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SECRETARY OF THE AIR FORCE

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Safety

HAZARDS OF ELECTROMAGNETIC RADIATION TO ORDNANCE (HERO) CERTIFICATION AND MANAGEMENT

COMPLIANCE WITH THIS PUBLICATION IS MANDATORY

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This Air Force Instruction (AFI) implements and extends the policy of the Department of Defense (DoD) Directive (DoDD) 5000.01, *The Defense Acquisition System*, DoD Instruction 5000.02, *Operation of the Defense Acquisition System*, DoDD 3222.3, *DoD Electromagnetic Environmental Effects (E3) Program*, DoDD 6055.9E, *Explosives Safety Management and the DoD Explosives Safety Board*, DoD 6055.09-M, *DoD Ammunition and Explosives Safety Standards*, AF Policy Directive (AFPD) 33-5, *Warfighting Integration*, AFPD 91-2, *Safety Programs*, AF Manual (AFMAN) 91-201, *Explosives Safety Standards*, and AF Space Command Manual 91-710, *Range Safety User Requirements Manual*. This publication establishes AF policy for hazards of electromagnetic radiation to ordnance (HERO) certification and management of ordnance in the AF inventory. It applies to explosive operations of any kind in AF, Air National Guard, AF Reserve-owned or –leased facilities, and to United States-titled ammunition in contractor or host-nation facilities, including Foreign Military Sales. Compliance is mandatory. The use of the name or mark of any specific manufacturer, commercial product, commodity, or service in this publication does not imply endorsement by the AF. Refer recommended changes and questions about this publication to the Office of Primary Responsibility (OPR) using AF Form 847, *Recommendation for Change of Publication*; route AF Form 847s from the field through the appropriate (Major Command) publications/forms manager. Ensure that all records created as a result of processes described in this publication are maintained in accordance with AFMAN 33-363, *Management of Records*, and disposed of in accordance with the AF Records Disposition Schedule located at

https://www.my.af.mil/afrims/afrims/afrims/rims.cfm. Send recommendations for improvements to Headquarters AF Safety Center, AF Weapons Safety (AFSEC/SEW), 9700 G Avenue SE, Kirtland AFB NM 87117-5670, or email **HQAFSECSEW@kirtland.af.mil.** Send Major Command (MAJCOM) supplements to this instruction to AFSEC/SEW, 9700 G Avenue SE, Kirtland AFB NM 87117-5670 for coordination before publication. The authorities to waive wing/unit level requirements in this publication are identified with a Tier ("T-0, T-1, T-2, T-3") 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 waiver requests through the chain of command to the appropriate Tier waiver approval authority, or alternately, to the Publication OPR for non-tiered compliance items.

SUMMARY OF CHANGES

This interim change incorporates AFI 33-360 guidance to include tier waiver requirements and provides the correct paragraph reference in paragraph A2.5.3 and correct units in Table A2.11. A margin bar (|) indicates newly revised material.

1. OVERVIEW.

1.1. Purpose.

1.1.1. This Air Force (AF) Instruction (AFI) implements the hazards of electromagnetic radiation to ordnance (HERO) certification and management requirements of the Weapon System Safety and Explosives Safety Programs.

1.1.2. With the exception of the Eastern and Western Space Test Ranges, the HERO program encompasses the establishment and implementation of explosives safety standards, criteria, instructions, regulations, and electromagnetic emission control procedures of electromagnetic radiation (EMR) emitters throughout the AF in accordance with (IAW) the organization and general responsibilities assigned by this instruction.

1.1.3. Military-Standard (MIL-STD) -464, *Electromagnetic Environmental Effects Requirements for Systems*, latest revision, general requirements indicate that each system (i.e., aircraft, ground vehicles, ordnance containing electrically initiated devices (EIDs), etc.) will be electromagnetically compatible among all subsystems and equipment within the system and with environments generated by emitters and other electromagnetic sources external to the system to ensure safe and proper operation and performance. Design techniques used to protect ordnance against EMR effects must be verifiable, maintainable, and effective over the rated lifecycle of the system. Verification addresses all lifecycle aspects of the system, including (as applicable) normal in-service operations, checkout, storage, transportation, handling, packaging, loading, unloading, launch, and normal operating procedures associated with each aspect.

1.1.4. MIL-STD-464 requirement of intra-system electromagnetic compatibility indicates the system will be electromagnetically compatible with itself such that system operational performance requirements are met. Verify compliance by system-level test, analysis, or a combination thereof IAW guidance provided by Military-Handbook (MIL-HDBK)-240, *Hazards of Electromagnetic Radiation to Ordnance Test Guide,* latest revision. Integration of individual components shown to be HERO SAFE does not imply the resulting system is a HERO SAFE system.

1.1.5. MIL-HDBK-240 defines HERO as the situation in which exposure of ordnance to external electromagnetic environments (EMEs) results in specific safety or reliability margins of EIDs or electrically powered ordnance firing circuits to be exceeded, or EIDs to be inadvertently actuated. External EMEs may originate from equipment emitting on command (e.g., radios, radars, electronic countermeasures, etc.), automatic sources (e.g., arcing, high current switching transients, etc.), and the EME defined in MIL-STD-464. Consequences include both safety (premature firing) and reliability (EID dudding or altered function characteristics) effects.

1.1.6. MIL-STD-464 and MIL-HDBK-240 define three classifications pertinent to HERO for ordnance:

1.1.6.1. HERO SAFE. Any ordnance item proven by test or analysis to be sufficiently shielded or otherwise so protected that all EIDs contained by the item are immune to adverse effects (safety or reliability) when the item is employed in the EME delineated in MIL-STD-464.

1.1.6.2. HERO SUSCEPTIBLE. Any ordnance item containing EIDs proven by test or analysis to be adversely affected by EMR to the point that the safety and/or reliability of the system is in jeopardy when the system is employed in the EME delineated in MIL-STD-464.

1.1.6.3. HERO UNSAFE. Any ordnance item containing EIDs not classified as HERO SAFE or HERO SUSCEPTIBLE as a result of a HERO analysis or test. Additionally, any ordnance item containing EIDs (including those previously classified as HERO SAFE or HERO SUSCEPTIBLE) that has its internal wiring exposed; when tests are being conducted on that item resulting in additional electrical connections to the item; when EIDs having exposed wire leads are present and handled or loaded in any but the tested condition; when the item is being assembled or disassembled; or when such ordnance items are damaged causing exposure of internal wiring or components or destroying engineered HERO protective devices.

1.1.7. Percussion or non-electrically initiated ordnance items have no HERO requirements.

1.2. **Requirement.**

1.2.1. To address HERO as stated in Department of Defense (DoD) Directive (DoDD) 3222.3, *DoD Electromagnetic Environmental Effects (E3) Program*, latest revision, and DoD Manual 6055.09-M, *DoD Ammunition and Explosives Safety Standards*, latest revision. AF programs shall conform to MIL-STD-464. Exceptions to such certification are commercial space launched type EID applications.

1.2.2. IAW DoDD 3222.3, E3 issues, which include HERO, shall be identified and assessed prior to entering the Systems Demonstration and Production and Deployment phases and shall be addressed during critical design reviews. Ordnance shall not be deployed or released for service use until it is HERO certified unless a deviation is granted.

1.3. **Scope.**

1.3.1. The HERO program includes, but not limited to, vulnerable assets and sources. Vulnerable assets include nuclear and conventional ordnance such as gun systems and their munitions, missiles, bombs, flares, aerial target drones, depth charges, mines, torpedoes, and other materials embodying EIDs (e.g., cable cutters, chaff and munitions dispensers, self-destruct devices, aircraft engine fire extinguishing systems, aircraft ejection seats, etc. Sources include aircraft emitters, radars, antennas, radio frequency identification (RFID) systems, wireless laptops, handheld communication devices, etc.

1.3.2. Ordnance applicable to this instruction consists of all equipment, subsystems, and materials containing EIDs, which affects safety and/or mission reliability and are defined as explosives, chemicals, pyrotechnic, and similar stores carried on an airborne, sea, space, or ground system.

1.3.3. An EID is a single unit, device, or subassembly that uses electrical energy to produce an explosive, pyrotechnic, thermal, or mechanical output. Examples include electro-explosive devices such as hot bridgewire, exploding bridgewire, semiconductor bridge, carbon bridge, and conductive composition, as well as, laser initiators, burn wires, fusible links, and exploding foil initiators (EFIs), such as slapper detonators and low energy EFIs.

1.3.4. Ordnance test variants that contain EIDs and include temporary instrumentation, such as measurement hardware, telemetry, flight safety systems/flight termination systems, etc., are subject to this instruction.

1.3.5. This instruction applies to research, development, testing, operations, and equipment utilized during all six phases of the stockpile-to-safe separation sequence (S4) as defined in MIL-HDBK-240; transportation/storage, assembly/disassembly, staged, handling/loading, platform-loaded, and immediate post-launch. Furthermore, the program applies during the disposal of ordnance.

1.4. **Applicability.**

1.4.1. All ordnance, except for percussion or non-electrically initiated ordnance, used in or on AF installations, ground vehicles, aircraft, etc., including Foreign Military Sale items.

1.4.2. Certification of complete rounds is required. A complete round (CR) is any combination of DoD Identification Codes (DODICs) to form a higher assembly. Identify complete rounds by using the Complete Round Code (CRC) in the Complete Round Dictionary (CRD) maintained by the Global Ammunition Control Point (GACP) at Hill AFB.

1.4.3. Ordnance, EIDs, and emitters used by the Eastern (45th Space Wing) and Western (30th Space Wing) Ranges are addressed by AF Space Command Manual (AFSPCMAN) 91-710, *Range Safety User Requirements Manual*, latest revision, local Space Wing instructions, and AF Manual (AFMAN) 91-201, *Explosives Safety Standards*, latest revision.

1.4.4. DoD or foreign ordnance used by the AF or as part of a joint development effort and/or usage. Foreign ordnance is classified as HERO UNSAFE unless certified as HERO SAFE or HERO SUSCEPTIBLE.

1.5. **Deviations.**

1.5.1. A deviation is written authority provided by AFSEC/SEW, permitting exception from the requirement for HERO SAFE certification. For ordnance items containing EIDs with a firing consequence of safety, AFSEC/SEW will only grant a deviation based on overriding field requirement for strategic or other compelling reasons (AFMAN 91-201, Section 1B-Exception Program).

1.5.2. Deviations or Launch Safety Requirement Relief Requests must be IAW AFSPCMAN 91-710 requirements.

1.5.3. For circumstances where a deviation is required, the PM shall perform a risk assessment to determine the level of risk associated with a (S4) deployment of the ordnance. The risk assessment may follow MIL-STD-882, *Standard Practice for System Safety*, latest revision, AF Air Worthiness Bulletin-013, *Risk Identification and Acceptance for Airworthiness Determinations*, latest revision, or other equivalent method, for determining the relative level of risk associated consequence and probability. Risk assessment shall be based upon the currently available set of electromagnetic environmental effects (E3) test data and analysis and shall be assessed against the completeness, or lack thereof, versus MIL-STD-464 EME.

1.6. **Implementation.**

1.6.1. The primary objective of the HERO program is to have all AF ordnance certified and classified as HERO SAFE. Until an ordnance system is certified, follow standard best practices and procedures. Ordnance System Program Offices (SPOs)/Project Management Offices (PMOs) have five years after the publication of this instruction to achieve certification and classification of HERO SAFE. If funding is received in the fifth year, the responsible ordnance SPO/PMO shall have two more years to have the ordnance certified and classified appropriately. Ordnance not certified by this timeframe shall be deemed HERO UNSAFE by AFSEC/SEW.

1.6.2. All existing ordnance, including nuclear weapons, must be certified IAW this instruction. For ordnance having HERO test data and/or analysis, the responsible ordnance SPO/PMO shall submit a certification request to AFSEC/SEW (Attachment 6). For ordnance not having HERO test data, analysis, or a combination thereof, the responsible ordnance SPO/PMO shall have the ordnance HERO evaluated, analyzed, or a combination thereof IAW this instruction.

1.6.1.1. If HERO test data, analysis, or a combination thereof, for existing ordnance indicates a classification of HERO SUSCEPTIBLE, the responsible ordnance SPO/PMO shall attempt to resolve the issue and achieve HERO SAFE classification. If unable to achieve HERO SAFE classification, the responsible ordnance SPO/PMO submits a request for deviation IAW this instruction and the ordnance is classified as either HERO SUSCEPTIBLE or HERO UNSAFE, depending on the information provided.

1.6.1.2. Legacy ordnance can also be considered for HERO certification if an assessment of the existing data, supporting analysis, or a combination thereof, shows the ordnance shall satisfy the HERO requirements per MIL-STD-464 and the host platform EME. Existing data needs to address the ordnance item in all configurations (i.e., storage, transportation, loading/installation, and operation) including the appropriate margins. Operational history alone does not provide justification for HERO certification no matter how much time has passed without incident.

1.6.1.3. For ordnance classified as either HERO SUSCEPTIBLE or HERO UNSAFE, exposure to EMR must be minimized by ensuring ordnance distance to EMR sources are beyond the calculated safe separation distance (SSD) and by isolating the ordnance from EMR sources if the ordnance are within SSD. This is applicable for all S4 phases. For ordnance on aircraft, ground vehicles, etc., adjust the SSD to mitigate risk due to the fixed emitter/store locations.

1.6.1.4. Foreign ordnance is considered HERO UNSAFE unless certified. The ordnance SPO/PMO having foreign ordnance under their cognizance may request test data and/or analysis from the country of origin indicating compliance with EME levels in MIL-STD-464 for classification of HERO SAFE or SUSCEPTIBLE, otherwise the item shall be classified as HERO UNSAFE.

1.6.2. SPOs/ PMOs employing ordnance on their platforms (aircraft, ground vehicles, etc.) shall ensure platform EME have been characterized. The platform SPO/PMO shall comply within five years after the publication of this instruction by providing to AFSEC/SEW documentation of the EME characterization. System modifications may alter the baseline EME. Evaluate modifications for EME impact and adjust the baseline throughout the system lifecycle. Coordinate changes with AFSEC/SEW by updating the EME characterization.

1.6.3. The base or installation Weapons Safety Manager (WSM) shall prepare and maintain the HERO package (Attachment 4) after ordnance under their cognizance has been certified IAW this instruction.

1.6.4. The nuclear weapon design agencies (Lawrence Livermore National Laboratory, Los Alamos National Laboratory, and Sandia National Laboratories) ensure a nuclear weapon design meets military characteristics (MCs) and stockpile-to-target sequence (STS) requirements, which will include MIL-STD-464 EME levels. The Department of Energy (DOE), National Nuclear Security Administration, nuclear certifies a nuclear weapon (the articles under their cognizance) and delivers it to DoD. Air Force Nuclear Weapons Center (AFNWC) is responsible for having the weapon HERO certified by providing AFSEC/SEW the appropriate HERO evaluation and/or analysis from the design agency.

1.6.5. AFNWC shall submit certification requests to AFSEC/SEW (Attachment 6) for all current nuclear weapons, including test and/or analysis regarding nuclear weapon systems compliance with MIL-STD-464 EME, within five years of publication. For DOE ordnance not meeting the criteria for classification of HERO SAFE, AFNWC shall take the necessary action to resolve these issues. Legacy nuclear weapons are required to maintain current safety standards with respect to HERO until HERO certified. Upon certification, the safety standards outlined in this document shall apply.

2. RESPONISIBILITIES.

2.1. **Air Force Spectrum Management Office (AFSMO).** EMR emitters and receivers, including commercial-off-the-shelf and non-developmental items purchases, and all AF spectrum dependent equipment must receive spectrum certification. IAW AFI 33-580, *Spectrum Management*, latest revision, AFSMO reviews all spectrum certification requests for technical accuracy and submits these requests to the national spectrum certification system for their acceptance.

2.1.1. **DELETED**

2.1.2. **DELETED**

2.2. **Air Force Safety Center (AFSEC) will:**

2.2.1. Establish criteria and guidance to ensure future designs are safe from EMR hazards.

2.2.2. Establish and maintain procedures for HERO certification of ordnance and promulgate these procedures to AF, e.g., AF Sustainment Center (AFSC) and AF Life Cycle Management Center (AFLCMC) Organization Commanders, Program Executive Offices (PEOs), Program Managers (PMs), and Inventory Management Specialists (IMSs) for all ordnance under their cognizance.

2.2.3. Establish and maintain procedures for using electronic equipment that emits on command or automatically generates EMR, such as Modern Mobile Emitters (MMEs), in the vicinity of ordnance.

2.2.4. Review requests for certification submitted IAW this instruction and certify and classify ordnance within thirty days after receipt of request.

2.2.5. Return HERO certification requests to the submitter within seven days after receipt of request without granting certification for items classified as HERO SUSCEPTIBLE or HERO UNSAFE when exposed to MIL-STD-464 EME, unless a deviation has been requested and granted.

2.2.6. Maintain a permanent file of the following:

2.2.6.1. Certifications for all AF ordnance (both conventional and nuclear). For items not classified as HERO SAFE, the file will include a detailed description of the ordnance item HERO susceptibility and restrictions either on ordnance handling and loading procedures, or on the control of EMR required for HERO safe operations.

2.2.6.2. Platform EME characterizations.

2.2.7. Provide a method for preparing the HERO package (Attachment 4) to determine safe processes for use on AF installations, when the storage, handling, loading, and/or maintenance of ordnance occurs. The HERO package is required for ordnance provided by other Services or coalition partners, and used by the AF.

2.2.8. Represent the AF in HERO matters on the following:

2.2.8.1. Committees, boards, panels, and programs with other Services and foreign nations.

2.2.8.2. Joint Ordnance Commanders Group E3 program.

2.2.8.3. Joint Spectrum Center (JSC) Operations E3 Risk Analysis Database (JOERAD) Configuration Control Board.

2.2.9. Ensure all HERO data generated by ordnance SPO/PMO is provided to JSC for incorporation into JOERAD, which provides a list of approved equipment and the capability to calculate the associated SSDs. Obtain access to JOERAD database by contacting JSC (J5) at commercial (410) 293-4957, DSN 287-4957, or online at **https://acc.dau.mil/joerad** (complete the Defense Spectrum Organization access request form). JOERAD is available to United Stated Military, United States Government, and their supporting contractors.

2.3. **Nonnuclear Munitions Safety Board.** Considers HERO evaluations and HERO certifications by AFSEC/SEW when assessing munitions and related items containing EIDs for final Operational Certification and flight test.

2.4. **Major Commands (MAJCOMs) will:**

2.4.1. Perform spectrum management process and obtain frequency assignment and allocation for spectrum dependent systems in support of operational requirements.

2.4.2. Provide, through the MAJCOM safety office, responses to installation safety offices' HERO safety inquiries and distribute updated HERO information to their installations when it becomes available.

2.4.3. Provide the requisite parametric data as specified in this instruction for EMR emitting equipment under their design cognizance to the installation safety office in order to calculate SSDs for ordnance.

2.4.4. Treat nuclear weapons with exposed EIDs as HERO UNSAFE. Conduct maintenance operations under HERO UNSAFE conditions only when the EME is restricted and does not exceed levels defined in Table A2.3 and illustrated in Figure A2.3 (Attachment 2).

2.5. **Air Force Materiel Command (AFMC) and System Lead Commands.** Shall ensure engineering, support, and test facilities are available to verify ordnance complies with MIL-

STD-464 EME and this instruction, testing is conducted IAW the guidance provided in MIL-HDBK-240, and acquisition is performed IAW guidance from MIL-HDBK-237, *Electromagnetic Environmental Effects and Spectrum Supportability Guidance for the Acquisition Process*, latest revision.

2.5.1. Air Force Nuclear Weapons Center (AFNWC) will:

2.5.1.1. Ensure, IAW AFMAN 91-118, *Safety Design and Evaluation Criteria for Nuclear Weapon Systems*, latest revision, the design of a nuclear weapon systems, such as AF and foreign aircraft, cruise missiles, Intercontinental Ballistic Missiles (ICBMs), transportation aircraft, etc., will minimize undesired emissions that could cause a nuclear hazard or ordnance ignition.

2.5.1.2. Specify MIL-STD-464 EME in the nuclear weapon MCs and STS to ensure DOE ordnance is HERO SAFE.

2.5.1.3. Ensure design for nuclear weapons to be HERO SAFE IAW MIL-STD-464 HERO aspects during all phases except assembly/disassembly.

2.5.1.4. Ensure when changes to DOE ordnance are proposed that requests for HERO evaluation (test, analysis, or a combination thereof) is IAW this instruction when the changes involve the EIDs directly, any modification that affects the EIDs susceptibility to EMR, or adds EMR devices to the weapons.

2.5.1.5. Require nuclear weapons entering the Phase 6.X or DoD 5000-series acquisition process (life extension programs or major modifications) undergo HERO classification IAW this instruction and MIL-STD-464 HERO aspects.

2.5.1.6. Ensure DOE ordnance variants, which include temporary instrumentation such as measurement hardware, telemetry, flight safety systems/flight termination systems, etc., and contain EIDs or adds EMR are subject to this instruction.

2.5.2. Air Force Life Cycle Management Center (AFLCMC) will:

2.5.2.1. Define the EME for HERO and establish design and verification requirements (AFLCMC is the preparing activity for MIL-STD-464).

2.5.2.2. Provide technical advisors on HERO certification and overall E3 matters to AFSEC and AFMC.

2.5.2.3. Review and provide technical coordination for deviation requests.

2.5.3. Air Force Program Executive Officer will:

2.5.3.1. Ensure implementation of HERO requirements for applicable programs.

2.5.3.2. Ensure the applicable criteria for HERO safety are included in applicable program documents (i.e., Systems Engineering Plans, Test and Evaluation Master Plans, System and Equipment Specifications, etc.) IAW guidance from MIL-HDBK-237.

2.5.3.3. Ensure ordnance variants, which include temporary instrumentation such as measurement hardware, telemetry, flight safety systems/flight termination systems, etc., and contain EIDs are subject to this instruction.

2.5.4. Platform SPOs/PMOs will:

2.5.4.1. Characterize the EME of the delivery system, including the EME in enclosed cavities such as weapon bays, by system-level test, analysis, or a combination thereof, which directly impacts ordnance, and retains the information to ensure ordnance remains safe from EMR hazards. Document the EMR characterizations and provides the information to AFSEC/SEW.

2.5.4.2. Update the initial EME characterization when modifications to the delivery system affect the platform EME every year.

2.6. **Installation Safety Office will:**

2.6.1. Implement HERO safety procedures for ordnance on their base. **(T-1)**.

2.6.2. Ensure the WSM prepares and maintains the installation HERO package (Attachment 4) and annually reviews this information against munitions procedures performed on their base (AFI 91-202, *The US Air Force Mishap Prevention Program*, latest revision). **(T-1)**.

2.6.3. Review and approve, for HERO safety, all installation-level design changes for new EMR transmitters and relocating or upgrading EMR emitting systems. **(T-1)**.

2.6.4. Determine, for the development, installation, and use of electronic equipment that emits on command or automatically generates EMR for use within magazine or ordnance assembly/disassembly areas or employed around ordnance, if the equipment falls within characterized EMR environment. Use guidance provided in paragraph A2.4 (Attachment 2) for MMEs radiating less than 1 watt. **(T-1)**.

2.6.5. Ensure an EMR survey is performed when all the sources of EMR cannot be taken into account, the attenuation of the surrounding environment is unknown, and/or minimum SSD cannot be complied with. Perform periodic reviews on a yearly basis to determine if an EMR survey is necessary and, if required, perform an EMR survey following major changes to the installation's EMR environment or at least periodically every ten years. **(T-1)**.

2.7. **Installation Spectrum Manager (ISM) will:**

2.7.1. Provide installation safety office with EMR data necessary to prepare the HERO package. **(T-1)**.

2.7.2. Ensure coordination between using unit and safety office prior to relocating EMR emitters or changing frequency, gain, and/or power characteristics of existing EMR emitters on the installation. **(T-1)**.

2.7.3. Prepare and maintain spectrum assignment records for their installation and provide the installation safety office a radio frequency authorization upon request. **(T-1)**.

2.8. **Civil Engineering Squadron will:**

2.8.1. Report any using unit project plans/efforts to install new emitters to the ISM and installation safety offices. **(T-1)**.

2.8.2. Report any using unit project plans/efforts to relocate any existing EMR emitters or change to the frequency, gain, and/or power characteristics of any existing EMR emitter on their installation to the ISM and installation safety office. **(T-1)**.

2.9. **Munitions Squadrons will:**

2.9.1. Incorporate into the unit's Explosives Safety Training Plan the susceptibility of EIDs, classification of ordnance, and their physical configuration, IAW AFMAN 91-201. **(T-1)**.

2.9.2. Maintain configuration control of their maintenance facilities with respect to the permanent/recurring EME and submit EMR configuration changes to the ISM and safety office. **(T-1)**.

3. HERO CERTIFICATION PROCESS FOR ORDNANCE.

3.1. **Scope.**

3.1.1. This chapter provides guidance on the procedures used to obtain HERO certification for ordnance.

3.1.2. This process is used by AF programs responsible for the design, development, test and evaluation, and sustainment of ordnance.

3.2. **Process.**

3.2.1. DoD Manual 6055.09-M requires HERO certification of all DoD ordnance. This certification covers all six-phases of the S4 in the EME cited in MIL-STD-464, Table 9 and applies during the disposal of ordnance.

3.2.2. The six-phases, as defined in MIL-HDBK-240, are as follows:

3.2.2.1. Transportation/Storage. The phase in which the ordnance is packaged, containerized, or otherwise prepared for shipping or stored in an authorized storage facility. This includes transporting of the ordnance.

3.2.2.2. Assembly/Disassembly. The phase involving all operations required for ordnance build-up or breakdown and typically involves personnel.

3.2.2.3. Staged. The phase where the ordnance has been prepared for loading and is pre-positioned in a designated staging area.

3.2.2.4. Handling/Loading. The phase where physical contact is made between the ordnance item and personnel, metal objects, or structures during the process of preparing, checking out, performing built-in tests, programming/reprogramming, installing, or attaching the ordnance item to its end-use platform/system; e.g., aircraft, launcher, launch vehicle, or personnel. These procedures may involve making or breaking electrical connections, opening and closing access panels, and removing/installing safety pins, shorting plugs, clips, and dust covers. This configuration also includes all operations required for unloading; i.e., removing, disengaging, or repackaging the ordnance item.

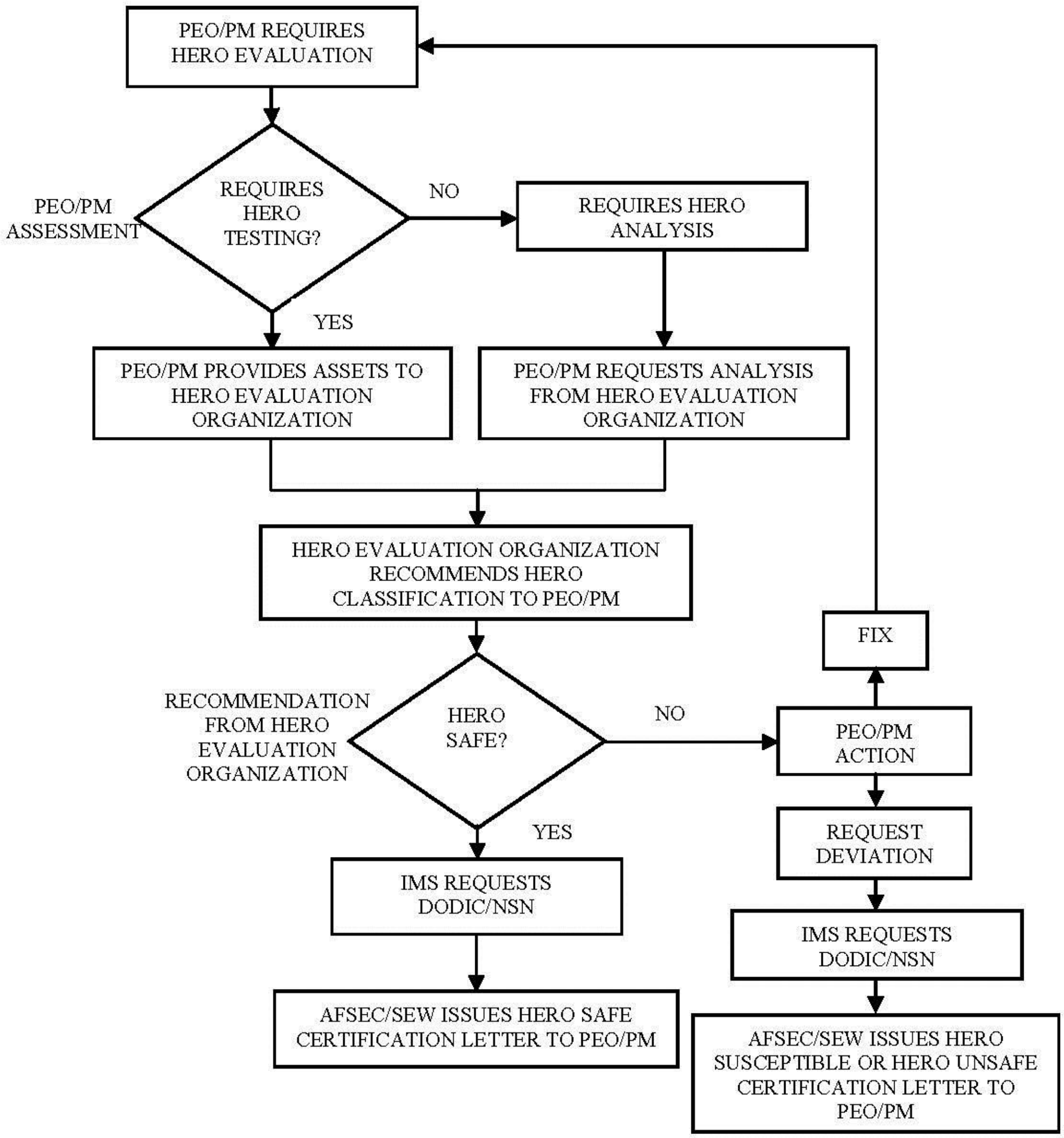
3.2.2.5. Platform-Loaded. The phase where the ordnance item has been installed on or attached to the host platform/system (e.g., aircraft, ground vehicle, and personnel and so forth) and all loading procedures have been completed.

3.2.2.6. Immediate Post-Launch. The phase where the ordnance item has been launched from its platform/system, but up to its SSD with regard to the actuation of its explosives, pyrotechnics, or propellants.

3.2.3.

Figure 3. 1 illustrates the process of HERO certification for ordnance.

Figure 3.1. HERO Certification Process for Ordnance.



3.2.4. PM of new or modified ordnance provides information to the HERO evaluation organization concerning the design, development, and evaluation schedules for items under their cognizance. **(T-1)**.

3.2.5. PM provides all of the affected CRCs, anticipated deployable aircraft, ground vehicles, etc., with applicable launcher or bomb racks, and designates all subsystems containing EIDs be evaluated individually. PM provides item nomenclature, DODIC/National Stock Number (NSN) (for existing ordnance), cognizant branch, field station, or contractor concerned with development or modification of the ordnance (Attachment 5), and anticipated period for various development phases. This information is essential for planning and scheduling consultation, analysis, and/or test. **(T-1)**.

3.2.6. HERO evaluation organization shall be either a DoD facility (e.g., Naval Surface Warfare Center, Dahlgren Division, E3 Assessment and Evaluation Branch, Q52; White Sands Missile Range, Electromagnetic Radiation Effects facility; and Redstone Technical Test Center) or an appropriate contractor. **(T-1)**.

3.2.6.1. HERO evaluation organization provides the PM with cost and schedule estimates regarding requested consultation services, analysis, and/or testing services.

3.2.6.2. PM ensures adequate funding is provided to the HERO evaluation organization for supporting the required consultation services, analysis, and/or testing services. **(T-1)**.

3.2.6.3. HERO evaluation organization provides test plans, test reports (including data), and/or a plan of action and milestones for consultation services, analysis, and/or test services to the PM. **(T-1)**.

3.2.6.4. PM reviews and approves the test plan prior to start of the HERO test submitted by the HERO evaluation organization for accuracy of handling and loading procedures and hardware nomenclature and provide comments prior to the performance of the HERO tests. **(T-1)**.

3.2.6.5. HERO evaluation organization schedules the HERO test based on the availability of the facilities and assets. At the request of the PM, preliminary tests may be conducted during the various developmental phases to obtain engineering data. **(T-1)**.

3.2.6.6. PM provides all test articles to the HERO evaluation organization IAW requirements of the approved HERO test plan. **(T-1)**.

3.2.6.7. HERO evaluation organization will instrument the test article and conduct the test. **(T-1)**.

3.2.6.8. HERO evaluation organization submits the HERO test and/or analysis report to the PM with a HERO classification recommendation. **(T-1)**.

3.2.7. PM submits the HERO certification and provides the HERO test and/or analysis report as rationale for requesting HERO certification. PM also provides system and component NSNs and DODICs. This ensures that the production design is the same as the tested configuration with respect to HERO (Attachment 6). **(T-1)**.

3.2.8. AFSEC/SEW reviews the HERO certification request along with supporting data and/or analysis and either approves or rejects the request as follows:

3.2.8.1. If determined HERO SAFE, the ordnance is certified and classified as HERO SAFE, be included in the next change/revision of JOERAD, and listed by AFSEC/SEW. AFSEC/SEW retains the HERO certification on file and provides the PM a copy. **(T-1)**.

3.2.8.2. If not determined HERO SAFE, AFSEC/SEW provides justification. The PM may authorize corrective actions to rectify the hazards identified by the HERO test, analysis, or combination thereof. Funding for this activity is the responsibility of the PM. **(T-1)**.

3.2.8.3. If use of the system is required due to operational necessity, the ordnance is treated as HERO UNSAFE, until suitable modifications are fabricated, evaluated, and retrofitted, or HERO SUSCEPTIBLE, if test data and/or analysis supports such classification. The PM shall request a deviation of the HERO certification requirements IAW this instruction. **(T-1)**.

3.2.9. The IMS applies to the AF Cataloging, Battle Creek, Michigan, for DODIC/NSN IAW AFMAN 23-110, *USAF Supply Manual*, latest revision, before the ordnance has been certified. **(T-1)**.

3.2.10. HERO certification is required prior to deployment or release for service unless a deviation is granted. However, a HERO assessment is necessary to support test and evaluation (e.g., to support aircraft/store compatibility) any time prior to low rate initial production or production approval. The PEO/PM requests a HERO evaluation from AFSEC/SEW and provides tests data and/or analysis to support the evaluation. If AFSEC/SEW determines that the ordnance does not comply with MIL-STD-464, AFSEC/SEW advises the PEO/PM on the suitability of ordnance production, fielding and use in writing within thirty days after receipt of the request. Test data and/or analysis used to support the HERO evaluation may be used to support final HERO certification if modifications performed after HERO evaluation does not directly affect the EIDs and/or their EMR susceptibility (Attachment 5). **(T-1)**.

4. MAINTAINING SAFE HERO OPERATIONS.

4.1. **Overview.**

4.1.1. The primary method to protect ordnance from EMR hazards is to ensure the ordnance are never located where EMR power density is sufficiently high to couple enough electrical energy into the device to initiate the device or degrade performance. In addition, shielding the ordnance can protect the ordnance item.

4.1.2. HERO SAFE ordnance are considered unserviceable after exposure to EME above those defined in MIL-STD-464, Table 9, due to the potential for both direct EMR induced actuation of the EIDs and inadvertent activation of an electrically powered firing circuit.

4.1.3. HERO UNSAFE and HERO SUSCEPTIBLE ordnance are considered unserviceable after exposure to EME above those defined in Tables A2.1 and A2.2 (Attachment 2), respectively, due to the potential for both direct EMR induced actuation of the EIDs and inadvertent activation of an electrically powered firing circuit.

4.1.4. The following general HERO requirements must be implemented when conducting operations with any ordnance, regardless of HERO classification:

4.1.4.1. Plan ordnance operations so that the ordnance has a minimal exposure to EME. Use the HERO package for guidance. **(T-1)**.

4.1.4.2. Do not alter ordnance or handle umbilical cables and cable connectors unnecessarily. **(T-1)**.

4.1.4.3. Unless authorized by item technical order, do not expose internal wiring and firing circuits by assembling or disassembling the ordnance in EME. **(T-1)**.

4.1.4.4. Transport all HERO SUSCEPTIBLE and HERO UNSAFE ordnance in sealed, all-metal containers whenever possible. When transporting ordnance in a vehicle, the minimum SSD requirements are applicable. **(T-1)**.

4.1.4.5. Ordnance containing disassembled EIDs or when exposed EIDs, firing circuits, or wiring are present shall be treated as HERO UNSAFE. **(T-1)**.

4.1.4.6. For HERO SAFE ordnance, maintain a minimum SSD of 10 feet from a transmitting antenna. This assumes that at 10 feet the EMR from the transmitting antenna does not exceed MIL-STD-464 EME. If the transmitting antenna is an MME, refer to guidance provided in paragraph A2.4 (Attachment 2). For ordnance on a delivery platform, where a minimum of 10 feet is not possible, an analysis must prove that a smaller SSD is permissible. **(T-1)**.

4.1.4.7. For HERO UNSAFE or HERO SUSCEPTIBLE ordnance, formulas for SSDs from Tables A2.4 and A2.5 (Attachment 2), respectively, determine the appropriate SSDs. If the calculation results in SSDs less than 10 feet, maintain an SSD of 10 feet. If an MME is involved, refer to guidance provided in paragraph A2.4 (Attachment 2). **(T-1)**.

4.2. **Platform EME.**

4.2.1. Platforms externally carrying items containing EIDs shall assess the onboard EME to ensure it is sufficiently low to prevent initiation or degradation of the EIDs. **(T-1)**.

4.2.2. Platforms internally carrying items containing EIDs, such as in equipment or weapons compartments, shall assess the EME in these compartments to ensure it is sufficiently low to prevent initiation or degradation of the EIDs. Techniques such as mode stirring/reverberation or equivalent shall be used. **(T-1)**.

4.3. **Traditional Fixed-Location Emitter (TFE).**

4.3.1. The emitters are in a fixed location, usually mounted on a tower, mast, or rooftop and separated at a distance from the ordnance such that the far field applies.

4.3.2. For HERO UNSAFE and HERO SUSCEPTIBLE ordnance, the choice of formula used to calculate the SSD for a TFE depends on the frequency of the transmitted EMR and the total effective isotropic radiated power (EIRP) of the emitter (Tables A2.4 and A2.5 (Attachment 2), respectively). If this minimum distance (SSD) is maintained between the ordnance and the emitter, the EMR power density at the location of the ordnance, even under the most optimal transmission and more efficient coupling conditions, will be too low to provide sufficient energy to initiate or degrade the ordnance.

4.3.3. WSM shall collect and review the following information prior to performing any operation involving ordnance:

4.3.3.1. HERO classification of the ordnance during the planning operation is determined by reviewing the HERO package or contacting AFSEC/SEW for the listing. Ordnance classified as HERO SAFE or HERO SUSCEPTIBLE can be degraded to HERO UNSAFE during assembly, disassembly, or by subjecting the item to unauthorized conditions and/or operations. **(T-1)**.

4.3.3.2. The EME at the location of the planned operation must be determined. This information is available from the HERO package, the ISM, or the installation safety office. **(T-1)**.

4.4. **Modern Mobile Emitter (MME).** MMEs may transmit lower power levels than conventional emitters (TFEs), but they may also be brought much closer to conventional ordnance, even into the near field of their antenna. Use guidance provided in paragraph A2.4 (Attachment 2) for MMEs radiating less than 1 Watt.

4.4.1. The Program Manager Joint-Automatic Identification Technology (PM J-AIT) is testing radiated emissions from RFID and automatic identification technology equipment for near field operation using worst-case guidance limitations. Observe all SSDs calculated, approved, and published by PM J-AIT for individual pieces of equipment applicable to munitions operations. Contact AFSEC/SEW for listing.

4.4.2. Transceiver devices such as cellular telephones, active pagers, and some walkie-talkies automatically transmit EMR without operator action. Follow guidance set forth in paragraph A2.4 (Attachment 2), otherwise turn off the devices when the 10 feet SSD cannot be maintained.

4.4.3. For all remote entry devices, including car entry keys, the SSD is 0.5 feet from all EIDs regardless of configuration. This guidance assumes the remote entry devices comply with Code of Federal Regulations, Title 47, *Radio Frequency Devices*, paragraph 15.231, *Periodic operation in the band 40.66-40.70 MHz and above 70 MHz*.

4.5. **Electronic Devices.** Electronic devices are authorized for use in storage, build-up, and assembly areas where conventional ammunition and explosives are present, as long as they are not connected to power via power cords, with the following restrictions:

4.5.1. For electronic devices, without any radiating wireless capability and unknown EMR emissions, shall undergo an EMR survey. Use the distance at which the measurement is performed to establish the SSD. Compare the EMR results with Table 9, MIL-STD-464, for HERO SAFE ordnance, Table A2.2 (Attachment 2) for HERO SUSCEPTIBLE ordnance, and Table A2.1 (Attachment 2) for HERO UNSAFE ordnance, to ensure the EMR level poses no hazard. Emissions may occur at various frequencies and the worst case EMR level shall be used to establish the SSD.

4.5.2. Electronic devices, without radiating wireless capability, that are certified to meet Code of Federal Regulations, Title 47, *Radio Frequency Devices*, Class A and B limits and labeled accordingly, require no SSD and can be used in close proximity but must not come in direct contact with ordnance, regardless of classification.

4.5.3. For electronic devices radiating at less than 1 Watt with known transmitter average power output, antenna gain, and transmission frequency, use Table A2.7 (Attachment 2) to establish the SSD.

4.6. **TFE and MME Safety Procedures for Nuclear Weapons.**

4.6.1. IAW this instruction all nuclear weapons must be certified and classified as HERO SAFE. The procedures for ensuring the EMR from TFEs do not cause inadvertent EID initiation or degradation are similar to the procedures for conventional ordnance, i.e., maintain a minimum of 10 feet between transmitting antennas and all nuclear weapons containing EIDs, assuming that at 10 feet the EMR from the transmitting antenna does not exceed MIL-STD-464 EME.

4.6.2. The following are safety procedures involving nuclear weapons in a HERO SAFE configuration (Ultimate User configuration, i.e., all-up-round, shipping configuration) and electronic devices:

4.6.2.1. MMEs and electronics devices cannot be connected to power via power cords.

4.6.2.2. For an MME radiating at less than 1 Watt with known transmitter average power output, antenna gain, and transmission frequency, use Table A2.7 (Attachment 2), HERO SAFE column, to establish the SSD.

4.6.2.3. Electronic devices, without radiating wireless capability, that are certified to meet Code of Federal Regulations, Title 47, *Radio Frequency Devices*, Class A and B limits and labeled accordingly, require no SSD and can be used in proximity to the nuclear weapon but must not come in direct contact with the nuclear weapon.

4.6.2.4. For electronics devices, without wireless capability and unknown electromagnetic emissions, require an EMR survey. The distance at which the EMR is measured will establish the SSD as long as the EMR is below HERO SAFE EME levels listed in Table 9, MIL-STD-464. Emissions may occur at various frequencies and the worst case EMR level shall be used to establish an SSD.

4.6.3. The following are safety procedures involving nuclear weapons in a non-Ultimate User configuration, e.g., undergoing maintenance, (HERO UNSAFE nuclear weapon) and electronic devices that intentionally or unintentional emit EMR:

4.6.3.1. The use of electronic equipment within 10 feet of a nuclear weapon or associated nuclear weapon component is prohibited, unless:

4.6.3.1.1. An EMR survey is accomplished for the specific electronic device and the appropriate SSD established. Use the distance at which the measurement is performed to establish an SSD. Compare the EMR results with Table A2.3, which is illustrated in Figure A2.3 (Attachment 2), to ensure the EMR level poses no hazard. Emissions may occur at various frequencies and the worst case EMR level shall be used to establish the SSD. This applies to all unintentional emitters of EMR for which an SSD cannot be calculated IAW with this instruction due to unknown power or frequency characteristics.

4.6.3.1.2. The local Weapon Safety Office has determined the item is certified by the manufacturer to meet Code of Federal Regulations, Title 47, *Radio Frequency Devices*, Class A and B limits, and is labeled accordingly. The item can be used in proximity to the nuclear weapon but must not come in direct contact with the nuclear weapon.

4.6.3.2. For an MME radiating at less than 1 Watt with known transmitter average power output, antenna gain, and transmission frequency, use Table A2.7 (Attachment 2), HERO UNSAFE column, to establish the SSD. The item must not come in direct contact with the nuclear weapon.

4.6.4. **DELETED**

MARGARET H. WOODWARD
Major General, USAF
Chief of Safety

Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

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Prescribed Forms

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Abbreviations and Acronyms

AF—Air Force

AFB—Air Force Base

AFI—Air Force Instruction

AFLCMC—Air Force Life Cycle Management Center

AFMAN—Air Force Manual

AFMC—Air Force Material Command

AFNWC—Air Force Nuclear Weapons Center

AFPD—Air Force Policy Directive

AFSC—Force Sustainment Center

AFSEC—Air Force Safety Center

AFSEC/SEW—Air Force Safety Center, Weapons Safety Division

AFSMO—Air Force Spectrum Management Office

AFSPCMAN—Air Force Space Command Manual

CR—complete round

CRC—Complete Round Code

CRD—Complete Round Dictionary

DC—duty cycle

DoD—Department of Defense

DoDD—Department of Defense Directive

DODIC—Department of Defense Identification Code

DOE—Department of Energy

E3—electromagnetic environmental effects

EFI—exploding foil initiator

EID—electrically initiated device

EIS—Engineering Installation Squadron

EIRP—effective isotropic radiated power

EME—electromagnetic environment

EMR—electromagnetic radiation

EOD—explosive ordnance disposal

ERP—effective radiated power

GACP—Global Ammunition Control Point

HERO—hazards of electromagnetic radiation to ordnance

IAW—in accordance with

ICBM—Intercontinental Ballistic Missile

IMS—Inventory Management Specialist

ISM—Installation Spectrum Manager

JOERAD—Joint Spectrum Center Operations Electromagnetic Environmental Effects Risk Analysis Database

JSC—Joint Spectrum Center

MAE—maximum allowable environment

MAJCOM—Major Command

MCs—military characteristics

MDA—Milestone Decision Authority

MIL—HDBK–Military-Handbook

MIL—STD–Military-Standard

MME—modern mobile emitter

NSN—National Stock Number

PEO—Program Executive Office

PM—Program Manager

PM J—AIT–Program Manager Joint-Automatic Identification Technology

PMO—Project Management Office

prf—pulse repetition frequency

pri—pulse repetition interval

p-static—precipitation static

pw—pulse width

RFID—radio frequency identification

rms—root-mean-squared

S4—stockpile-to-safe separation sequence

SPO—System Program Office

SSD—safe separation distance

STS—stockpile-to-target sequence

TFE—traditional fixed-location emitter

Terms

Antenna—That part of the receiving or transmitting system designated to radiate or receive electromagnetic fields.

Antenna Gain (G)—An antenna's power gain, or simply gain, is a performance figure combining the antenna's directivity and electrical efficiency. In a transmitting antenna, gain describes how well the antenna converts input power into electromagnetic fields headed in a specified direction. In a receiving antenna, gain describes how well the antenna converts electromagnetic fields arriving from a specific direction into electrical power. For the purposes of this instruction, gain is expressed in dBi, unless otherwise noted. The numerical (far field) gain ratio, not the dBi value, of a transmitting antenna can be determined from the gain expressed in dBi as follows:

$$G_t = log^{-1}\left(\frac{G_{dBi}}{10}\right) = 10^{G_{dBi}/10}$$

where

G_t = numerical (far field) gain ratio of the transmitting antenna

G_{dBi} = antenna gain (dBi)

Decibel isotropic is the measurement of gain in a directional antenna compared with a theoretical isotropic antenna radiating the exact same energy in all directions. Gain may also be expressed relative to a dipole antenna with units of dBd. Use the following formula to convert from dBd to dBi:

$$G_{dBi} = G_{dBd} + 2.15$$

where

G_{dBi} = antenna gain (dBi)

G_{dBd} = antenna gain (dBd)

Antenna Field Regions–The electromagnetic fields surrounding an antenna are divided into three principle regions as illustrated in Figure A1.1. For a more detailed explanation of antenna field regions, reference technical order 31Z-10-4 or MIL-HDBK-235-1C. The electromagnetic fields around an antenna are divided into three regions: the reactive near field, the radiating near field or Fresnel, and the far field or Fraunhofer. The distance, close to the antenna, the reactive near field, is given approximately by the following formula:

$$R_{nf} = 0.62\sqrt{\frac{d^3}{\lambda}}$$

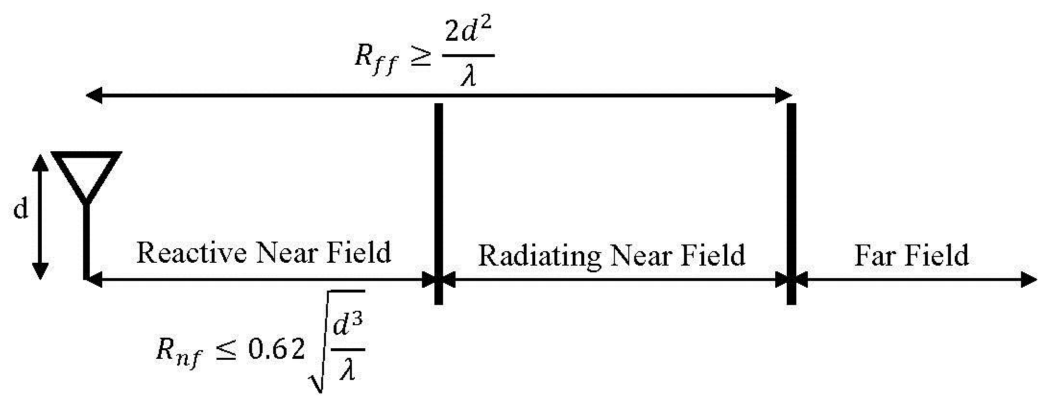
where

R_{nf} = reactive near field distance (meters)

d = maximum linear dimension of an antenna (meters)

λ = wavelength (meters) of the antenna derived from the frequency

Figure A1.1. Antenna Field Regions.



The near field of an antenna is any location closer to the antenna than the far field distance, comprising of the reactive and radiating near fields. In the near field, the equations for the radiating electromagnetic fields must be used without simplification and calculating the coupling of EMR to the receiving antenna becomes very complicated and difficult. For a more detailed explanation of near field calculations, see technical order 31Z-10-4 or MIL-HDBK-235-1C. Replacement of equations for radiated electromagnetic fields at the far field distance with simpler equations is the point where the difference has dropped below a threshold margin accepted by engineers. The simpler far field EMR equations describe a more consistent power density environment and the propagation and coupling of the EMR to a receiving antenna is easier to apply to the EID scenario. Use the following formula to determine the distance from an antenna where the far field region begins:

$$R_{ff} \geq \frac{2d^2}{\lambda}$$

where

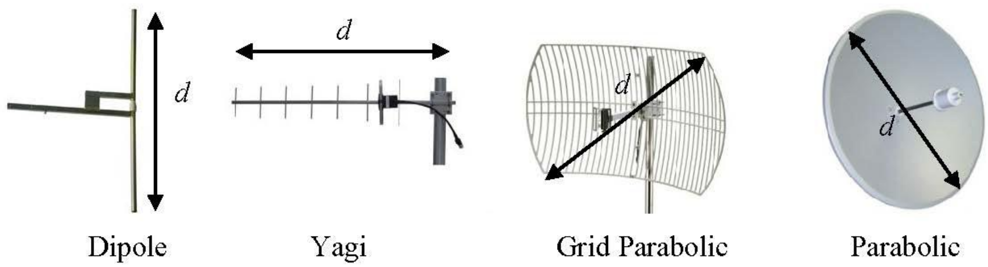
R_{ff} = far field distance (meters)

d = maximum linear dimension of an antenna (meters)

λ = wavelength (meters) of the antenna derived from the frequency

Note that the distance from the antenna must be much greater than the maximum linear dimension of the antenna and wavelength. The antenna maximum linear dimension is the length of the longest dimension of the antenna itself. For a dipole antenna or yagi it is simply the length of the antenna. For a parabolic dish, the dimension is the diameter of the dish. For any other shape, use the longest single dimension, which could be diagonal across a rectangular element such as a grid sectional parabolic antenna. Figure A1.2 consists of examples of antenna maximum linear dimensions.

Figure A1.2. Examples of Antenna Maximum Linear Dimensions.



Average Power Output of a Transmitter (P_t)–For continuous systems, the peak radiated power is considered the average power output of the transmitter, expressed in watts.

$P_t = P_{pk}$

where

P_t = average power output of a transmitter (W)

P_{pk} = peak radiated power of a transmitter (W)

For pulsed-modulated signals, typically radars have differences between peak and average root-mean-squared (rms) power. Determine the average power output of the transmitter by using the ratio of time-on and time-off over an interval. The time-on/off is the duty cycle (DC).

$DC = \frac{pw}{pri}$ or $DC = (pw)(prf)$

where

DC = duty cycle (unitless)

pw = pulse width (seconds)

pri = pulse repetition interval (seconds)

prf = pulse repetition frequency (Hz)

The product of the peak power and DC is the average power output of the transmitter.

$P_t = (P_{pk})(DC)$

where

P_t = average power output of a transmitter (W)

P_{pk} = peak radiated power of a transmitter (W)

DC = duty cycle (unitless)

Use peak power as P_t for pulsed transmitters with wide pulse widths, one millisecond or greater.

Bridgewire–A metal wire heated by the passage of electrical current, which initiates the deflagrating or detonating charge surrounding the wire.

Dudding–The inability of the EIDs to function as intended because the physical/electrical properties have been altered due to the application or repeated application of energy below that required to initiate the device.

Effective Isotropic Radiated Power (EIRP)–EIRP is the amount of power in watts a theoretical isotropic antenna would emit to produce a peak power density observed in the direction of maximum antenna gain. Assuming a lossless system, EIRP is the product of average power output and numerical gain.

$$EIRP = P_t G_t$$

where

$EIRP =$ effective isotropic radiated power (W)

$P_t =$ average power output of the transmitter (W)

$G_t =$ numerical (far field) gain ratio (not the dBi value) of the transmitting antenna

For EIRP in terms of power ratio, average transmitter power output to a milliwatt, with a unit of decibel milliwatt (dBm) or average transmitter power output to one watt, with a unit of decibel watt (dBW), use the following equations to convert from dBm or dBW to watts:

$$EIRP(W) = \frac{log^{-1}\left[\frac{EIRP(dBm)}{10}\right]}{1{,}000} = \frac{10^{EIRP(dBm)/10}}{1{,}000}$$

$$EIRP(W) = log^{-1}\left[\frac{EIRP\,(dBW)}{10}\right] = 10^{EIRP\,(dBW)/10}$$

In some cases, the average power output of the transmitter may be expressed in terms of effective radiated power (ERP) instead of EIRP. ERP is referenced to a half-wave dipole radiator instead of an isotropic radiator. To convert ERP to EIRP, multiply ERP by a factor of 1.64, the gain of a half-wave dipole antenna relative to an isotropic radiator.

$$EIRP = (ERP)(1.64)$$

where

$EIRP =$ effective isotropic radiated power (W)

$ERP =$ effective radiated power (W)

Electric Field Strength (E)–Electric field strength is the magnitude of the electric field vector with units of volts (V) per meter. Determine the electric field strength from the power density using the following formula:

$$E = \sqrt{P_d Z_0}$$

where

$E =$ electric field strength (V/m)

$P_d =$ power density (W/m^2)

$Z_0 =$ intrinsic impedance of free space (120π or approximately 377 Ω)

This relationship only exists for a plane wave, within the far field of the antenna where the relationship between the electric field and magnetic field is orthogonal and clearly defined.

Electromagnetic Environment (EME)–EME is the resulting product of the power and time distribution, in various frequency ranges, of the radiated or conducted electromagnetic emission levels that may be encountered by a military force, system, or platform when performing its assigned mission in its intended operational environment (in the case of ordnance, during its S4). It is dynamically comprised of electromagnetic energy from a multitude of natural sources (lightning, precipitation static (p-static), electrostatic discharge, galactic and stellar noise, and so forth) and man-made sources (electrical and electronic systems, radio frequency systems, electromagnetic devices, ultra-wideband systems, high-power microwaves systems, and so forth). When defined, the EME will be for a particular time and place. Specific equipment characteristics, such as operating frequencies and emitter power levels, operational factors, such as distance between items and force structure and frequency coordination, all contribute to the EME.

Electromagnetic Environmental Effects (E3)–E3 is the impact of the EME upon the operational capability of military forces, equipment, systems, and platform/systems. It encompasses all electromagnetic disciplines, including electromagnetic compatibility; electromagnetic interference; electromagnetic vulnerability; electromagnetic pulse; electronic protection; electrostatic discharge; and hazards of electromagnetic radiation to personnel, ordnance, and volatile materials such as fuel; and includes the electromagnetic effects generated by all EME contributors including radio frequency systems; ultra-wideband devices; high-power microwaves systems; lightning; p-static; and so forth.

Frequency (*f*)–For a periodic function, frequency is the number of cycles or events per unit time measured in hertz (Hz) or cycles per second. Use the following formulas to convert between kilohertz (kHz) (1,000 Hz), Megahertz (MHz) (1,000,000 Hz), and Gigahertz (GHz) (1,000,000,000 Hz)
1 kHz = 0.001 Mhz
1 GHz = 1,000 MHz
For EMR, frequency is related to wavelength, in a vacuum, as follows:
$f = \frac{c}{\lambda}$
where
$f =$ frequency (Hz)
$c =$ speed of light (3×10^8 meters/second)
$\lambda =$ wavelength (meters)

HERO Margin–The difference between the maximum no-fire stimulus and the permissible EID response level. For EIDs with a safety consequence, the margin is defined in MIL-STD-464 as 16.5 dB; for EIDs with a reliability consequence, the margin is defined as 6 dB.

Maximum Allowable Environment (MAE)–MAE is the highest radiated field strength levels to which ordnance can be exposed to without exceeding EID HERO margins.

Modern Mobile Emitter (MME)–Certain EMR emitters have the capability of moving with respect to the location of the EIDs, as well as any other low power emitters, part of modern communication and data systems including MMEs, e.g, cellular telephones, barcode readers, RFID devices, wireless laptops, network access points, and any other transmitter potentially brought close to EIDs.

Power Density (P_d)–Power density is the power flow per unit area with units of W/m^2 or mW/m^2. Average power density is the quantity related to the heating properties of EMR and, hence, to personnel and other hazards, while peak power density becomes important in the study of the effects of electromagnetic fields on EIDs and on fuel hazards. In the far field, assuming a lossless system, calculate the power density of a directional antenna as follows:

$$P_d = \frac{P_t G_t}{4\pi r^2} = \frac{EIRP}{4\pi r^2}$$

where

P_d = power density (W/m^2)

P_t = average power output of a transmitter (W)

G_t = numerical (far field) gain ratio of a transmitter

r = distance or range from an antenna (meters)

$EIRP$ = effective isotropic radiated power (W)

Power density levels are calculated within a 3 dB beam width or the main beam.

Reliability Consequence–The inadvertent actuation of an EID that does not result in a safety consequence, but degrades system performance; i.e., renders the ordnance item either ineffective or unable to function as intended. In addition, the definition has been expanded to include dudding where the system would no longer be reliable.

Safe Separation Distance (SSD)–For HERO, SSD is the calculated distance, in meters or feet, from an emitter beyond which the radiated power density from the emitter has decreased to a level too low to couple enough energy into the EIDs to initiate detonation. Measurements of the SSD may take into account both the horizontal and vertical difference in length and height between the emitter and the EIDs.

Safety Consequence–The inadvertent actuation of an EID that creates an immediate catastrophic event with the potential to either destroy equipment or injure personnel, such as the firing of an inline rocket motor igniter by EMR energy; or the inadvertent actuation of an EID that increases the probability of a future catastrophic event by removing or otherwise disabling a safety feature of the ordnance item. This, for example, might be caused by the EMR initiation of a piston actuator that removes a lock on the safety-and-arming rotor of an artillery fuze, thus allowing a sensitive detonator to rotate in-line with the explosive train.

Symbols and Units–The following are symbols and units used in this instruction:

c–speed of light (3×10^8 meters/second)

d–antenna maximum linear dimension

dB–decibel

dBi–decibel isotropic

dBm–decibel milliwatt

dBW–decibel watt

E–electric field strength

E_{MAE}–maximum allowable environment electric field strength

f–frequency

G–antenna gain

G_{dBd}–antenna gain relative to a dipole antenna

G_{dBi}–antenna gain expressed in dBi

GHz–gigahertz

G_t–numerical (far field) gain ratio of a transmitting antenna

Hz–hertz

i–number of traditional fixed-location emitters

kHz–kilohertz

λ–wavelength

m–meter

MHz–Megahertz

mW–milliwatt

Ω–ohm

π–pi (3.14159)

P_d–power density

P_{pk}–peak radiated power

P_t–average power output of a transmitter

r–distance or range from an antenna

R_{ff}–far field distance

R_{nf}–near field distance

SSD_i–safe separation distance for each traditional fixed-location emitter

SSD_m–safe separation distance for multiple traditional fixed-location emitters

$\sum_{i=1}^{n}$ –summation operator

V–volts

W–watts

Z_0–instrinstic impedance of free space (120π or 377 Ω)

Traditional Fixed-Location Emitter (TFE)–TFEs are all EMR emitters traditionally tracked by the ISM. These emitters are in a fixed location, usually mounted on a tower, mast, or rooftop, and separated by a great distance from the EIDs such that the far field applies.

Attachment 2

SAFE SEPARATION DISTANCE (SSD)

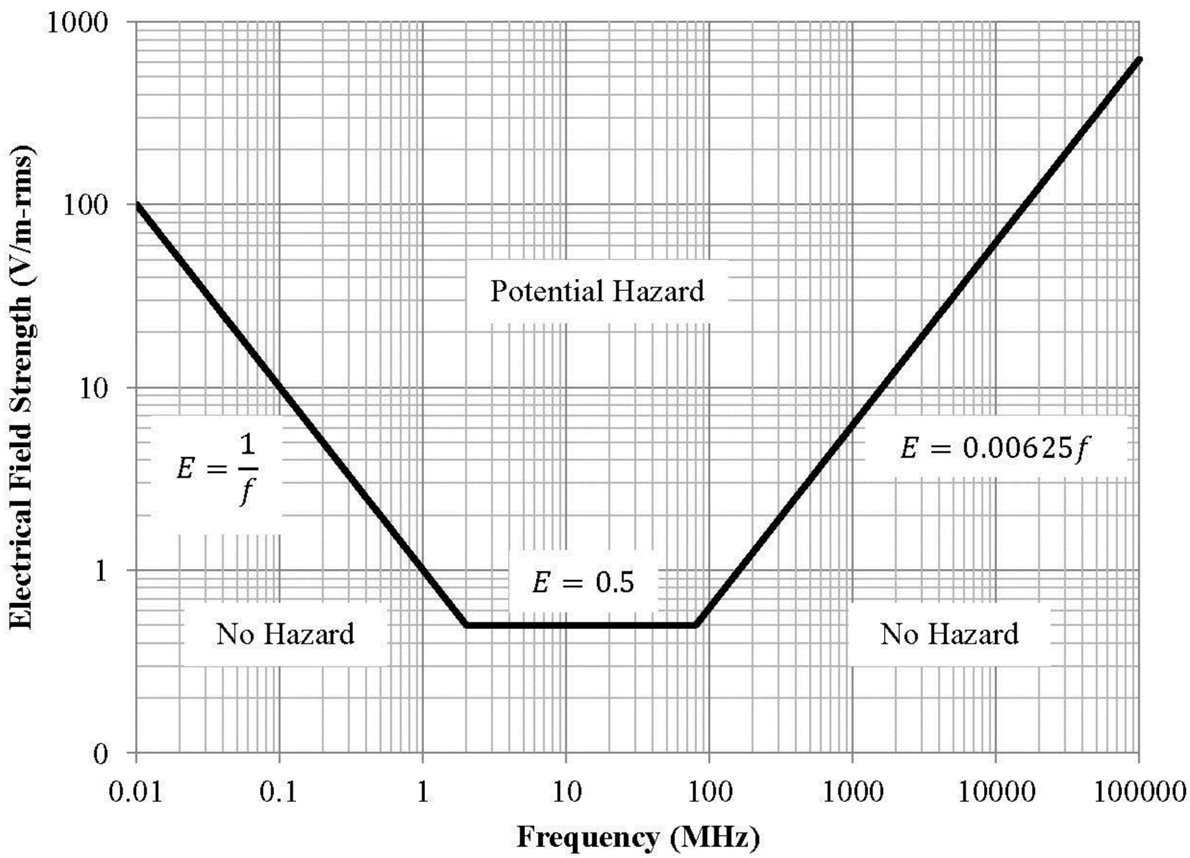
A2.1. Maximum Allowable Environment (MAE).

A2.1.1. For ordnance classified as HERO UNSAFE, the MAE electric field strength (E_{MAE}) is defined in Table A2.1 and illustrated in Figure A2.1.

Table A2.1. E_{MAE} for HERO UNSAFE Ordnance.

Frequency Range (MHz)	E_{MAE} (V/m-rms)
$0.01 \leq f < 2.0$	$E_{MAE} = \frac{1}{f}$
$2.0 \leq f < 80.0$	$E_{MAE} = 0.5$
$80.0 \leq f < 100{,}000$	$E_{MAE} = 0.00625f$
f = transmitting frequency (MHz)	

Figure A2.1. HERO UNSAFE E_{MAE} Curve.

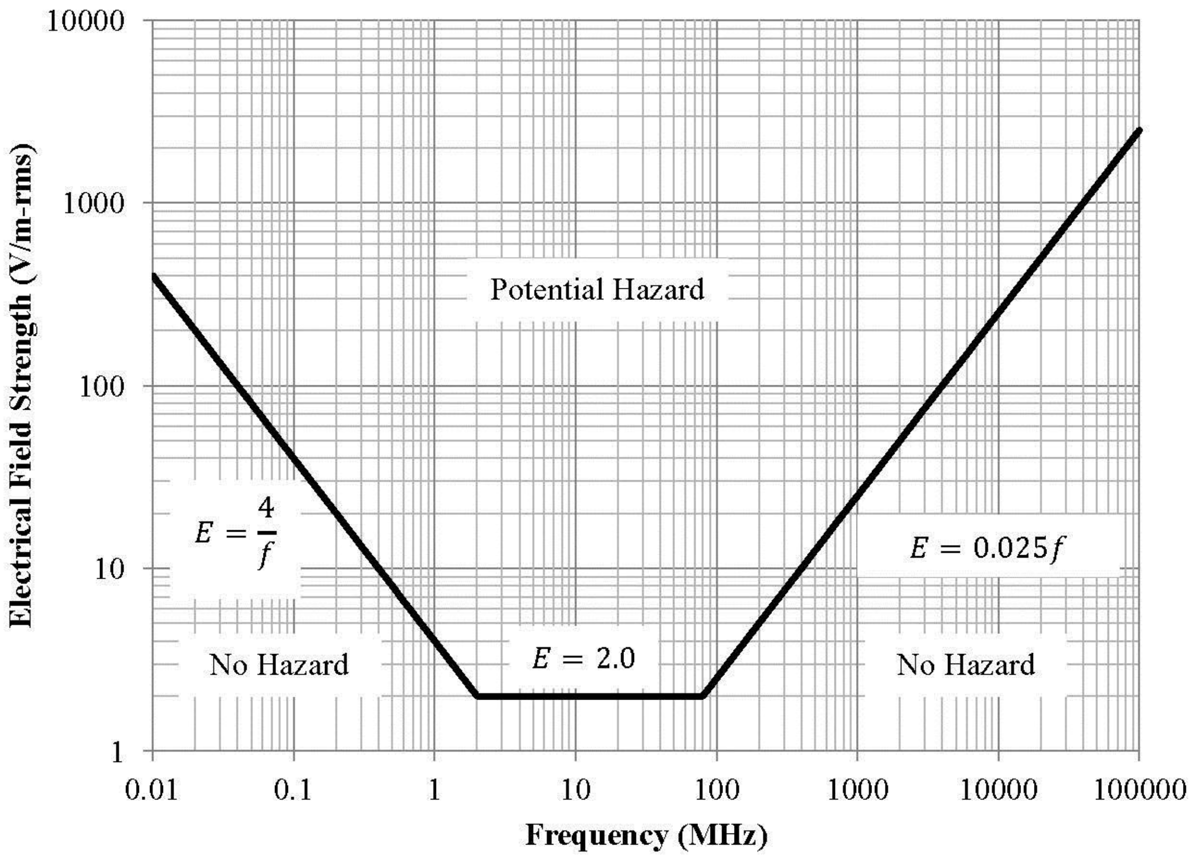


A2.1.2. For ordnance classified as HERO SUSCEPTIBLE, the E_{MAE} is defined in Table A2.2 and illustrated in Figure A2.2.

Table A2.2. E_{MAE} for HERO SUSCEPTIBLE Ordnance.

Frequency Range (MHz)	E_{MAE} (V/m-rms)
$0.01 \leq f < 2.0$	$E_{MAE} = \frac{4}{f}$
$2.0 \leq f < 80.0$	$E_{MAE} = 2.0$
$80.0 \leq f < 100{,}000$	$E_{MAE} = 0.025f$
f = transmitting frequency (MHz)	

Figure A2.2. HERO SUSCEPTIBLE E_{MAE} Curve.

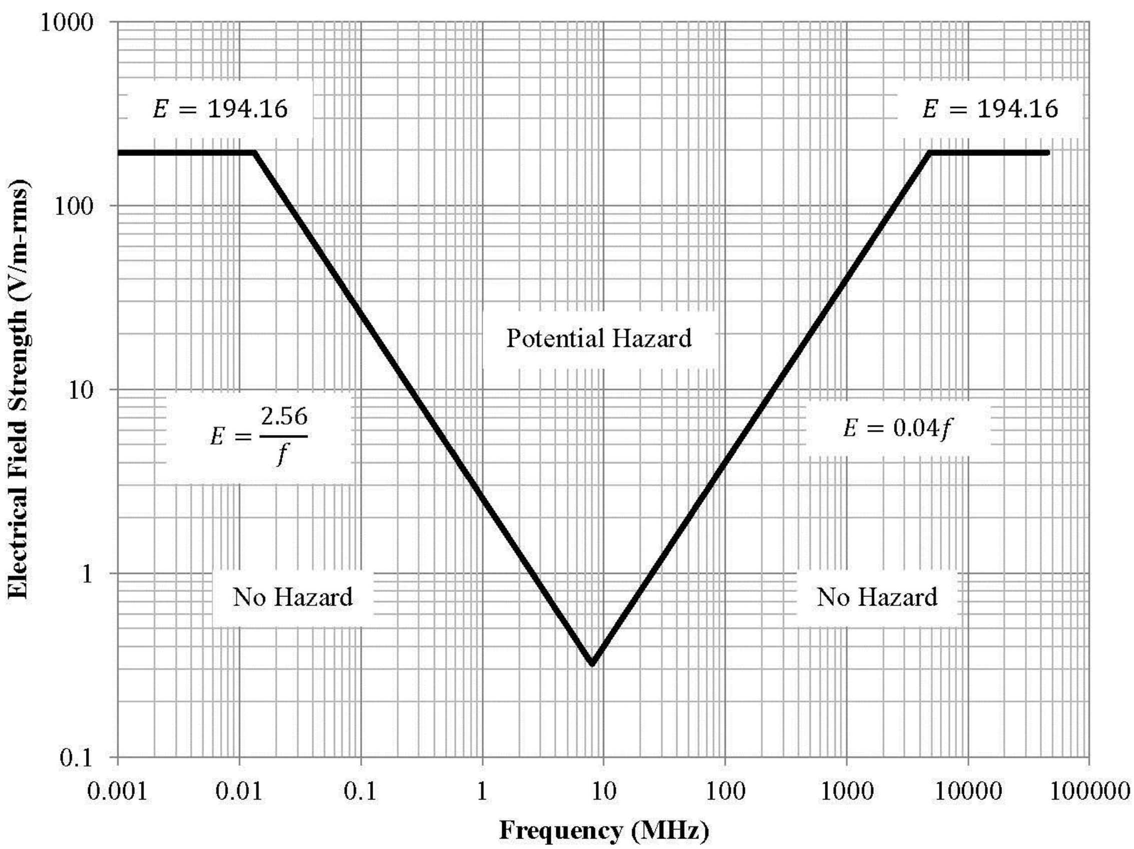


A2.1.3. For nuclear weapons classified as HERO UNSAFE, the E_{MAE} is defined in Table A2.3 and illustrated in Figure A2.3.

Table A2.3. E_{MAE} for HERO UNSAFE Nuclear Weapons.

Frequency Range (MHz)	E_{MAE} (V/m-rms)
$f < 0.0132$	$E_{MAE} = 194.16$
$0.0132 \leq f < 8.0$	$E_{MAE} = \frac{2.56}{f}$
$8.0 \leq f < 4{,}850$	$E_{MAE} = 0.04f$
$4{,}850 \leq f < 45{,}000$	$E_{MAE} = 194.16$
f = transmitting frequency (MHz)	

Figure A2.3. HERO UNSAFE Nuclear Weapons E_{MAE} Curve.



A2.1.4. To convert from power density to electrical field strength, use the formula provided in Attachment 1.

A2.2. SSD Formulas.

A2.2.1. SSD is determined using formulas in Table A2.4 for HERO UNSAFE ordnance.

A2.2.2. SSD is determined using formulas in Table A2.5 for HERO SUSCEPTIBLE ordnance.

A2.2.3. SSD is determined using formulas in Table A2.6 for HERO UNSAFE nuclear weapons. Nuclear weapons are HERO UNSAFE when EIDs are exposed due to maintenance, assembly, or disassembly.

Table A2.4. Equations for Computing SSD for HERO UNSAFE Ordnance.

Frequency Range (MHz)	SSD Formulas
$0.01 \leq f < 2.0$	$SSD = 5.5f\sqrt{P_t G_t}$ meters $SSD = 18f\sqrt{P_t G_t}$ feet
$2.0 \leq f < 80.0$	$SSD = 10.95\sqrt{P_t G_t}$ meters $SSD = 36\sqrt{P_t G_t}$ feet
$80.0 \leq f < 100{,}000$	$SSD = \frac{876\sqrt{P_t G_t}}{f}$ meters $SSD = \frac{2{,}873\sqrt{P_t G_t}}{f}$ feet
SSD = safe separation distance (feet or meters) f = transmitted frequency (MHz), use the lowest operational frequency for frequencies greater than 2 MHz and use the highest operational frequency for frequencies less than or equal to 2 MHz P_t = average power output of the transmitter (W) G_t = numerical (far field) gain ratio (not the dBi value) of the transmitting antenna, derived as follows: $G_t = log^{-1}\left(\frac{G_{dBi}}{10}\right) = 10^{G_{dBi}/10}$ G_{dBi} = antenna gain (dBi)	

Table A2.5. Equations for Computing SSD for HERO SUSCEPTIBLE Ordnance.

Frequency Range (MHz)	SSD Formulas
$0.01 \leq f < 2.0$	$SSD = 1.37f\sqrt{P_t G_t}$ meters $SSD = 4.5f\sqrt{P_t G_t}$ feet
$2.0 \leq f < 80.0$	$SSD = 2.74\sqrt{P_t G_t}$ meters $SSD = 9\sqrt{P_t G_t}$ feet
$80.0 \leq f < 100{,}000$	$SSD = \frac{219\sqrt{P_t G_t}}{f}$ meters $SSD = \frac{718\sqrt{P_t G_t}}{f}$ feet
SSD = safe separation distance (feet or meters) f = transmitted frequency (MHz), use the lowest operational frequency for frequencies greater than 2 MHz and use the highest operational frequency for frequencies less than or equal to 2 MHz P_t = average power output of the transmitter (W) G_t = numerical (far field) gain ratio (not the dBi value) of the transmitting antenna, derived as follows: $G_t = log^{-1}\left(\frac{G_{dBi}}{10}\right) = 10^{G_{dBi}/10}$ G_{dBi} = antenna gain (dBi)	

Table A2.6. Equations for Computing SSD for HERO UNSAFE Nuclear Weapons.

Frequency Range (MHz)	SSD Formulas
$f < 0.0132$	$SSD = 0.03\sqrt{P_t G_t}$ meters $SSD = 0.09\sqrt{P_t G_t}$ feet
$0.0132 \leq f < 8.0$	$SSD = 2.14f\sqrt{P_t G_t}$ meters $SSD = 7f\sqrt{P_t G_t}$ feet
$8.0 \leq f < 4{,}850$	$SSD = \frac{137\sqrt{P_t G_t}}{f}$ meters $SSD = \frac{449\sqrt{P_t G_t}}{f}$ feet
$4{,}850 \leq f < 45{,}000$	$SSD = 0.03\sqrt{P_t G_t}$ meters $SSD = 0.09\sqrt{P_t G_t}$ feet
SSD = safe separation distance (feet or meters) f = transmitted frequency (MHz), use the lowest operational frequency for frequencies greater than 2 MHz and use the highest operational frequency for frequencies less than or equal to 2 MHz P_t = average power output of the transmitter (W) G_t = numerical (far field) gain ratio (not the dBi value) of the transmitting antenna, derived as follows: $G_t = log^{-1}\left(\frac{G_{dBi}}{10}\right) = 10^{G_{dBi}/10}$ G_{dBi} = antenna gain (dBi)	

Note: For Tables A2.4, A2.5, and A2.6:

1. Formulas in the subject tables apply to the far field region of the antenna only. Far field region is determined using the formula provided in Attachment 1. For other far field requirements, see technical order 31Z-10-4, *Joint Services Command, Control, Communications, and Computer Systems Electromagnetic Radiation Hazards*, latest revision, or MIL-STD-235-1, *Military Operational Electromagnetic Environmental Profiles*, latest revision.

2. In cases where the calculated SSD is less than 10 feet, refer to paragraph A2.4 for guidance if MMEs are involved, otherwise the SSD is 10 feet.

3. For frequencies outside the range specified in these tables, request assistance from AFSEC/SEW.

4. Use average transmitter power (W), antenna gain (dBi), and the lowest operation frequency (MHz) for frequencies greater than 2 MHz and the highest operational frequency for frequencies less than or equal to 2 MHz.

5. For pulsed transmitters with wide pulse widths one millisecond or greater, use the peak transmitter power, P_t, instead of the average power of the transmitter.

6. The SSD for HERO SAFE ordnance in EME higher than MIL-STD-464 EME is determined by multiplying 10 feet (3 meters) by the ratio of the higher EME (EME measured or determined using the antenna characteristics) to the lower EME (MIL-STD-464 EME).

A2.3. Multiple TFEs. When multiple TFEs are present, use the following methodology:

A2.3.1. For multiple TFEs operating in the same frequency/band, the SSD is determined using the formula in Figure A2.4:

Figure A2.4. SSD for Multiple TFEs Operating in the Same Frequency/Band.

A2.3.2. For multiple TFEs operating at different frequency/bands, the largest individual SSD applies.

A2.4. MMEs. For MMEs radiating less than 1 Watt, use Table A2.7. Use the lowest operation frequency (MHz) for frequencies greater than 2 MHz and the highest operational frequency for frequencies less than or equal to 2 MHz.

Table A2.7. Determining SSDs Involving Ordnance and MMEs.

Minimum SSD (feet)	HERO Classification		
	SAFE	SUSCEPTIBLE	UNSAFE
≥ 10	General HERO requirements per paragraph 4.1.4	Use either calculated SSD per Table A2.4 or 10 feet, whichever is greater	Use either calculated SSD per Table A2.3 or 10 feet, whichever is greater
5	$0.5 < EIRP \leq 5$ All f	$EIRP \leq 0.5$ $f \geq 100$ MHz	$0.025 < EIRP \leq 0.1$ 200 MHz $\leq f < 1$ GHz
1	$0.1 < EIRP \leq 0.5$ All f	$0.025 < EIRP \leq 0.1$ $f \geq 200$ MHz	$0.025 < EIRP \leq 0.1$ $f \geq 1$ GHz
0*	$EIRP \leq 0.1$ All f	$EIRP \leq 0.025$ All f	$EIRP \leq 0.025$ $f \geq 100$ MHz

f = transmitted frequency (MHz), use the lowest operational frequency for frequencies greater than 2 MHz and use the highest operational frequency for frequencies less than or equal to 2 MHz

$EIRP = P_t G_t$

$EIRP$ = effective isotropic radiated power (W)

P_t = average power output of the transmitter (W)

G_t = numerical (far field) gain ratio (not the dBi value) of the transmitting antenna, derived as follows:

$$G_t = log^{-1}\left(\frac{G_{dBi}}{10}\right) = 10^{G_{dBi}/10}$$

G_{dBi} = antenna gain (dBi)

***WARNING: Do not touch antennas to ordnance**

A2.5. Examples for Calculating SSDs.

A2.5.1. E_{MAE} Examples.

Scenario 1. HERO SUSCEPTIBLE ordnance exposed to power density of 450 W/m^2 at a frequency of 200 MHz.

Step 1. Assuming the ordnance is in the far field region of the antenna, using the formula for electrical field strength (Attachment 1), convert the measured power density to the measured electric field strength (V/m-rms).

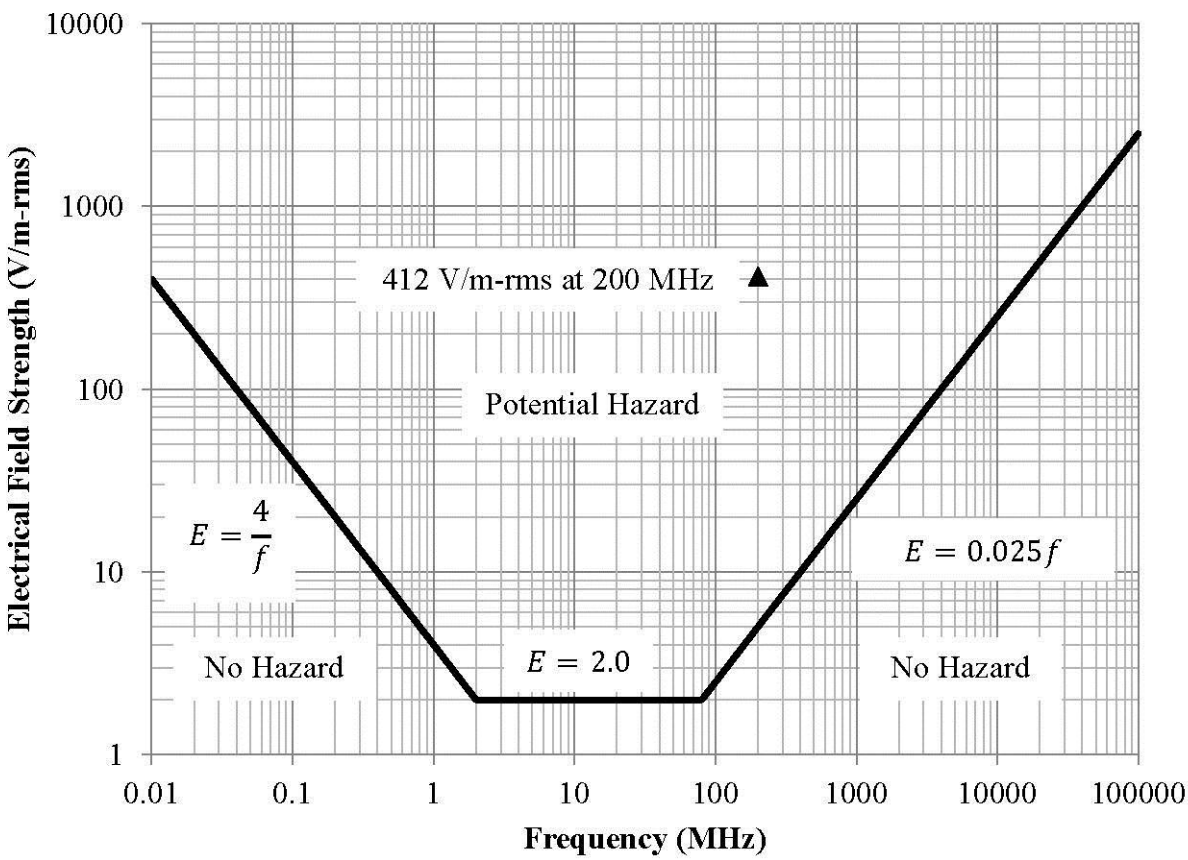
$E = \sqrt{P_d Z_0} = \sqrt{(450)(120\pi)} \cong 412\ \mathrm{V/m - rms}$

Step 2. Using Table A2.2, determine E_{MAE} for HERO SUSCEPTIBLE ordnance.

$E_{MAE} = 0.025f = (0.025)(200) = 5\ \mathrm{V/m - rms}$

Step 3. Compare the E_{MAE} and the measured electric field strength, determined from the measured power density (Figure A2.5). The ordnance exposure is 412 V/m-rms. The E_{MAE} is 5 V/m-rms. The situation is unacceptable. Therefore, the ordnance must be moved to an area where the electric field is lower than 5 V/m-rms or power density is less than 66 mW/m^2.

Figure A2.5. Scenario 1. Comparing E_{MAE} to Measured Electric Field Strength.



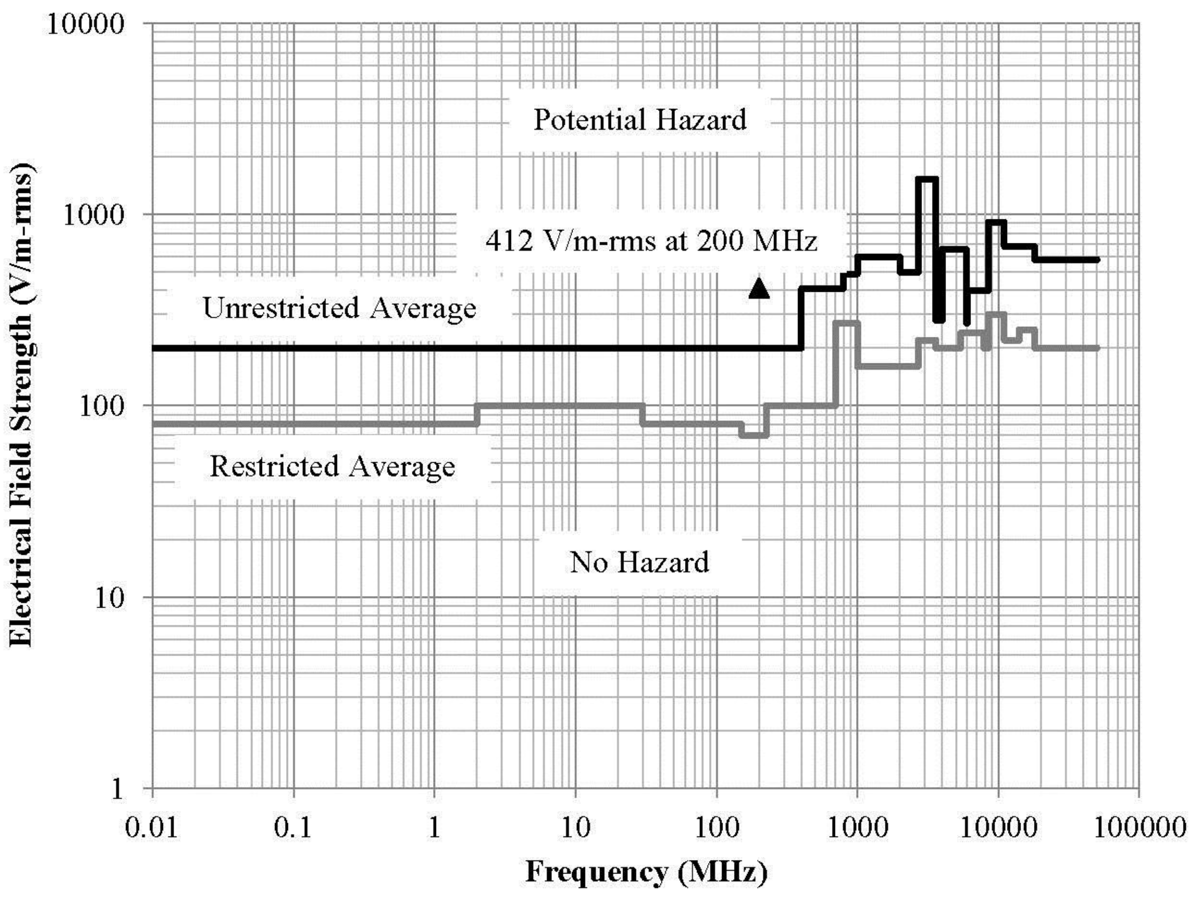
Scenario 2. HERO SAFE ordnance exposed to a power density of 450 W/m^2 at a frequency of 200 MHz.

Step 1. As determined in Scenario 1, the measured electrical field strength is determined to be 412 V/m-rms.

Step 2. Using MIL-STD-464, Table 9, determine the E_{MAE} for the ordnance. For the frequency range from 150 to 225 MHz, the unrestricted average E_{MAE} is 200 V/m-rms and the restricted average E_{MAE} is 70 V/m-rms.

Step 3. Compare E_{MAE} for the ordnance to the measured electric field strength, determined from the measured power density (Figure A2.6). This situation is unacceptable no matter which S4 phase the ordnance is in. Therefore, move the ordnance to an area where the electric field strength is less than 200 V/m-rms for unrestricted and 70 V/m-rms for restricted. This corresponds to power density levels of 106 and 13 W/m^2, respectively.

Figure A2.6 Scenario 2. Comparing E_{MAE} to Measured Electric Field Strength.



A2.5.2. TFE Example.

Scenario 3. Assuming the ordnance is in the far field region of the antenna, HERO SUSCEPTIBLE ordnance exposed to an emitter transmitting at 300 MHz having an average transmitter power of 1,000 W and antenna gain of 15 dBi.

Step 1. Determine the EIRP (W) given the following
$P_t = 1{,}000$ W
$G_{dBi} = 15$ dBi

The numerical gain ratio is determined as follows:

$$G_t = log^{-1}\left(\frac{G_{dBi}}{10}\right) = 10^{G_{dBi}/10} = 10^{15/10} = 31.6$$

and

$$EIRP = P_t G_t = (1{,}000)(31.6) = 31{,}600 \text{ W}$$

Step 2. The ordnance is classified as HERO SUSCEPTIBLE; therefore use the formula from Table A2.5. Because the frequency is 300 MHz, the applicable formula, in feet, is as follows:

$$SSD = \frac{718\sqrt{P_t G_t}}{f} = \frac{718\sqrt{EIRP}}{f} = \frac{718\sqrt{31{,}600}}{300} \cong 425 \text{ feet}$$

A2.5.3. Multiple TFEs Example.

Scenario 4. Assuming the ordnance is in the far field region of the antennas, consider the site where the antennas are collocated on a tower and have characteristics listed in Table A2.8.

Table A2.8. Scenario 4. Antenna Characteristics.

Antenna	Frequency (MHz)	EIRP (dBm)
1	1,930	64.87
2	1,930	71.00
3	1,960.63	62.72
4	935	66.93
5	880	71.19

Step 1. Convert EIRP from dBm to watts using the formula from Attachment 1, resulting in values listed in Table A2.9.

$$EIRP(\text{W}) = \frac{log^{-1}\left[\frac{EIRP(dBm)}{10}\right]}{1{,}000} = \frac{10^{EIRP(dBm)/10}}{1{,}000}$$

Table A2.9. Scenario 4. EIRP(W).

Antenna	Frequency (MHz)	EIRP (W)
1	1,930	3,069.02
2	1,930	12,589.25
3	1,960.63	1,870.68
4	935	4,931.74
5	880	13,152.25

Step 2. Calculate the SSD based on equations from Tables A2.4 and A2.5 (Attachment 2) for HERO UNSAFE and HERO SUSCEPTIBLE ordnance, respectively, resulting in values listed in Table A2.10.

Table A2.10. Scenario 4. Individual TFE SSDs.

Antenna	SSD (feet) HERO UNSAFE	SSD (feet) HERO SUSCEPTIBLE
1	82	21
2	167	42
3	63	16
4	216	54
5	374	94

Step 3. For the two antennas, antennas 1 and 2, operating at 1,930 MHz, the SSD based on multiple TFEs is determined using the formulas in paragraph A2.3 (Attachment 2). For HERO UNSAFE ordnance, the SSD, in feet is based on multiple TFEs, is a follows:

$$SSD_m = \sqrt{\sum_{i=1}^{n} SSD_i^2} = \sqrt{82^2 + 167^2} \cong 186 \text{ feet}$$

For HERO SUSCEPTIBLE ordnance, the SSD, in feet, and based on multiple TFEs, is as follows:

$$SSD_m = \sqrt{21^2 + 42^2} \cong 47 \text{ feet}$$

Step 4. Compare all of the determined SSDs (Table A2.11) and apply the largest value to the situation because the other antennas (antennas 3, 4, and 5) are not operating at the same frequency as antennas 1 and 2.

Table A2.11. Scenario 4. Final SSDs.

Antenna	SSD (feet) HERO UNSAFE	SSD (feet) HERO SUSCEPTIBLE
1&2	186	47
3	63	16
4	216	54
5	374	94

Note: For this scenario, the SSD value of 374 feet would apply if all ordnance items were classified as HERO UNSAFE. The SSD value of 94 feet would apply if all ordnance items were classified as HERO SUSCEPTIBLE. If the site has mixed classification, the worst SSD value applies, and, in this case, the value of 374 feet. If all ordnance items were classified as HERO SAFE, the SSD would be 10 feet. To verify that the ordnance, classified as HERO SAFE, EME exposure does not exceed MIL-STD-464 levels at 10 feet, determine the electric field strength using the formula from Attachment 1.

$$E = \sqrt{P_d Z_0} = \sqrt{P_d 120\pi} = \sqrt{\frac{120\pi EIRP}{4\pi r^2}} = \sqrt{\frac{120 EIRP}{4r^2}}$$

Table A2.12 lists the resulting approximate electric field strengths at 10 feet from each antenna. To use this formula, the distance or range from the antenna (r), is in meters, therefore use 3 meters.

Table A2.12. Scenario 4. Electric Field Strengths.

Antenna	Frequency (MHz)	EIRP (W)	E (V/m-rms)
1	1,930	3,069.02	101
2	1,930	12,589.25	205
3	1,960.63	1,870.68	79
4	935	4,931.74	128
5	880	13,152.25	209

For the two antennas operating at the same frequency, antennas 1 and 2, the superimposed fields are determined as follows:

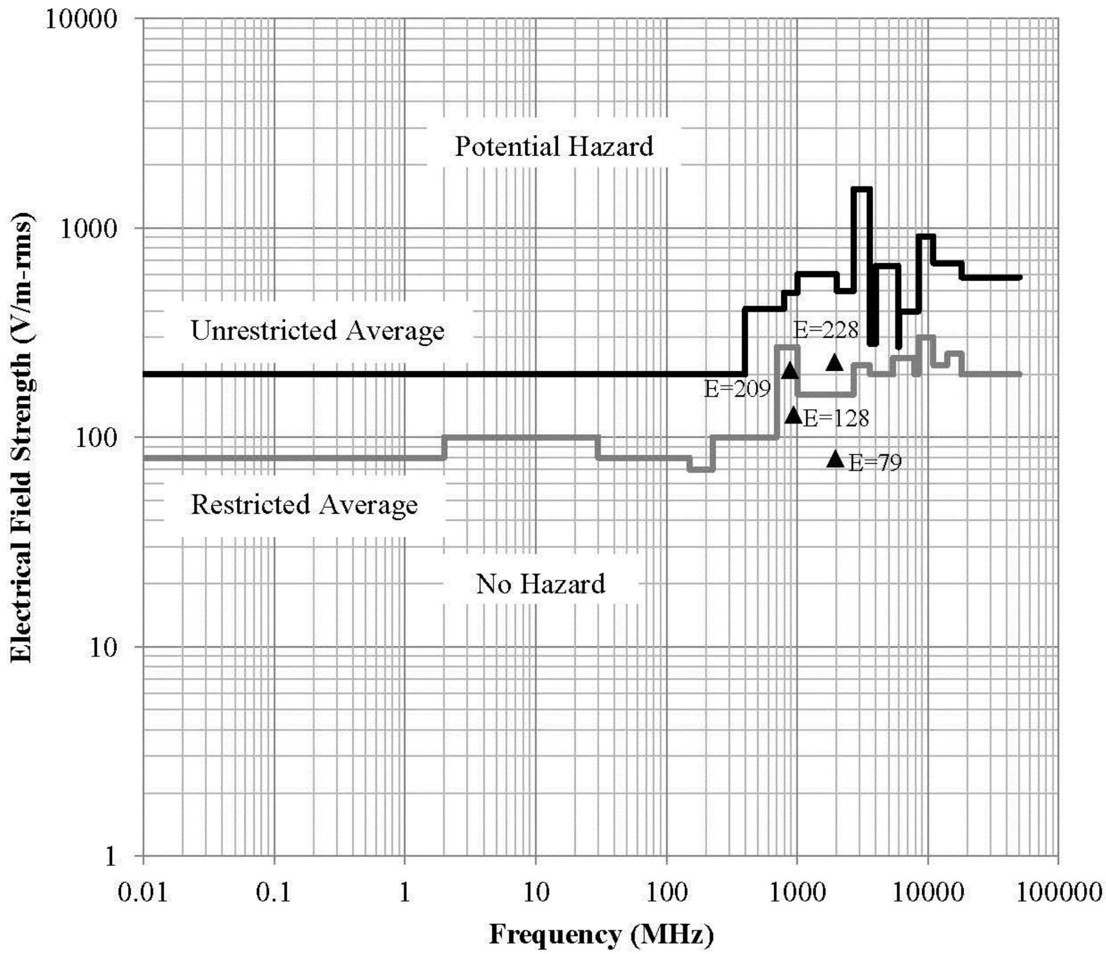
$$E_T = \sqrt{E_1^2 + E_2^2} = \sqrt{101^2 + 205^2} \cong 228\ \mathrm{V/m - rms}$$

Comparing the calculated fields from Table A2.12 with average values given in MIL-STD-464, Table 9, EME (Table A2.13 and illustrated in Figure A2.7) indicate that at 10 feet, for ordnance classified as HERO SAFE, the EME exposure does not exceed MIL-STD-464 EME for S4 phases involving transportation/storage, staged, platform-loaded, and immediate post launch, which is known as the unrestricted environment. For S4 phases involving assembly/disassembly and loading/unloading, known as the restricted environment, there is an issue because the calculated electric field exceeds the average MIL-STD-464 EME for restricted environment. That is the combined fields of antennas 1 and 2 exceed the restricted average.

Table A2.13. Scenario 4. Electric Field Strengths Comparison.

Antenna	Frequency (MHz)	E(V/m-rms)	Unrestricted Average E_{MAE} (V/m-rms)	Restricted Average E_{MAE} (V/m-rms)
1 & 2	1,930	228	600	160
3	1,960.63	79	600	160
4	935	128	490	270
5	880	209	490	270

Figure A2.7. Scenario 4. Comparing E_{MAE} to Calculated Electric Field Strength.



To determine the SSD for HERO SAFE ordnance involved in assembly/disassembly and loading/unloading, the electric field strength needs to be less than 160 V/m-rms. As stated in Note 6 for Tables A2.4, A2.5, and A2.6, the SSD is determined by multiplying 10 feet by the ratio of the higher EME as measured or determined using the antenna characteristics (228 V/m-rms) to the lower EME per MIL-STD-464 EME (160 V/m-rms).

$$SSD = 10\left(\frac{228}{160}\right) = 14.25\ feet$$

For this scenario, HERO SAFE ordnance in the restricted environment must be kept 14.25 feet away from the antennas.

Attachment 3

EMR ANALYSIS ASSISTANCE

A3.1. Assistance Requests.

A3.1.1. When a HERO situation is suspected or the minimum SSD for a particular location is in question, request assistance from MAJCOM/SEW. When classification of an emitter as a TFE or an MME is unclear, request assistance from AFSEC/SEW.

A3.1.2. MAJCOM/SEW may request assistance from AFSEC/SEW.

A3.1.3. Assistance requests must include all of the information needed for a complete understanding of the situation. Minimum requirements are as follows:

A3.1.3.1. Type of aircraft or ground vehicle, ordnance, and applicable EIDs involved (HERO classification) and, if available, characteristics of the EIDs (maximum no fire power or energy levels).

A3.1.3.2. Base layout of the area showing transportation routes of EIDs and ordnance subsystems, locations of ordnance, and EIDs maintenance, storage, and assembly/disassembly areas, and location of all transmitting systems, including the antenna system characteristics as listed in the HERO package.

A3.1.4. Decisions are sent to the originating base or command, with information copies sent to all agencies involved in the decision process and an additional copy to AFSEC/SEW, if applicable.

A3.2. Radiation Hazard Tools.

A3.2.1. The United States Navy provides radiation hazard tools online at **https://www.e3teamonline.org**. In particular, use the HERO SSD calculator to determine SSDs for HERO classified ordnance.

A3.2.2. Input the transmitter start or lower frequency (MHz) for frequencies greater than 2 MHz or the higher frequency for frequencies less than or equal to 2 MHz, the transmitter maximum average power (W), and antenna gain (dBi). The program calculates EIRP (W) and SSD (feet and meters) for HERO SAFE, HERO SUSCEPTIBLE, and HERO UNSAFE ordnance.

A3.2.3. The calculator also provides SSDs of less than 10 feet for certain emitters. In that case, refer to paragraph A2.4 (Attachment 2) for guidance. Note that the calculator does not take into account EME that exceed MIL-STD-464 EME and the result of 10 feet may be misleading for HERO SAFE ordnance. Before using the tool, determine if the EME is below MIL-STD-464 EME.

Attachment 4

HERO PACKAGE AND EMR SURVEY

A4.1. Requirement. The Weapons Safety Manager shall prepare and maintain a HERO package consisting of the following:

A4.1.1. D-8 map showing EMR emissions affecting the following operations per AFI 91-202, paragraph 9.4.9.10: Storage, handling, maintaining, loading/unloading, explosive ordnance disposal (EOD), and assembly areas of explosives; delivery routes (nuclear/conventional); weapons loading operations (nuclear/conventional); and EOD operations.

A4.1.2. Excel spreadsheet, built with the assistance of the base frequency manager, consisting of an emitter list (both mobile and non-mobile). Document and ensure that the ordnance is located in the far field region of the antenna by determining the far field distance (R_{ff}) (Attachment A) using the maximum linear dimension of the antenna and the wavelength.

A4.1.3. Excel spreadsheet of SSDs for all ordnance containing EIDs.

A4.1.4. Weapons Safety Manager's assessment, in writing, of hazards to explosives/nuclear operations.

A4.1.5. Provide the HERO package to base users, EOD, Munitions Supervision/Control, fire department, and any other organization deemed necessary.

A4.2. Purpose. To prescribe, through advanced planning, the easiest and most efficient method of managing the conflict between the EME created by transmitting equipment and HERO classified ordnance.

A4.3. HERO Package.

A4.3.1. The purpose of completing an emitter list is to gather all installation, emitter system information. This includes all specifications necessary to calculate the HERO SUSCEPTIBLE and HERO UNSAFE ordnance SSDs for each emitter system and ensure that for HERO SAFE ordnance the EME are below MIL-STD-464 EME. The list consists of all transmitters and antennas, including MMEs, identified by military nomenclature or, if appropriate, manufacturer and model. Cite all transmitter and antenna facilities, including fixed, mobile, relay, etc. Document this information ninety days prior to the intent-to-install of any transmitter or antenna system.

A4.3.1.1. For each transmitter/antenna system, document the following parameters: frequency range (MHz), maximum average output power (W), antenna type, antenna gain (dBi), antenna dimensions, and transmitter/antenna location.

A4.3.1.2. Use the maximum antenna dimension (see Figure A1.2 for examples) and wavelength (determined from frequency, see Attachment 1) to determine where the far field region begins for each antenna (see Attachment 1 for far field region formula). Ensure ordnance is in the far field region of the antenna.

A4.3.1.3. For radar systems, the important parameters to document are average power, frequency band, antenna type, and gain. Because the average power is derived from formulas involving peak power, DC, pulse width (pw), and pulse repetition frequency (prf), these parameters must also be documented. Use this information and the formulas provided in Attachment 1 to determine the transmitter average power. Note the pw and prf are calculated from radar modes producing the highest average power. Consider peak power as the average power for pulsed transmitters with wide pulse widths, one millisecond or greater.

A4.3.1.4. Inform the Communication Squadron and/or ISM of an EMR equipment increase ninety days prior to the change. This information consists of data required to calculate SSDs IAW this instruction, determine ordnance operational impact, and update existing HERO packages and EME. The installation safety office updates the emitter list as required.

A4.3.2. Once the transmitter/emitter characteristics are obtained, calculate the HERO UNSAFE and/or HERO SUSCEPTIBLE ordnance SSDs using Tables A2.4 and A2.5 (Attachment 2), respectively. For MMEs radiating less than 1 Watt, use the guidance provided in paragraph A2.4 (Attachment 2) to determine the SSDs. Alternatively, use the online HERO calculator to determine SSDs. Compare the calculated distance to the actual distance between each antenna and the various ordnance locations, this process allows for identification of potential HERO problems. Using the information obtained from the transmitter/antenna systems or actual EMR survey results ensures the EME at the ordnance location are below MIL-STD-464 EME for HERO SAFE ordnance.

A4.3.3. The purpose of the listing and identifying the location of the ordnance present is to determine their HERO classification and to make note of EMR concerns at their respective locations. Ordnance locations include all locations represented in the S4 for a specific ordnance item; e.g., storage areas, assembly areas, transportation routes, staging areas, and deployment locations. AFSEC/SEW provides HERO classification and susceptibility criteria. Ordnance not having a HERO classification is treated as HERO UNSAFE until a HERO status is provided by AFSEC/SEW. This ordnance may include components or subsystems of all-up rounds or HERO untested ordnance. In all instances, observe the protective requirements outlined in paragraph 4.1.4 of this instruction. Perform the following steps to complete the ordnance list and location identification:

A4.3.3.1. Consult with Munitions Accountable Systems Officer to determine the types and locations of ordnance items, ensure Operational Security and security classification requirements are enforced. Identify ordnance locations on the base D-8 map, as well as the ordnance transportation routes. This information is useful when performing EMR surveys.

A4.3.3.2. Once all ordnance and their location have been identified, refer to AFSEC/SEW listing to determine their HERO classification. The ordnance items are subject to the HERO package and their location is compared to the location of the emitter system listed, as described in paragraph A4.3.1.

A4.3.4. Once emitters, ordnance, and their respective locations have been identified, use the base D-8 map to determine the distances between the antennas and the various ordnance locations. Identify the emitter systems requiring HERO EMR control for each ordnance location, if required. In those instances where the SSDs exceed the distance to a specific ordnance location, HERO EMR control (radio silence) is necessary. Impose this HERO

EMR control condition when conducting ordnance operations, if necessary. Different locations may have identical HERO conditions as a result of this process; i.e., the same emitter system is restricted by HERO EMR control imposed in more than one location. In these instances, combine the same HERO EMR control condition by applying to more than one location in order to limit the number of HERO conditions imposed.

A4.3.5. Changes to the emitter and/or ordnance configuration can necessitate the update or modification of an existing HERO package. The deletion of either ordnance or emitters is simply a matter of removing the item from the existing HERO package.

A4.3.5.1. Upon receipt of new ordnance, identify its location and classification as described in paragraph A4.3.3 to determine if the existing HERO package needs modification. If the ordnance is percussion initiated or non-explosive, there is no EMR control requirement. For ordnance containing EIDs, match its location to the location description and specific conditions and procedures provided in the existing HERO package. Similarly, when ordnance items are relocated to an additional area, evaluate the ordnance location and add the results to the HERO package under the new location.

A4.3.5.2. The following applies to new emitter systems as well as relocated or upgraded existing emitter systems. Add relocated or upgraded emitter systems to an existing HERO package when system parameters change (e.g., power or gain increase) results in changes to the appropriate SSD. Assess whether the emitter SSD encompasses the ordnance location outlined in the existing HERO package. Assess the SSD and identify antenna location, then compare these distances with the distances from known ordnance locations outlined in the existing HERO package. If the SSD encompasses any of these ordnance locations, as outlined in the existing HERO package, incorporate EMR control restrictions (radio silence) into the existing HERO package for the appropriate location.

A4.3.6. The HERO package also documents the use of MMEs or other electronic equipment that emits on command or automatically generates EMR for use within magazine or ordnance assembly/disassembly areas or when employed around ordnance.

A4.4. EMR Survey. When the installation safety office cannot take into account all sources of EMR, needs to evaluate the attenuation of the surrounding environment, and/or cannot comply with minimum SSD because of the lack of real estate or other limitations, the Air Base Wing Commander shall request an EMR survey.

A4.4.1. An EMR survey provides measurements of the EMR fields, as well as a more detailed look at the operational environment. In some instances, data gathered by the EMR survey will alleviate some restrictions imposed by this instruction. The Air Base Wing Commander is responsible for requesting and funding an EMR survey. The installation safety office documents the results in the HERO package.

A4.4.2. The 85th Engineering Installation Squadron (EIS), Keesler AFB, is the AF provider of electromagnetic compatibility, electromagnetic interference, EMR and electromagnetic pulse field measurements, and analytical capabilities. Request these capabilities from 85th EIS at (228) 377-3920, DSN 597-3920, or email: **5EIS.SCYM.1@us.af.mil**, or from the Naval Surface Warfare Center, Dahlgren Division,

E3 Assessment and Evaluation Branch (Q52).

A4.4.3. The EMR survey consists of performing EME measurements and documenting the results with relevant technical data. Conclusions and recommendations regarding the use of transmitters during ordnance operations must be included and presented with supporting documentation. The organization performing the EMR survey prepares a report and provides their assessment to the WSM.

A4.4.4. IAW Engineering Technical Letter, 11-7, *Nuclear Weapons-Capable Maintenance and Storage Facilities*, latest revision, an EMR survey is required within each facility to ensure that exposure of nuclear weapon systems to the EME from all equipment installed or used within the facility, individually and collectively, does not result in an overall EME that exceeds the weapons' STS levels. Because nuclear weapons shall be certified as HERO SAFE, the EME shall not exceed MIL-STD-464, Table 9 levels, when the weapon is configured as an all-up round. If the nuclear weapon is undergoing maintenance, the weapon is classified as HERO UNSAFE, and the EME at that particular time and place must not exceed levels indicated in Table A2.3 and illustrated in Figure A2.3 (Attachment 2). Furthermore, perform EMR surveys at all other areas where nuclear weapons are employed during their S4 (e.g., dock, transportation routes, etc.).

Attachment 5

ORDNANCE MODIFICATION GUIDANCE

A5.1. Guidance. Use the following as guidance to determine what changes in ordnance usually result in a recommendation for a HERO test. Note that most changes to firing circuits result in a recommendation to conduct a HERO test.

A5.1.1. EID changes that require a HERO evaluation consist of changing firing stimulus response characteristics, changing the type of transducer that converts electrical input to energetic output, changing the fit or form of the EID, changes to EMR suppression components, and relocating EID to within ¼ λ (approximately 0.667 inches) of wiring that enters or exits ordnance envelope.

A5.1.2. Firing circuit changes that require a HERO evaluation consist of all non-direct current firing circuits (always require testing), relocating firing circuits within ¼ λ (approximately 0.667 inches) of wiring that carries signal or enters or exits ordnance envelope, changes to EMR suppression components, and most change to firing circuits.

A5.1.3. Ordnance envelope changes that require a HERO evaluation are any added aperture or antenna, changes to corrosion protection at mating seams, changes to wiring running outside the ordnance envelope, changes to EMR absorber coatings or gaskets, and relocating connectors involving ordnance subassemblies that contain EIDs.

A5.1.4. S4 changes that require a HERO evaluation consist of changes in EMR levels in authorized assembly/disassembly spaces for operations that expose EIDs or internal wiring of ordnance subassemblies that contain EIDs, and changes in shipping/storage container where container is intended to provide protection from EMR.

Attachment 6

REQUEST FOR HERO CERTIFICATION LETTER GUIDANCE

A6.1. Request for Certification Letter Contents. The first step in achieving HERO certification is the preparation of the request for HERO certification letter. The PM will prepare a letter, which consists of the following information:

A6.1.1. Nomenclature and/or description of ordnance, DODIC, and NSN of the system.

A6.1.2. If the ordnance requires assembly of several components, include the DODIC and NSN as well as part numbers for each component. These components must have been used when the ordnance was HERO tested/analyzed. Only that configuration, using those specific parts, will be certified.

A6.1.3. The recommended HERO classification (HERO SAFE, HERO SUSCEPTIBLE, or HERO UNSAFE) based on the information provided. If the HERO test/analysis indicates that the ordnance is HERO SUSCEPTIBLE or HERO UNSAFE and the PM has not elected to resolve the issue, the PM shall request a deviation. The contents and attachments will consist of the same information as listed above and will include a detailed risk assessment IAW paragraph 1.5.3.

A6.1.4. A technical point of contact familiar with the technical data/analysis provided.

A6.2. Attachments. Include with the letter any information that supports the HERO certification. In particular, include HERO test/analysis reports or in depth information, when comparing the article in question with existing HERO certified ordnance. Include the original test plan with the test report. The test report/test plan shall consist of the information outlined in MIL-HDBK-240. An analysis will consists of the same sections except a detailed analysis replaces any test results/discussions.