitter's maximum authorized peak power, maximum duty cycle, 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 nonairport mobile tactical military transmitters were excluded.

(15) Certain transmitters have the capability to reduce power or restrict scanning coverage if aircraft operate in close vicinity. This capability was assumed to be operating for calculating illumination and power density.

(16) Transmitter losses into the antenna were estimated at 3 decibels in the U.S. HIRF environment, unless transmitter data were available. For further information on the development of the HIRF environments, consult NAWCAD Technical Memorandum, Report No. NAWCADPAX-98-156-TM, High Intensity Radiated Field External Environments for Civil Aircraft Operating in the United States of America (Unclassified), dated November 12, 1998. A copy of the NAWCAD Technical Memorandum is available in the docket.

Table I - Summary of Transmitter Locations Used to Develop the HIRF Environments

Geographic Location of Transmitter Source	Transmitter Distance from Aircraft (feet, slant or adjusted (adj.) slant range)			
	Rotorcraft Severe	Fixed-wing Severe	Certification (All Aircraft)	Normal (All Aircraft)
Airport[1], heliport, and offshore platform[2]				
Fixed:				
Air route/Airport surveillance radar	300 adj. slant	500 adj. slant	500 adj. slant	500 adj. slant
All others	100 slant	250 adj. slant	250 adj. slant	250 adj. slant
Mobile:				
Aircraft weather radar	150 slant	150 slant	150 slant	250 slant
All others	50 slant	50 slant	50 slant	50 slant
Land-based (other than airport and heliport)[3]				
HIRF SUA	Edge of SUA	Edge of SUA	Edge of SUA	Edge of SUA
All others (distance from facility)				
>0-3 nautical miles (nm)	100 slant	500 adj. slant	500 adj. slant	500 adj. slant
3-5 nm	100 slant	500 adj. slant	1000 adj. slant	1000 adj. slant
5-10 nm	100 slant	500 adj. slant	1000 adj. slant	1500 adj. slant
10-25 nm	100 slant	500 adj. slant	1000 adj. slant	2500 adj. slant
>25 nm	100 slant	500 adj. slant	1000 adj. slant	1000 adj. slant

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), airport 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 sounders, submarine and UHF/VHF communication, radar astronomy, land mobile equipment, test and training equipment, weather radar, national defense radar, long-range navigation (LORAN),

Geographic Location of Transmitter Source	Transmitter Distance from Aircraft (feet, slant or adjusted (adj.) slant range)			
	Rotorcraft Severe	Fixed-wing Severe	Certification (All Aircraft)	Normal (All Aircraft)
Ship-based transmitters[4]				
All ships	500 slant	500 adj. slant	1000 adj. slant	Not applicable
Air-to-air[5]				
Interceptor	Not applicable	100 slant	100 slant	Not applicable
All others	Not applicable	500 slant	500 slant	Not applicable

television broadcast, air route surveillance radar, and satellite uplinks.

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 nonhostile transmitters were assumed to be operational, and for all military aircraft on intercept courses all transmitters were assumed to be operational.

HIRF Environments

Table II - HIRF Environments, as developed versus as proposed

HIRF Environment, as developed	HIRF Environment, as proposed
Fixed-wing Severe	Not used
Rotorcraft Severe	HIRF Environment III
Certification	HIRF Environment I
Normal	HIRF Environment II

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 rotorcraft severe HIRF environment, as shown in table III, is HIRF environment III as proposed; however, the fixed-wing severe HIRF environment, as shown in table IV, was used only to develop the certification HIRF environment.

The certification HIRF environment, as shown in table V (HIRF environment I as proposed) provides test and analysis levels to demonstrate that the 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) 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 in the vicinity of airports.

Table III – Rotorcraft Severe HIRF Environment

(HIRF Environment III)

FREQUENCY	FIELD STRENGTH (V/M)	
	PEAK	AVERAGE
10 kHz - 100 kHz	150	150
100 kHz - 500 kHz	200	200
500 kHz - 2 MHz	200	200
2 MHz - 30 MHz	200	200
30 MHz - 70 MHz	200	200
70 MHz - 100 MHz	200	200
100 MHz - 200 MHz	200	200
200 MHz - 400 MHz	200	200
400 MHz - 700 MHz	730	200
700 MHz - 1 GHz	1,400	240
1 GHz - 2 GHz	5,000	250
2 GHz - 4 GHz	6,000	490
4 GHz - 6 GHz	7,200	400
6 GHz - 8 GHz	1,100	170
8 GHz - 12 GHz	5,000	330
12 GHz - 18 GHz	2,000	330
18 GHz - 40 GHz	1,000	420

Table IV – Fixed-Wing Severe HIRF Environment

FREQUENCY	FIELD STRENGTH (V/M)	
	PEAK	AVERAGE
10 kHz - 100 kHz	50	50
100 kHz - 500 kHz	60	60
500 kHz - 2 MHz	70	70
2 MHz - 30 MHz	200	200
30 MHz - 70 MHz	30	30
70 MHz - 100 MHz	30	30
100 MHz - 200 MHz	90	30
200 MHz - 400 MHz	70	70
400 MHz - 700 MHz	730	80
700 MHz - 1 GHz	1,400	240
1 GHz - 2 GHz	3,300	160
2 GHz - 4 GHz	4,500	490
4 GHz - 6 GHz	7,200	300
6 GHz - 8 GHz	1,100	170
8 GHz - 12 GHz	2,600	330
12 GHz - 18 GHz	2,000	330
18 GHz - 40 GHz	1,000	420

Table V – Certification HIRF Environment

(HIRF Environment I)

FREQUENCY	FIELD STRENGTH (V/M)	
	PEAK	AVERAGE
10 kHz - 100 kHz	50	50
100 kHz - 500 kHz	50	50
500 kHz - 2 MHz	50	50
2 MHz - 30 MHz	100	100
30 MHz - 70 MHz	50	50
70 MHz - 100 MHz	50	50
100 MHz - 200 MHz	100	100
200 MHz - 400 MHz	100	100
400 MHz - 700 MHz	700	50
700 MHz - 1 GHz	700	100
1 GHz - 2 GHz	2,000	200
2 GHz - 4 GHz	3,000	200
4 GHz - 6 GHz	3,000	200
6 GHz - 8 GHz	1,000	200
8 GHz - 12 GHz	3,000	300
12 GHz - 18 GHz	2,000	200
18 GHz - 40 GHz	600	200

Table VI – Normal HIRF Environment

(HIRF Environment II)

FREQUENCY	FIELD STRENGTH (V/M)	
	PEAK	AVERAGE
10 kHz - 100 kHz	20	20
100 kHz - 500 kHz	20	20
500 kHz - 2 MHz	30	30
2 MHz - 30 MHz	100	100
30 MHz - 70 MHz	10	10
70 MHz - 100 MHz	10	10
100 MHz - 200 MHz	30	10
200 MHz - 400 MHz	10	10
400 MHz - 700 MHz	700	40
700 MHz - 1 GHz	700	40
1 GHz - 2 GHz	1,300	160
2 GHz - 4 GHz	3,000	120
4 GHz - 6 GHz	3,000	160
6 GHz - 8 GHz	400	170
8 GHz - 12 GHz	1,230	230
12 GHz - 18 GHz	730	190
18 GHz - 40 GHz	600	150

Equipment Test Levels

The EEHWG developed four equipment HIRF test levels, which have been included in this proposed rule. The four test levels were created using typical aircraft HIRF protection characteristics and data from aircraft service experience to provide the ability to perform testing in a laboratory environment.

Equipment HIRF test levels 1 and 2 are based on the normal HIRF environment reduced by typical aircraft attenuation. The typical aircraft attenuation was determined using the mean attenuation measured on a number of transport airplanes, small airplanes, and rotorcraft. Equipment HIRF test level 3 is based on the normal HIRF environment reduced by the aircraft attenuation for a specific aircraft. Equipment HIRF test level 4 was developed to provide assurance for HIRF protection based on service experience for certain aircraft systems. To develop level 4, the EEHWG reviewed all available reports of HIRF interference. This equipment HIRF test level was selected to minimize the effects of HIRF and is 5 to 10 times higher than the system test levels currently used.

General Discussion of the Proposals

HIRF Certification Requirements

The proposed HIRF certification requirements would apply to applicants seeking issuance of TCs, amended TCs, and STCs to meet the airworthiness requirements in parts 23, 25, 27, and 29 for the initial approval of a new type of aircraft design or a change in type design.

An applicant for a TC, amended TC, or STC first would determine the aircraft's hazards and failures in compliance with §§ 23.1309, 25.1309, 27.1309, and 29.1309. Acceptable

approaches for this hazard assessment are described in AC No. 23.1309-1C and AC No. 25.1309-1A, "Systems Design and Analysis."

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 cope with adverse operating conditions, or (3) reduce the capability of the aircraft or the ability of the flightcrew to cope with adverse operating conditions. This resulting failure classification would determine to which HIRF environment the aircraft and/or electrical and electronic systems would be exposed 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.

In addition, functions required for operations under VFR in 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 14 CFR part 91 and, therefore, may operate closer to transmitters. Accordingly, under the proposed rule, 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, must be designed and installed so that, in addition to the first design and installation requirement specified above, 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 meet only HIRF environment I.

The proposed rule 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 cope with adverse operating conditions 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 1, 2, or 3. Any one of these test levels is acceptable. Test levels 1 and 2 have equivalent energy, but provide different modulation applications. This allows the test laboratories to use existing test equipment. Test level 2 allows an applicant to use equipment test levels developed for the specific aircraft being certified. Any one of these test levels may be used to demonstrate HIRF protection.

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 cope with adverse operating conditions 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.

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

timely input by elected officers (or their designees) of State, local, and tribal governments on a proposed "significant intergovernmental mandate." A "significant intergovernmental mandate" under the Act is any provision in a Federal agency regulation that would impose an enforceable duty upon State, local, and tribal governments, in the aggregate, of $100 million (adjusted annually for inflation) in any one year. Section 203 of the Act, 2 U.S.C. 1533, which supplements section 204(a), provides that before establishing any regulatory requirements that might significantly or uniquely affect small governments, the agency shall have developed a plan that, among other things, provides for notice to potentially affected small governments, if any, and for a meaningful and timely opportunity to provide input in the development of regulatory proposals.

This proposed rule [does/does not] contain a Federal intergovernmental or private sector mandate that exceeds $100 million in any one year.

Environmental Analysis

FAA Order 1050.1D defines FAA actions that may be categorically excluded from preparation of a National Environmental Policy Act (NEPA) environmental assessment or environmental impact statement. In accordance with FAA Order 1050.1D, appendix 4, paragraph 4(j), this rulemaking action qualifies for a categorical exclusion.

Energy Impact

The energy impact of the notice has been assessed in accordance with the Energy Policy and Conservation Act (EPCA), Public Law 94-163, as amended (43 U.S.C. 6362) and FAA Order 1053.1. It has been determined that the notice is not a major regulatory action under the provisions of the EPCA.

List of Subjects

14 CFR Part 23

Air transportation, Aircraft, Aviation safety, Certification, Safety.

14 CFR Part 25

Air transportation, Aircraft, Aviation safety, Certification, Safety.

14 CFR Part 27

Air transportation, Aircraft, Aviation safety, Certification, Rotorcraft, Safety.

14 CFR Part 29

Air transportation, Aircraft, Aviation safety, Certification, Rotorcraft, Safety.

The Proposed Amendment

In consideration of the foregoing, the Federal Aviation Administration proposes to amend parts 23, 25, 27, and 29 of Title 14, Code of Federal Regulations (14 CFR) as follows:

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) Each 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) Each electrical and electronic 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) Each electrical and electronic 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 cope with adverse operating conditions 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 J to this part.

(c) Each electrical and electronic system that performs a function whose failure would reduce the capability of the airplane or the ability of the flightcrew to cope with adverse operating conditions 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 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 as follows:

Table I – HIRF Environment I

FREQUENCY	FIELD STRENGTH (V/M)	
	PEAK	AVERAGE
10 kHz - 100 kHz	50	50
100 kHz - 500 kHz	50	50
500 kHz - 2 MHz	50	50
2 MHz - 30 MHz	100	100
30 MHz - 70 MHz	50	50
70 MHz - 100 MHz	50	50
100 MHz - 200 MHz	100	100
200 MHz - 400 MHz	100	100
400 MHz - 700 MHz	700	50
700 MHz - 1 GHz	700	100
1 GHz - 2 GHz	2,000	200
2 GHz - 4 GHz	3,000	200
4 GHz - 6 GHz	3,000	200
6 GHz - 8 GHz	1,000	200
8 GHz - 12 GHz	3,000	300
12 GHz - 18 GHz	2,000	200
18 GHz - 40 GHz	600	200

[editing will combine the frequencies with identical field strengths for all the charts and add the language ▒ up to and including▒]

(b) HIRF environment II is specified as follows:

Table II – HIRF Environment II

FREQUENCY	FIELD STRENGTH (V/M)	
	PEAK	AVERAGE
10 kHz - 100 kHz	20	20
100 kHz - 500 kHz	20	20
500 kHz - 2 MHz	30	30
2 MHz - 30 MHz	100	100
30 MHz - 70 MHz	10	10
70 MHz - 100 MHz	10	10
100 MHz - 200 MHz	30	10
200 MHz - 400 MHz	10	10
400 MHz - 700 MHz	700	40
700 MHz - 1 GHz	700	40
1 GHz - 2 GHz	1,300	160
2 GHz - 4 GHz	3,000	120
4 GHz - 6 GHz	3,000	160
6 GHz - 8 GHz	400	170
8 GHz - 12 GHz	1,230	230
12 GHz - 18 GHz	730	190
18 GHz - 40 GHz	600	150

(c) 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.

(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 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.

(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.

(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) Each 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) Each electrical and electronic 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) Each electrical and electronic 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 capability of the airplane or the ability of the flightcrew to cope with adverse operating conditions 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 K to this part.

(c) Each electrical and electronic system that performs a function whose failure would reduce the capability of the airplane or the ability of the flightcrew to cope with adverse operating conditions 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 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 as follows :

Table I – HIRF Environment I

FREQUENCY	FIELD STRENGTH (V/M)	
	PEAK	AVERAGE
10 kHz - 100 kHz	50	50
100 kHz - 500 kHz	50	50
500 kHz - 2 MHz	50	50
2 MHz - 30 MHz	100	100
30 MHz - 70 MHz	50	50
70 MHz - 100 MHz	50	50
100 MHz - 200 MHz	100	100
200 MHz - 400 MHz	100	100
400 MHz - 700 MHz	700	50
700 MHz - 1 GHz	700	100
1 GHz - 2 GHz	2,000	200
2 GHz - 4 GHz	3,000	200
4 GHz - 6 GHz	3,000	200
6 GHz - 8 GHz	1,000	200
8 GHz - 12 GHz	3,000	300
12 GHz - 18 GHz	2,000	200
18 GHz - 40 GHz	600	200

(b) HIRF environment II is specified as follows:

Table II – HIRF Environment II

FREQUENCY	FIELD STRENGTH (V/M)	
	PEAK	AVERAGE
10 kHz - 100 kHz	20	20
100 kHz - 500 kHz	20	20
500 kHz - 2 MHz	30	30
2 MHz - 30 MHz	100	100
30 MHz - 70 MHz	10	10
70 MHz - 100 MHz	10	10
100 MHz - 200 MHz	30	10
200 MHz - 400 MHz	10	10
400 MHz - 700 MHz	700	40
700 MHz - 1 GHz	700	40
1 GHz - 2 GHz	1,300	160
2 GHz - 4 GHz	3,000	120
4 GHz - 6 GHz	3,000	160
6 GHz - 8 GHz	400	170
8 GHz - 12 GHz	1,230	230
12 GHz - 18 GHz	730	190
18 GHz - 40 GHz	600	150

(c) 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.

(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 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.

(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.

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

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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) Each 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;

(2) Each electrical and electronic 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) Each electrical and electronic 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 cope with adverse operating conditions 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 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 cope with adverse operating conditions, 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.

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 as follows ow:

Table I – HIRF Environment I

FREQUENCY	FIELD STRENGTH (V/M)	
	PEAK	AVERAGE
10 kHz - 100 kHz	50	50
100 kHz - 500 kHz	50	50
500 kHz - 2 MHz	50	50
2 MHz - 30 MHz	100	100
30 MHz - 70 MHz	50	50
70 MHz - 100 MHz	50	50
100 MHz - 200 MHz	100	100
200 MHz - 400 MHz	100	100
400 MHz - 700 MHz	700	50
700 MHz - 1 GHz	700	100
1 GHz - 2 GHz	2,000	200
2 GHz - 4 GHz	3,000	200
4 GHz - 6 GHz	3,000	200
6 GHz - 8 GHz	1,000	200
8 GHz - 12 GHz	3,000	300
12 GHz - 18 GHz	2,000	200
18 GHz - 40 GHz	600	200

(b) HIRF environment II is specified as follows:

Table II – HIRF Environment II

FREQUENCY	FIELD STRENGTH (V/M)	
	PEAK	AVERAGE
10 kHz - 100 kHz	20	20
100 kHz - 500 kHz	20	20
500 kHz - 2 MHz	30	30
2 MHz - 30 MHz	100	100
30 MHz - 70 MHz	10	10
70 MHz - 100 MHz	10	10
100 MHz - 200 MHz	30	10
200 MHz - 400 MHz	10	10
400 MHz - 700 MHz	700	40
700 MHz - 1 GHz	700	40
1 GHz - 2 GHz	1,300	160
2 GHz - 4 GHz	3,000	120
4 GHz - 6 GHz	3,000	160
6 GHz - 8 GHz	400	170
8 GHz - 12 GHz	1,230	230
12 GHz - 18 GHz	730	190
18 GHz - 40 GHz	600	150

(c) HIRF environment III is specified as follows:

Table III – HIRF Environment III

FREQUENCY	FIELD STRENGTH (V/M)	
	PEAK	AVERAGE
10 kHz - 100 kHz	150	150
100 kHz - 500 kHz	200	200
500 kHz - 2 MHz	200	200
2 MHz - 30 MHz	200	200
30 MHz - 70 MHz	200	200
70 MHz - 100 MHz	200	200
100 MHz - 200 MHz	200	200
200 MHz - 400 MHz	200	200
400 MHz - 700 MHz	730	200
700 MHz - 1 GHz	1,400	240
1 GHz - 2 GHz	5,000	250
2 GHz - 4 GHz	6,000	490
4 GHz - 6 GHz	7,200	400
6 GHz - 8 GHz	1,100	170
8 GHz - 12 GHz	5,000	330
12 GHz - 18 GHz	2,000	330
18 GHz - 40 GHz	1,000	420

(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.

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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) Each 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) Each electrical and electronic 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) Each electrical and electronic 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 cope with adverse operating conditions 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 such a function whose failure would reduce the capability of the rotorcraft or the ability of the flightcrew to cope with adverse operating conditions 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 as follows:

Table I – HIRF Environment I

FREQUENCY	FIELD STRENGTH (V/M)	
	PEAK	AVERAGE
10 kHz - 100 kHz	50	50
100 kHz - 500 kHz	50	50
500 kHz - 2 MHz	50	50
2 MHz - 30 MHz	100	100
30 MHz - 70 MHz	50	50
70 MHz - 100 MHz	50	50
100 MHz - 200 MHz	100	100
200 MHz - 400 MHz	100	100
400 MHz - 700 MHz	700	50
700 MHz - 1 GHz	700	100
1 GHz - 2 GHz	2,000	200
2 GHz - 4 GHz	3,000	200
4 GHz - 6 GHz	3,000	200
6 GHz - 8 GHz	1,000	200
8 GHz - 12 GHz	3,000	300
12 GHz - 18 GHz	2,000	200
18 GHz - 40 GHz	600	200

(b) HIRF environment II is specified as follows:

Table II – HIRF Environment II

FREQUENCY	FIELD STRENGTH (V/M)	
	PEAK	AVERAGE
10 kHz - 100 kHz	20	20
100 kHz - 500 kHz	20	20
500 kHz - 2 MHz	30	30
2 MHz - 30 MHz	100	100
30 MHz - 70 MHz	10	10
70 MHz - 100 MHz	10	10
100 MHz - 200 MHz	30	10
200 MHz - 400 MHz	10	10
400 MHz - 700 MHz	700	40
700 MHz - 1 GHz	700	40
1 GHz - 2 GHz	1,300	160
2 GHz - 4 GHz	3,000	120
4 GHz - 6 GHz	3,000	160
6 GHz - 8 GHz	400	170
8 GHz - 12 GHz	1,230	230
12 GHz - 18 GHz	730	190
18 GHz - 40 GHz	600	150

(c) HIRF environment III is specified as follows:

Table III – HIRF Environment III

FREQUENCY	FIELD STRENGTH (V/M)	
	PEAK	AVERAGE
10 kHz - 100 kHz	150	150
100 kHz - 500 kHz	200	200
500 kHz - 2 MHz	200	200
2 MHz - 30 MHz	200	200
30 MHz - 70 MHz	200	200
70 MHz - 100 MHz	200	200
100 MHz - 200 MHz	200	200
200 MHz - 400 MHz	200	200
400 MHz - 700 MHz	730	200
700 MHz - 1 GHz	1,400	240
1 GHz - 2 GHz	5,000	250
2 GHz - 4 GHz	6,000	490
4 GHz - 6 GHz	7,200	400
6 GHz - 8 GHz	1,100	170
8 GHz - 12 GHz	5,000	330
12 GHz - 18 GHz	2,000	330
18 GHz - 40 GHz	1,000	420

(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.

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[Name of Office Director]
[Title of Office Director]