SUMMARY OF CHANGES

This revision includes administrative changes throughout, updates guidance for nuclear weapons, updates RADHAZ survey information, provides guidance on HERO warning symbols, includes information from MIL-STD-464C, clarifies SSD calculations, provides guidance on X-rays, and provides guidance for HERO uncertified ordnance, which eliminates chapter 9 from AFMAN 91-201, resulting in an all HERO inclusive instruction.

Attachment 1—GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION
Attachment 2—SAFE SEPARATION DISTANCE (SSD)
Attachment 3—EMR ANALYSIS ASSISTANCE
Attachment 4—HERO SURVEY PACKAGE
Attachment 5—ORDNANCE MODIFICATION GUIDANCE
Attachment 6—REQUEST FOR HERO CERTIFICATION OR ASSESSMENT
Attachment 7—NUCLEAR WEAPONS
Attachment 8—HERO WARNING SYMBOLS
Attachment 9—MIL-STD-464 REQUIREMENTS
Attachment 10—HERO PROTECTION OF UNCERTIFIED ORDNANCE

1. OVERVIEW.

1.1. Purpose.

1.1.1. This Air Force 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 reliability and safety standards, criteria, instructions, regulations, and electromagnetic emission control procedures of electromagnetic radiation (EMR) emitters throughout the Air Force 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 EMR 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, maintenance, 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 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 to external electromagnetic environments (EMEs) results in specified 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 intentional transmitting sources (e.g., radios, radars, electronic countermeasures equipment) or unintentional sources (e.g., arcing, high current switching transients). Consequences include both safety (premature firing) and reliability (EID dudding or altered functional characteristics) effects.

1.1.6. MIL-STD-464 and MIL-HDBK-240 define HERO SAFE, HERO SUSCEPTIBLE, and HERO UNSAFE as follows:

1.1.6.1. HERO SAFE. Any ordnance item that is sufficiently shielded or otherwise so protected that all EIDs contained by the item are immune to adverse effects (safety and reliability) when the item is employed in the radio frequency (RF) environment delineated in MIL-STD-464. The general HERO requirements defined in the hazards from EMR manuals must still be observed.

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 certified as HERO SAFE or HERO SUSCEPTIBLE as a result of a HERO analysis or test. Additionally, any ordnance item containing EIDs (including those previously certified 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-initiated ordnance have no HERO requirements and shall be notated as no HERO requirement (NHR).

1.2. Requirement.

1.2.1. To address HERO as stated in Department of Defense (DoD) Instruction (DoDI) 3222.03, DoD Electromagnetic Environmental Effects (E3) Program, latest revision, DoD Directive (DoDD) 6055.09E, Explosives Safety Management (ESM), latest revision, and DoD Manual 6055.09-M, Volume 2, DoD Ammunition and Explosives Safety Standards: Explosives Safety Construction Criteria, latest revision. Air Force shall ensure all programs conform to MIL-STD-464. Exceptions to such certification are commercial space launched type EID applications.

1.2.2. Per DoDI 3222.03, the Air Force shall ensure all E3 issues, which include HERO, shall be identified and assessed prior to entering the Systems Demonstration and Production and Deployment phases and are addressed during critical design reviews. The Air Force shall ensure ordnance is not deployed or released for Service use until it is HERO certified (HERO SAFE, HERO SUSCEPTIBLE, or HERO UNSAFE).

1.3. Scope.

1.3.1. The HERO program includes, but is not limited to, vulnerable assets and sources. Vulnerable assets include nuclear weapons 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 and store EMR emitters, radars, antennas, RF identification (RFID) systems, wireless laptops, handheld communication devices, etc.

1.3.2. Ordnance applicable to this instructions consists of all equipment, subsystems, and materials containing EIDs, which affects safety and/or mission reliability. Safety or mission critical EIDs are typically used to initiate explosives, chemicals, pyrotechnics, and similar stores carried on airborne, sea, space, or ground systems.

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 and require a HERO assessment.

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 Air Force installations, ground vehicles, aircraft, etc., including Foreign Military Sales (FMS) items only if they are also fielded for Air Force use.

1.4.2. Responsible ordnance Program Managers (PMs) will ensure certification of complete rounds (CRs) and any systems containing EIDs at the appropriate assembly level. Ordnance components do not require HERO certification and shall be considered HERO UNSAFE. PMs may request HERO certification of components to alleviate assembly/disassembly operations in the field. A CR is any combination of DoD Identification Codes (DODICs) to form a higher assembly. Identify CRs by using the CR Code (CRC) in the CR Dictionary maintained by the Global Ammunition Control Point at Hill Air Force Base.

1.4.3. Ordnance EIDs and EMR emitters used by the Eastern (45th Space Wing) and Western (30th Space Wing) Ranges are addressed by Air Force Space Command Manual (AFSPCMAN) 91-710, Range Safety User Requirements Manual, latest revision, local Space Wing instructions, and Air Force Manual (AFMAN) 91-201, Explosives Safety Standards, latest revision. PMs will ensure deviations that affect Launch Safety Requirements Relief Requests are IAW AFSPCMAN 91-710 requirements.

1.4.4. Foreign ordnance to be fielded by the Air Force requires HERO certification. Foreign ordnance used by the Air Force as part of a joint development effort and/or usage requires a HERO assessment.

1.4.5. PMs employing or transporting ordnance on their platforms and/or transportation vehicles, e.g., aircraft, ground vehicles, drones, etc., are subject to this instruction.

1.5. Implementation.

1.5.1. The primary objective of the HERO program is to have all Air Force ordnance certified as HERO SAFE. Until ordnance systems are HERO certified, guidance in Attachment 10 shall apply to all HERO uncertified ordnance. Ordnance PMs have until May 2018 to achieve certification. If funding is not received until May 2018, the responsible ordnance PM has until May 2020 to have the ordnance certified appropriately. Uncertified ordnance shall be considered HERO UNSAFE and listed on the HERO website, https://cs1.eis.af.mil/sites/afsec/HERO/default.aspx.

1.5.2. Ordnance PMs must ensure all existing ordnance, including nuclear weapons, are certified IAW this instruction. For ordnance having HERO test data and/or analysis, the responsible ordnance PM shall submit a certification request to Air Force Safety Center,
Weapons Safety Division, (AFSEC/SEW) (Attachment 6). For ordnance not having HERO test data, analysis, or a combination thereof, the responsible ordnance PMs shall have the ordnance HERO tested, analyzed, or a combination thereof IAW this instruction.

1.5.2.1. If HERO test data, analysis, or a combination thereof, for existing ordnance indicates a certification of HERO SUSCEPTIBLE or HERO UNSAFE, the responsible ordnance PM shall attempt to resolve the issue and achieve HERO SAFE certification. If unable to achieve HERO SAFE certification, the responsible PM submits a certification request IAW this instruction and the ordnance is certified as either HERO SUSCEPTIBLE or HERO UNSAFE, depending on the information provided.

1.5.2.2. To HERO certify legacy ordnance, an assessment of the existing data, supporting analysis, or a combination thereof, will be required to show the ordnance satisfies 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.

1.5.2.3. For ordnance certified as either HERO SUSCEPTIBLE or HERO UNSAFE, Major Commands (MAJCOMs) will ensure separation distances from EMR emitters are greater than the determined safe separation distance (SSD) for the EMR emitters. Other means of protecting the ordnance from EMR emitters may be used if the ordnance is within the SSD. This is applicable for all S4 phases. For ordnance on aircraft, ground vehicles, etc., maintain a standoff distance greater than the SSD for EMR emitters at fixed locations to mitigate the risk of HERO. Guidance for determining SSDs is provided by Attachment 2. For HERO uncertified nuclear weapons and conventional ordnance, follow guidance provided by Attachment 10 until the ordnance is HERO certified. After May 2018, uncertified ordnance shall be certified as HERO UNSAFE.

1.5.2.4. Foreign ordnance requires HERO certification. Ordnance PMs having foreign ordnance under their cognizance may request test data and/or analysis from the country of origin indicating compliance with MIL-STD-464 EME levels for HERO certification. Otherwise the item shall be certified as HERO SUSCEPTIBLE or HERO UNSAFE, depending on the information provided.

1.5.3. The PM, Acquisition Manager, or Installation Activity employing ordnance on their platforms (aircraft, ground vehicles, etc.) shall ensure platform EME has been characterized either by test, analysis, and/or a combination thereof. The EME characterization shall verify that intra-system EME does not pose a hazard to platform carried ordnance. EME characterization shall be accomplished by May 2018. If funding is not received until May 2018, EME characterization shall be due by May 2020. System modifications may alter the baseline EME characterization. Evaluate modifications for EME impact and adjust the baseline throughout the system lifecycle. Resulting platform EME characterization will include all documentation achieved through testing, analysis, and/or combination thereof. Additional guidance for platform EME characterization is provided in paragraph 4.3.
1.5.4. The installation Weapon Safety Manager (WSM) shall prepare and maintain the HERO survey package (Attachment 4). (T-1).

2. RESPONSIBILITIES.


2.1.1. Within the continental United States, AFSMO reviews all spectrum certification requests for technical accuracy and submits these requests to the national spectrum certification system for their acceptance.

2.1.2. Outside the United States, AFSMO reviews all spectrum certification requests for technical accuracy and submits these requests to Host Nation via the Combatant Command responsible for that region for their acceptance.

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

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

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

2.2.3. Establish and maintain procedures for using modern mobile emitters (MMEs) that emit on command or automatically in the vicinity of ordnance.

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

2.2.5. Maintain a permanent file of certifications and assessments for all Air Force ordnance (both conventional and nuclear weapons). For items not certified or assessed as HERO SAFE, the file includes 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 safe operations. A database of certified and assessed ordnance, approved MMEs, ordnance exempt from certification, and platform EME characterization is maintained at the HERO website, https://cs1.eis.af.mil/sites/afsec/HERO/default.aspx.

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

2.2.7. Represents the Air Force in HERO matters on the following:

2.2.7.1. Committees, boards, panels, and program with other Services and foreign nations.
2.2.7.2. Joint Ordnance Commanders Group (JOCG) E3 Ordnance Safety Subgroup program

2.2.7.3. Joint Spectrum Center (JSC) Ordnance E3 Risk Assessment Database (JOERAD) Configuration Control Board.

2.2.8. Ensure all HERO data generated by ordnance PMs is provided to JSC for incorporation into JOERAD, which will provide a list of approved equipment, a joint ordnance repository, and the capability to calculate the associated SSD. Obtain access to JOERAD database when online development is complete by contacting Defense Spectrum Organization (DSO)/JSC (J5) at commercial (410) 293-9264, DSN 281-9264, disa.usna.dso.list.jsc-j5-joerad-help@mail.mil, or online at https://acc.dau.mil/Joerad (complete the DSO access request form). JOERAD is available to United States Military, United Stated Government, and their supporting contractors.

2.3. Nonnuclear Munitions Safety Board (NNMSB). NNMSB considers HERO assessments and certifications by AFSEC/SEW when assessing munitions and related items containing EIDs for final Operational Certification and flight test.

2.4. MAJCOMs. MAJCOMs will:

2.4.1. Coordinate RF spectrum requirements through the MAJCOM spectrum management office and obtain allocation for spectrum dependent systems and frequency assignments 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 determine SSDs for ordnance.

2.5. Air Force Materiel Command (AFMC) and System Lead Commands. 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, and that testing is conducted IAW the guidance in MIL-HDBK-240.

2.6. Air Force Life Cycle Management Center (AFLCMC). AFLCMC, E3, will:

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

2.6.2. Provide technical advisors on HERO certification and overall E3 matters to AFSEC and AFMC. (T-1).

2.6.3. Review and provide technical coordination for HERO SUSCEPTIBLE and HERO UNSAFE certifications.

2.7. Air Force PEOs. Air Force PEOs will:

2.7.1. Ensure implementation of HERO requirements for applicable programs.

2.7.2. Ensure the applicable criteria for HERO safety are included in applicable program documents (i.e., System Engineering Plans, Test and Evaluation Master Plans, System

2.7.3. Ensure ordnance variants, which include temporary instrumentation such as measurement hardware, telemetry, flight safety systems/flight termination systems, etc., and contain EIDs or EMR emitters are subject to this instruction. (T-1).

2.8. Platform PMs. Platform designs, modifications, and ordnance integration involving EIDs affect both ground-based platforms and airborne platform airworthiness. Therefore, airborne platform EME characterization shall be considered an element of SEEK EAGLE certification and airworthiness certification IAW AFI 63-104, The SEEK EAGLE Program, latest revision, and AFI 62-601, USAF Airworthiness, latest revision. Platform PM will:

2.8.1. Characterize the EME of the platform, including the EME in enclosed cavities such as weapon bays, by system-level test, analysis, or a combination thereof, which directly impacts ordnance, and retain the information to ensure ordnance remains safe from EMR hazards. (T-1). Document the EME characterization and provide the information to AFSEC/SEW.

2.8.2. Update the initial EME characterization when modifications to the delivery system affect the platform EME. (T-1).

2.9. Installation Safety Office. Installation safety office will:

2.9.1. Ensure HERO safety procedures for ordnance on their installation have been implemented. (T-1).

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

2.9.3. Review and approve for HERO safety all installation-level design changes or new EMR emitters and relocating or upgrading EMR emitters. (T-1).

2.9.4. Ensure a Radiation Hazard (RADHAZ) survey is performed when all sources of EMR cannot be taken into account, the attenuation of the surrounding environment is unknown, and/or minimum SSD cannot be complied with. (T-1).

2.9.5. Perform a review annually to determine if a RADHAZ survey is necessary. (T-1).

2.9.6. Ensure the WSM, with the assistance of the Installation Spectrum Manager (ISM), identify EMR emitters, including MMEs, which constitutes a radiation hazard to military munitions. If the installation does not have an ISM, the WSM shall contact the local communications squadron and, if applicable, the Host Nation equivalent to identify and characterize EMR emitters located on the installation. These areas shall display HERO warning signage (Attachment 8) and be identified on HERO survey package D-8 maps if they pose a risk to munition operations. (T-1).

2.10. Installation Spectrum Manager (ISM). ISM will:

2.10.1. Provide installation safety office and WSM with EMR data. At a minimum, provide the following emitter characteristics: military nomenclature or, if appropriate,
manufacturer and model, location, mode (continuous or pulse-modulated), power type (average or peak, depending on mode), EMR emitter power, frequency/band, and antenna gain, in addition pulse width (pw) and pulse repetition frequency (prf) for pulse-modulated systems. (T-1).

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

2.10.3. Prepare and maintain spectrum assignment records for their installation and provide the installation safety office a RF authorization upon request. (T-1).

2.11. Civil Engineering Squadron. Civil Engineering Squadron will:

2.11.1. Report any using unit plans/efforts to install new EMR emitters to the ISM, installation safety office, and WSM. (T-1).

2.11.2. Report any using unit plans/effort to relocate any existing EMR emitters or changes to the frequency(ies), antenna gain, and/or EMR emitter power of any existing EMR emitter on the installation to the ISM, installation safety office, and WSM. (T-1).

2.12. Munitions Squadrons and Organizations Utilizing Ordnance. Munitions Squadrons and organizations utilizing ordnance will:

2.12.1. Maintain configuration control of their facilities and equipment with respect to the permanent/recurring EME and submit EMR configuration changes to the ISM, installation safety office, and WSM.

2.12.2. Incorporate into the unit’s Explosives Safety Training Plan the susceptibility of EIDs, certification of ordnance, and their physical configurations, IAW AFI 91-202, and this instruction. (T-1). Training should include information on all phases of S4 that the unit interacts with and general HERO requirements in paragraph 4.2.

2.12.3. Provide the installation safety office and WSM with current ordnance procedures, the location where the operations are planned, and a list of ordnance at the installation.

2.12.4. Procure and install HERO warning signs, if required.

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 Air Force programs responsible for the design, development, test and evaluation, and sustainment of ordnance.

3.2. Process.

3.2.1. DoD Manual 6055.09-M, Volume 2, requires HERO certification of all DoD ordnance. This certification covers all six-phases of the S4 in the EME identified in MIL-STD-464, Table 9, and applies during the disposal of ordnance.

3.2.2. The six-phases of the S4, 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 test, 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 regards to the actuation of its explosives, pyrotechnics, or propellants.

3.2.3. PM of new or modified ordnance will provide information to the HERO evaluation organization concerning the design, development, and evaluation schedules for items under their cognizance.

3.2.4. PM will provide a list of all affected CRCs, if applicable, 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, CRC, 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.

3.2.5. HERO evaluation organization shall be either a DoD facility, e.g., Naval Surface Warfare Center, Dahlgren Division Laboratory, E3 Assessment and Evaluation Branch, B52, HERO PM, (540) 653-3445; United States Army White Sands Test Center, E3 Test Facility, Electromagnetic Effects Division, (575) 993-0885; and United States Army Redstone Test Center, System Engineering Directorate (256) 876-3556; or an appropriate contractor. (T-1).

3.2.5.1. HERO evaluation organization provides the PM with cost and schedule estimates regarding required consultation services, analysis, and/or testing services.
3.2.5.2. PM will ensure adequate funding is provided to the HERO evaluation organization for supporting the required consultation services, analysis, and/or testing services.

3.2.5.3. HERO evaluation organization will provide 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).

3.2.5.4. PM will review and approve 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.

3.2.5.5. HERO evaluation organization will provide 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).

3.2.5.6. PM will provide all test articles to the HERO evaluation organization IAW requirements of the approved HERO test plan. (T-1).

3.2.5.7. HERO evaluation organization will instrument the EIDs and install them in ordnance test article and conducts the test. (T-1).

3.2.5.8. HERO evaluation organization will submit the HERO test and/or analysis report to the PM with a HERO certification recommendation. (T-1).

3.2.5.9. Results of the risk assessment/acceptance process IAW AFI 91-202 and MIL-STD-882, System Safety, latest revision, for determining the relative level of risk associated consequence and probability shall be submitted for all HERO SUSCEPTIBLE and HERO UNSAFE certifications. (T-1). The PM will ensure the risk assessment is based upon the currently available set of E3 test data and/or analysis or a combination thereof and is assessed against the completeness, or lack thereof, versus Table A2.2 EME levels, illustrated in Figure A2.2, for HERO SUSCEPTIBLE and Table A2.1 EME levels, illustrated in Figure A2.1, for HERO UNSAFE.

3.2.6. PM will request HERO certification (Attachment 6) and will provide the HERO test and/or analysis report as rationale. For HERO SUSCEPTIBLE or HERO UNSAFE certification, the PM will also provide a risk assessment. PM will provide system CRC, if applicable, and component NSNs and DODICs. This ensures production design is the same as the tested configuration with respect to HERO.

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

3.2.8.2. If not certified as 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). Otherwise the ordnance shall be certified as HERO UNSAFE or HERO SUSCEPTIBLE depending on the information provided. The PM shall prepare
a risk assessment as described in paragraph 3.2.7. The ordnance will be included in the next change/revision of JOERAD and listed by AFSEC/SEW. (T-1). AFSEC/SEW retains the HERO certification on file and provides the PM a copy.

3.2.8.3. If the system requires use due to operational necessity, the ordnance is treated as HERO UNSAFE, until suitable modifications are fabricated, evaluated, and retrofitted. (T-1).

3.2.9. HERO certification is mandatory prior to fielding.

3.3. HERO Assessments.

3.3.1. 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.

3.3.2. The PEO/PM requests a HERO assessment (Attachment 6) from AFSEC/SEW and provides test data and/or analysis to support the assessment.

3.3.3. If the test asset contains telemetry, ensure an intersystem HERO test and/or analysis is accomplished. Provide AFSEC/SEW the telemetry antenna’s characteristics, such as frequency, antenna gain, and EMR emitter power to establish appropriate SSDs.

3.3.4. Test data and/or analysis used to support the HERO assessment may be used to support final HERO certification if modifications performed after HERO assessment do not directly affect the EIDs and/or their EMR susceptibility (Attachment 5).

3.3.5. At a minimum, the PEO/PM shall provide test data and/or analysis regarding all EIDs that have a safety consequence. If the PEO/PM accepts the risk that EIDs having a reliability consequence might dud or inadvertently fire, test data and/or analysis are not required and the item shall be assessed for safety only.

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 is never located where EMR electric field/power density is sufficiently high to couple enough electrical energy into the device to initiate the device or degrade performance. In addition, shielding, filtering, bonding, grounding, or a combination may be used if an approved analysis and/or test supports protection against EME.

4.1.2. HERO SAFE ordnance is considered unserviceable after exposure to EME above those defined in MIL-STD-464 and Attachment 9 of this publication due to the potential for both direct EMR induced actuation of the EIDs and inadvertent activation of an electrically powered firing circuit. Report the unserviceable condition through appropriate Service channels.

4.1.3. HERO SUSCEPTIBLE ordnance may not necessarily be susceptible to the levels in Table A2.2. The susceptibility may be a level between Table A2.2 levels and MIL-STD-464 levels. HERO SUSCEPTIBLE ordnance is considered unserviceable after exposure to EME above those determined by analysis or testing resulting in a HERO SUSCEPTIBLE certification, due to the potential for both direct EMR induced actuation
of the EIDs and inadvertent activation of an electrically powered firing circuit. Report the unserviceable condition through appropriate Service channels.

4.1.4. HERO UNSAFE ordnance is considered unserviceable after exposure to EME above those defined in Table A2.1 due to the potential for both direct EMR induced actuation of the EIDs and inadvertent activation of an electrically powered firing circuit. Report the unserviceable condition through appropriate Service channels.

4.1.5. The WSM shall clearly mark with warning symbols areas where the levels of RF electromagnetic fields constitutes a radiation hazard to military munitions (Attachment 8). (T-1).

4.2. General HERO Requirements. The following must be implemented when conducting operations with any ordnance, regardless of HERO certification. Personnel handling ordnance shall:

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

4.2.2. Not alter ordnance or handle umbilical cables and cable connectors unless authorized or approved by technical order or higher authority. (T-1).

4.2.3. Not expose internal wiring and firing circuits by assembling or disassembling the ordnance, unless authorized by item technical order or higher authority. (T-1).

4.2.4. Transport all HERO UNSAFE and HERO SUSCEPTIBLE ordnance in sealed, all-metal containers whenever possible, which is considered a HERO SAFE configuration. When transporting ordnance in a vehicle, the minimum SSD requirements are applicable. (T-1).

4.2.5. Treat ordnance containing disassembled EIDs or when exposed EIDs, firing circuits, or wiring are present as HERO UNSAFE. (T-1).

4.2.6. Maintain a minimum SSD of 10 feet for HERO SAFE ordnance unless the EMR emitter effective isotropic radiated power (EIRP) and frequency meet the criteria of Table A2.5, then the minimum SSD listed applies. (T-1). For MME SSD, refer to guidance provided in paragraph 4.5. For ordnance on a delivery platform, where a minimum of 10 feet may not be possible, platform PM must conduct an analysis and/or test proving the maximum allowable environment (MAE) of the ordnance is not exceeded (paragraph 4.3). (T-1).

4.2.7. Maintain the appropriate SSD for HERO UNSAFE or HERO SUSCEPTIBLE ordnance. If relying on a RADHAZ survey, ensure the EME does not exceed Table A2.1 levels for HERO UNSAFE ordnance and, when no measured data are available, Table A2.2 levels for HERO SUSCEPTIBLE ordnance. If a RADHAZ survey is not available or does not take into account all EMR emitters present, determine the appropriate SSD using guidance provided in Attachment 2. (T-1). If the EMR emitter is a MME, refer to guidance provided in paragraph 4.5. For ordnance on a delivery platform, where the calculated SSD is not possible, platform PM must conduct an analysis and/or test proving the MAE of the ordnance is not exceeded (paragraph 4.3). (T-1).

4.3. EME Characterization Process for Platforms.
4.3.1. The characterization process for the host platform’s EME is a key step in weapon system integration process and supports compliance to the HERO certification requirements. This process is applied to both ground-based and airborne platforms (airworthiness requirements are defined by AFI 62-601 and specifically for HERO by MIL-HDBK-516, Airworthiness Certification Criteria, latest revision). Regardless of ordnance HERO certification, ordnance must be integrated onto the host platform so as not to exceed the safe exposure levels of EME dictated by the ordnance certification. This integration process is an assessment looking at the balance of locating the ordnance at a sufficient distance apart from on-board emitters in order to adhere to the SSD criteria of the given ordnance. To properly manage that balance, knowledge is required of the ordnance capability to withstand EME (i.e., HERO certification) and the host platform emitters’ capability to produce EME.

4.3.2. The following steps outline the platform EME characterization process. The data can be acquired by accessing existing historical data, component/system testing, analysis, or a combination thereof:

4.3.2.1. Ordnance Locations. A full list of ordnance locations, i.e. station (STA): fuselage station (FS)/but line (BL)/water line (WL), on the platform need to be known and cataloged prior to performing this analysis.

4.3.2.2. Platform Emitter Data. Obtain the following data for each emitter on the host platform to support EME characterization:

4.3.2.2.1. Emitter antenna location(s) on the host platform, i.e., STA: FS/BL/WL.

4.3.2.2.2. Emitter antenna transmit patterns, including side lobes and gain.

4.3.2.2.3. Emitter transmitter power characteristics, i.e., peak power, average power, and duty cycle (DC).

4.3.2.2.4. Frequency(ies) of operation of emitters and associated bandwidths.

Note: Item 4.3.2.2.1 is typically supplied by the host platform integrator. Items 4.3.2.2.2, 4.3.2.2.3, and 4.3.2.2.4 are typically determined by examination of the emitter’s certification data sheet, i.e., DD Form 1494, Application for Equipment Frequency Allocation.

4.3.2.3. SSD Determination. From the data acquired in 4.3.2.2, determine the EME/SSD at each ordnance location as it related to each of the three HERO ordnance certifications. For HERO SAFE ordnance, EME levels must be less than MIL-STD-464 levels. For HERO SUSCEPTIBLE and HERO UNSAFE ordnance, calculate SSDs IAW Attachment 2 guidance. In cases where the EME/SSD is not met, a corrective action to remedy the conflict must be accomplished or limitations shall be placed on the host platform to reduce or eliminate risk. If a correction action cannot be accomplished and the situation impacts airworthiness, ordnance reliability, or ordnance premature firing, the limitation placed upon the host platform or the ordnance to reduce or eliminate risk shall be coordinated and accepted by the appropriate risk acceptance authority IAW AFI 62-601.

4.3.2.4. Documentation. Each characterization package must contain a cover memorandum with a cumulative HERO summation for the platform based on test or
engineering analysis. This summation is the most restrictive HERO certification of all involved ordnance. A risk acceptance package is required for each ordnance location not meeting MIL-STD-464 EME levels for HERO SAFE ordnance. Also, document if the platform cannot accommodate HERO SUCEPTIBLE or HERO UNSAFE ordnance or what mitigation steps to be taken to reduce the EME to accommodate such ordnance.

4.3.3. The platform EME characterization process has been outlined to assist the weapon system integrator understand the key/critical aspects that the host platform EME plays in safe weapon integration. There are several caveats, exceptions, and variables that can play into this process that are not explicitly defined herein.

4.3.3.1. Typically, the platform EME characterization is performed using computer-based calculations/equations because of the complexities of a typical host platform geometry. The EME and resulting SSDs have very strong dependency upon the geometry of the platform, the complexity of the emitter radiation patterns and side lobes, reflections, multiple antenna locations and cavities/enclosed weapons bays. Also, variables such as transmitter DCs, modulations, power settings, and equipment with classified performance parameters add to the overall complexity of the analysis.

In some cases, it is prudent and sufficient to make simplifying assumptions to keep calculations in a first order line of sight SSD calculation (Attachment 2). When these simplifications yield noncompliant EME, SSDs, or overly severe limitations, a more detailed analysis or in some cases testing will be required.

4.3.3.2. EME characterization process shall be performed by an experienced E3 engineer who has detailed knowledge of the host platform’s electromagnetic performance characteristics. This responsibility typically falls upon the platform’s PM technical staff such as the Chief Engineer, or the platform contractor responsible for E3 integration. Additional technical support for consultation and/or performing these assessments can be provided by the Air Force E3 subject matter experts. Their contact information can be found at https://cs3.eis.af.mil/sites/AFLCMCEZA/E3/SitePages/Home.aspx.

4.4. Traditional Fixed-Location Emitter (TFE)/Mobile Emitter (ME).

4.4.1. TFEs are in a fixed location, usually mounted on a tower, mast, or rooftop. MEs are similar to TFEs except they can be moved to different locations.

4.4.2. Determine the EME utilizing the RADHAZ survey or determine the SSD using guidance provided in Attachment 2. If the minimum distance (SSD) is maintained between the ordnance and the TFE/ME, the EMR electric field/power density at the location of the ordnance, even under optimal transmission and coupling conditions, is too low to provide sufficient energy to initiate or degrade the EIDs within the ordnance.

4.4.3. WSM shall evaluate the potential for HERO, i.e., HERO certification, SSD, RADHAZ survey results, etc., for all explosive locations with ordnance. This information is documented in the HERO survey package.

4.5. Modern Mobile Emitter (MME). MMEs may emit lower power levels than conventional EMR emitters (TFEs/MEs), but may also be brought much closer to ordnance
even into the near-field of their antenna. MMEs, such as cellular telephones, active pagers, tablets, and some walkie-talkies automatically emit EMR without operator action.

4.5.1. Use of a MME less than a SSD of 10 feet requires approval from AFSEC/SEW, which determine SSDs using Table A2.5.

4.5.1.1. The installation safety office, the unit needing to use the MME, or the PM responsible for purchasing and/or issuing the MME shall request approval for use from AFSEC/SEW and provide the average output power, antenna gain, and frequency(ies), actual EMR test data, and/or Federal Communications Commission (FCC) identification to AFSEC/SEW.

4.5.1.2. AFSEC/SEW responds with an approval memorandum documenting the appropriate SSDs thirty days after receiving the request.

4.5.1.3. A list of approved MMEs is maintained by AFSEC/SEW at the HERO website, https://cs1.eis.af.mil/sites/afsec/HERO/default.aspx.

4.5.1.4. Organizations employing these devices must address other hazards and security concerns with their MAJCOM. Final authority for use resides with the MAJCOM.

4.5.2. MMEs authorized for use in storage, build-up, and assembly areas where ammunition and explosives are present, shall not be connected to power via power cords. Batteries shall not be charged in the magazines, in storage, build-up, or assembly areas when ammunition and explosives are present due to the possibility of the batteries exploding.

4.5.3. Multiple MMEs (two or more) are not authorized in enclosed, reflective spaces such as magazines or facilities where ordnance is stored or built-up; the aggregated effects on the ambient or volumetric electromagnetic field in those spaces may increase as a results of complex cavity effects, unless authorized by AFSEC/SEW. If the RADHAZ survey included the use of two or more AFSEC/SEW approved MMEs while maintaining EME levels that did not exceed HERO EME levels for ordnance (HERO SAFE, HERO SUSCEPTIBLE, or HERO UNSAFE), multiple MMEs are permissible.

4.5.4. All remote entry devices including car entry keys in compliance with Code of Federal Regulations (CFR), Title 47, Telecommunication, Part 15, Radio Frequency Devices, paragraph 15.231, Periodic operation in the band 40.66-40.70 MHz and above 70 MHz, are only restricted from coming into physical contact with ordnance, regardless of certification. Remote entry devices not in compliance with regulations or not properly labeled must maintain a SSD of 10 feet. If a planned operation occurs outside the United States where FCC regulations are not applicable, request assistance from AFSEC/SEW.

4.6. Other EMR Emitters.

4.6.1. The PM Joint-Automatic Identification Technology (PM J-AIT) is testing radiated emission from RFID and AIT equipment for near-field operation using worst-case guidance limitations. Observe the SSD calculated, approved, and published by PM J-AIT for individual pieces of equipment applicable to munitions operations.

4.6.2. Items, such as desktop computers, laptops, tablets, associated hardware (such as printer, mice, etc.), etc., not configured with radiating wireless capability, e.g., cellular,
Wi-Fi, Bluetooth, etc., are authorized for use in storage, build-up, and assembly areas where ordnance are present with the following restrictions:

4.6.2.1. Items shall be certified to meet CFR, Title 47, *Telecommunication*, Part 15, *Radio Frequency Devices*, Class A or B limits and labeled accordingly. They require no SSD and can be used in close proximity but cannot come in direct contact with ordnance regardless of certification. If the item is not properly labeled or cannot be determined to meet the appropriate regulation, a SSD of 10 feet applies. If a planned operation occurs outside the United States where FCC regulations are not applicable, request assistance from AFSEC/SEW.

4.6.2.2. Items with RF wireless capabilities are considered MMEs and paragraph 4.5 applies.

4.7. Nuclear Weapons.

4.7.1. Guidance for maintaining safe HERO operations when nuclear weapons and components are involved is provided in Attachment 7.

4.8. X-Rays.

4.8.1. Damage to explosives, resulting from exposure to X-ray radiation, is related to total dose, exposure time (dose rate in some instances), and the physical properties of the material. With the addition of a safety margin, the X-ray rate dose will not exceed 1,400 rads/minute, and/or the total dosage will not exceed 100,000 rads. Under these conditions, no HERO problems are expected and explosives should remain safe and reliable. Total doses exceeding 100,000 rads will likely change decomposition rates and increase the time to explosion.

ANDREW M. MUELLER  
Major General, USAF  
Chief of Safety
Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References
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Technical Order 31Z-10-4, Joint Services Command, Control, Communication, and Computer Systems Electromagnetic Radiation Hazards, 1 February 2005
DoD Directive 6055.09E, Explosives Safety Management (ESM), 18 November 2016
DoD Instruction 3222.03, DoD Electromagnetic Environmental Effects (E3) Program, 25 August 2015, Incorporating Change 1, 8 January 2015
DoD Instruction 5000.02, Operation of the Defense Acquisition System, 7 January 2015
Code of Federal Regulations, Title 47, Telecommunication, Chapter I, Federal Communications Commission

**Prescribed Forms**

Air Force Form 847, *Recommendations for Change of Publication*

DD Form 1494, *Application for Equipment Frequency Allocation*

**Abbreviations and Acronyms**

AFI—Air Force Instruction

AFLCMC—Air Force Life Cycle Management Center

AFMAN—Air Force Manual

AFMC—Air Force Materiel Command

AFNWC—Air Force Nuclear Weapons Center

AFPD—Air Force Policy Directive

AFRIMS—Air Force Records Information Management System

AFSC—Air 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

BL—butt line

CFR—Code of Federal Regulations

COMSEC—Communication Security

CR—complete round

CRC—complete round code

DC—duty cycle

DoD—Department of Defense
DoDD—Department of Defense Directive
DoDI—Department of Defense Instruction
DODIC—Department of Defense Identification Code
DOE—Department of Energy
DSO—Defense Spectrum Organization
E3—electromagnetic environmental effects
EFI—exploding foil initiator
EID—electrically initiated device
EIS—Engineering Installation Squadron
EIRP—effective isotropic radiated power
EME—electromagnetic environment
EMFR—electromagnetic field radiation
EMR—electromagnetic radiation
EOD—explosive ordnance disposal
ERP—effective radiated power
ESM—Explosives Safety Management
FCC—Federal Communications Commission
FMS—Foreign Military Sales
FS—fuselage station
HERO—hazards of electromagnetic radiation to ordnance
IAW—in accordance with
ICBM—Intercontinental Ballistic Missile
IMS—Inventory Management Specialist
ISM—Installation Spectrum Manager
JOCG—Joint Ordnance Commanders Group
JOERAD—Joint Spectrum Center Ordnance Electromagnetic Environmental Effects Risk Assessment Database
JSC—Joint Spectrum Center
MAE—maximum allowable environment
MAJCOM—Major Command
MASO—Munition Accountable Systems Officer
ME—mobile emitter
MCs—military characteristics
MIL-HDBK—Military—Handbook
MIL-STD—Military—Standard
MME—modern mobile emitter
NAVSEA—Naval Sea Systems Command
NHR—no hazards of electromagnetic radiation to ordnance requirement
NNMSB—Nonnuclear Munitions Safety Board
NSN—National Stock Number
OPR—Office of Primary Responsibility
OPSEC—Operations Security
PEO—Program Executive Officer
PM—Program Manager
PM J-AIT—Program Manager Joint—Automatic Identification Technology
prf—pulse repetition frequency
pri—pulse repetition interval
p—static—precipitation static
pw—pulse width
RADHAZ—radiation hazard
RDS—Records Disposition Schedule
RF—radio frequency
RFID—radio frequency identification
rms—root-mean-squared
S4—stockpile-to-safe separation sequence
STMS—Secure Transportable Maintenance System
SSD—safe separation distance
STA—station
STS—stockpile-to-target-sequence
TFE—traditional fixed-location emitter
WL—water line
WMT—Weapons Maintenance Truck
WSM—Weapon Safety Manager
Terms

Antenna—That part of the receiving or emitting system designated to radiate or receive electromagnetic energy.

Antenna Gain—Antenna gain (G) is a performance figure combining the antenna’s directivity and electrical efficiency. In an antenna, antenna gain describes how well the antenna converts input power into electromagnetic fields headed in a specific direction. In a receiving antenna, antenna gain describes how well the antenna converts electromagnetic fields arriving from a specific direction into electrical power. For the purposes of this instruction, antenna gain is expressed in dBi, unless otherwise noted.

Bridgewire—A metal wire heated by the passage of electrical current, which initiates the deflagration or detonation charge surrounding the wire.

Continuous Signal—An emitter producing uninterrupted electromagnetic energy. Amplitude modulation, frequency modulation, and phase modulation are considered continuous because the electromagnetic energy is continuously present. The power may vary with time due to modulation, but electromagnetic energy is always present.

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—Effect isotropic radiated power (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.

Electric Field Strength—Electric field strength (E) is the magnitude of the electric field vector with units of volts (V) per meter (V/m).

Electromagnetic Environment—Electromagnetic environment (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, such as lightning, precipitation static (p-static), electrostatic discharge, galactic and stellar noise, and so forth, and man-made sources, such as electrical and electronic systems, RF 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 EMR emitter power levels, operational factors, such as distance between items and force structure and frequency coordination, all contribute to the EME.

Electromagnetic Environmental Effects—Electromagnetic environmental effects (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 RF systems; ultra-wideband devices; high-powered microwaves systems; p-static; and so forth.

**Frequency**—For a period function, frequency (f) is the number of cycles or events per unit time measured in hertz (Hz) or cycles per second.

Hertz Conversion

1 Hz = 1 Hertz
1,000 Hz = 1 kHz (kilohertz)
1,000,000 Hz = 1 MHz (Megahertz)
1,000,000,000 Hz = 1 GHz (Gigahertz)

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)

\( c = \text{speed of light (}3 \times 10^8 \text{ meters/second)}\)

\( \lambda = \text{wavelength (meters)}\)

**Hazards of Electromagnetic Radiation to Ordnance**—MIL-HDBK-240 defines hazards of electromagnetic radiation to ordnance (HERO) as the situation in which exposure to external EME results in specified safety or reliability margins of EIDs or electrically powered ordnance firing circuits to be exceeded, or EIDs to be inadvertently actuated. MIL-STD-464 and MIL-HDBK-240 define HERO SAFE, HERO SUSCEPTIBLE, and HERO UNSAFE as follows:

**HERO Safe**—Any ordnance item that is sufficiently shielded or otherwise so protected that all EIDs contained by the item are immune to adverse effects (safety and reliability) when the item is employed in the RF environment delineated in MIL-STD-464. The general HERO requirements defined in the hazards from EMR manuals must still be observed.

**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.

**HERO Unsafe**—Any ordnance item containing EIDs not certified as HERO SAFE or HERO SUSCEPTIBLE as a result of a HERO analysis or test. Additionally, any ordnance item containing EIDs (including those previously certified 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.

**HERO Margin**—HERO margin is the difference between the maximum no-fire stimulus and the permissible EID response level. For EIDs used in conventional ordnance, the margin is
defined in MIL-STD-464 as 16.5 dB for EIDs having a safety consequence and 6 dB for EIDs having a reliability consequence. For nuclear weapons, the margin is defined as 16.5 dB for EIDs having a safety consequence only. For Intercontinental Ballistic Missiles (ICBMs), when exposed to the EME levels specified in MIL-STD-464, the maximum root-mean-squared (rms) current in its bridgewire shall be 20 dB below the maximum no-fire current of the EIDs having a safety consequence only.

**No HERO Requirement**—No HERO requirement (NHR) is a category of ordnance that do not contain EIDs. The ordnance may be totally inert or it may contain explosive material that cannot be initiated by RF energy. These items are not subject to HERO testing/analysis or the HERO requirements of Services’ publications. These items may be included in the ordnance databases as NHR ordnance.

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

**Mission Critical**—Unless otherwise defined in the procurement specification, a term applied to a condition, event, operating, process, or item which if performed improperly, may: 1) prohibit execution of mission, 2) significantly reduce the operational capability, or 3) significantly increase system vulnerability.

**Mobile Emitter**—Mobile emitters (MEs) are similar to a TFE except they can move, e.g., mobile ATC system, AN/TPS-75 radar system, etc. MEs must be tracked by the ISM and WSM.

**Mode Stirring and Reverberation**—Mode stirring and reverberation testing are RF techniques whose goals are to describe an enclosed space stochastically in terms of the distribution of the electric fields due to energy that may be within the space, either through internal EMR emitters or leakage into the space from external sources. They are particularly useful for describing the frequency response of aircraft weapon compartments which are often very complex structures. The tests are performed such that the boundary conditions of the compartment are maintained constant while the frequency of the RF radiation is allowed to vary over a narrow interval about some center frequency. The contributions of each reverberant mode to a given spatial point in the compartment, known as eigen-modes, are averaged over each narrow frequency band tested resulting in an approximation of the field homogeneity within the compartment. The results allow an evaluation of the likelihood of fields at, above, or below certain levels.

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

**Ordnance**—Explosives, chemicals, pyrotechnics, and similar stores, e.g., bombs, guns and ammunition, flares, smoke, or napalm).
Power Density—Power density ($P_d$) is the power flow per unit area with units of $\text{W/m}^2$ or $\text{mW/cm}^2$. 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 to electromagnetic fields on EIDs and on fuel hazards.

Pulse-Modulated Signal—Electromagnetic energy transmitted by pulse-modulated radars consists of a series of equally spaced pulses separated by very short but relatively long periods during which no electromagnetic energy is transmitted. The pulse width ($p_w$) is the duration of the radar pulse. The pulse repetition frequency ($\text{prf}$) is the number of pulses per second. Peak power of the system is the power of the transmitter contained in the radiated pulses. Because the radar is resting for a time that is long with respect to the operating time, the average power delivered during one cycle of operating is relatively low compared with the peak power available during the pulse time. The operating cycle of the radar can be described in terms of the fraction of the total time electromagnetic energy is radiated. This time relationship is the DC.

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—Safe separation distance (SSD) for HERO is the calculated distance, in feet or meters, from an EMR emitter beyond which the radiated power density from the EMR 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 EMR 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 or the ordnance item. This, e.g., might be caused by the EMR initiation of a piston actuator that removes a lock of the safety-and-arming rotor of an artillery fuze, thus allowing a sensitive detonator to rotate-in-line with the explosive train.

Stockpile-to-Safe Separation Sequence—Stockpile-to-safe separation sequence (S4), which consists of six phases as defined in MIL-HDBK-240, are as follows:

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.

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

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

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.

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

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

c—speed of light (3x10^8 meters/second)

cm—centimeter

d—antenna maximum linear distance

dB—decibel

dBd—decibels related to dipole antenna

dBi—decibel isotropic

dBm—decibel milliwatt

dBW—decibel watt

E—electric field strength

E_{MAE}—maximum allowable environment electric field strength

f—frequency

FF—far-field region

G—antenna gain

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

G_{dBi}—antenna gain expressed in decibel isotropic

GHz—Gigahertz

G_{tr}—numerical (far-field) antenna gain ratio

Hz—Hertz

i—number of traditional fixed-location emitters

kHz—kilohertz
\( \lambda \)–wavelength

MHz–Megahertz

m–meter

mW–milliwatt

\( \text{NF}_r \)–reactive near-field region

\( \text{NF}_{\text{rad}} \)–radiating near-field region

\( \Omega \)–ohm

\( \pi \)–pi (3.14159)

\( \text{P}_a \)–average power

\( \text{P}_d \)–power density

\( \text{P}_p \)–peak power

\( r \)–distance or range from an antenna

\( \text{SSD}_i \)–safe separation distance for each traditional fixed-location emitter

\( \text{SSD}_m \)–safe separation distance for multiple traditional fixed-location emitter

\( \sum \)–summation operator

V–volt

\( \text{V/m} \)–volts per meter

\( \text{V/m-rms} \)–volts per meter-root-mean-squared

W–watt

\( Z_0 \)–intrinsic impedance of free space, approximately 120\( \pi \) \( \Omega \) or 377 \( \Omega \)

**Traditional Fixed-Location Emitter**–Traditional fixed-location emitters (TFEs) are all EMR emitters traditionally tracked by the ISM. These EMR emitters are in a fixed location, usually mounted on a tower, mast, or rooftop.

**United States**–The several States, the District of Columbia, the Commonwealths of Puerto Rico and the Northern Mariana Islands, American Samoa, Guam, Midway and Wake Islands, the U.S. Virgin Islands, any other territory or possession of the United States, and associated navigable waters, contiguous zones, and ocean waters of which the natural resources are under the exclusive management authority of the United States.
A2.1. Maximum Allowable Environment (MAE).

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

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

<table>
<thead>
<tr>
<th>Frequency Ranges (MHz)</th>
<th>$E_{\text{MAE}}$ (V/m-rms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0.01 \leq f &lt; 2.0$</td>
<td>$\frac{1}{f}$</td>
</tr>
<tr>
<td>$2.0 \leq f &lt; 80.0$</td>
<td>0.5</td>
</tr>
<tr>
<td>$80.0 \leq f \leq 100,000$</td>
<td>0.00625$f$</td>
</tr>
</tbody>
</table>

Figure A2.1. HERO UNSAFE $E_{\text{MAE}}$ Curve.

A2.1.2. For ordnance certified as HERO SUSCEPTIBLE, the minimum $E_{\text{MAE}}$ is defined in Table A2.2 and illustrated in Figure A2.2.
### Table A2.2. E_{\text{MAE}} for HERO SUSCEPTIBLE Ordnance.

<table>
<thead>
<tr>
<th>Frequency Ranges (MHz)</th>
<th>$E_{\text{MAE}}$ (V/m-rms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0.01 \leq f &lt; 2.0$</td>
<td>$\frac{4}{f}$</td>
</tr>
<tr>
<td>$2.0 \leq f &lt; 80.0$</td>
<td>2.0</td>
</tr>
<tr>
<td>$80.0 \leq f \leq 100,000$</td>
<td>$0.025f$</td>
</tr>
</tbody>
</table>

**Figure A2.2.** HERO SUSCEPTIBLE $E_{\text{MAE}}$ Curve.

A2.1.3. Ordnance certified as HERO SUSCEPTIBLE may have a MAE that is less restrictive than the MAE presented in the general HERO curve given in Table A2.2 and illustrated in Figure A2.2. Equations given in Table A2.4 allow for a calculated SSD for HERO SUSCEPTIBLE when no measured data are available.

**A2.2. Near- and Far-Field Regions.**

A2.2.1. The electromagnetic fields around an antenna are divided into three regions: the reactive near-field, radiating near-field (Fresnel Region), and the far-field (Fraunhofer Region) which are illustrated in Figure A2.3.
A2.2.2. The reactive near-field always exists around a radiating antenna. But if the antenna is small compared to the wavelength ($\lambda > 10d$), the radiating near-field (Fresnel Region) will not exist. $\lambda$ is the wavelength and $d$ is the largest linear dimension of the antenna. If an antenna is not radiating, no fields exist.

A2.2.3. The reactive near-field is closest to the source (i.e., EMR emitters). In this region, the electromagnetic energy does not behave like EMR because it does not radiate away from the source. The changing electrical potential in the antenna separates the moving charges thereby producing an electric dipole field (i.e., electric charge of equal magnitude but opposite signs, positive versus negative) and magnetic dipole field (i.e., a closed circulation of electric current) where the electromagnetic energy oscillates back and forth so that any energy not received by a receiver is returned to the source instead of radiating away from it. The reactive near-field is capable of only affecting receivers close by (e.g., feedback within the source, magnetic induction inside a nearby electrical transformer, increased load in the source, etc.).

A2.2.3.1. The reactive near-field extends from the antenna a distance of:

$$0.62 \sqrt[3]{\frac{d^3}{\lambda}} \leq NF_{\text{rad}} < \frac{2d^2}{\lambda}$$

where

- $NF_{\text{rad}}$ = radiating near-field region (meters)
- $\lambda$ = wavelength (meters)
- $d$ = maximum linear dimension of an antenna (meters)

A2.2.3.2. For the reactive near-field region, the equation is valid for all types of antennas. This guidance assumes that most radar antennas behave as aperture type antennas and most communication antennas behave as wire antennas.

A2.2.4. In the radiated near-field, the EMR travels away from the source in a straight beam about the size of the aperture’s projected area with the power level remaining fairly constant with distance. In this region the source’s terminal voltage, impedance, and driver current affect the electric and magnetic fields comprising the EMR causing them to vary at different rates where one field becomes dominant. This means that these field do not exhibit a
constant ratio of $120\pi \ \Omega$, approximately 377 $\Omega$, the intrinsic impedance of free space. However, as the EMR approaches the far-field, the ratio of the two fields begins approximating 377 $\Omega$, the variation between them lessens, and they settle into phase.

A2.2.5. The vast majority of radar antennas can be treated as aperture antennas while the vast majority of communication antennas can be treated as wire antennas.

A2.2.5.1. For most radar antennas (apertures antennas), the near-field (radiating near-field if it exists, otherwise the reactive near-field) extends from the antenna a distance of:

$$0.62 \sqrt[3]{\frac{d^3}{\lambda}} \leq NF_{\text{rad}} < \frac{2d^2}{\lambda}$$

where

$NF_{\text{rad}} =$ radiating near-field region (meters)
$
\lambda =$ wavelength (meters)
$d =$ maximum linear dimension of an antenna (meters)

A2.2.5.2. For communication antennas (wire antennas) the near-field extends to one wavelength ($\lambda$) from the antenna:

$$0.62 \sqrt[3]{\frac{d^3}{\lambda}} \leq NF_{\text{rad}} \leq \frac{\lambda}{2\pi}$$

where

$NF_{\text{rad}} =$ radiating near-field region (meters)
$
\lambda =$ wavelength (meters)
$d =$ maximum linear dimension of an antenna (meters)

A2.2.6. The far-field is the region in which the antenna is focused. At the leading edge of the far-field the radiated beam from the source starts to spread out. This means that the power density along the beam axis decreases with distance until the antenna becomes a point source and the power density obeys the inverse square law.

A2.2.6.1. The boundary between the near-field and the far-field for apertures antennas is:

$$FF \geq \frac{2d^2}{\lambda}$$

where

$FF =$ far-field region (meters)
$
\lambda =$ wavelength (meters)
$d =$ maximum linear dimension of an antenna (meters)
A2.2.6.2. The boundary between the near-field and the far-field for wire antennas is:

$$FF \geq \frac{\lambda}{2\pi}$$

where

- $FF =$ far-field region (meters)
- $\lambda =$ wavelength (meters)
- $d =$ maximum linear dimension of an antenna (meters)

A2.2.7. The antenna maximum linear dimension is the length of the longest dimension of the antenna itself. For example, 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.

A2.2.8. In the far-field region of an antenna, the power density and electric field are related to each other by the intrinsic impedance of free space:

$$E = \sqrt{\frac{P_d}{2Z_0}}$$

where

- $E =$ electric field strength (V/m)
- $P_d =$ power density (W/m²)
- $Z_0 =$ intrinsic impedance of free space, approximately 120Ω or 377Ω

A2.2.8.1. In the far-field, assuming a lossless system, the power density of a directional antenna is:

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

where

- $P_d =$ power density (W/m²)
- $P_t =$ EMR emitter power (W)
- $G_t =$ numerical (far-field) antenna gain ratio (unitless)
- $r =$ distance or range from an antenna (meters)
- $EIRP =$ effective isotropic radiated power (W)

A2.2.8.2. This equation is generally accurate in the far-field of an antenna but will over-predict power density when close to the antenna, or in the near-field, making worst case or conservative prediction.

A2.2.9. Most EMR emitters either produce continuous or pulse-modulated signals. A continuous EMR emitter produces uninterrupted RF such as from an oscillator. Amplitude modulation, frequency modulation, and phase modulation are considered continuous because the RF is continuously present. The power may vary with time due to modulation, but RF is
always present. For pulse-modulated signals, typically radars, have differences between peak and average rms power.

A2.2.9.1. Determine the average power by using the ratio of time-on and time-off over an interval. The time-on/off is the DC:

\[
DC = \frac{pw}{pri} \quad \text{or} \quad DC = (pw)(prf)
\]

where

\(DC\) = duty cycle (unitless)
\(pw\) = pulse width (seconds)
\(pri\) = pulse repetition interval (seconds)
\(prf\) = pulse repetition frequency (Hz)

A2.2.9.2. The product of the peak power and DC is the average power:

\[
P_a = P_p DC
\]

where

\(P_p\) = peak power (W)
\(DC\) = duty cycle (unitless)

A2.2.9.3. EMR emitter power is equal to peak power for pulse-modulated systems with \(pw\) one millisecond or greater or average power for \(pw\) less than one millisecond.

A2.2.10. The numerical (far-field) antenna gain ratio, not the dBi value, of an antenna can be determined from the antenna gain expressed in dBi:

\[
G_t = \log_{10} \left( \frac{G_{\text{dBi}}}{10} \right) = 10^{G_{\text{dBi}}/10}
\]

where

\(G_t\) = numerical (far-field) antenna gain ratio (unitless)
\(G_{\text{dBi}}\) = antenna gain (dBi)

A2.2.10.1. Decibel isotropic is the measurement of antenna 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.

A2.2.10.2. Convert from dBd to dBi:

\[
G_{\text{dBi}} = G_{\text{dBd}} + 2.15
\]

where

\(G_{\text{dBi}}\) = antenna gain (dBi)
\(G_{\text{dBd}}\) = antenna gain (dBd)

A2.2.11. Assuming a lossless system, EIRP is the product of EMR emitter power and numerical (far-field) antenna gain ratio:
A2.2.11.1. For EIRP in terms of power ratio, EMR emitter power to a milliwatt, with a unit of decibel milliwatt (dBm), or EMR emitter power to one watt, with a unit of decibel watt (dBW), use the following equations to convert from dBm or dBW to watts:

\[
E_{\text{IRP}} = \frac{1}{1000} \log_{10} \left( \frac{\text{EIRP}_{\text{dBm}}}{10} \right) = 10^{\frac{\text{EIRP}_{\text{dBm}}}{10}} \\
E_{\text{IRP}} = \log_{10} \left( \frac{\text{EIRP}_{\text{dBW}}}{10} \right) = 10^{\frac{\text{EIRP}_{\text{dBW}}}{10}}
\]

A2.2.11.2. In some cases, the EMR emitter power 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 antenna gain of a half-wave dipole antenna relative to an isotropic radiator:

\[
\text{EIRP} = 1.64\text{ERP}
\]

where

\[
\text{ERP} = \text{effective isotropic radiated power (W)}
\]

A2.2.12. In the near-field region of an antenna, determination of electromagnetic field characteristics is more complicated. The electric and magnetic fields are generally dependent on the source of the radiation and can vary with both angular position and distance around an antenna. Furthermore, the wave impedance of the radiation is no longer a constant value, as it was in the far-field region. Determine the electric field/power density at the near-field using guidance provided in Technical Order 31Z-10-4, *Joint Services Command, Control, Communication, and Computer Systems Electromagnetic Radiation Hazards*, latest revision, or MIL-HDBK-235-1, *Military Operational Electromagnetic Environment Profiles, Part 1C, General Guidance*, latest revision.

A2.2.13. A prediction for electric field/power density in the far-field of the antenna can be made by using the equations in paragraph A2.2.8. These equations are generally accurate in the far-field of an antenna but will over-predict electric field/power density when close to the antenna, or in the near-field. In this case they are used for making a worst case or conservative prediction. Therefore, equations in paragraph A2.3 take this assumption into consideration and the resulting SSD equations are considered conservative predictions.

A2.3. TFE/MEs.

A2.3.1. The following SSD determinations apply to situation involving TFEs/MEs and HERO certified ordnance. (T-1). A RADHAZ survey provides actual measured data and
A2.3.2. HERO SAFE ordnance. Maintain a minimum SSD of 10 feet. If the EMR emitter EIRP and frequency(ies) meet the criteria of Table A2.5, the minimum SSD listed applies; otherwise the minimum SSD is 10 feet.

A2.3.3. HERO UNSAFE ordnance. If the EMR emitter EIRP and frequency(ies) meets the criteria of Table A2.5, the minimum SSD listed applies. Otherwise calculate the SSD using equations in Table A2.3. If the calculated SSD is less than 10 feet, then the resulting SSD is 10 feet.

A2.3.4. HERO SUSCEPTIBLE ordnance. If the EMR emitter EIRP and frequency(ies) meets the criteria of Table A2.5, when no measured data are available, the minimum SSD listed applies. Otherwise calculate the SSD using equations in Table A2.4, when no measured data are available. If the calculated SSD is less than 10 feet, then the resulting SSD is 10 feet.

A2.3.5. For TFEs/MEs that operate over a frequency band and maintain similar power and antenna gain over the frequency band, apply the following guidance:

A2.3.5.1. If the EMR emitter’s frequency band has a start or lower frequency greater than 80 MHz, use the lowest frequency to determine the SSD for the frequency band.

A2.3.5.2. If the EMR emitter’s frequency band has an end or upper frequency less than 2 MHz, use the highest frequency to determine the SSD for the frequency band.

A2.3.5.3. If the EMR emitter’s frequency band has a start or lower frequency greater than or equal to 2 MHz and an end or upper frequency less than 80 MHz, calculate the SSD using the formula for the frequency range of $2.0 \text{ MHz} \leq f < 80 \text{ MHz}$ because this is the worst case SSD for the frequency band.

A2.3.6. For continuous systems and pulse-modulated systems, with $pw$ less than one millisecond, the EMR emitter power is average power and for pulse-modulated systems with $pw$ one millisecond or greater the EMR emitter power is peak power.

A2.3.7. For frequency(ies) outside the range specified in Tables A2.3, A2.4, and A2.5, request assistance from AFSEC/SEW.
Table A2.3. Equations for Computing SSDs for HERO UNSAFE Ordnance.

<table>
<thead>
<tr>
<th>Frequency Ranges (MHz)</th>
<th>SSD Equations</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01 ≤ f &lt; 2.0</td>
<td>5.5f√P_tG_t meters</td>
</tr>
<tr>
<td></td>
<td>18f√P_tG_t feet</td>
</tr>
<tr>
<td>2.0 ≤ f &lt; 80.0</td>
<td>10.95√P_tG_t meters</td>
</tr>
<tr>
<td></td>
<td>36√P_tG_t feet</td>
</tr>
<tr>
<td>80.0 ≤ f ≤ 100,000</td>
<td>876√P_tG_t meters</td>
</tr>
<tr>
<td></td>
<td>2.873√P_tG_t feet</td>
</tr>
</tbody>
</table>

f = frequency (MHz)  
P_t = EMR emitter power (W)  
P_1 = P_a = average power (W) for TFE/ME continuous systems and TFE/ME pulse-modulated systems with pulse width < 1 millisecond  
P_1 = P_p = peak power (W) for TFE/ME pulse-modulated systems with pulse width ≥ 1 millisecond  
G_t = numerical (far-field) antenna gain ratio (not the dBi value)  
G_t = \log^{-1}\left(\frac{G_{dbi}}{10}\right) = 10^{G_{dbi}/10}  
G_{dbi} = antenna gain (dBi)
Table A2.4. Equations for Computing SSDs for HERO SUSCEPTIBLE Ordnance.

<table>
<thead>
<tr>
<th>Frequency Ranges (MHz)</th>
<th>SSD Equations</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01 ≤ f &lt; 2.0</td>
<td>1.37f√(P_tG_t) meters</td>
</tr>
<tr>
<td></td>
<td>4.5f√(P_tG_t) feet</td>
</tr>
<tr>
<td>2.0 ≤ f &lt; 80.0</td>
<td>2.74f√(P_tG_t) meters</td>
</tr>
<tr>
<td></td>
<td>9f√(P_tG_t) feet</td>
</tr>
<tr>
<td>80.0 ≤ f ≤ 100,000</td>
<td>( \frac{219}{f} \sqrt{\frac{P_tG_t}{f}} ) meters</td>
</tr>
<tr>
<td></td>
<td>( \frac{718}{f} \sqrt{\frac{P_tG_t}{f}} ) feet</td>
</tr>
</tbody>
</table>

f = frequency (MHz)

\( P_t \) = EMR emitter power (W)

\( P_t = P_a \) = average power (W) for TFE/ME continuous systems and TFE/ME pulse-modulated systems with pulse width < 1 millisecond

\( P_t = P_p \) = peak power (W) for TFE/ME pulse-modulated systems with pulse width ≥ 1 millisecond

\( G_t \) = numerical (far-field) antenna gain ratio (not the dBi value)

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

\( G_{\text{dbi}} \) = antenna gain (dBi)

A2.4. Multiple TFEs/MEs.

A2.4.1. For multiple TFEs/MEs that are collocated and operating in phase, the SSD is determined as:

\[
SSD_m = \sqrt{\sum_{i=1}^{n} SSD_i^2}
\]

where

\( \sum \) = summation operator

\( i = 1, 2, \ldots, n \), number of TFEs/MEs

SSD_m = SSD for multiple TFEs/MEs (meters or feet)

SSD_i = SSD for each TFE/ME (meters or feet)

A2.4.2. For multiple TFEs/MEs operating at different frequency/bands, the largest individual SSD applies.
A2.5. Minimum SSD Exceptions.

A2.5.1. There are exception whereby EMR emitters are expected to be, or are required to be, closer than 10 feet to HERO certified ordnance. Their proximity to HERO certified ordnance and low-power EMR emitters require different techniques for mitigating HERO.

A2.5.2. Table A2.5 is used for TFEs/MEs if the EIRP and frequency(ies) requirements are met. AFSEC/SEW uses Table A2.5 when determining the appropriate SSD for MMEs. Multiple MMEs (two or more) are not allowed in enclosed, reflective spaces or facilities where conventional ordnance are stored or undergoing maintenance; the aggregated effects on the ambient or volumetric electromagnetic field in those spaces may increase as a result of complex cavity effect, unless a RADHAZ survey proves otherwise and if approved by AFSEC/SEW. (T-1).

Table A2.5. Minimum SSD Exceptions for HERO Certified Ordnance.

<table>
<thead>
<tr>
<th>Minimum SSD (feet)</th>
<th>HERO Certification</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 10</td>
<td>SAFE</td>
</tr>
<tr>
<td></td>
<td>General HERO</td>
</tr>
<tr>
<td></td>
<td>requirements per</td>
</tr>
<tr>
<td></td>
<td>paragraph 4.2</td>
</tr>
<tr>
<td>5</td>
<td>0.5 &lt; EIRP ≤ 5</td>
</tr>
<tr>
<td></td>
<td>All f</td>
</tr>
<tr>
<td>1</td>
<td>0.1 &lt; EIRP ≤ 0.5</td>
</tr>
<tr>
<td></td>
<td>All f</td>
</tr>
<tr>
<td>0*</td>
<td>EIRP ≤ 0.1</td>
</tr>
</tbody>
</table>

\[ f = \text{frequency (MHz)} \]
\[ \text{EIRP} = \text{P}_\text{E}, \text{effective isotropic radiated power (W)} \]
\[ \text{P}_\text{E} = \text{P}_\text{ave}, \text{average power (W)} \] for TFE/ME continuous systems, TFE/ME pulse-modulated systems with pulse width < 1 millisecond, and MMEs
\[ \text{P}_\text{p} = \text{peak power (W)} \] for TFE/ME pulse-modulated systems with pulse width ≥ 1 millisecond
\[ G_t = \log^{-1} \left( \frac{G_{\text{dB}}}{10} \right) = 10^{G_{\text{dB}}/10} \]
\[ G_{\text{dB}} = \text{antenna gain (dBi)} \]

*WARNING: Do not touch antennas to ordnance.*

A2.6. Examples for Calculating SSDs.

A2.6.1. Scenario 1. HERO SUSCEPTIBLE ordnance exposed to power density of 450 W/m² at a frequency of 200 MHz.

Step 1. Using the formula for electrical field strength, paragraph A2.2.8, convert the power density to the electric field strength (V/m-rms):

\[ E = \frac{P}{2 \pi R^2} \]

where
\[ E = \text{electric field strength (V/m)} \]
\[ P = \text{power density (W/m}^2\text{)} \]
\[ R = \text{distance from source (m)} \]

Step 2. Use the calculated electric field strength to determine the appropriate SSD.

\[ S = \frac{E}{E_{\text{min}}} \]

where
\[ S = \text{SSD (feet)} \]
\[ E_{\text{min}} = \text{minimum electric field strength (V/m)} \]
E = \sqrt{P_d \frac{Z_0}{120\pi}} = \sqrt{(450)(120\times2)} = 412 \text{ V/m -rms}

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

\[
E_{\text{MAE}} = 0.025f = (0.025)(200) = 5 \text{ V/m -rms}
\]

Step 3. Compare the $E_{\text{MAE}}$ and the electric field strength, determined from the power density. The ordnance exposure is 412 V/m-rms. The $E_{\text{MAE}}$ 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 0.066 W/m$^2$ or the EMR emitter must be turned off.

A2.6.2. Scenario 2. HERO SUSCEPTIBLE ordnance exposed to continuous EMR emitter having a frequency of 300 MHz, EMR emitter power of 1,000 W, and antenna gain of 15 dBi.

Step 1. The numerical (far-field) antenna gain ratio is:

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

Step 2. Determine the EIRP (W) using the numerical antenna gain ratio and $P_t = 1,000$ W:

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

Step 3. The ordnance is certified as HERO SUSCEPTIBLE, therefore use the formula from Table A2.4. Because the frequency is 300 MHz, the applicable formula, in feet, is:

\[
\text{SSD} = \frac{718\sqrt{\frac{P_t G_t}{f}}}{f} = \frac{718\sqrt{31,600}}{300} = 426 \text{ feet}
\]

A2.6.3. Scenario 3. Considered the site where the antennas are collocated on a tower, where two of the five antennas are operating in phase and at the same frequency, and have characteristics listed in Table A2.6.

\[
\text{Table A2.6. Scenario 4. Antenna Characteristics.}
\]

<table>
<thead>
<tr>
<th>Antenna</th>
<th>Frequency (MHz)</th>
<th>EIRP (dBm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1,930</td>
<td>64.87</td>
</tr>
<tr>
<td>2</td>
<td>1,930</td>
<td>71.00</td>
</tr>
<tr>
<td>3</td>
<td>1,960.63</td>
<td>62.72</td>
</tr>
<tr>
<td>4</td>
<td>935</td>
<td>66.93</td>
</tr>
<tr>
<td>5</td>
<td>880</td>
<td>71.19</td>
</tr>
</tbody>
</table>

Step 1. Convert EIRP from dBm to watts using the formula from paragraph A2.2.12, resulting in values listed in Table A2.7:

\[
\text{EIRP}_W = 10^{\frac{\log^{-1}(\text{EIRP}_{\text{dBm}})}{1,000}} = 10^{\frac{\text{EIRP}_{\text{dBm}}}{10}}
\]
Step 2. Calculate the SSDs based on equations from Tables A2.3 and A2.4 for HERO UNSAFE and HERO SUSCEPTIBLE ordnance, respectively, resulting in values listed in Table A2.8.

### Table A2.8. Scenario 4. Individual TFE SSDs.

<table>
<thead>
<tr>
<th>Antenna</th>
<th>SSD (feet)</th>
<th>HERO UNSAFE</th>
<th>SSD (feet)</th>
<th>HERO SUSCEPTIBLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>82</td>
<td></td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>167</td>
<td></td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>63</td>
<td></td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>216</td>
<td></td>
<td>54</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>374</td>
<td></td>
<td>94</td>
<td></td>
</tr>
</tbody>
</table>

Step 3. For the two antennas, antennas 1 and 2, operating at 1,930 MHz, in phase, and are collocated, the SSD based on multiple TFEs is determined using the formulas from paragraph A2.4.

Step 3.a. For HERO UNSAFE ordnance, the SSD in feet is based on multiple TFEs is:

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

Step 3.b. For HERO SUSCEPTIBLE ordnance, the SSD in feet and based on multiple TFEs is:

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

Step 4. Compare all of the determined SSDs (Table A2.9) 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 A2.9. Scenario 4. Final SSDs.

<table>
<thead>
<tr>
<th>Antenna</th>
<th>SSD (feet)</th>
<th>HERO UNSAFE</th>
<th>SSD (feet)</th>
<th>HERO SUSCEPTIBLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 and 2</td>
<td>186</td>
<td></td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>63</td>
<td></td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>216</td>
<td></td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>374</td>
<td></td>
<td>94</td>
<td></td>
</tr>
</tbody>
</table>

Note: For this scenario, the SSD value of 374 feet would apply if all ordnance items were certified as HERO UNSAFE. The SSD value of 94 feet would apply if all ordnance items were certified as HERO SUSCEPTIBLE. If the site has mixed certifications, the worst SSD value
applies and in this case a SSD of 374 feet. If all ordnance items were certified HERO SAFE, the SSD would be 10 feet.

A2.6.4. Scenario 4. Consider a monopole antenna with a frequency of 450 MHz, EMR emitter power of 2 W, and antenna gain of 2 dBi. The EMR emitter is considered a continuous system and the EMR emitter power is the average power.

Step 1. For HERO SAFE ordnance, guidance provided in paragraph A2.3.2 indicates a SSD of 10 feet unless the EIRP and frequency meets Table A2.5 criteria:

\[
EIRP = P_t G_t = (2) \left(10^{2/10}\right) = 3.17 \text{ W}
\]

Step 2. According to Table A2.5, if the EIRP is less than 5 watts for all frequencies, the minimum SSD is 5 feet. Therefore for this scenario the SSD is 5 feet.

Step 3.a. For HERO UNSAFE ordnance, use Table A2.3 to determine the SSD. Because the EMR emitter frequency is greater than 80 MHz, the SSD is:

\[
SSD = \frac{2.873\sqrt{3.17}}{450} = 11.4 \text{ feet}
\]

Step 3.b. For HERO SUSCEPTIBLE ordnance, use Table A2.4 to determine the SSD. Because the EMR emitter frequency is greater than 80 MHz, the SSD is:

\[
SSD = \frac{718\sqrt{3.17}}{450} = 2.8 \text{ feet}
\]

Step 3.c. Because the EIRP does not meet the criteria of Table A2.5 and the calculated SSD is less than 10 feet, the resulting SSD is 10 feet.

A2.6.5. Scenario 5. Consider a parabolic antenna with a frequency of 1,030 MHz, peak power of 500 W, pw of 0.008 ms, prf of 375 Hz, and antenna gain of 10 dBi.

Step 1. For HERO SAFE ordnance, guidance provided in paragraph A2.3.2 indicates a SSD of 10 feet.

Step 2.a. Because the system is pulse-modulated and the pw is less than 1 millisecond the average power is determined. First determine the DC:

\[
DC = (\text{pw})(\text{prf}) = \left(\frac{0.008}{1,000}\right)(375) = 0.003
\]

Step 2.b. Second, determine the average power:

\[
P_a = P_p DC = (500)(0.003) = 1.5 \text{ W}
\]

Step 2.c. Third, determine the EIRP:

\[
EIRP = P_t G_t = (1.5) \left(10^{10/10}\right) = 15 \text{ W}
\]

Step 3.a. For HERO UNSAFE ordnance, use Table A2.3 to determine the SSD. Because the EMR emitter frequency is greater than 80 MHz, the SSD is determined using:

\[
SSD = \frac{2.873\sqrt{15}}{1,030} = 10.8 \text{ feet}
\]

Step 3.b. For HERO SUSCEPTIBLE ordnance, use Table A2.4 to determine the SSD. Because the EMR emitter frequency is greater than 80 MHz, the SSD is determined using:

\[
SSD = \frac{718\sqrt{15}}{1,030} = 2.7 \text{ feet}
\]
Step 3.c. Because the EIRP does not meet the criteria of Table A2.5 and the calculated SSD is less than 10 feet, the resulting SSD is 10 feet.
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 EMR emitter as a TFE, ME, or a MME is unclear, request assistance from AFSEC/SEW.

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

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

A3.1.3.1. Type of platform (aircraft, ground vehicle, etc.), ordnance, and applicable EIDs involved (HERO certification).

A3.1.3.2. Installation layout of the area showing transportation routes of EIDs and ordnance subsystems, locations of ordnance, and EIDs maintenance, storage, and assembly/disassembly areas, and locations of all EMR emitters and characteristics as listed in the HERO survey package.

A3.1.4. Decisions are sent to the originating installation or command, with information copies sent to all agencies involved in the decision process.

**A3.2. EMR Tools.** The WSM shall use the AFSEC SSD calculator for all HERO certified and uncertified ordnance under their cognizance. The calculator determines SSDs based on the TFE/ME characteristics, records the TFE/ME characteristics, and generates EMR emitter lists. The calculator is available at the HERO website, 
HERO SURVEY PACKAGE

A4.1. Requirement. The WSM shall prepare and maintain a HERO survey package and perform an annual review of its contents. (T-1).

A4.2. Purpose.

A4.2.1. To prescribe through advanced planning the easiest and most efficient method of managing the conflict between the EME created by EMR emitter equipment and HERO certified ordnance.

A4.2.2. The purpose of listing and identifying the location of the ordnance present is to determine their HERO certification and 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 certifications and list them on the HERO website, https://cs1.eis.af.mil/sites/afsec/HERO/default.aspx. Ordnance not having a HERO certification is treated as HERO UNSAFE until a HERO status is provided by AFSEC/SEW. This ordnance may include components or subsystems or all-up rounds or HERO untested ordnance. In all instances, observe the protective requirements outlined in paragraph 4.2 of this instruction.

A4.2.3. The purpose of the HERO survey package is to document all the EMR emitters on an installation, document ordnance HERO certification, calculate the appropriate SSD for each EMR emitter, and determine which, if any, EMR emitters pose a HERO risk to operations involving ordnance.

A4.2.4. The purpose of completing an EMR emitter list is to gather all installation EMR emitter information, a HERO survey. The EMR emitter list for TFEs/MEs is created using the AFSEC SSD calculator. Specific emitter characteristics are necessary for calculating the SSD for each TFE/ME. SSDs for approved MMEs are provided by AFSEC/SEW and must be documented on a separate listing. Each entry is identified by military nomenclature or if appropriate manufacturer and model, location, and calculated SSDs. The EMR emitter list must be available ninety days prior to the intent-to-install of any EMR emitter.

A4.2.5. The purpose of completing an ordnance list is to identify ordnance used during operations on the installation, document their HERO certification, and ensure identified EMR emitters to not pose a hazard.

A4.3. Contents.

A4.3.1. The HERO survey package shall consists of the EMR emitter list consisting of the EMR emitter list for TFEs/MEs generated by the AFSEC SSD calculator, the MME list consisting of all AFSEC/SEW approved MMEs used closer than 10 feet during operations involving ordnance at the installation, and ordnance list identifying the ordnance at the installation and their HERO certification.

A4.3.2. The D-8 map showing potential EMR zones that could affect munitions operations. Plot only those zones that actually impact munitions operations to include primary and alternate explosive routes. The review must be documented and maintained by the WSM.
Munition operations include storage, handling, maintaining, loading/unloading, explosive ordnance disposal (EOD), and assembly areas of explosives, delivery routes, and weapons loading operations.

A4.3.3. An assessment must be completed by the WSM in writing for existing and new EMR emitter hazards to operations. If required, the assessment shall be included as part of the site plan submittal and for new EMR emitters, an assessment will be added to the site plan.

A4.3.4. The RADHAZ survey results, if applicable.

A4.3.5. Provide the HERO survey package to installation users, EOD, Munitions Supervision/Control, fire department, and any other organization deemed necessary.

A4.4. Collecting Data.

A4.4.1. For each TFE/ME document the military nomenclature or if appropriate manufacturer and model, location, signal type (continuous or pulse-modulated), frequency type (single or band), EMR emitter power (average power for continuous and peak power for pulse-modulated), and antenna gain, in addition pw and prf for pulse-modulated systems.

A4.4.2. The pw and prf are calculated from radar modes producing the highest average power. EMR emitter power is peak power for pulse-modulated system with pw one millisecond or greater or average power for pulse-modulated system with pw less than one-millisecond.

A4.4.3. For each MME, document the manufacturer, model, and SSDs provided by AFSEC/SEW.

A4.4.4. Determine HERO certification for all ordnance containing EIDs.

A4.4.5. EMR emitters providing fire alarm systems, giant voice systems, and remote pump control/metering do not require individual identification but shall be evaluated for HERO to installation operations.

A4.5. ISM. Communication Squadron and/or ISM must inform the WSM and/or the installation safety office 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 survey package and EME. The WSM and/or the installation safety office updates the EMR emitter list.

A4.6. Munition Accountable Systems Officer (MASO). WSM consults with the MASO to determine the type and locations of ordnance items and ensures Operational Security and security certification requirements are enforced. Identify ordnance location on the installation D-8 map, as well as the ordnance transportation routes. This information is useful when performing RADHAZ surveys.

A4.7. RADHAZ Survey.

A4.7.1. Include the latest RADHAZ survey in the HERO survey package, if applicable.

A4.7.2. The installation Commander will request a RADHAZ survey when the installation safety officer cannot take into account all sources of EMR, needs to evaluate the attenuation
of the surrounding environment, and/or cannot comply with minimum calculated SSDs because of the lack of real estate or other limitations.

A4.7.3. The RADHAZ survey consists of performing EME measurements and documenting the results with relevant technical data. Conclusions and recommendation regarding the use of EMR emitters during ordnance operations are included and presented with supporting documentation. The organization performing the RADHAZ survey prepares a report and provides their assessment to the WSM.

A4.7.4. A RADHAZ survey provides measurements of EMR fields, as well as a more detailed look at the operational environment. In some instances, data gathered by the RADHAZ survey alleviates some restrictions imposed by this instruction.

A4.7.5. The RADHAZ survey may be performed by MAJCOMs, the 85th Engineering Installation Squadron (EIS), or the Naval Surface Warfare Center, Dahlgren Division, E3 Assessment and Evaluation Branch (B52), (540) 653-2931. The 85th EIS, Keesler Air Force Base, is the Air Force provider of electromagnetic compatibility, electromagnetic interference, EMR and electromagnetic pulse field measurements, and analytical capabilities. For technical information, contact 85 EIS/SCYM, (228) 377-3920/3926, DSN 597-3920 or email 85EIS.SCYM.1@us.af.mil.

A4.7.6. Ensure the RADHAZ survey consists of applicable ordnance certifications/locations and EMR emitters on the installation to include those that may have security classification restrictions. Ensure that Operations Security (OPSEC) and Communications Security (COMSEC) requirements adhere to AFI 10-701, Operations Security (OPSEC), latest revision and AFMAN 33-283, Communication Security (COMSEC) Operations, latest revision.


A4.8.1. Calculate the SSD using the AFSEC SSD calculator. For MMEs use the approved SSDs provided by AFSEC/SEW. If a RADHAZ survey has been performed, determine if the measured EMR levels are acceptable at the locations in question.

A4.8.2. Identify all ordnance and their location. Refer to the HERO website, https://cs1.eis.af.mil/sites/afsec/HERO/default.aspx, to determine ordnance HERO certification. The ordnance items are subject to the HERO survey package and their location is compared to the locations of the EMR emitters listed.

A4.8.3. Changes to the EMR emitters, and/or ordnance can necessitate the update or modification of an existing HERO survey package. The deletion of either ordnance or EMR emitters is simply a matter of removing the item from the existing HERO survey package.


A4.9.1. Compare the calculated distance to the actual distance between each EMR emitter and the various ordnance locations. This process allows for identification of potential HERO problems. If a RADHAZ survey has been performed, determine if the resulting EME is acceptable.

A4.9.2. Once EMR emitters, ordnance, and their respective locations have been identified, use the installation D-8 map to determine the distances between the EMR emitters and the various ordnance locations. Identify the TFE/ME systems requiring HERO EMR control for
each ordnance location if required. 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 TFE/ME systems are 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.

A4.9.3. Upon receipt of new ordnance, identify its location and HERO certification to determine if the existing HERO survey package needs modification. If the ordnance is percussion initiated or non-explosive, there is no EMR control requirement. For ordnance, match its location to the location description and specific conditions and procedures provided in the existing HERO survey package. Similarly, when ordnance items are relocated to an additional area, evaluate the ordnance location and add the results to the HERO survey package under the new location.

A4.9.4. The following applies to new EMR emitters as well as relocated or upgraded existing EMR emitters. Add relocated or upgraded EMR emitters to an existing HERO survey package when system parameters change, e.g., EMR emitter power or antenna gain increase, results in changes to the SSDs. Assess whether the SSDs encompass the ordnance location outlined in the existing HERO survey package. Assess the SSDs and identify EMR emitter location, then compare these distances with the distances from known ordnance locations outlined in the existing HERO survey package. If the SSDs encompass any of these ordnance locations, as outlined in the existing HERO survey package incorporate EMR control restrictions (radio silence) into the existing HERO survey package for the appropriate location.
A5.1. **Introduction.** Use the following as guidance to determine when changes in ordnance usually result in a recommendation for a HERO test. Most changes to firing circuits result in a recommendation to conduct a HERO test.

A5.2. **Guidance.**

A5.2.1. EID changes that require 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 $\frac{1}{4} \lambda$, approximately 0.667 inches, of wiring that enters or exits ordnance envelope.

A5.2.2. Firing circuit changes that require a HERO evaluation consist of all non-direct current firing circuits (always require testing), relocating firing circuits within $\frac{1}{4} \lambda$, approximately 0.667 inches, of wiring that carries signal or enters or exits ordnance envelope, changes to EMR suppression components, and most changes to firing circuits.

A5.2.3. 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 connects involving ordnance subassemblies that contain EIDs.

A5.2.4. S4 changes that require a HERO evaluation consists of changes in EMR levels in authorized assembly/disassembly spaces for operations that expose EIDs to internal wiring of ordnance subassemblies that contain EIDs and changes in shipping/storage containers where the container is intended to provide protection from EMR.
Attachment 6

REQUEST FOR HERO CERTIFICATION OR ASSESSMENT

A6.1. Certification. The PM will prepare a HERO certification memorandum which consists of the following information:

A6.1.1. CRC and/or nomenclature and/or description of ordnance.

A6.1.2. A CRC can be made up of components. Include DODIC, NSN, part number, and description 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 certification (HERO SAFE, HERO SUSCEPTIBLE, or HERO UNSAFE) based on the information provided.

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

A6.1.5. Send HERO certification requests to AFSEC/SEW, 9700 G Ave SE, Kirtland Air Force Base, NM 87117. Submission may be sent via email. Contact the AFSEC HERO safety office at (505) 846-0450 or DSN 246-0450 to obtain the appropriate email address and for having HERO questions answered or HERO concerns addressed.

A6.1.6. Include with the memorandum any information that supports the HERO certification. In particular include HERO test report or in depth information when comparing the article in question with existing HERO certified or assessed ordnance. The test report shall consists of the information outlined in MIL-HDBK-240. An analysis will consist of the same sections except a detailed analysis replaces any test results/discussions. For HERO SUSCEPTIBLE and HERO UNSAFE certifications, the PM shall provide risk assessment as described in paragraph 3.2.8.2 of this instruction.

A6.2. Assessment. PM will prepare an email consisting of the following information:

A6.2.1. Nomenclature and/or description of ordnance.

A6.2.2. The recommended HERO assessment (HERO SAFE, HERO SUSCEPTIBLE, or HERO UNSAFE) based on the information provided.

A6.2.3. A technical point of contact familiar with the technical data/analysis provided.

A6.2.4. Send HERO assessment requests to AFSEC/SEW, 9700 G Ave SE, Kirtland Air Force Base, NM 87117. Submission may be sent via email. Contact the AFSEC HERO safety office at (505) 846-0450 or DSN 246-0450 to obtain the appropriate email address and for having HERO questions answered or HERO concerns addressed.

A6.2.5. Include in the email any information that supports the HERO assessment. In particular include HERO test/analysis reports or in depth information when comparing the article in question with existing HERO certified or assessed ordnance. The test report shall consist of the information outlined in MIL-HDBK-240. An analysis will consist of the same sections except a detailed analysis replaces any test results/discussions.
A7.1. Implementation.

A7.1.1. The Air Force Nuclear Weapons Center (AFNWC) ensures military characteristics (MCs) and stockpile-to-target-sequence (STS) include MIL-STD-464 EME levels. The Department of Energy (DOE), National Nuclear Security Administration, certifies a nuclear weapon (the articles under their cognizance) and delivers it to DoD. AFNWC is responsible for having the nuclear weapon HERO certified by providing AFSEC/SEW the appropriate HERO evaluation and/or analysis from the design agency.

A7.1.2. 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 by May 2018 or May 2020 if funding is not received until May 2018 or after. For DOE ordnance not meeting the criteria for certification of HERO SAFE, AFNWC shall take the necessary action to resolve the issue. Until legacy nuclear weapons are HERO certified, guidance in Attachment 10 applies. Safety standards outlined in this Attachment shall apply after nuclear weapons have been HERO certified. After May 2018, uncertified nuclear weapons shall be certified as HERO UNSAFE.

A7.2. MAJCOMs. MAJCOMs will treat nuclear weapons in maintenance configurations and components, e.g., limited life components containing EIDs, as HERO UNSAFE, unless specifically certified as HERO SAFE. This includes removed shielding from EID sensitive external connectors. Conduct maintenance operations under HERO UNSAFE conditions only when the EME is restricted and does not exceed levels in Table A7.1 and illustrated in Figure A7.1.

A7.3. Air Force Nuclear Weapons Center (AFNWC). AFNWC will:

A7.3.1. Ensure IAW AFMAN 91-118, Safety Design and Evaluation Criteria for Nuclear Weapon Systems, latest revision, the design of nuclear weapons delivery systems, such as Air Force and foreign aircraft, cruise missiles, Intercontinental Ballistic Missiles (ICBMs), transportation aircraft, etc., will minimize undesired EMR emissions that could cause a nuclear hazard or ordnance ignition.

A7.3.2. Specify MIL-STD-464 EME levels in nuclear weapon MCs and/or STS to ensure DOE ordnance is HERO SAFE.

A7.3.3. Ensure design of nuclear weapons to be HERO SAFE IAW MIL-STD-464 HERO aspects during all phases except assembly/disassembly, if appropriate.

A7.3.4. Ensure when changes to DOE ordnance are proposed that requests for HERO evaluation (test, analysis, or a combination thereof) are 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 nuclear weapons (Attachment 5).

A7.3.5. Require nuclear weapons entering the Phase 6.X or DoD 5000-series acquisition process (life extension program or major modifications) undergo HERO certification IAW with this instruction and MIL-STD-464 HERO aspects.
A7.3.6. Ensure DOE ordnance variants or test items, which include temporary instrumentation such as measurement hardware, telemetry, flight safety systems/flight termination systems, etc., that contain EIDs or add EMR emitters are subject to this instruction.

A7.4. Certified HERO Nuclear Weapons.

A7.4.1. A HERO certified nuclear weapon is certified as HERO SAFE in an ultimate user configuration, as an all up round, whereby all EIDs contained by the weapon are immune to adverse effects from the EME delineated in MIL-STD-464. Weapon maintenance configurations shall be deemed HERO UNSAFE unless specifically certified as HERO SAFE, this includes removed shielding from EID sensitive external connectors. (T-1).

A7.4.2. Nuclear systems, e.g., ICBMs and cruise missiles, consist of components containing EIDs, e.g., reentry vehicles, fuzes, cruise missile warhead, etc. HERO certification of these components shall be based on their particular configurations during the nuclear system’s STS phases. (T-1).

A7.4.3. HERO certified nuclear weapons are listed at the HERO website, https://cs1.eis.af.mil/sites/afsec/HERO/default.aspx. Violations of SSD and/or exposure to EMR levels higher than HERO SAFE or HERO UNSAFE, depending on configuration, is cause for rejection of any or all weapons involved in the non-compliance condition. Rejected weapons will be reported IAW Technical Order 11N-5-1, Unsatisfactory Reports, and AFMAN 91-221, Weapons Safety Investigations and Reports, latest revision.

A7.5. HERO Requirements. The following requirements shall be implemented when conducting operations in facilities where nuclear weapons are intended to be stored or undergo maintenance. Personnel handling nuclear weapons shall:

A7.5.1. Plan operations so that the nuclear weapons have a minimal exposure to EME. Use the HERO survey package for guidance. (T-1).

A7.5.2. Not alter nuclear weapons or handle umbilical cables and cable connectors unless authorized or approved by technical order or higher authority. (T-0).

A7.5.3. Not expose internal wiring and firing circuits by assembling or disassembling the nuclear weapons or components in EME unless authorized by the nuclear weapon’s technical order or higher authority. (T-0).

A7.5.4. Not transport HERO UNSAFE nuclear weapons. (T-0). HERO UNSAFE components shall be transported in sealed, all-metal container whenever possible which is considered a HERO SAFE configuration. (T-0). When transporting components in a platform, the minimum SSD requirements are applicable. (T-0).

A7.5.5. Treat nuclear weapons as HERO UNSAFE when they contain disassembled EIDs or when an exposed EIDs, firing circuit, or wiring are present. (T-0). Components shall be treated as HERO UNSAFE when they contain a disassembled EID or when an exposed EID, firing circuit, or wiring is present. (T-0).

A7.5.6. Maintain a minimum SSD of 10 feet for HERO SAFE nuclear weapons and components unless the EMR emitter EIRP and frequency meet the criteria of Table A7.3 then the minimum SSD listed applies. (T-1). If the EMR emitter is a MME, refer to guidance provided in paragraph A7.7. For nuclear weapons on a delivery platform, where a minimum
of 10 feet is not possible, the platform PM must conduct an analysis and/or test that proves the MAE of the nuclear weapons is not exceeded. (T-1). When transporting nuclear weapons on a trailer or forklift external to a maintenance/storage facility or within an aircraft, the minimum SSD requirements apply. (T-1).

A7.5.7. Maintain the appropriate SSD for HERO UNSAFE nuclear weapons and components and verify that the EME is below HERO UNSAFE levels utilizing the RADHAZ survey. If a RADHAZ survey is not up to date or does not take into account all EMR emitters present, determine the appropriate SSDs using Table A7.2. (T-1). If the EMR emitter is a MME, refer to guidance provided in paragraph A7.8. (T-1). HERO UNSAFE nuclear weapons and components are only authorized in approved mobile maintenance platforms, i.e., Weapons Maintenance Truck (WMT) and Secure Transportable Maintenance System (STMS) and facilities maintaining an EME at or below HERO UNSAFE levels. (T-1). The WMT and STMS do not provide sufficient protection against EMR and during maintenance the appropriate SSD for HERO UNSAFE Nuclear Weapons must be maintained.

A7.6. HERO UNSAFE.

A7.6.1. HERO UNSAFE nuclear weapons and components shall not be exposed to electric fields exceeding levels given in Table A7.1 and illustrated in Figure A7.1. (T-1). A RADHAZ survey shall be performed IAW paragraph A7.9 to ensure the HERO UNSAFE EME is not exceeded when all sources of EMR cannot be taken into account, the attenuation of the surrounding environment is unknown, and/or minimum SSD cannot be complied with.

Table A7.1. $E_{MAE}$ for HERO UNSAFE Nuclear Weapons.

<table>
<thead>
<tr>
<th>Frequency Ranges (MHz)</th>
<th>$E_{MAE}$ (V/m-rms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f &lt; 0.0132$</td>
<td>194.16</td>
</tr>
<tr>
<td>$0.0132 \leq f &lt; 8.0$</td>
<td>$\frac{2.56}{f}$</td>
</tr>
<tr>
<td>$8.0 \leq f &lt; 4.850$</td>
<td>0.04$f$</td>
</tr>
<tr>
<td>$4.850 \leq f &lt; 45.000$</td>
<td>194.16</td>
</tr>
</tbody>
</table>
A7.6.2. The WSM shall ensure the EME reported by the RADHAZ survey is below HERO UNSAFE levels. If a RADHAZ survey is not up to date or does not take into account all EMR emitters present, the WSM shall determine the appropriate SSDs as follows: If the EMR emitter EIRP and frequency meets the criteria of Table A7.3 the minimum SSD listed applies. Otherwise calculate the SSDs using equations in Table A7.2. If the calculated SSD is less than 10 feet, then the resulting SSD is 10 feet.
Table A7.2. Equations for Computing SSDs for HERO UNSAFE Nuclear Weapons.

<table>
<thead>
<tr>
<th>Frequency Ranges (MHz)</th>
<th>SSD Equations</th>
</tr>
</thead>
</table>
| f < 0.0132             | $0.0282\sqrt{P_tG_t}$ meters  
                      | $0.0925\sqrt{P_tG_t}$ feet  |
| 0.0132 ≤ f < 8.0      | $2.14f\sqrt{P_tG_t}$ meters  
                      | $7.01f\sqrt{P_tG_t}$ feet  |
| 8.0 ≤ f < 4,850       | $\frac{136.741\sqrt{P_tG_t}}{f}$ meters  
                      | $\frac{448.625\sqrt{P_tG_t}}{f}$ feet  |
| 4,850 ≤ f < 45,000    | $0.0282\sqrt{P_tG_t}$ meters  
                      | $0.0925\sqrt{P_tG_t}$ feet  |

$f =$ frequency (MHz)  
$P_t =$ EMR emitter power (W)  
$P_a =$ average power (W) for TFE/ME continuous systems and TFE/ME pulse-modulated systems with pulse width < 1 ms  
$P_p =$ peak power (W) for TFE/ME pulse-modulated systems with pulse width ≥ 1 ms  
$G_t =$ numerical (far-field) antenna gain ratio (not the dBi value)  
$G_{dBi} =$ antenna gain (dBi)

A7.6.3. For TFEs/MEs that operate over a frequency band and maintain similar EMR emitter power and antenna gain over the frequency band, apply the following guidance:

A7.6.3.1. If the EMR emitter’s frequency band has a start or lower frequency greater than 8 MHz, use the lowest operation frequency to determine the SSD for the frequency band.

A7.6.3.2. If the EMR emitter’s frequency band has an end or upper frequency less than 8 MHz, use the highest operation frequency to determine the SSD for the frequency band.

A7.6.3.3. If the EMR emitter band has a start or lower frequency less than or equal to 8 MHz and an end or upper frequency greater than or equal to 8 MHz, calculate the SSD at 8 MHz because this is the worst case SSD for the frequency band.

A7.6.4. For continuous systems and pulse-modulated systems with pw less than one-millisecond the EMR emitter power is average power and for pulse-modulated systems with pw one-millisecond or greater the EMR emitter power is peak power.

A7.6.5. For frequencies outside the range specified in Table A7.2 request assistance from AFSEC/SEW.

A7.7. Minimum SSD Exceptions.

A7.7.1. There are exceptions whereby EMR emitters are expected to be, or are required to be, closer than 10 feet to HERO certified nuclear weapons. Their proximity to HERO
certified nuclear weapons and low-power EMR emitters require different techniques for mitigating HERO.

A7.7.2. Table A7.3 may be used for TFE/MEs if the EIRP and frequency requirements are met. AFSEC/SEW uses Table A7.3 when determining the appropriate SSDs for MMEs.

Table A7.3. Minimum SSD Exceptions for HERO Certified Nuclear Weapons.

<table>
<thead>
<tr>
<th>Minimum SSD (feet)</th>
<th>HERO Certification</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 10</td>
<td>General HERO requirements per paragraph A7.5.</td>
</tr>
<tr>
<td>5</td>
<td>0.5 &lt; EIRP ≤ 5</td>
</tr>
<tr>
<td></td>
<td>All f</td>
</tr>
<tr>
<td>1</td>
<td>0.1 &lt; EIRP ≤ 0.5</td>
</tr>
<tr>
<td></td>
<td>All f</td>
</tr>
<tr>
<td>0*</td>
<td>EIRP ≤ 0.1</td>
</tr>
</tbody>
</table>

f = frequency (MHz)
EIRP = P_{Gi}, effective isotropic radiated power (W)
P_t = EMR emitter power (W)
P_i = P_{ai} = average power (W) for TFE/ME continuous systems, TFE/ME pulse-modulated systems with pulse width < 1 ms, and MMEs
P_l = P_{pl} = peak power (W) for TFE/ME pulse-modulated systems with pulse width ≥ 1 ms
G_t = numerical (far-field) antenna gain ratio (not the dBi value)

\[ G_t = \log_{10} \left( \frac{G_{\text{dBi}}}{10} \right) = 10^{G_{\text{dBi}}/10} \]
G_{\text{dBi}} = antenna gain (dBi)

*WARNING: Do not touch antennas to ordnance.*


A7.8.1. This instruction provides only guidance for using MMEs in proximity to nuclear weapons and serves only as part of the safety evaluation required to gain approval for use. If approved by AFSEC/SEW for use, maintain the determined SSD. Organizations employing these devices must address other hazards and security concerns.

A7.8.2. If approved by AFSEC/SEW, MMEs may be authorized for use around HERO SAFE and HERO UNSAFE nuclear weapons if the required SSD is maintained and as long as they are not connected to power via power cords. Batteries shall not be charged in the magazines, in storage, build-up, or assembly areas when nuclear weapons are present due to the possibility of the batteries exploding.

A7.8.3. Multiple MMEs (two or more) are not authorized in enclosed, reflective spaces or facilities where nuclear weapons are stored or undergoing maintenance; the aggregated effects on the ambient or volumetric electromagnetic field in those spaces may increase as a result of complex cavity effects, unless authorized by AFSEC/SEW. If the RADHAZ survey included the use of two or more AFSEC/SEW approved MMEs while maintain EME levels...
that do not exceed HERO EME for HERO SAFE or HERO UNSAFE nuclear weapons, multiple MMEs are permissible.

A7.9. Other EMR Emitter Safety Procedures. Items, such as desktop computers, laptops, tablets, associated hardware (such as printer, mice, etc.), etc., not configured with radiating wireless capability, e.g., cellular, Wi-Fi, Bluetooth, etc., are authorized for use in storage, build-up and assembly areas where nuclear weapons are present with the following restrictions:

A7.9.1. Items shall be certified to meet CFR, Title 47, Radio Frequency Devices, Class A or B limits and labeled accordingly. They require no SSD and can be used in close proximity but cannot come in direct contact with nuclear weapons, regardless of certification. If the item is not properly labeled or cannot be determined to meet the appropriate regulation, a SSD of 10 feet applies. If a planned operation occurs outside the United States where FCC regulations are not applicable, request assistance from AFSEC/SEW.

A7.9.2. Items with RF wireless capabilities are considered MMEs and paragraph A7.8 applies.

A7.10. HERO Survey Package. The WSM responsible for nuclear weapons shall prepare and maintain a HERO survey package IAW guidance provided in Attachment 4. (T-1).

A7.11. RADHAZ Survey.

A7.11.1. RADHAZ survey as defined in paragraph A4.7 shall be performed when the installation safety officer cannot take into account all sources of EMR, needs to evaluate the attenuation of the surrounding environment, and/or cannot comply with minimum calculated SSDs because of the lack of real estate or other limitations. (T-1).

A7.11.2. RADHAZ survey will be performed at all areas, e.g., dock, transportation routes, maintenance facilities, etc., where HERO certified nuclear weapons are employed during their STS.

A7.11.3. For HERO SAFE nuclear weapons, the EME cannot exceed MIL-STD-464 levels. For HERO UNSAFE nuclear weapons, the EME at the particular time and place cannot exceed levels indicated in Table A7.1 and illustrated in Figure A7.1.

A7.12. Test Articles.

A7.12.1. Test articles used in the development/flight testing of nuclear weapons, e.g., Joint Test Assemblies, do not require HERO certification but require HERO assessment. AFNWC requests a HERO assessment from AFSEC/SEW and provides test data and/or analysis to support the assessment. AFSEC/SEW will determine compliance with MIL-STD-464 levels and advise AFNWC in writing within thirty days after receipt of the request.

A7.12.2. At a minimum, AFNWC shall provide test data and/or analysis regarding all EIDs having a safety consequence. (T-1). If AFNWC, design laboratories, and users accept the risk that EIDs having a reliability consequence might dud or inadvertently fire, test data and/or analysis for the EIDs that pose only a reliability consequence are not required and the test article shall be assessed for safety only.

A7.13. HERO Margin. For nuclear weapons, HERO margin is defined as 16.5 dB for EIDs having a safety consequence only. For ICBM systems, when exposed to the EME levels
specified in MIL-STD-464, the maximum rms current in its bridgewire shall be 20 dB below the maximum no-fire current of the EIDs having a safety consequence only.
A8.1. **HERO Warning Symbol.** Warning symbols shall be posted by units operating any location where an EMR emitter creates the potential for premature initiation or dudding of ordnance due to HERO. (T-1). An example of a HERO warning symbol is shown in Figure A8.1. Units conducting ordnance operations, e.g., missile assembly, ammunition storage, etc., may place these symbols along ordnance transportation routes at prescribed locations to alert emitter operators, such as radios, cellular telephones, etc., to a potential hazard when using these devices past this point.


**Figure A8.1.** HERO Warning Symbol.
A9.1. **Introduction.** MIL-STD-464 HERO tables are included for reference only and will be updated if the parent document changes.

A9.2. **Requirements.** EIDs in ordnance shall not be inadvertently actuated during or experience degraded performance characteristics after exposure to the external EME levels listed in MIL-STD-464, Table 9 (Table A9.1), for both direct RF inducted actuation of the EID and inadvertent activation or an electrically powered firing circuit. (T-1). Relevant ordnance phases involving unrestricted and restricted levels in MIL-STD-464, Table 10 (Table A9.2).

A9.3. **Certification.** In order to receive a HERO SAFE certification at the all-up round or appropriate assembly level, the ordnance or system under test must be evaluated against and be in compliance with MIL-STD-464, Table 9 (Table A9.1). (T-1). Compliance shall be verified by test and/or analysis using the methodology in MIL-HDBK-240.
Table A9.1. Maximum External EME Level for Ordnance.

<table>
<thead>
<tr>
<th>Frequency Range (MHz)</th>
<th>Field Intensity (V/m-rms)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unrestricted Peak</td>
<td>Average</td>
<td>Restricted Peak</td>
</tr>
<tr>
<td>0.01</td>
<td>2</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>2</td>
<td>30</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>30</td>
<td>150</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>150</td>
<td>225</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>225</td>
<td>400</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>400</td>
<td>700</td>
<td>2,200</td>
<td>410</td>
</tr>
<tr>
<td>700</td>
<td>790</td>
<td>700</td>
<td>410</td>
</tr>
<tr>
<td>790</td>
<td>1,000</td>
<td>2,600</td>
<td>490</td>
</tr>
<tr>
<td>1,000</td>
<td>2,000</td>
<td>6,100</td>
<td>600</td>
</tr>
<tr>
<td>2,000</td>
<td>2,700</td>
<td>6,000</td>
<td>500</td>
</tr>
<tr>
<td>2,700</td>
<td>3,600</td>
<td>27,460*</td>
<td>2,620*</td>
</tr>
<tr>
<td>3,600</td>
<td>4,000</td>
<td>8,600</td>
<td>280</td>
</tr>
<tr>
<td>4,000</td>
<td>5,400</td>
<td>9,200</td>
<td>660</td>
</tr>
<tr>
<td>5,400</td>
<td>5,900</td>
<td>9,200</td>
<td>660</td>
</tr>
<tr>
<td>5,900</td>
<td>6,000</td>
<td>9,200</td>
<td>270</td>
</tr>
<tr>
<td>6,000</td>
<td>7,900</td>
<td>4100</td>
<td>400</td>
</tr>
<tr>
<td>7,900</td>
<td>8,000</td>
<td>550</td>
<td>400</td>
</tr>
<tr>
<td>8,000</td>
<td>8,400</td>
<td>7,500</td>
<td>400</td>
</tr>
<tr>
<td>8,400</td>
<td>8,500</td>
<td>7,500</td>
<td>400</td>
</tr>
<tr>
<td>8,500</td>
<td>11,000</td>
<td>7,500</td>
<td>910</td>
</tr>
<tr>
<td>11,000</td>
<td>14,000</td>
<td>7,500</td>
<td>680</td>
</tr>
<tr>
<td>14,000</td>
<td>18,000</td>
<td>8,700</td>
<td>680</td>
</tr>
<tr>
<td>18,000</td>
<td>50,000</td>
<td>2,900</td>
<td>580</td>
</tr>
</tbody>
</table>

*The EME levels in the table apply to ship launched ordnance that will traverse the main beam of systems in the 2,700 to 3,600 MHz frequency range on surface combatants. For all other ordnance, the unrestricted peak EME level is 12,667 V/m and the unrestricted average level is 1,533 V/m.

**In some of the frequency ranges for the Restricted Average column, limiting exposure of personnel through time averaging will be required to meet the requirement for personnel safety.
Table A9.2. Ordnance Phases and Associated Environment.

<table>
<thead>
<tr>
<th>S4 Phase</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation/Storage</td>
<td>Unrestricted</td>
</tr>
<tr>
<td>Assembly/Disassembly</td>
<td>Restricted</td>
</tr>
<tr>
<td>Staged</td>
<td>Unrestricted</td>
</tr>
<tr>
<td>Loading/Unloading</td>
<td>Restricted</td>
</tr>
<tr>
<td>Platform-Loaded</td>
<td>Unrestricted</td>
</tr>
<tr>
<td>Immediate Post-Launch</td>
<td>Unrestricted</td>
</tr>
</tbody>
</table>

A9.4. Environment. The unrestricted environment represents the worst case levels to which the ordnance may be exposed. The restricted environment involves circumstances where personnel are directly interacting with the ordnance (assembly/disassembly, loading/unloading). For the special case of handling operations, the environment is intentionally restricted to prevent personnel from being exposed to hazardous levels of EMR energy or contact currents. However, those operations also tend to increase coupled levels into the ordnance because of actions such as mating and de-mating of electrical connectors. Therefore, ordnance must be designated to be safe under these types of actions at the lower fields associated with the restricted levels.
A10.1. Overview.

A10.1.1. This Attachment, formerly chapter 9 in AFMAN 91-201, provides guidance for all HERO uncertified ordnance.

A10.1.2. The installation WSM shall prepare and maintain the HERO survey package (Attachment 4) for ordnance under their cognizance. Guidance for determining SSDs in this Attachment applies when HERO uncertified ordnance is involved.

A10.2. TFE/ME Safety Procedures (Conventional Ordnance). The following outlines the procedures for ensuring the EMR from a TFE/ME does not cause inadvertent EID initiation. This is done by maintaining SSDs between the EMR emitters and the EIDs.

A10.2.1. Collect and review the following information prior to performing any operation involving HERO uncertified conventional ordnance:

A10.2.1.1. Determine the configuration of the ordnance during the planned operation.

A10.2.1.2. Determine the EME at the location of the planned operations. This information should be available from the HERO survey package, the ISM, or installation safety office.

A10.2.1.3. Use the RADHAZ survey to determine if the EME at the location of ordnance operations is acceptable, otherwise determine the SSD from each known TFE/ME using Table A10.1. Conduct the planned operations at locations greater than the SSD for each TFE/ME. If the calculated SSD is less than 10 feet, the SSD is 10 feet.

A10.3. TFE/ME Safety Procedures (Nuclear Weapons). The following outlines the procedures for ensuring the EMR from a TFE/ME does not cause inadvertent EID initiation. This is done by maintaining SSDs between the EMR emitters and the EIDs.

A10.3.1. Collect and review the following information prior to performing any operation involving HERO uncertified nuclear weapons:

A10.3.1.1. Determine the configuration of the nuclear weapon during the planned operation.

A10.3.1.2. Determine the EME at the location of the planned operations. This information should be available from the HERO survey package, the ISM, or installation safety office.

A10.3.2. Use the RADHAZ survey to determine if the EME at the location of nuclear weapons operations is acceptable, otherwise determine the SSD from each known TFE/ME using Table A10.2. Conduct the planned operations at locations greater than the SSD for each TFE/ME. If the calculated SSD is less than 10 feet, the SSD is 10 feet.

A10.4. MME Safety Procedures and Considerations. If any commercial, common-use EMR emitters fitting the category of MMEs are present in the location where EID operations are planned apply the following additional guidelines:
A10.4.1. Most of the EMR emitters considered MMEs are governed by the FCC and CFR, Title 47, *Telecommunication*. Common commercially obtained sources of RF energy, such as cellular telephones, remote key fobs, etc., are normally governed for emission levels by FCC Part 15 or Part 22 and are identified accordingly. If compliance cannot be ascertained via markings on the device or within the owner’s/user’s manual or if a planned operation occurs outside the United States where FCC regulations are not applicable, request assistance from AFSEC/SEW.

A10.4.2. MMEs are not authorized within 10 feet of any exposed EID, or any weapons system containing an EID except those specific items that have been individually researched and addressed in writing by AFSEC/SEW. When a lesser distance is allowed, keep MMEs at least 10 feet away whenever possible. Using any EMR emitter device closer than 10 feet must only take place if required for the proper use of the EMR emitter device or if required to complete the planned and approved operation and is not justified by issues of convenience or for the sole purpose of ease of operations.

A10.4.2.1. All remote entry devices, including car entry keys, in compliance with Code of Federal Regulations (CFR), Title 47, *Telecommunication*, Part 15, *Radio Frequency Devices*, paragraph 15.231, *Periodic operation in the band 40.66-40.70 MHz and above 70 MHz*, are only restricted from coming into physical contact with ordnance, regardless of configuration. Remote entry devices not in compliance with regulations must maintain a SSD of 10 feet. If a planned operation occurs outside the United States where FCC regulations are not applicable, request assistance from AFSEC/SEW.

A10.4.2.2. If the operator is unsure a device should be defined as an MME or the operator has an MME not specifically addressed in this section, request assistance from AFSEC/SEW. AFSEC/SEW will analyze and distribute information regarding decisions, approved use guidelines, and SSDs for specified devices on a case-by-case basis.

A10.5. **Maximum Power Density Criteria.** When the minimum SSD cannot be achieved because of lacking real estate or any other limitation, a RADHAZ survey must be made at the location where the operations are planned to occur. Compare the measured power density with the recommended maximum power density calculated from Table A10.1 for HERO uncertified conventional ordnance or Table A10.2 for HERO uncertified nuclear weapons. The measured power density must be no greater than the maximum power density provided in the appropriate table.
Table A10.1. Power Densities and SSDs for HERO Uncertified Conventional Ordnance.

<table>
<thead>
<tr>
<th>Frequency Ranges (MHz)</th>
<th>Maximum Allowable Power Density (W/m²)</th>
<th>SSD Equations (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>“Worst-Case”</td>
<td></td>
</tr>
<tr>
<td>f &lt; 0.005</td>
<td>100</td>
<td>0.0925\sqrt{P_tG_t}</td>
</tr>
<tr>
<td>0.005 ≤ f &lt; 2</td>
<td>\left(\frac{0.05}{f}\right)^2</td>
<td>18.5f\sqrt{P_tG_t}</td>
</tr>
<tr>
<td>2 ≤ f &lt; 80</td>
<td>6.25 × 10^{-4}</td>
<td>37.0\sqrt{P_tG_t}</td>
</tr>
<tr>
<td>80 ≤ f &lt; 32,000</td>
<td>\left(\frac{f}{3,200}\right)^2</td>
<td>2,960\sqrt{P_tG_t}\frac{1}{f}</td>
</tr>
<tr>
<td>f ≥ 32,000</td>
<td>100</td>
<td>0.0925\sqrt{P_tG_t}</td>
</tr>
<tr>
<td></td>
<td>“Exposed EID”</td>
<td></td>
</tr>
<tr>
<td>f &lt; 0.02</td>
<td>100</td>
<td>0.0925\sqrt{P_tG_t}</td>
</tr>
<tr>
<td>0.02 ≤ f &lt; 2</td>
<td>\left(\frac{0.2}{f}\right)^2</td>
<td>4.625f\sqrt{P_tG_t}</td>
</tr>
<tr>
<td>2 ≤ f &lt; 48.5</td>
<td>0.01</td>
<td>9.25\sqrt{P_tG_t}</td>
</tr>
<tr>
<td>48.5 ≤ f &lt; 4.850</td>
<td>\left(\frac{f}{485}\right)^2</td>
<td>448.625\sqrt{P_tG_t}\frac{1}{f}</td>
</tr>
<tr>
<td>f ≥ 4.850</td>
<td>100</td>
<td>0.0925\sqrt{P_tG_t}</td>
</tr>
<tr>
<td></td>
<td>“In Storage or Ground Transport in a Metallic Container”</td>
<td></td>
</tr>
<tr>
<td>f &lt; 0.06325</td>
<td>100</td>
<td>0.0925\sqrt{P_tG_t}</td>
</tr>
<tr>
<td>0.06325 ≤ f &lt; 2</td>
<td>\left(\frac{0.2}{f}\right)^2</td>
<td>4.625f\sqrt{P_tG_t}\frac{1}{10}</td>
</tr>
<tr>
<td>2 ≤ f &lt; 48.5</td>
<td>0.1</td>
<td>2.925\sqrt{P_tG_t}</td>
</tr>
<tr>
<td>48.5 ≤ f &lt; 1,533.7</td>
<td>\left(\frac{f}{485}\right)^2</td>
<td>448.625\sqrt{P_tG_t}\frac{P_tG_t}{f}\frac{1}{10}</td>
</tr>
<tr>
<td>f ≥ 1,533.7</td>
<td>100</td>
<td>0.0925\sqrt{P_tG_t}</td>
</tr>
<tr>
<td></td>
<td>“In Storage or Ground Transport in a Metallic Container” or “In or On an Aerial Delivery Platform”</td>
<td></td>
</tr>
<tr>
<td>All f</td>
<td>100</td>
<td>0.0925\sqrt{P_tG_t}</td>
</tr>
<tr>
<td></td>
<td>“Leadless EID”</td>
<td></td>
</tr>
<tr>
<td>All f</td>
<td>N/A</td>
<td>10</td>
</tr>
</tbody>
</table>

Notes Table A10.1:
1. For the formulas in this table
f = frequency (MHz)
\[ P_t = \text{EMR emitter power (W)} \] which is equal to peak power for pulse-modulated systems with \( pw \) one-millisecond or greater or average power for \( pw \) less than one-millisecond and continuous systems.

\[ G_t = \text{numerical (far-field) antenna gain ratio} \]

Power density conversion: 10 W/m² = 1 mW/cm²

2. When more than one EMR emitter is operating in an area, each at a different frequency, the maximum allowable power density is the greatest power density calculated for each of the EMR emitters.

3. For frequencies outside the ranges specified in this table request assistance from AFSEC/SEW.

4. Maximum allowable power densities for HERO uncertified conventional ordnance do not include personnel exposure limit considerations. While “Exposed EID” values are all below personnel exposure limits as specified in AFI 48-109, *Electromagnetic Field Radiation (EMFR)* *Occupational and Environmental Health Program*, latest version, review additional guidance for operations involving EIDs “In Storage or Ground Transport in a Non-Metallic Container,” for EIDs “In Storage or Ground Transport in a Metallic Container,” or for EIDs “In or On an Aerial Delivery Platform.”

5. Configuration Descriptions:

   “Worst-Case.” When EIDs are unshielded or the leads or circuitry could inadvertently be formed into a resonant dipole or loop antenna or the configuration of the EIDs is unknown.

   “Exposed EID.” When EIDs are exposed due to maintenance, assembly, or disassembly or the item or munition which contains the EID is exposed due to maintenance, assembly or disassembly.

   “In Storage or Ground Transport in a Non-Metallic Container.” When EIDs are stored or in a ground transport configuration inside a conductive (metallic) container. This includes EIDs assembled in a weaponized configuration when the weapon case provides a conductive shield.

   “In or On an Aerial Delivery Platform.” When EIDs or the item or munition containing them are in a transport configuration inside cargo aircraft, externally loaded on an aircraft, or on a drone.

   “Leadless EID.” When EIDs do not have lead wires and are in original shipping configurations and/or containers.

6. When handling or installing EIDs use “Exposed EID” configuration even though leadless EIDs are involved because weapon system wiring could form a resonant antenna during installation.

7. When unclear about the appropriate configuration to apply use the most conservative, i.e., the greatest distance or largest power density.
Table A10.2. EID Power Densities and SSDs for HERO Uncertified Nuclear Weapons.

<table>
<thead>
<tr>
<th>Frequency Ranges (MHz)</th>
<th>Maximum Allowable Power Density (W/m²)</th>
<th>SSD Equations (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Exposed”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$f &lt; 0.0132$</td>
<td>100</td>
<td>$0.0925 \sqrt{P_t G_t}$</td>
</tr>
<tr>
<td>$0.0132 \leq f &lt; 8$</td>
<td>$\left( \frac{0.132}{f} \right)^2$</td>
<td>$7.01 f \sqrt{P_t G_t}$</td>
</tr>
<tr>
<td>$8 \leq f &lt; 4,850$</td>
<td>$\left( \frac{f}{485} \right)^2$</td>
<td>$448.625 \sqrt{P_t G_t}$</td>
</tr>
<tr>
<td>$4,850 \leq f &lt; 45,000$</td>
<td>100</td>
<td>$0.0925 \sqrt{P_t G_t}$</td>
</tr>
</tbody>
</table>

“In Storage or Ground Transport”

| $f < 1$                | 100                                    | $0.0925 \sqrt{P_t G_t}$ |
| $1 \leq f < 18.42$    | 26.53                                  | $0.18 \sqrt{P_t G_t}$ |
| $18.42 \leq f < 30$   | $\frac{9,000}{f^2}$                   | $f \sqrt{P_t G_t}$ |
|                        |                                        | 1025                  |
| $30 \leq f < 300$     | 10                                     | $0.2925 \sqrt{P_t G_t}$ |
| $300 \leq f < 3,000$  | $\frac{f}{30}$                        | $5.066 \sqrt{\frac{P_t G_t}{f}}$ |
| $3,000 \leq f < 45,000$| 100                                    | $0.0925 \sqrt{P_t G_t}$ |

Notes for Table A10.2: Notes 1 through 4 for Table A10.2 are exactly the same as Notes 1 through 4 for Table A10.1.

5. Configuration Descriptions:
   “Exposed.” EIDs exposed due to maintenance, assembly, or disassembly.
   “In Storage or Ground Transport.” EIDs assembled in a weaponized configuration for storage or ground transport.