

**BY ORDER OF THE
SECRETARY OF THE AIR FORCE**

AIR FORCE INSTRUCTION 48-109



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**ELECTROMAGNETIC FIELD RADIATION
(EMFR) OCCUPATIONAL AND
ENVIRONMENTAL HEALTH PROGRAM**

COMPLIANCE WITH THIS PUBLICATION IS MANDATORY

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This publication implements the provisions of Department of Defense Instruction (DODI) 6055.11, Protecting Personnel from Electromagnetic Fields, or latest version thereof, which requires compliance with all applicable Federal, ANSI, and IEEE standards. This instruction incorporates guidance and safety criteria with respect to human exposure to radio frequency electromagnetic fields as defined in the American National Standards Institute (ANSI) / Institute of Electrical and Electronics Engineers (IEEE) C95.1

The criteria in this instruction are the Air Force's minimum occupational health requirements for an Electromagnetic Field (EMF) health surveillance program. A program is established in this instruction to prevent possible harmful effects to personnel from exposure to potentially hazardous levels of EMF. This instruction applies to all USAF organizations, including all Reserve and Air National Guard organizations. Major commands (MAJCOM), direct reporting units (DRU), and field operating agencies (FOA) may supplement this instruction when additional or more stringent safety and health criteria are required, but all direct supplements must be routed to the Office of Primary Responsibility (OPR) of this publication for coordination prior to certification and approval. This instruction does not apply to employees working under government contract or private contractors performing work under government contracts. Contractors are solely responsible for compliance with Occupational Safety and Health Administration (OSHA) standards and the protection of their employees unless otherwise provided by law or regulation to be specified in the contract. This AFI does not prohibit providing workplace sampling and survey information to contractors based on local arrangements. The authorities to waiver wing/unit level requirements in this publication are identified with a Tier number following the compliance statement. See AFI 33-360,

Publications and Forms Management, Table 1.1 for a description of the authorities associated with the Tier numbers. Submit requests for waivers through the chain of command to the appropriate Tier waiver approval authority, or alternately, to the Publication OPR for non-tiered compliance items. Refer to Air Force Instruction (AFI) 48-145, *Occupational and Environmental Health*, for instructions, processing supplements or variances and AFI 91-202, *Air Force Mishap Prevention Programs*, for instructions processing supplements or variances. Ensure that all records created as a result of processes prescribed in this publication are maintained IAW Air Force Manual 33-363, *Management of Records*, and disposed of IAW Air Force Records Information Management System (AFRIMS) Records Disposition Schedule (RDS). This publication requires the collection and or maintenance of information protected by the Privacy Act (PA) of 1974. Forms affected by the Privacy Act have the appropriate Privacy Act statement. The authority to collect and or maintain the records prescribed in this publication is DODI 6055.05, *Occupational and Environmental Health* (OEH). Refer recommended changes and questions about this publication to the OPR using the AF Form 847, *Recommendation for Change of Publication*; route AF Form 847s from the field through the appropriate chain of command. Technical assistance in applying this instruction can be obtained by contacting the US Air Force School of Aerospace Medicine (USAFSAM) located at Wright-Patterson AFB, OH or (888) 232-ESOH (3764), DSN 798-3764, esoh.service.cent@wpafb.af.mil.

SUMMARY OF CHANGES

This document is substantially revised to accommodate insertion of tiering resulting from changes to the inspection process outlined in AFI 90-201, *The Air Force Inspection System*, and must be completely reviewed. Tiering is designated with a “(T-x)”, where x ranges from 0 to 3.

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Chapter 1

PROGRAM OVERVIEW

1.1. Purpose. This instruction outlines the responsibilities, policies, and structure of the Air Force EMF Occupational Health program. It implements the provisions of Department of Defense Instruction (DODI) 6055.11, *Protecting Personnel from Electromagnetic Fields*, or latest version thereof, which requires compliance with all applicable Federal, ANSI, and IEEE standards.

1.2. Applicability. This instruction applies to all Air Force military members (including the Reserve and National Guard), Department of the Air Force civilian employees (including foreign nationals) and to all sources of EMF owned or operated by the US Air Force, or under Air Force control. Overseas Air Force installations to include deployed locations will comply with this instruction or the requirements established by the Status of Forces Agreement, whichever is more stringent. Policies and procedures specific to Directed Energy Weapons (DEW) are not covered by this instruction but are provided in AFI 91-401, *Directed Energy Weapons Safety*. This instruction excludes optical and laser radiation frequencies, standards and reporting which are covered by AFI 48-139, *Laser and Optical Radiation Protection Program*. The Maximum Permissible Exposure (MPE) limits referenced in this instruction are detailed in the Attachment 2 and come from ANSI/IEEE C95.1, *IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz*. MPE limits do not apply to patients who are undergoing diagnostic or therapeutic procedures when EMF application is specifically prescribed by a physician, e.g., diathermy during physical therapy treatments, electromagnetic imaging, etc. The MPE does, however, apply to patients or medical staff who may be exposed incidentally during the medical procedure. The term “overexposure” used in this instruction refers to EMFR exposures greater than the MPE.

1.3. Regulatory Basis. This document contains the same MPEs used throughout industry as instructed by DODI 6055.11. Measurement units will follow the MPEs and are derived from the recommended exposure levels in the current ANSI/IEEE C95.1, *IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz*, which serve as a consensus standard developed by representatives of industry, scientific communities, government agencies, and the public. Control measures at least as stringent as those recommended by the current DODI 6055.11 and ANSI/IEEE C95.1, are implemented by this instruction. Refer also to National Council on Radiation Protection (NCRP) 86, *Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields*, NCRP 119, *A Practical Guide to the Determination of Human Exposure to Radiofrequency Fields*, and the current American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs) Booklet for additional information on EMF. IEEE C95 standards are the main reference for exposure limit values. Refer to AFRL-SA-WP-SR-2013-0003, *Base-Level Guide for Electromagnetic Field Radiation* for further guidance information on how to implement this instruction in applying regulatory standards.

Chapter 2

ROLES AND RESPONSIBILITIES

2.1. Office of the Assistant Secretary (SAF /AQ, Acquisition). Ensures that Program Offices (POs) address the issues of EMF health and safety early and throughout the acquisition and sustainment life cycle and obtains measured personnel hazard data for all emitters at the earliest possible time in the acquisition cycle for inclusion into applicable Technical Orders (TOs), handbooks, manuals, and other publications related to operational EMF systems.

2.2. Deputy Assistant Secretary of the Air Force (Environment, Safety and Occupational Health) (SAF/IEE). Provides oversight, guidance and direction for all Air Force Environment, Safety and Occupational Health (ESOH) policy.

2.3. AF Surgeon General (AF/SG). Provides oversight of the Air Force EMF Occupational Health Program IAW this instruction, DODI 6055.11, and ANSI/IEEE C95.1-2005.

2.3.1. Establishes policy for the identification, assessment, and control of EMF and electromagnetic interference (EMI) health hazards of medical equipment/devices in AF workplaces and operating environments.

2.3.2. Establishes EMF personnel exposure standards and criteria based on industry standards.

2.3.3. Acts as the approval authority for waivers of protection standards and control procedures.

2.3.4. Delegates appropriate organizations responsibility for appointment of subject matter experts on EMF protection issues to the DOD Transmitted Electromagnetic Radiation Protection (TERP) Working Group.

2.4. The Judge Advocate General (AF/JA). Reviews legal issues associated with use of EMF and EMF systems in the military.

2.5. Commander, Air Force Safety Center (AFSEC).

2.5.1. Establishes and implements policy and standards for safety programs associated with the non-biological hazards of EMF-producing systems and equipment, e.g., hazard of electromagnetic radiation to ordnance (HERO), hazard of electromagnetic radiation to fuel (HERF), and electromagnetic interference (EMI). Unlike other federal agencies and DoD services, the AF requires Bioenvironmental Engineering to conduct assessments for Hazard of Electromagnetic Radiation to Personnel (HERP) for joint installations with the AF as lead component.

2.5.2. Establishes and implements policy and procedures for safety programs associated with EMF-directed energy weapons.

2.5.3. Delegates appropriate organizations responsibility for appointment of subject matter experts on EMF protection issues to the DOD Transmitted Electromagnetic Radiation Protection (TERP) Working Group.

2.6. Commander, Air Force Inspection Agency (AFIA). Supplements MAJCOM inspectors with required specialties to MAJCOM IGs to support Unit Effectiveness Inspections (UEI) as needed.

2.7. Commander, Air Force Materiel Command (AFMC).

2.7.1. Develops and implements guidance and procedures to ensure that required personnel hazard data for emitters is measured at the earliest possible time in the acquisition cycle and is made available to the appropriate procuring agency.

2.7.2. Ensures that Air Force laboratories and other AFMC activities address EMF health and safety issues throughout the RDT&E cycle and acquisition life cycle.

2.7.3. Provides information to using commands concerning the adequacy of EMF hazard protective devices, materials, and engineering control measures, relative to EMF hazards.

2.8. 711th Human Performance Wing (HPW).

2.8.1. Conducts EMF bioeffects research. Provides consultation, assistance, and research review on the biological effects of EMF for the AF/SG. (T-0)

2.8.2. Coordinates with AFMC laboratories and other services to evaluate any unique or unusual EMF safety issues. (T-1)

2.8.3. Establishes EMF personnel exposure limits for the AF/SG. (T-0)

2.8.4. Provides formal training programs for medical personnel to ensure they are proficient in: (T-0)

2.8.4.1. Conducting the necessary EMF measurements,

2.8.4.2. Determining hazard assessments, and

2.8.4.3. Evaluating known bioeffects due to EMF exposure.

2.8.5. Recommends medical surveillance requirements due to EMF exposure. (T-0)

2.8.6. Develops methods to evaluate occupational injuries resulting from EMF exposures greater than the MPE. (T-0)

2.8.7. Maintain specialized measurement equipment to conduct EMF health risk assessments to identify areas in excess of the MPE and to determine the type of control measures required. (T-0)

2.8.8. Maintains the EMF Emitter Inventory containing the nominal characteristics of AF owned and operated EMF emitters to assist installation level personnel with the inventory and identification of potentially hazardous systems. (T-1)

2.8.9. Conducts EMF health hazard evaluations for new systems, operations, and modified systems in use on the installation and maintain documentation of the evaluation in the Defense Occupational and Environmental Health Readiness System (DOEHRS). Provide guidance and recommendations regarding engineering controls, personal protective equipment and warning devices, posting requirements, and other administrative controls as necessary. (T-0)

2.8.10. Administers and maintains the DoD EMF Injury Hotline as directed by the SAF to provide timely expert medical advice in the event of an injury or suspected injury from EMF devices. (T-0)

2.8.11. Maintains the EMF Radiation Exposure Registry (EMFRER) containing pertinent records of personnel overexposures that were found to be five (5) times the MPE or greater and provides a report of their annual review to AFMSA/SG3PB. (T-1)

2.9. Major Commands (MAJCOM), Direct Reporting Units (DRU), and Field Operating Agencies (FOA).

2.9.1. Conduct inspection of EMF Occupational Health Programs during a UEI. Coordinate with AFIA/SG, if necessary, to obtain required medical inspector specialties and/or guidance. (T-1)

2.9.2. Request specific EMF exposure criteria or standards not contained herein from AFMSA/SG3P, Aerospace Medicine Policy and Operations. (T-1)

2.9.3. Contact USAFSAM for guidance and assistance in resolving personnel EMF hazards. (T-1)

2.9.4. Track and coordinate installation EMF overexposure incident investigations with the affected installation Bioenvironmental Engineering office. (T-0)

2.10. Wing, Center, Installation, Element Commander. Wing, Center, and (or) Installation Commander will:

2.10.1. Ensure operation and maintenance activities implement measures to prevent personnel exposure to EMF in excess of the limits prescribed in this instruction. (T-1)

2.10.2. Through the Medical Treatment Facility Commander (MTF/CC), support integrated implementation of this instruction throughout the wing, center or division. (T-1)

2.10.3. Support MTF/CC in their efforts to ensure compliance with this instruction. (T-1)

2.10.4. Through Weapons Safety, investigate incidents related to EMF weapon safety hazards per AFI 91-204, *Safety Investigations and Reports* and AFMAN 91-221, *Weapons Safety Investigations and Reports*. (T-0)

2.11. Medical Treatment Facility (MTF)/Mission Support Commander (MSC). The MTF or MSC (for ANG, AFR) commander's responsibilities are carried out, through the appropriate agencies as follows:

2.11.1. Bioenvironmental Engineering (BE) will:

2.11.1.1. Maintain a proficient level of knowledge, training and experience in assessing EMF hazards in the workplace, performing required measurements, and responding to health issues raised by workers, installation residents, and the general public. (T-0)

2.11.1.2. Conduct EMF health hazard evaluations for operations and modified systems in use on the installation and maintain documentation of the evaluation in the DOEHRS. Provide guidance and recommendations regarding engineering controls, personal protective equipment and warning devices, posting requirements, and other administrative controls as necessary. (T-0)

2.11.1.3. Assist unit commanders and workplace supervisors in the development of EMF safety awareness training programs, particularly in the area of bioeffects, exposure incident reporting, and identification and control of hazardous areas in the workplace. (T-0)

2.11.1.4. Conduct an assessment for Hazard of Electromagnetic Radiation to Personnel (HERP). (T-1)

2.11.1.5. During home station and deployed operations, provide guidance to local commanders regarding the potential for personnel injuries from EMF emissions. (T-0)

2.11.1.6. Investigate all alleged or suspected overexposures. Complete the final report of the investigation for submission as described in **paragraph 4.6.5** with guidance and sample reports shown in AFRL-SA-WP-SR-2013-0003, Base-Level Guide for Electromagnetic Field Radiation. (T-0)

2.11.1.7. Notify and coordinate with USAFSAM/OEC, AFMSA/SG3PB, and the MAJCOM BE on all EMF overexposure investigations, and provide copies of final documentation for evaluation and possible inclusion in the EMFRER. Coordinate with MAJCOM Weapons Safety on EMF weapon incident investigations. (T-0)

2.11.1.8. Consult with the Installation Frequency Manager to review and update EMF emitter inventories across all installation host/tenant units as described in **paragraph 4.2.1**.

2.11.2. Public Health (PH) will:

2.11.2.1. Work with BE in investigating EMF incidents and provide medical surveillance feedback to BE. (T-0)

2.11.2.2. For all incident cases of overexposure to EMF, PH will initiate and complete an occupational illness report (AF Form 190) in the Air Force Safety Automated System (AFSAS), with input from the BE and investigating physician IAW AFI 48-145. The medical provider will document findings in the patient's medical record for all incident cases of overexposed to EMF. (T-0)

2.11.3. Installation Occupational & Environmental Medicine Consultant will:

2.11.3.1. Ensure medical follow-up examinations for EMF overexposed persons are conducted as specified by the occupational medicine consultant at USAFSAM/FE. (T-1)

2.11.3.2. The medical provider will document findings in the patient's medical record for all incident cases of overexposed to EMF. (T-1)

2.12. Unit Commanders. Unit commanders will:

2.12.1. Establish a unit EMF safety program when required by **paragraph 3.1.1.3**. (T-0)

2.12.2. Ensure workplace supervisors responsible for the operation of potentially hazardous EMF emitters develop a unit radiation safety awareness training plan to aid in the implementation of the unit training program. (T-0)

2.12.3. Establish procedures for workers to report suspected overexposures to the responsible supervisor and to BE. Support BE investigative efforts and reconstruction of

exposure incidents. Ensure these procedures are incorporated into the unit safety awareness training plan. (T-0)

2.13. Supervisor. The supervisor shall:

2.13.1. Ensure workers under their supervision are aware of and follow the safety procedures outlined in this instruction, equipment technical manuals, and the unit EMF safety awareness training program. (T-0)

2.13.2. Prepare an EMF safety awareness training plan to provide initial training for newcomers and annual refresher training for system operators, maintenance personnel, and other workers assigned to duties in potential exposure to EMFR as well as action-level environments. (T-0)

2.13.3. Coordinate with BE to ensure the safety awareness training plan includes topics specific to the shop functions. (T-0)

2.13.4. Coordinate EMF survey and measurement activities with command and supervisory personnel and ensure these individuals are kept informed of the status of all such activities, particularly during investigations of suspected or actual overexposures. (T-0)

2.13.5. Inform BE and request a hazard assessment survey for each new EMF system prior to operation. Provide BE with system parameters for hazard calculations. Notify BE of any physical or operational changes that could change the output frequencies or increase the power density of the field generated by the emitter. (T-0)

2.13.6. Contact and coordinate with BE immediately for a suspected overexposure to initiate an investigation. (T-0)

2.13.6.1. Ensure workers attend medical exam appointments as directed by the Installation Occupational & Environmental Medicine Consultant. (T-0)

2.13.7. Ensure work areas identified by BE as hazardous EMF areas are clearly posted. (T-0)

2.13.8. Ensure proper corrective actions are accomplished according to AFI 91-202, whenever a risk assessment code is assigned to a hazardous EMF situation. (T-0)

2.14. Worker. Workers shall:

2.14.1. Follow safe work procedures given in this instruction, equipment TOs, manuals, and unit OIs. (T-0)

2.14.2. Follow procedures established by the supervisor to ensure safe working conditions. (T-0)

2.14.3. Ensure required warning signs and safety devices are in place and functional before beginning work. (T-0)

2.14.4. Immediately report any suspected overexposure and any unsafe work condition to their supervisor. (T-0)

2.14.5. Attend medical exam appointments as directed by the Installation Occupational & Environmental Medicine Consultant. (T-0)

Chapter 3

EXPOSURE STANDARDS AND PERSONNEL PROTECTION POLICIES

3.1. EMF Protection Standards.

3.1.1. Maximum Permissible Exposure (MPE). As detailed in Attachment 2, the Air Force will implement a two tiered approach with action level requirements for MPEs as follows: (T-0)

3.1.1.1. Upper Tier (formerly, Controlled Environment) MPEs include the following:

3.1.1.1.1. Exposure that may be incurred by personnel who are aware of the potential for EMF exposures conjoined with their employment or duties.

3.1.1.1.2. Exposure of other cognizant individuals.

3.1.1.1.3. Exposure that is the incidental result of passage through such areas where analysis shows the levels may exceed those given in the lower tier MPE table (Table A.2.2. and Table 5 in AFRL-SA-WP-SR-2013-0003), but do not exceed those values in the upper tier MPE table (Table A.2.1. and Table 4 in AFRL-SA-WP-SR-2013-0003).

3.1.1.2. Lower Tier (formerly, Uncontrolled Environment) MPEs. Lower Tier exposures can occur in areas where individuals would have no knowledge or control of their exposure. These locations include living quarters or workplaces where there are no expectations that the exposure levels may exceed those shown in the lower tier MPE table (Table A.2.2. and Table 5 in AFRL-SA-WP-SR-2013-0003).

3.1.1.3. Action level. Any exposure in excess of those indicated in the lower tier MPE table (Table A.2.2. and Table 5 in AFRL-SA-WP-SR-2013-0003) requires the adoption of an EMF safety program. This will include training and posting requirements at a minimum. Where individuals unfamiliar with the phenomenon of induced EMF currents may have access, precautions shall be taken to limit induced currents to values not normally perceptible to individuals, as well as prevent the possibility of EMF burns. (T-0)

3.1.2. Induced and Contact Current Standard. If the frequency range identified is 100 kHz to 110 MHz, seek additional guidance from USAFSAM for induced and contact current hazard analysis. (T-2)

3.1.3. The High Power Microwave (HPM) Upper Tier environment exposure limits are provided in Table A.2.1. for HPM and Electromagnetic Pulse (EMP) Simulator Systems. Contact USAFSAM for measurement and evaluation assistance at the ESOH Service Center at 1-888-232-3764, DSN 798-3764. (T-0)

3.1.4. Commanders will avoid exposure of personnel to EMF levels in excess of the applicable MPE, except where necessary for medical treatment, or in training or operation of a DEW used in accordance with AFI 91-401, *Directed Energy Weapons Safety*. (T-0)

3.1.5. For personnel with implanted medical devices, no specific exposure limits for implanted devices are specified. Certain environments such as an area with an arc welding

process pose a potential hazard to these personnel due to potential EMI. These personnel shall consult with their physician(s) to determine how this potential exposure can affect the implanted medical device. (T-1)

3.2. Personal Protective Equipment Policies.

3.2.1. EMF Protective Clothing. EMF shielded clothing is not authorized for use during Air Force operations. (T-0)

3.2.2. EMF Sensors, Detectors, Alarms, Area Monitors, and Personal Warning Devices. AF/SG does not allow the use of personal detectors as a means of personal protection from EMF exposure in Air Force operational environments. In cases where the environment may exceed ten (10) times the MPE, special needs may be addressed and evaluated through consultation with USAFSAM. Use of these types of devices will require approval from AFMSA/SG3PB on advice of USAFSAM consultants. For area monitors, contact USAFSAM for approved monitors and guidelines for use. (T-0)

3.2.3. EMF personal protective clothing such as insulated boots and gloves to protect against frequency dependent contact currents is authorized. All PPE must be inspected with each use and routinely tested to ensure protective efficacy, per manufacture's guidelines. (T-0)

Chapter 4

INSTALLATION PROGRAM REQUIREMENTS

4.1. General Guidelines. The requirements for the effective management of an installation level EMF protection program are defined herein. Questions regarding the management or implementation of an installation program requirement should be referred to USAFSAM. Assistance with electromagnetic compatibility (EMC) and EMI testing or the assessment of EMF hazards to personnel, HERO and HERF (especially with regards to difficult to test transmitters like rotating radars) must be referred to the 85 EIS/SCYM, 670 Maltby Hall Drive, Suite 234, Keesler AFB, MS 39534-2633, (228) 377-3920 or DSN 597-3920.

4.2. EMF Hazard Evaluations.

4.2.1. All EMF transmitters owned and operated by avionics workplaces, communications facilities, industrial processes, and medical facilities shall be identified during the regularly scheduled, on-site BE health risk assessment activities to these areas. Minimally, EMF emitters shall be inventoried biennially to identify new emitters, and evaluations shall be conducted if operations change or new systems are added to the inventory. Consultation with the Installation Frequency Manager shall be conducted to verify all emitters have been identified from these workplaces and potential additional work centers. (T-0)

4.2.2. Commercially procured telecommunications systems designed for public use (e.g. cellular phones, Wi-Fi networks) that are used in their manufactured condition do not require evaluations. Devices intended to provide medical treatment do not require a special evaluation beyond manufacturer recommendations. (T-3)

4.2.3. Inventories will be maintained for the EMF transmitters identified in Paragraph 4.2.1. BE should coordinate with the Weapons Safety Manager and Installation Spectrum Manager to ensure a complete base inventory. The inventories will include at a minimum the following categories: Work Center, Point of Contact (POC), POC Phone Number, Emitter Nomenclature (i.e. AN/GRT-21), Emitter Description (i.e. TACAN), Quantity, Frequency Range, Upper Tier and Lower Tier MPEs, and Hazard Distances. (T-0)

4.2.4. The operational and maintenance environments, operational parameters, and exposure potential shall be evaluated against the applicable MPEs by BE to determine if exposures may be in excess of the standard. (T-2)

4.2.5. Records of surveys, reports, calculations, and control measures imposed shall be maintained for each fielded EMF emitter which is capable of exceeding the MPEs in the lower tier MPE table (Table A.2.2. and Table 5 in AFRL-SA-WP-SR-2013-0003). (T-0)

4.3. EMF Hazards Control. Control measures may be recommended by BE following thorough evaluation of the hazard potential, to include survey measurements. Follow the hierarchy of controls IAW AFMAN 48-155, *Occupational and Environmental Health Exposure Controls*, i.e., engineering controls followed by administrative controls. (T-0)

4.3.1. Engineering Controls. Engineering controls are either inherent in the system or used in conjunction with its maintenance or operation to prevent potential overexposure or injury to the worker. (T-0)

4.3.2. Administrative and Physical Controls. These controls are used primarily as exclusions to the EMF operational area by barrier or administrative procedures such as access restriction (e.g. elevation or fencing) and signage. These control measures should be used when engineering controls or other methods are not adequate. (T-0)

4.3.2.1. Signage. Areas where the potential exists for EMF exposures to exceed exposure limits shall be clearly marked with appropriate signs. The signs shall be posted when engineering controls or other methods are not adequate. Signs may be used as a complement to other administrative controls. Signs will be multilingual when in locations where English is not the primary language and compliant with the requirements of the host nation. (T-0)

4.4. EMF Training Requirements.

4.4.1. All personnel with the potential to exceed the Lower Tier MPEs (Table 5 in AFRL-SA-WP-SR-2013-0003) shall be provided initial and refresher training. BE will assist to develop this training and will include at a minimum the subject areas identified from the health risk assessment. Training guidance is found in AFRL-SA-WP-SR-2013-0003. The depth of information will be commensurate with the potential for exposure as well as the level of responsibility within the workplace EMF safety program. (T-0)

4.4.2. The AF Form 55, Employee Safety and Health Record, authorized versions, or an equivalent computer-generated product that is a true, reproducible and historically accurate facsimile shall be used to record employee training. (T-0)

4.5. Medical Surveillance Requirements.

4.5.1. Routine pre-placement, baseline, periodic, and termination occupational medical examinations are not required. (T-3)

4.5.2. There are no special EMF exposure limits for pregnant females. Any EMF environment that is safe for the mother is also safe for the developing embryo or fetus. (T-3)

4.6. Incidents/Accidents Investigations. BE shall investigate and document all alleged incidents involving personnel exposure that may exceed the MPEs in the upper tier MPE table (Table A.2.1. and Table 4 in AFRL-SA-WP-SR-2013-0003), after including adjustments to the MPE, such as spatial and time averaging, partial-body exposure, etc. The following immediate actions must be taken whenever an overexposure is suspected or alleged to have occurred: (T-0)

4.6.1. The individual will immediately report the incident to their supervisor. For personnel whose exposure(s) occurred at, or above, five times (5) the applicable MPE in the upper tier MPE table (Table A2.1. and Table 4 in AFRL-SA-WP-SR-2013-0003), a medical examination and recommendations for medical follow-up are mandatory within 72 hours of exposure. Individuals, who perceive they have symptoms from the exposure to EMF that are not at or above five (5) times the applicable MPE, may seek medical attention if they desire. The attending physician will consult with BE to confirm whether or not the individual was exposed to EMF five (5) times the applicable MPE and annotate this in the individual's medical records. (T-0)

4.6.2. The responsible area supervisor will stop operations and leave settings in place for the BE investigation unless operations are deemed mission critical. If the operation cannot be delayed for the investigation, the supervisor will record all settings necessary to recreate the

incident for the BE investigation. The supervisor will notify BE upon initial report of the incident and will advise all other appropriate authorities within the unit according to unit reporting procedures. (T-0)

4.6.3. BE will contact the DoD EMF Injury Hotline (ESOH Service Center) at 1-888-232-3764 or DSN 798-3764 and provide initial notification of the alleged incident to the MAJCOM BE and AFMSA/SG3PB. BE will conduct a preliminary investigation of the alleged incident and perform a reconstruction of the incident, to include field measurements if warranted. BE will notify PH and SEG of the alleged incident. (T-0)

4.6.4. Public Health will initiate an occupation illness investigation per **Paragraph 2.11.2.2**, and Flight Medicine will conduct a post-exposure medical examination within 72 hours following the alleged overexposure for reported cases if the exposure exceeds five (5) times the MPE. (T-0)

4.6.5. Final Report. Upon completion of the investigation and within 30 workdays, BE shall forward a detailed report to servicing AF PH, SEG, MAJCOM BE, and AFMSA/SG3PB with a courtesy copy to ESOH Service Center. BE shall complete the report in AFSAS. (T-1)

4.7. Additional Information: Additional information and guidelines concerning the management of the installation EMF program can be found in AFRL-SA-WP-SR-2013-0003.

THOMAS W. TRAVIS, Lt Gen, USAF, MC, CFS
Surgeon General

Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References

- DODI 6490.03, *Deployment Health*, 11 August 2006
- DODI 6055.05, *Occupational and Environmental Health (OEH)*, 11 November 2008
- DODI 6055.07, *Mishap Notification, Investigation, Reporting, and Record Keeping*, 6 June 2011
- DODI 6055.11, *Protecting Personnel from Electromagnetic Fields*, 19 August 2009
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- AFI 91-204, *Safety Investigations and Reports*, 12 February 2014
- AFI 91-401, *Directed Energy Weapons Safety*, 5 September 2013
- AFMAN 33-363, *Management of Record*, 1 March 2008
- AFMAN 48-154, *Occupational and Environmental Health Site Assessments*, 28 March 2007
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- AFRL-SA-WP-SR-2013-0003, *Base-Level Guide for Electromagnetic Frequency Radiation*, December 2012
- Institute of Electrical and Electronics Engineers C95.1-2005, *IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz*, 1 May 2006
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- Institute of Electrical and Electronics Engineers C95.3-2002, *IEEE Recommended Practice for the Measurement and Computations of Radio Frequency Electromagnetic Fields with Respect to Human Exposure to Such Fields, 100 kHz to 300 GHz*, 13 January 2003
- American National Standards Institute/Institute of Electrical and Electronics Engineers C95.6-2002, *IEEE Standard for Safety Levels with Respect to Human Exposure to Electromagnetic Fields, 0 to 3 kHz*, 23 October 2002
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- Military Standard MIL-STD-882E, *Department of Defense Standard Practice System Safety*, 11 May 2012
- North Atlantic Treaty Organization Standardization Agreement 2345, *Evaluation and Control of Personnel Exposure to Radio Frequency Fields – 3kHz to 300 GHz*, 13 February 2003 NCRP 86, *Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields*,

1986NCRP 119, *A Practical Guide to the Determination of Human Exposure to Radiofrequency Fields*, 1993

Adopted Forms

AF Form 847, Recommendation for Change of Publication

Acronyms

AFI—Air Force Instruction

AFIA—Air Force Inspection Agency

AFMAN—Air Force Manual

AFMC—Air Force Material Command

AFMSA—Air Force Medical Support Agency

AFOSH—Air Force Occupational and Environmental Safety, Fire Protection and Health

AFSAS—Air Force Safety Automated System

ANSI—American National Standards Institute

BE—Bioenvironmental Engineering

DEW—Directed Energy Weapons

DOEHRS—Defense Occupational and Environmental Health Readiness System

DRU—Direct Reporting Units

EED—Electro Explosive Device

EMF—Electromagnetic Field

EMFR—Electromagnetic Field Radiation

EMI—Electromagnetic Interference

EMP—Electromagnetic Pulse

FOA—Field Operating Agency

HPM—High Powered Microwave

HPW—Human Performance Wing

IEEE—Institute of Electrical and Electronics Engineers

JAO—Judge Advocate Office

MAJCOM—Major Commands

MPE—Maximum Permissible Exposure

MTF—Medical Treatment Facility

OI—Operating Instruction

PDO—Publishing Distribution Office

PH—Public Health

SG—Surgeon General

TO—Technical Orders

USAFSAM—United States Air Force School of Aerospace Medicine

Terms

Action level—The values of the electric and magnetic field strength, the incident power density, contact and induced current, and contact voltages above which actions shall be taken to protect against exposures that exceed the lower tier, specifically, implementation of an EMF safety program.

Action Level Environment—Locations where EMF exposures do not exceed the MPEs in Table A.2.1. but do exceed those in [Table A2.2](#) (i.e., the exposure range between the Upper and Lower Tier environments).

Antenna—A device designed for radiating (or receiving) electromagnetic energy.

Diathermy—The medical application of EMF energy to produce heat within some part of the human body for therapeutic purposes. Most diathermy equipment operates in the High Frequency (HF) band.

Electro—Explosive Device (EED)—A pyrotechnic or explosive device designed to detonate when an electric current passes through it, commonly called a squib.

Electromagnetic Interference (EMI)—Interference with the proper functioning of an electronic device by electromagnetic means, internal or external.

Electromagnetic Radiation—The propagation of energy in the form of EM waves through space. (Not intended to describe propagation along waveguides and other transmission lines).

Emitter—Any device which is designed to generate EMF energy and couple this energy into the surrounding space.

Exposure, Partial Body—Partial-body exposure results when EMF are substantially non-uniform over the body. Fields that are non-uniform over volumes comparable to the human body occur due to highly directional sources, re-radiating sources, standing waves or when in the antenna's Near-Field region. For most antennas the far-field starts at twice the diameter of the antenna divided by the wavelength.

Field Strength—The magnitude of the electric field (volts per meter) or magnetic field (amperes per meter).

Frequency—The number of cycles completed by an electromagnetic wave in one second, given in cycles per second (1/sec) or hertz.

Hertz (Hz)—The unit for expressing frequency. One hertz equals one cycle per second. Commonly used multiples are kilohertz (kHz), megahertz (MHz), and gigahertz (GHz).

Lower Tier—A set of limits that provide an additional margin of safety, i.e., a margin of safety greater than that for the Upper Tier. See: **action level**.

Lower Tier Environments—Locations where EMF exposures do not exceed the MPEs in [Table A2.2](#). Such locations generally represent living quarters, workplaces, or public access areas where personnel would not expect to encounter higher levels of EMF energy.

Magnetic Field Strength (H)—The magnitude of the magnetic field vector, expressed in units of amperes per meter (A/m).

Microwaves—A term used to signify EMF waves from approximately 300 MHz upward.

Power—A physical quantity describing the rate of delivery or transmission of energy. In this instruction, power referred to as radiofrequency power with units of watts (W).

Power Density (S)—Power per unit area normal to the direction of propagation, usually expressed in watts per meter squared (W/m^2) or, for hazard assessment, mW/cm^2 .

Response Time—The time required for a field-measuring instrument to reach some specified percentage of the final value after being placed in the field to be measured. In this document, 90 percent of the final value is assumed.

Root—Mean-Square (rms)—The effective value, or the heating value, of a periodic EMF wave. The rms value for E or H fields is obtained by taking the square root of the mean of the squared values for E or H over an area equivalent to the vertical cross-section of the human body (projected area).

Standing Wave—A spatially periodic or repeating field pattern of amplitude maxima and minima that is generated by two equal-wavelength propagating waves traveling in different directions. For any component of the field, the ratio of the amplitude at one point to that at any other point does not vary with time.

Transmission Line—A system of conductors, such as wires, waveguides, or coaxial cables, which conducts EMF energy between points in an EMF system.

Upper Tier—A set of EMF exposure limits that are scientifically based and that provide a margin of safety for all, including those in an Upper Tier environment

Upper Tier Environment—Locations where EMF exposures may exceed the levels in [Table A2.1](#), but do not exceed the levels in [Table A2.2](#). Generally, Upper Tier environments represent areas that may be occupied by personnel who accept potential exposure as a concomitant of employment or duties, by individuals who knowingly enter areas where such levels are to be expected, or by personnel passing through such areas. Existing physical arrangements or areas, such as fences, perimeters, or weather decks of a ship may be used in establishing Upper Tier environments

Waveguide—An enclosed system capable of guiding electromagnetic waves from one place to another. Usually consisting of a hollow metallic tube or a solid dielectric material.

Wavelength (λ)—The distance between two points having the same phase, in two consecutive cycles of a periodic wave.

Attachment 2

MAXIMUM PERMISSIBLE EXPOSURE (MPE) TABLES

A2.1. Maximum Permissible Exposure (MPE).

A2.1.1. MPE values have been based upon a whole-body specific absorption rate (SAR) of 0.4 watts per kilogram (W/kg), and incorporate a safety factor of 10 or more below a SAR of 4.0 W/kg, which is the conservative threshold for the occurrence of potentially deleterious health effects in humans. SAR as the basis is only applicable for 100 kHz – 3 GHz.

A2.1.2. MPEs are expressed in terms of measurable field parameters as a convenient correlation to the SAR. These field parameters include root-mean-square (rms) electric field (E) and magnetic (H) field strengths, their squares, or the plane-wave equivalent power densities (S) associated with these fields, and peak electric field strengths. Induced and contact current limits that can be associated with exposures to such fields are also established.

A2.1.2.1. Section A in **Table A2.1** and **Table A2.2**, refer to time-averaged exposure values obtained by spatially averaging S, or the mean squared E and H values, over an area equivalent to the vertical cross-section of the human body (projected area). In the case of partial-body exposure or non-uniform fields, these MPEs, **Table A2.1**, may be exceeded. However the increased MPE must comply with the exposure limits listed in the additional sections of **Table A2.1** and **Table A2.2**.

A2.1.2.2. BE may contact USAFSAM for guidance when evaluating exposure incidents to determine if the MPE may be exceeded.

A2.1.2.3. MPES are derived quantities that are based upon the basic restriction, i.e. the SAR.

A2.1.3. Commanders will avoid exposure of personnel to EMF levels in excess of the applicable MPE, except where necessary for medical treatment, or in training or operation of a directed energy weapon used in accordance with AFI 91-401, or where mission requirements necessitate such exposure. (T-1)

A2.2. MPE Averaging Periods.

A2.2.1. MPEs in **Table A2.1** refer to values averaged over any 6-minute period for frequencies less than 15 GHz, and over shorter periods for higher frequencies (10 seconds at 300 GHz). The MPEs in **Table A2.2** refer to values generally averaged over any 6-minute or 30-minute period for frequencies less than 3 GHz. For certain frequency intervals, the averaging period will vary as a function of frequency as shown in **Table A2.1** and **Table A2.2**

A2.2.2. For exposure duration less than the averaging period, the maximum permissible exposure level, is $MPE [T_{avg}/T_{exp}]$, where T_{exp} is the exposure duration in that interval expressed in the same time units as **Tavg**.

A2.3. Upper Tier MPEs. The Upper Tier MPEs, **Table A2.1**, are given as a function of frequency and are based on a SAR of 0.4 W/kg. These limits were developed to control human exposures to electromagnetic energy at frequencies ranging from 0 kHz to 300 GHz, and to limit

the localized SAR occurring in the feet, ankles, wrists, and hands of personnel due to exposure to such fields or contact with objects exposed to such fields. MPEs are given in terms of rms electric (E) and magnetic (H) field strengths, equivalent plane-wave free space power densities (S), and induced currents (I) in the body.

Table A2.1. MPEs for the Upper Tier.

A. MPE for Upper Tier				
Frequency Range (f) (MHz)	Electric Field - rms (E) ^a (V/m)	Magnetic field strength - rms (H) ^a (A/m)	Power Density - rms (S) E-field, H-field (W/m ²)	Averaging time $ E ^2, H ^2$ or S (min)
0.1 - 1.0	1842	$16.3/f_M$	$(9000, 100\,000/f_M^2)^b$	6
1.0 - 30	$1842/f$	$16.3/f_M$	$(9000/f_M^2, 100\,000/f_M^2)$	6
30 - 100	61.4	$16.3/f_M$	$(10, 100\,000/f_M^2)$	6
100 - 300	61.4	0.163	10	6
300 - 3000			$f_M/30$	6
3000 - 30 000			100	$19.63/f_G^{1.079}$
30 000 - 300 000			100	$2.524/f_G^{0.476}$
NOTE: f_M is the frequency in MHz, f_G is the frequency in GHz				
^a For exposures that are uniform over the dimensions of the body, such as certain far-field plane-wave exposures, the exposure field strengths and power densities are compared with the MPEs in section A of this table. For non-uniform exposures, the mean values of the exposure fields, as obtained by spatially averaging the squares of the field strengths or averaging the power densities over an area equivalent to the vertical cross section of the human body (projected area), or a smaller area depending on the frequency, are compared with the MPEs in section A of this table.				
^b These plane-wave equivalent power density values are commonly used as a convenient comparison with MPEs at higher frequencies and are displayed on some instruments in use.				
B. Electric field MPE: whole body exposure: F= 3 kHz to 100 kHz				
Frequency range (kHz)		E (rms) (V/m)		
3 - 100		1842		
C. MPE for exposure of head and torso: F= 3 kHz to 5 MHz				
Frequency range (kHz)	Flux Density B_{rms} (mT)		H_{rms} (A/m)	
3.0 - 3.35	$2.06/f$		$1640/f$	
3.35 - 5000	0.615		490	
NOTE—f is expressed in kHz.				
D. MPE for limbs: 3 kHz to 5 MHz				
Frequency range (kHz)	B_{rms} (mT)		H_{rms} (A/m)	

3.0 – 3.35	3.79/f	3016/f
3.35 - 5000	1.13	900

NOTE: f is expressed in kHz.

**E. RMS induced and contact current limits for continuous sinusoidal waveforms
3 kHz to 100 kHz**

Condition	Persons in Upper Tier environments (mA)
Both feet	2.00f
Each foot	1.00f
Contact, grasp ^b	1.00f
Contact, touch	0.50f

NOTE 1: f is expressed in kHz.

NOTE 2: Limits apply to current flowing between the body and a grounded object that may be contacted by the person.

NOTE 3: The averaging time for determination of compliance is 0.2 s.

^bThe grasping contact limit pertains to Upper Tier environments where personnel are trained to make grasping contact and to avoid touch contacts with conductive objects that present the possibility of painful contact.

**F. RMS induced and contact current limits for continuous sinusoidal waveforms
F=100 kHz to 110 MHz**

Condition	Persons in Upper Tier Environments (mA)
Both feet	200
Each foot	100
Contact, grasp ^b	100
Contact, touch	50

NOTE 1: Limits apply to current flowing between the body and a grounded object that may be contacted by the person.

NOTE 2: The averaging time for determination of compliance is 6 minutes.

^bThe grasping contact limit pertains to Upper Tier environments where personnel are trained to make grasping contact and to avoid touch contacts with conductive objects that present the possibility of painful contact.

G. Basic restrictions applying to various regions of the body

Exposed tissue	f_e (Hz)	E_0 (rms) (V/m)
Brain	20	1.77×10^{-2}
Heart	167	0.943
Extremities	3350	2.10
Other tissue	3350	2.10

H. Basic restrictions for frequencies between 100 kHz and 3 GHz

Whole-body exposure	Whole-body average (WBA)	Persons in Upper Tier SAR ^c (W/kg)
		0.4
Localized exposure	Localized (peak spatial-average)	10 ^c

	Extremities and pinnae	20 ^c
^b SAR is averaged over the appropriate averaging times as shown in section A of this table		
^c Averaged over any 10 g of tissue (defined as a tissue volume in the shape of a cube)*		
^d The extremities are the arms and legs distal from the elbows and knees, respectively		
I. Relaxation of the power density MPEs for localized exposures (partial-body exposure)		
Frequency Range (f) (MHz)	Peak Value of Mean Squared Field	Equivalent Power Density (W/m ²)
0.003 – 300	<20 E ² or 20 H ² *	-
300 – 3000	-	200
3000 – 96 000	-	200(f _G /3) ^{1/5}
f _M > 96 000	-	400
NOTE: f _M is the frequency in MHz, F _G is the frequency in GHz		
* E and H are the spatially averaged values from section A of this table		
J. Pulsed EMF Fields (apply only when there are < 5 pulses with the averaging time).		
Frequency Range (f) (MHz)	Peak Electric Field (E) (kV/m)	Power Density Pulse for Pulse Durations < 100 msec (W/m ²)
0.1 – 300 000	100	(MPE)(T _{avg})/(5)(pulse width)
K. Magnetic maximum permissible exposure (MPE) levels: exposure of head and torso^{a, b}		
Frequency Range (Hz)	Upper Tier environment	
	B – rms (mT)	H – rms (A/m)
<0.153	353	2.81x10 ⁵
0.153-20	54.3/f	4.32x10 ⁴ /f
20-759	2.71	2.16x10 ³
759-3000	2060/f	1.64x10 ⁶ /f
^a f is frequency in Hz ^b MPEs refer to spatial maximum		
L. Magnetic flux density maximum permissible exposure levels: exposure of arms or legs^a		
Frequency Range (Hz)	Upper Tier B – rms (mT)	
<10.7	353	
10.7 - 3000	3790/f	
^a f is frequency in Hz		

A2.4. Action Level. Any exposure in excess of those indicated in [Table A.2.2](#) requires the creation of an EMF safety program. Where individuals unfamiliar with the phenomenon of induced EMF currents may have access, precautions shall be taken to limit induced currents to values not normally perceptible to individuals, as well as prevent the possibility of EMF burns. (T-0)

A2.5. Lower Tier MPEs. Lower Tier exposures can occur in areas where individuals would have no knowledge or control of their exposure. These locations might include living quarters or workplaces where there are no expectations that the exposure levels may exceed those shown in [Table A2.2](#).

Table A2.2. MPEs for Lower Tier.

A. MPEs for Lower Tier					
Frequency Range (f) (MHz)	rms electric field (E) ^a (V/m)	rms magnetic field strength (H) ^a (A/m)	rms power density (S) E-field, H-field (W/m ²)	Averaging time $ E ^2, H ^2$ or S (min)	
0.1-1.34	614	$16.3/f_M$	$(1000, 100\ 000/f_M^2)^c$	6	6
1.34-3	$823.8/f_M$	$16.3/f_M$	$(1800/f_M^2, 100\ 000/f_M^2)$	$f_M^2/0.3$	6
3-30	$823.8/f_M$	$16.3/f_M$	$(1800/f_M^2, 100\ 000/f_M^2)$	30	6
30-100	27.5	$158.3/f_M^{1.668}$	$(2, 9\ 400\ 000/f_M^{3.336})$	30	$0.0636 f_M^{1.337}$
100-400	27.5	0.0729	2	30	30
400-2000	-	-	$f_M/200$	30	
2000-5000	-	-	10	30	
5000-30 000	-	-	10	150/f _G	
30 000-100 000	-	-	10	$25.24/f_G^{0.476}$	
100 000-300 000	-	-	$(90f_G-7000)/200$	$5048/[(9f_G-700)f_G^{0.476}]$	
NOTE: f _M is the frequency in MHz, f _G is the frequency in GHz					
^a For exposures that are uniform over the dimensions of the body, such as certain far-field plane-wave exposures, the exposure field strengths and power densities are compared with the MPEs in section A of this table. For non-uniform exposures, the mean values of the exposure fields, as obtained by spatially averaging the squares of the field strengths or averaging the power densities over an area equivalent to the vertical cross section of the human body (projected area), or a smaller area depending on the frequency, are compared with the MPEs in section A of this table.					
^c These plane-wave equivalent power density values are commonly used as a convenient comparison with MPEs at higher frequencies and are displayed on some instruments in use.					
B. Electric field MPE- whole body exposure:					
3 kHz to 100 kHz					
Frequency range (kHz)			E (rms) (V/m)		
3 – 100			614		
C. MPE for exposure of head and torso:					
3 kHz to 5 MHz					
Frequency range (kHz)	B _{rms} (mT)		H _{rms} (A/m)		
3.0 – 3.35	0.687/f		547/f		
3.35 – 5000	0.205		163		
NOTE—f is expressed in kHz.					
D. MPE for limbs:					
3 kHz to 5 MHz					

Frequency range (kHz)	B_{rms} (mT)	H_{rms} (A/m)
3.0 – 3.35	3.79/f	3016/f
3.35 - 5000	1.13	900
NOTE: If is expressed in kHz.		
E. RMS induced and contact current limits for continuous sinusoidal waveforms 3 kHz to 100 kHz		
Condition	Persons in Lower Tier environments (mA)	
Both feet	0.90f	
Each foot	0.45f	
Contact, grasp ^b	-	
Contact, touch	0.167f	
NOTE 1: f is expressed in kHz.		
NOTE 2: Limits apply to current flowing between the body and a grounded object that may be contacted by the person.		
NOTE 3: The averaging time for determination of compliance is 0.2 s.		
F. RMS induced and contact current limits for continuous sinusoidal waveforms 100 kHz to 110 MHz		
Condition	Persons in Lower Tier Environments (mA)	
Both feet	90	
Each foot	45	
Contact, grasp ^b	-	
Contact, touch	16.7	
NOTE 1: Limits apply to current flowing between the body and a grounded object that may be contacted by the person.		
NOTE 2: The averaging time for determination of compliance is 30 minutes.		
G. Basic restrictions applying to various regions of the body		
Exposed tissue	f_e (Hz)	E_0 (rms) (V/m)
Brain	20	5.89×10^{-3}
Heart	167	0.943
Extremities	3350	2.10
Other tissue	3350	0.701
H. Basic restrictions for frequencies between 100 kHz and 3 GHz		
		Persons in Lower Tier Environments SAR ^c (W/kg)
Whole-body exposure	Whole-body average (WBA)	0.08
Localized exposure	Localized (peak spatial-average)	2 ^c

Localized exposure	Extremities ^d and pinnae	4 ^c
^c Averaged over any 10 g of tissue (defined as a tissue volume in the shape of a cube)*		
I. Relaxation of the power density MPEs for localized exposures (partial-body exposure)		
Frequency Range (f) (MHz)	Peak Value of Mean Squared Field	Equivalent Power Density (W/m ²)
.003 – 400	<20 E ² or 20 H ² *	-
400 – 3000	-	40
3000 – 30 000	-	18.56(f _G) ^{0.699}
f _M > 30 000	-	200
NOTE- f _M is the frequency in MHz, f _G is the Frequency in GHz		
* E and H are the spatially averaged values from section A of this table		
J. Pulsed EMF Fields (apply only when there are less than 5 pulses with the averaging time).		
Frequency Range (f) (MHz)	Peak Electric Field (E) (kV/m)	Power Density Pulse for Pulse Durations < 100 msec (W/m ²)
0.1 – 300 000	100	(MPE)(T _{avg})/(5)(pulse width)
K. Magnetic Maximum permissible exposure (MPE) levels: exposure of head and torso^{a,b}		
Frequency Range (Hz)	Lower Tier	
	B - rms (mT)	H – rms (A/m)
<0.153	118	9.39x10 ⁴
0.153-20	18.1/f	1.44x10 ⁴ /f
20-759	0.904	719
759-3000	687/f	5.47x10 ⁵ /f
^a f is frequency in Hz		
^b MPEs refer to spatial maximum		
L. Magnetic flux density maximum permissible exposure levels: exposure of arms or legs^a		
Frequency Range (Hz)	Lower Tier B - rms (mT)	
<10.7	353	
10.7 - 3000	3790/f	
^a f is frequency in Hz		
NOTE: Measurements to determine adherence to the MPE shall be made at distances of at least 20 centimeters (cm) or greater from any object.		

A2.6. Electric field MPE—whole body exposure (of Table A2.1 and Table A2.2). For 3 kHz to 100 kHz, MPEs are listed in terms of the undisturbed (absent a person) external electric field, E. The exposure parameters are assumed to be an undisturbed field with a constant magnitude, direction, and relative phase over the exposed person. Exposures shall be averaged over 0.2 seconds. (T-0)

A2.7. MPE for exposure of head and torso (of Table A2.1 and Table A2.2). Section C lists the MPE for the magnetic field (flux density, B , and magnetic field strength, H) for exposure of the head and torso between 3 kHz and 5 MHz. For a rms measurement, the averaging time is 0.2 seconds.

A2.8. MPE for the limbs (of Table A2.1 and Table A2.2). Section D describes the MPE for the limbs (entire arms and legs). Measurements use an averaging time of 0.2 seconds. Compliance with this MPE ensures compliance with the basic restrictions (BRs) for various parts of the body (Table A2.1 and 3.2 G and, paragraph A2.10). However, lack of compliance with this section does not necessarily indicate lack of compliance with the basic restrictions. In the event of this condition, further evaluation may be required to ensure that compliance is met. (T-0)

A2.9. Induced and contact current (of Table A2.1 and Table A2.2). If the frequency range identified falls between 100 kHz to 110 MHz, seek additional guidance from usafsam for induced and contact current hazards. (T-1)

A2.10. Basic Restrictions (BRs) applying to various regions of the body (of Table A2.1 and Table A2.2). For frequencies from 3 kHz to 5 MHz, the BRs refer to limits on the *in situ* electric fields. This will minimize adverse health effects associated with electro-stimulation to human exposure to electromagnetic energy on various parts of the body.

A2.11. BRs for frequencies between 100 kHz and 3 GHz (of Table A2.1 and Table A.2.2). BR for the frequency range of 100 kHz to 3 GHz is established to avoid adverse health effects from tissue heating. The SAR of 0.4 W/kg averaged over the whole body incorporates a safety factor of 10 for Upper Tier environments and a higher safety factor for Lower Tier environments to ensure safety for the general population.

A2.12. Relaxation of the power density MPEs (partial-body exposures) (of Table A2.1 and Table A2.2).

A2.12.1. Implicit in the MPE definition of a whole-body averaged SAR of 0.4 W/kg for an Upper Tier environment and 0.08 W/kg for a Lower Tier environment, is the assumption that spatial peak SARs may occur that exceed the whole body averaged values by a factor of more than 20 times. The values provided in of Table A2.1 and Table A2.2 allow for equating substantially non-uniform field exposure or partial-body exposure to an equivalent uniform field exposure. BE should consider the values given for partial body exposures when the exposure exceeds the MPEs given in Table A2.1 or Table A2.2, and the exposure was limited to a specific part of the body, or the field was not uniformly distributed over the whole body of the individual exposed.

A2.12.2. For exposure of parts of the body, the spatially averaged MPEs given in of Table A2.1 and Table A2.2 may be relaxed provided the peak value of the mean squared field strength (E and H Fields) does not exceed 20 times the square of the allowed spatially averaged values at frequencies below 300 MHz, or the equivalent S levels do not exceed the levels shown in of Table A2.1 and Table A2.2 as averaged over the T_{avg} periods given for frequencies above 300 MHz. Those rules for relaxation of the limits for partial-body exposure do not apply for exposures to the eyes. The SAR exclusion rules in paragraph A.2.13.1 can still be used to show conformance to the MPE, despite localized S values above the specified whole-body average. In such cases, exposures to the eyes are limited by the

basic exposure criteria of a whole-body averaged SAR of 0.4 W/kg (Upper Tier environment) or 0.08 W/kg (Lower Tier environment), and spatial peak SARs of 8 W/kg (Upper Tier environment) or 1.6 W/kg (Lower Tier environment) as averaged over any one gram of tissue. (T-0)

A2.13. Pulsed Peak Field Limits (of [Table A2.1](#) and [Table A2.2](#)).

A2.13.1. Peak power exposure limitations are provided for pulses in the frequency range of 0.1 to 300,000 MHz, where each pulse is less than 100 milliseconds (msec) and there are no more than five (5) pulses in the time averaging period. Those limits are given to prevent unintentionally high exposure and to preclude high specific absorption for decreasingly short widths of pulses. If there are more than five (5) pulses during any time period equal to the averaging time, or if the pulse durations are greater than 100 msec, the time-averaged S should not exceed the MPEs given in [of Table A2.1 and Table A2.2](#)

A2.13.2. For exposure to EMF pulses in the frequency range of 0.1 to 300,000 MHz, exposure is limited by either a peak (temporal) E field of 100 kV/m for each pulse or in terms of a peak power density value (S) for each single pulse, whichever is more limiting. For high frequencies and longer pulses, peak S will be more conservative.

A2.13.3. The limitation on EMF fields under pulsed conditions, (less than 100 msec), means that the MPE as averaged over any 100 msec is reduced by a factor of five (5), and a maximum of five (5) such pulses is permitted during any period equal to the averaging time. For example, in the microwave region for exposure to a single pulse, the specific absorption over any 6-minute period is limited to 28.8 J/kg per pulse (spatial average) with a maximum of five (5) such pulses (i.e., $(5)(28.8 \text{ J/kg}) = 144 \text{ J/kg}$), which is equivalent to a SAR of 0.4 W/kg over a 6-minute period).

A2.14. MPEs and Exposure Guidance for High Power Microwave (HPM) and Electromagnetic Pulse (EMP) Simulators.

A2.14.1. HPM Systems. For exposures in Upper Tier environments involving HPM narrow-band systems, the exposure limit for any single pulse or series of pulses lasting less than 10 seconds is provided in [Table A2.3](#). For Lower Tier environments, exposures shall conform to the MPEs in [Table A2.2](#). (T-0)

A2.14.2. The exposure guidance given below in [Table A2.3](#) is based on HPM narrow-band systems operating within the following parameters: maximum pulse width of 10 microseconds, peak S of 0.1 to 10 kW/cm², frequency greater than 100 MHz, repetition rate not greater than 10 pulses per second.

A2.14.3. The exposure guidance is specific for HPM narrow-band systems and does not apply to exposure from EMP broad-band simulator systems. If the HPM system is not within those parameters, then the MPEs in [Table A2.1](#) apply. (T-0)

A2.14.4. For personnel exposure to HPM in an Upper Tier environment, the measured fluence is not to exceed the values given in [of Table A2.3](#) for any single pulse or series of multiple pulses lasting less than 10 seconds. The total fluence delivered over any 6-minute period shall not exceed the values in [of Table A2.3](#). In all cases, the instantaneous E field shall not exceed 200 kV/m. (T-0)

A2.14.5. If the exposure values given in of **Table A2.3** cannot be met, then the total measured SA to the head shall not exceed 150 J/kg for any single pulse or 150 J/kg for multiple pulses in any 6-minute period. (T-0)

A2.14.6. EMP Simulator Systems. For exposure in Upper Tier environments involving broad-band EMP simulators, the exposure limit is given in of **Table A2.3**. Measurements of EM Fields from broad-band EMP simulator systems require special instrumentation and techniques because of the inherent rapid rise time and the high field strengths associated with EMP. Contact USAFSAM for measurement and evaluation assistance. (T-1)

Table A2.3. MPEs for HPM and EMP Simulator Systems.

A. HPM (Narrow-Band Systems)		
Frequency Range (f) (MHz)	Peak Electric Field (E) (kV/m)	Maximum Fluence Level in Upper Tier Environments for Any Single Pulse or Series of Multiple Pulses Lasting Less Than 10 seconds Within Any 6Minute Period (J/cm²)
100 – 300	200	0.36
300 – 3000	200	3.6(f/3000)
> 3000	200	3.6
B. EMP Simulators (Broad Band Systems)		
Frequency Range (f) (MHz)	Peak Electric Field E in Upper Tier environment (kV/m)	
0.1 – 300 000	100	