BY ORDER OF THE
SECRETARY OF THE AIR FORCE

AIR FORCE INSTRUCTION 91-401

29 SEPTEMBER 2008

Safety

DIRECTED ENERGY WEAPONS SAFETY

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RELEASABILITY: There are no releasability restrictions on this publication.

OPR: HQ AFSC/SEW

Certified by: HQ USAF/SED
(Mr William C. Redmond)
Pages: 32

This instruction implements Air Force Policy Directive (AFPD) 91-4, *Directed Energy Weapons Safety*. It provides the requirements for Directed Energy Weapon (DEW) safety certification and guidance for establishing an operational DEW safety program. This instruction applies to programs of record that have at least reached Milestone B and operational organizations that test, evaluate, train, operate, maintain, store, or decommission DEW systems, including Air Force Reserve Command (AFRC) units and the Air National Guard (ANG). This instruction also applies to research and development organizations when research efforts are ready to transition from Joint Capability Technology Demonstrations (JCTDs) and/or when research programs are identified for Emergency Operational Capability (EOC). See **Attachment 1** for abbreviations and acronyms used in this instruction. Send Major command (MAJCOM) supplements to HQ AFSC/SEW, 9700 G Avenue SE, Kirtland AFB NM 87117-5670, for coordination and approval before publication. Ensure that all records created as a result of processes prescribed in this publication are maintained in accordance with Air Force Manual (AFMAN) 33-363, *Management of Records*, and disposed of in accordance with Air Force Records Information Management System (AFRIMS) Records Disposition Schedule (RDS) located at **https://afrims.amc.af.mil/rds_series.cfm**. Refer recommended changes and questions about this publication to the Office of Primary Responsibility (OPR) using the AF IMT 847, *Recommendation for Change of Publication*; route AF IMT 847s from the field through the appropriate functional's chain of command. Guidance on waivers to this instruction is included in **Chapter 1** and **Chapter 3**.

Chapter 1

INTRODUCTION

1.1. Purpose. The purpose of this instruction is to implement, IAW AFPD 91-4, *Directed Energy Weapons Safety*, the Air Force DEW Safety Program to protect personnel, property, operational capability, and the environment from undue risk of damage or harm. The intent of this instruction is to implement a safety program throughout the lifecycle of a DEW program, including safety certification prior to fielding (see **Chapter 3**) and the establishment of a unit level DEW safety program (DEWSP) once a system is operational (see **Chapter 5**).

1.2. Applicability.

1.2.1. This instruction applies to DEW systems using directed energy primarily as a direct means to deny, disrupt, degrade (damage), or destroy enemy equipment, facilities, or personnel.

1.2.1.1. DEW systems create unique hazards that are different from conventional and nuclear weapons. Potential DEW systems covered by this instruction include, but are not limited to, high-energy lasers, weaponized microwave and millimeter wave beams, explosive-driven electromagnetic pulse devices, acoustic weapons, laser induced plasma channel systems, non-lethal directed energy devices, and atomic-scale and subatomic particle beam weapons. The power levels of these DEW systems span a range from levels that are considered safe for human exposure, through levels that can induce pain but cause no permanent cell damage to levels that would be fatal to humans or that would destroy materiel.

1.2.2. This instruction does not apply to:

1.2.2.1. Directed energy devices that support or are an element of a conventional/nuclear weapon if directed energy from those devices is not intended to deny, disrupt, damage, or destroy enemy equipments, facilities, or personnel.

1.2.2.2. Directed energy devices that are not weapons including guidance radar, laser range finders, target designators, medical lasers, DEW trainers or simulators, electronic warfare systems, etc. The safety programs for these systems are detailed in other publications, such as Air Force Occupational Safety and Health Standard (AFOSH-STD) 48-139, *Laser Radiation Protection Program*.

1.2.2.3. Systems determined by the AF/SE to fall under other instructions.

1.2.2.4. Hazardous materials or energy before they become part of the weapon system. DEW related hazardous material or energy will be managed like any other similar hazardous material or energy under provisions of applicable safety guidance, (e.g. Air Force Instruction (AFI) 32-7086, *Hazardous Materials Management*, Air Force Joint Manual (AFJMAN) 23-209, *Storage and Handling of Hazardous Materials*).

1.3. Waivers to this Instruction. Waivers to this instruction will be requested through the MAJCOM/SE to HQ USAF/SE. Details on DEW certification waivers can be found in **Chapter 3**.

Chapter 2

RESPONSIBILITIES AND AUTHORITIES

2.1. Vice Chief of Staff of the Air Force: Approves Emergency Operational Capability (EOC).

2.2. Assistant Secretary of the Air Force (Acquisition), (SAF/AQ): Serve as the Service Acquisition Executive (SAE) as delegated for non-space AF programs and execute responsibilities as the senior corporate operating official for non-space acquisition. Execute SAE responsibilities outlined in the DOD 5000-series for execution of non-space AF acquisitions.

2.3. Assistant Secretary of the Air Force (Installations, Environment & Logistics), (SAF/IE): Ensures oversight and policy for all DEW installation, safety and health issues.

2.4. Air Force Chief of Safety (AF/SE): The final authority for the AF DEW safety policy applicability including DEW certification and waivers.

2.5. Air Force Surgeon General (AF/SG):

2.5.1. Supports DEW safety with policy and standards for directed energy exposure (e.g. AFOSH-STD 48-9, *Radiofrequency Radiation (RFR) Safety Program,* and AFOSH-STD 48-139).

2.5.2. Supports the certification process by providing health effects evaluation for the DEW Certification Board (DEWCB) and applies requirements of AFI 48-145, *Occupational and Environment Health Program*, for medical surveillance and control procedures.

2.5.3. Ensures base Bioenvironmental Engineering (BE) conducts health risk assessments of work areas where DEW are used or maintained, IAW AFI 48-145 and AFMAN 48-153, *Health Risk Assessment*.

2.5.4. Provides health related input to AF/SE when additional guidance and/or resources are needed.

2.6. Headquarters Air Force Safety Center (HQ AFSC):

2.6.1. Develops Air Force DEW safety criteria and policy.

2.6.2. Chief, Weapons Safety Division (AFSC/SEW) manages the AF DEW Certification process for the AF/SE.

2.6.2.1. Chairs the DEWCB and develops organizational charter.

2.6.2.2. Maintains the official record of all DEW certification documentation and waivers.

2.6.3. Maintains the DEW safety mishap database and distributes mishap prevention crosstalk.

2.6.4. Reviews MAJCOM DEW AFI supplements and staffs documents through AF/SE.

2.6.5. Ensures important DEW safety issues are addressed at the AF Environment, Safety, and Occupational Health (ESOH) Council.

2.6.6. Ensures the effectiveness of MAJCOM DEW safety programs.

2.6.7. Advises the Program Manager on all safety issues regarding DEW.

2.6.8. Support the Milestone Decision Authority on DEW areas during Milestone Reviews and other processes as required.

2.7. MAJCOMs, FOAs, and DRUs:

2.7.1. Establish a MAJCOM DEWSP that implements the requirements of this instruction.

2.7.2. Ensure DEW systems are certified prior to fielding and operational or training use.

2.7.3. Report DEW mishaps IAW AFI 91-204, *Safety Investigations and Reports,* and AFMAN 91-221, *Weapons Safety Investigations and Reports*.

2.7.4. Ensure MAJCOM DEW AFI supplements are staffed through HQ AFSC/SEW for AF/SE approval IAW AFPD 91-4.

2.7.5. Report developments/issues on DEW Safety to the ESOH Council.

2.7.6. Chief of Weapons Safety and Weapons Safety Managers (WSMs) will provide policy guidance regarding DEW systems' compliance with DEW Program Office technical data, assisting Program Managers' efforts to assure the Operational Safety, Suitability, and Effectiveness (OSS&E) of the DEW systems. Program Managers provide the technical data that govern DEW operations and maintenance and communicate the ESOH risks.

2.7.7. Develop DEW site safety plan and coordinate as required. At a minimum the plan should include a concept of operations (CONOPS) overview, identification of potential hazards (include those to personnel, equipment, interoperability, and the environment), a risk assessment and planned mitigation

2.8. Air Force Materiel Command (AFMC):

2.8.1. Maintains technical expertise to evaluate DEW health effects and safety in AF operations. The Air Force Research Laboratory Human Effectiveness-Directed Energy Division (AFRL/RHD) and Directed Energy Directorate (AFRL/RD) can provide an entry point for DEW questions.

2.8.2. Provides additional DEWCB members based on requirements for specific technical expertise.

2.8.3. Through AFRL, conducts research on hazards associated with DEW systems, to include hazards to people, property, and materiel. Communicate new discoveries in DEW principles and effects in a timely manner.

2.8.4. Maintains expertise on directed energy personnel protective technologies for AF use.

2.9. Program Manager (PM):

2.9.1. Complies with the DEW certification process.

2.9.2. Creates and manages the DEW Certification Plan (DEWCP). See **Chapter 3** for DEWCP approval process. Because of the overlap with parts of the Programmatic Environment, Safety, and Occupational Health Evaluation (PESHE) (required by Department of Defense Instruction (DoDI) 5000.2, *Operation of the Defense Acquisition System*), the DEWCP may be considered as a section (or sections) of the PESHE.

2.9.3. Ensures DEW certification is an element of the Program's System Safety technical requirements which the Program Office manages as part of the overall Systems Engineering effort.

2.9.4. Ensures DEW safety criteria as identified in the DEWCP are integrated into overall system safety, configuration control, and included in training manuals and technical orders (TOs) prior to fielding.

2.9.5. Maintains currency of DEW certification throughout the lifecycle of DEW systems.

2.9.6. Identifies funding needed for AF-directed AFRL research to conduct system safety analysis and to fully characterize human effects if data is lacking or unknown.

2.9.7. Identifies to operating MAJCOMs the funding needed to support Directed Energy surveillance from an occupational health standpoint.

2.10. Commanders or Directors:

2.10.1. Commanders and Directors at all levels with a DEW mission are responsible for ensuring requirements of this instruction are met and personnel are appropriately trained (as outlined in AFOSH-STD 48-9, AFOSH-STD 48-139, etc.).

2.11. Range Commanders:

2.11.1. Ensures safe operations of DEW on their range IAW AFI 13-212, *Range Planning and Operations*.

2.12. Unit Chiefs of Safety:

2.12.1. Select personnel for the DEW Safety Officer (DEWSO) position. The DEWSO position should be aligned under the Weapons Safety area (typically at the wing level). To maintain DEW Safety continuity, consider requesting an Assignment Availability Code 39 for the DEWSO with 18 months for officer and 24 months for enlisted personnel IAW AFI 36-2110, *Assignments*.

2.12.2. Ensure DEWSO receives the appropriate training for the type of DEW used, (as outlined in AFOSH-STD 48-9, AFOSH-STD 48-139, etc.)

2.12.3. Appoint additional staff members to support the DEWSO as the mission requires.

2.13. Directed Energy Weapons Safety Officer:

2.13.1. Manages the unit level DEWSP.

2.13.2. Ensures the unit safety program meets the requirements of this instruction.

2.13.3. Develops tailored local guidance for storage, mishap prevention plans, etc.

2.13.4. For more specific guidance on DEWSO responsibilities, see **Chapter 5**.

Chapter 3

DIRECTED ENERGY WEAPONS SAFETY CERTIFICATION PROCEDURE

3.1. Overview.

3.1.1. DEW certification provides the basis for operational and training safety for the DEW. The certification process is conducted in two phases. Phase I initiates within 60 days after acquisition milestone B so the safety community is aware of an upcoming DEW system and the PM can influence system safety early in the acquisition cycle. Phase II occurs after acquisition milestone C so the DEW system can be safety certified prior to operational and training use. The DEWCB oversees the DEW certification procedure.

3.1.2. The DEWCP details the strategy to ensure that the weapon is in compliance with applicable safety and health criteria.

3.1.3. The DEWCB will issue a Certification Statement to the PM following Phase II approval of the DEWCP.

3.1.4. Since Joint Capability Technology Demonstrations (JCTDs) have varying acquisition timelines and objectives, safety certification phasing will be handled on a case-by-case basis by AFSC. The certification phasing will be determined using the acquisition transition plan and an initial safety/ hazards/environmental assessment from JCTD Management Plan required by the Office of the Deputy Under Secretary of Defense for Advanced Systems & Concepts.

3.1.5. Some Commercial off-the-shelf (COTS) systems have the potential to be used as DEW systems (e.g. laser dazzlers). The proposed user will work with AFSC/SEW to determine certification requirements.

3.1.6. DEW systems that are already beyond acquisition milestone B prior to the implementation of this AFI will still need safety certification prior to operational use as directed in AFPD 91-4. The PM will work with AFSC/SEW to safety certify the weapon system.

3.1.7. AFSC/SEW will determine if DEW certification is required for any system that has already been fielded prior to implementation of this AFI.

3.2. Certification Requirements.

3.2.1. Safety Requirement. All DEW will be certified prior to operational or training use as required by AFPD 91-4.

3.2.2. DEW Certification Plan.

3.2.2.1. Purpose. The DEWCP communicates to the DEWCB the intent to comply with AF DEW safety criteria. The DEWCP will document the safety procedures and controls used to mitigate specific hazards within the operational DEWSP.

3.2.2.2. The PM will maintain configuration control and update the DEWCP to the DEWCB as it evolves with the program and prior to major program milestones.

3.2.2.3. At any time, the PM may request clarification of safety requirements, request feedback, or certification advice from the DEWCB through HQ AFSC/SEW.

3.2.2.4. A Programmatic Environment, Safety, and Occupational Health Evaluation (PESHE) for all systems is required by Department of Defense Instruction DoDI 5000.2 and AFI 63-101, *Operations of Capabilities Based Acquisition System*. The PESHE may reference the DEWCP or directly incorporated it to minimize duplication. This is analogous to the relationship between the PESHE and the Technical Munitions Safety Study (TMSS) required by AFI 91-205, *Nonnuclear Munitions Safety Board*, for certification of conventional weapons.

3.3. Directed Energy Weapon Certification Board (DEWCB).

3.3.1. The DEWCB is the review panel for DEW certification.

3.3.2. DEWCB organization and membership is provided in **Attachment 2**.

3.3.3. The DEWCB conducts an annual DEWCP review until DEW certification is completed.

3.3.4. The DEWCB evaluates the program-specific DEWCP to identify the likelihood of success in meeting safety criteria, and applicable national or international scientific safety standards.

3.3.5. HQ AFSC/SEW will schedule DEWCB meetings and request additional technical advisors to review new acquisitions, modifications, or add-on capability.

3.3.6. Provides AF input into other Department of Defense (DoD) boards.

3.4. DEW Certification Phase I.

3.4.1. Phase I is required upon initiation of a DEW acquisition program.

3.4.1.1. The PM will submit the Phase I DEWCP to HQ AFSC/SEW as notification to begin the certification process within 60 days after completion of acquisition milestone B.

3.4.2. Directed Energy Weapon Certification Board Functions.

3.4.2.1. HQ AFSC/SEW will notify the DEWCB organizations no later than 15 days following receipt of the Phase I DEWCP from the PM to establish a target Phase I DEWCB meeting date. HQ AFSC/SEW will provide DEWCP to DEWCB organizations.

3.4.2.2. Standing DEWCB members will determine their own requirements for technical support advisors to attend the DEWCB and request support from applicable organizations. These additional technical advisors (see paragraph **A2.3.2.**) should be identified to HQ AFSC/SEW within 45 days after notification of the target Phase I DEWCB meeting.

3.4.2.3. HQ AFSC/SEW will finalize the DEWCB membership within 60 days after receiving the Phase I DEWCP.

3.4.2.4. The DEWCB will meet within 90 days of initial PM notification and evaluate the DEWCP. Findings and recommendations will be documented and supplied to the PM by HQ AFSC/SEW no later than 60 days from the DEWCB Phase I review of the DEWCP.

3.4.2.5. Refer to **Table 3.1.** for certification timetable.

3.4.3. DEWCP Phase I Content.

3.4.3.1. DEW System Description.

3.4.3.1.1. Describe the desired capabilities, the intended use, and the intended operational environment.

3.4.3.2. Primary Hazards Overview.

3.4.3.2.1. Identify and document the damage mechanisms of the DEW and the resulting primary hazards. Use MIL-STD-882D to develop a hazard risk matrix. Describe the approach to complete the DEW safety analysis so sufficient data is available for risk reduction endpoints.

3.4.3.3. Safety Techniques.

3.4.3.3.1. Identify and document the implementation of applicable system safety techniques.

3.4.3.3.2. Ensure that DEW hardware, software, operator, procedures, interfaces, and operational environment are evaluated.

3.4.3.4. Range Testing.

3.4.3.4.1. Initial plan for testing on specified test ranges. A range ready designation is required prior to live-fire testing of DEW on ranges and is obtained from the appropriate Responsible Test Organization (RTO) using a Safety Review Board (SRB) IAW AFI 99-103, *Capabilities Based Test and Evaluation*.

3.4.3.4.2. All relevant ESOH hazards must have the applicable risks accepted prior to the start of testing.

3.4.3.5. Safety Documentation.

3.4.3.5.1. Present safety documentation and lessons learned to this point of the DEW program.

3.4.3.6. Mishap Response Plan.

3.4.3.7. Configuration Management Plan IAW AFMAN 63-119, *Certification of System Readiness for Dedicated Operational Test and Evaluation.*

3.4.3.8. Schedule that includes major certification and program milestones.

3.4.3.9. Responsibilities of each agency identified in the DEWCP.

3.4.3.10. Signature page that indicates coordination with all responsible agencies.

3.4.3.11. Applicable Standards and Requirements.

3.4.3.11.1. Identify standards and requirements applicable to the DEW.

3.4.3.11.2. Identify any exemptions and authority for making the exemption. This is especially important in those rare cases when, because of the operational requirements of a DEW, AF personnel may be exposed in training, system evaluation, CONOPS development, etc, to levels above accepted limits. Contact the AF Safety Center for questions on how to obtain policy exemptions.

3.4.3.12. Appendices as needed.

3.4.3.12.1. Applicable Security Classification Guides.

3.4.3.12.2. Classified information should be limited to a classified attachment.

3.4.4. At the completion of the DEWCP Phase I review, the safety concerns and recommendations identified by the DEWCB will be provided to the PM, allowing the PM to implement design safety and analyze risk mitigation techniques early in the acquisition program.

3.5. DEW Certification Phase II.

3.5.1. Phase II completion is required prior to DEW operational or training use.

3.5.1.1. The PM will submit the Phase II DEWCP to HQ AFSC/SEW as notification that certification approval is required.

3.5.1.2. The PM will submit the Phase II DEWCP to the HQ AFSC/SEW no later than 120 days prior to the required certification date.

3.5.1.3. HQ AFSC/SEW will provide DEWCP to DEWCB members within 15 days of PM notification.

3.5.1.4. HQ AFSC/SEW will convene the DEWCB no later than 60 days following receipt of the Phase II DEWCP.

3.5.1.5. Refer to **Table 3.1.** for certification timetable.

3.5.2. DEWCB Functions:

3.5.2.1. Evaluate the DEWCP. Findings, recommendations, and applicable certification statement, will be documented and supplied to the PM no later than 60 days from the Phase II review of the DEWCP.

3.5.2.2. The DEWCB reviews and reports the concurrence or non-concurrence with the DEW Certification Recommendation (DEWCR) section of the DEWCP. If the DEWCB non-concurs, they must document all safety criteria that are not met.

Table 3.1. DEW Certification Action Timetable

Certification Action	OPR	Phase I No Later Than Date	Phase II No Later Than Date
Request initiation of DEW Certification and provide DEWCP to AFSC/SEW	PM	60 days after Milestone B	After Milestone C, 120 days prior to required certification date
Provide DEWCP to DEWCB organizations and arrange meeting date	AFSC/SEW	15 days after PM initiation	15 days after PM initiation
DEWCB organizations determine technical support personnel requirements	DEWCB organizations	45 days after PM initiation	N/A membership determined
Finalize DEWCB and technical support membership	AFSC/SEW	60 days after PM initiation	N/A
DEWCB meeting	AFSC/SEW	90 days after PM initiation	60 days after PM initiation
Provide DEWCB results to PM	AFSC/SEW	60 days after DEWCB meeting	60 days after DEWCB meeting

3.5.3. DEWCP Phase II Content.

3.5.3.1. DEW Certification Recommendation (DEWCR).

3.5.3.1.1. Submit a recommendation for full DEW certification approval or certification approval with restrictions. The recommendation acts as a 1-page executive summary of the planned use of the system and a statement that the risks have been properly mitigated.

3.5.3.1.2. The recommendation will be evaluated by the DEWCB based on compliance with DEW safety policy and applicable risk assessments.

3.5.3.2. Safety Criteria. Define the DEW-specific criteria for use in the DEWSP IAW **Chapter 4**.

3.5.3.3. Compliance/Risk Mitigation Plan.

3.5.3.3.1. Document the results of the risk assessment for the DEW.

3.5.3.3.2. Document the results of the completed safety analysis.

3.5.3.3.3. Identify specific methods to be used for compliance verification.

3.5.3.3.4. Identify approaches for addressing system-level certification issues (such as compatibility requirements for aircraft systems and technical data development).

3.5.3.4. Safety Critical Functions and Safety Critical Components.

3.5.3.4.1. Provide identification of each item and a brief description of its purpose. Include hazard classification if appropriate.

3.5.3.4.2. Provide accompanying data to support how the hazard was mitigated to an acceptable level and provide the relative position on the system specific risk assessment matrix according to MIL-STD-882D.

3.5.3.4.3. Justify the mitigation technique chosen if design mitigation was not used.

3.5.3.4.4. Document results of modeling, simulation, and/or tests that show compliance.

3.5.3.5. Additional Safety Critical Function Information.

3.5.3.5.1. Identify which safety critical functions are required, as referenced in Section **4.4.** Designate the level of criticality for each function. Provide justification.

3.5.3.5.2. Provide information on methods to prevent the inadvertent or improper propagation of directed energy by the weapon.

3.5.3.5.3. Identify methods for transition between system states.

3.5.3.6. Additional Safety Critical Component Information.

3.5.3.6.1. Identify the components/systems and/or software that control the safety critical functions.

3.5.3.6.2. Provide a description stating how the equipment interacts to perform the safety critical function(s).

3.5.3.7. Subsystem and functional elements safety information.

3.5.3.7.1. Include all documentation and explanations of existing certification.

3.5.3.8. Other certifications. (e.g. Aircraft Airworthiness Certification or Air Force Laser System Safety Review Board approval).

3.5.3.9. Status of any policy exemptions required for operation of the system.

3.5.3.10. Appendices as needed.

3.6. Certification Determination.

3.6.1. The DEWCB Chair will consider the findings and recommendations of the DEWCB.

3.6.2. If approved, HQ AFSC/SEW will provide a DEW Statement of Certification, signed by AF/SE, to the PM.

3.6.2.1. The statement will list the hardware, software, procedures, and interfaces evaluated and their certification status.

3.6.2.2. The Statement of Certification will be supplied to PM no later than 60 days after DEWCB convenes the Phase II review of the DEWCP.

3.6.3. If disapproved, HQ AFSC/SEW will send a Statement of Deficiencies to the PM.

3.6.3.1. The statement will list the items evaluated and their deficiencies.

3.6.3.2. The Statement of Deficiencies will be documented and supplied to the PM no later than 60 days after DEWCB convenes the Phase II review of the DEWCP.

3.7. Certification Procedure for DEW System Modifications.

3.7.1. The following guidance applies to modifications of a DEW system that has already been safety certified. This includes all physical and functional configuration changes to existing certified hardware, software, procedures, and interfaces; addition of new equipment; and new operational uses for existing equipment.

3.7.1.1. The recertification process can be tailored. The scope of DEWCB review will be dependant on the modification's impact on the DEW certification.

3.7.1.2. DEW Certification Statement: The PM will attach the current DEW Certification Statement to the new modification of the DEWCP.

3.7.1.3. No-Impact Statement: If the PM determines the system modification will have no impact to the existing DEW certification, the PM can submit a no-impact statement (as an addendum to the existing DEWCP) with sufficient supporting analysis to justify this conclusion.

3.7.1.3.1. If HQ AFSC/SEW determines that the no-impact statement is warranted, the DEW certification statement will be reissued for the modified system.

3.7.1.3.2. If HQ AFSC/SEW non-concurs, the PM shall modify the DEWCP to address the areas of concern and resubmit to HQ AFSC/SEW.

3.8. Certification Waiver Procedure. Follow this process when the DEW fails to meet the requirements for certification or in situations of urgent military need where the operational necessity outweighs the operational risk.

3.8.1. Certification waivers.

3.8.1.1. In cases where a system component or safety requirement is preventing certification, the MAJCOM sends a waiver request letter to HQ AFSC/SEW.

3.8.1.2. The PM will include the DEWCR from Phase II of the DEWCP.

3.8.1.3. A waiver must include a hazard analysis that shows how the proposed design will satisfy the intent of the safety requirement, IAW MIL-STD-882D.

3.8.1.4. AFSC/SEW in conjunction with the DEWCB will analyze the adequacy of compensatory measures when criteria cannot be met to determine if an adequate level of safety exists and if a waiver is justified.

3.8.1.5. If approved, HQ AFSC/SEW will issue a certification waiver, signed by AF/SE, to the PM and MAJCOM.

3.8.1.6. If certification is denied, the PM should seek other hazard mitigation alternatives to ensure deployment and mission success. The PM may reapply for certification when additional hazard mitigation techniques are completed.

3.8.2. Waivers for urgent military operation.

3.8.2.1. If EOC is requested by combatant commands, the PM will submit a certification waiver through the MAJCOM to HQ AFSC/SEW for AF/SE coordination and will be forwarded to the Vice Chief of Staff of the Air Force for approval.

3.8.2.2. The EOC request must include a Residual Risk Analysis (RRA). An RRA is an overall assessment of a system's suitability for emergency operations from a safety perspective. It should provide all information necessary to make informed risk management decisions. The RRA must address all items previously listed in the Statement of Deficiencies, Section **3.6.3.**, and should also include:

3.8.2.2.1. A risk analysis using the approach outlined in MIL-STD-882D.

3.8.2.2.2. Recommendations and strategies to mitigate mishap risks exposed through operations or maintenance.

3.8.2.2.3. A risk mitigation strategy approval by the appropriate Risk Acceptance Authority. Determine the appropriate Risk Acceptance Authority using the highest mishap category of the initial risks (while recommended actions are being incorporated into the design) and residual risks (after all recommended actions have been incorporated). Refer to MIL-STD-882D, Table A-IV, *Example Mishap Risk Categories and Mishap Risk Acceptance Levels*, and to DoDI 5000.2 to determine the required mishap Risk Acceptance Authority.

3.8.2.3. The PM will submit the operational necessity, the scope of intended use, and the period of time required to be excluded from the normal certification process.

3.8.2.4. If approved, HQ AFSC/SEW will provide a certification waiver to the PM. During the waiver period, data should be collected on safety related operational deficiencies and potential system improvements.

3.9. Operational Decertification:

3.9.1. HQ AFSC/SEW may decertify items that have demonstrated inadequate safety through analysis, testing, or operational performance. Decertification may be required when critical components or

systems have been improperly used, improperly stored or not maintained according to the DEWCP. The decertification may involve a specific user organization or the entire inventory.

3.9.2. Any DoD agency may send a recommendation for decertification to HQ AFSC/SEW. The recommendation must identify the DEW item and include documentation that supports the recommendation to decertify.

3.9.3. As the authority on decertification actions, HQ AFSC/SEW reviews the recommendation and takes action to notify all affected parties. HQ AFSC/SEW will then work with the PM to determine the best course of action to re-certify affected DEW systems.

Chapter 4

DIRECTED ENERGY WEAPONS SAFETY CRITERIA

4.1. Safety Analysis of the DEW. The safety analysis conducted by the PM provides decision-makers with a process for identifying and evaluating data needed to reach conclusions regarding risks from a particular use of a DEW. A comprehensive safety analysis may include modeling, test and evaluation, and an independent review of the DEW within its context of intended use.

4.1.1. Requirements. The safety analysis will apply the System Safety process in MIL-STD-882D to define DEW program-specific safety criteria.

4.1.1.1. Determine the hazardous effects of the DEW within the operational environment.

4.1.1.2. Complete a risk assessment to determine the appropriate level of risk mitigation.

4.1.1.3. Consider all safety critical functions, safety critical components and safety critical software of the DEW and its interfaces with the host platform.

4.1.1.4. Apply appropriate risk mitigation measures.

4.2. Hazardous Effects Identification. The identification of hazard-specific effects of the DEW provides the basis for implementation of safety controls.

4.2.1. Suggested hazardous effects to be reviewed/measured. Include other system-specific effects as appropriate. The process of identifying hazardous effects should include potential unintended effects of the weapon and potential occupational exposures.

4.2.1.1. Weapon Power Source.

4.2.1.1.1. Consider hazards associated with power source to activate DEW.

4.2.1.1.2. Consider potential hazards to personnel, equipment and delivery platform mounted to or carried with the DEW.

4.2.1.1.3. Consider parking requirements for DEW equipped aircraft, if applicable, based on the method of DEW power generation. The power generation/conversion could be fuel cell driven, gas turbine power take off, chemical mixing, conventional munition driven (flux generator), or another method. Refer to AFMAN 91-201, *Explosives Safety Standards,* for systems using explosive components.

4.2.1.2. Target Interaction and Scenario Dependent Effects.

4.2.1.2.1. Potential hazard of direct and reflected broadband energy (diffuse and specular).

4.2.1.2.2. Potential hazards due to tissue or material heating by DEW.

4.2.1.2.3. Exposure to burning materials.

4.2.1.3. Weapon User Effects. Consider hazards caused by energy delivery from DEW to target.

4.2.1.3.1. Scattered or sidelobe energy, radiofrequency energy interference, ionizing radiation and potential fratricide.

4.2.1.4. Weapon Accuracy Effects.

4.2.1.4.1. Effects due to beam drifting and failure to achieve pointing accuracy and to maintain pointing stability.

4.2.1.5. Personnel and Equipment Effects Due to Weapon Exposure.

4.2.1.5.1. Health and safety risks to personnel from direct and indirect weapons effects.

4.2.1.5.2. Risks of impacting infrastructure and legacy systems. Includes full spectrum of impact from temporarily disrupting operations to permanently damaging equipment.

4.2.1.6. Maintenance and Storage.

4.2.1.6.1. Review the potential hazards such as inadvertent chemical release, high pressure systems, electrical discharges, electromagnetic pulses, and confined space issues.

4.2.1.6.2. Consider potential hazards such as transporting, handling, interoperability with existing infrastructure and legacy systems, chemical venting and safety perimeters.

4.2.1.7. Transportation.

4.2.1.7.1. Any hazards of system components in shipping configuration should be identified.

4.2.1.8. DEW Munitions Handling and System Operation.

4.2.1.8.1. Identify the potential hazards from munitions handling and system operations such as chemical exposures, high pressure systems, electrical discharge, high voltage, wave guide leakage, noise and confined space entry. These hazards would be encountered during the day-to-day operation of the system.

4.2.1.9. End of Life/Disposal.

4.2.1.9.1. Review potential safety issues for end of system life such as disposal of chemical containment systems and hazardous system components.

4.3. Risk Assessment. The intent of the risk assessment is to evaluate hazards based on information gathered during the hazardous effects identification and to ensure the appropriate level of risk mitigation or acceptance was achieved.

4.3.1. Requirements:

4.3.1.1. Determine acceptability of risks IAW MIL-STD-882D.

4.3.1.2. Evaluate consequences and uncertainties of the weapon in situations of intended use.

4.4. Safety Critical Functions and Safety Critical Components.

4.4.1. Safety critical functions are actions that control the sequence leading to DEW activation, directed energy propagation, and subsequent termination. Equipment (hardware and/or software) designed to mitigate risk, contain energy flows, and specific approved procedures must be in place. The design of the DEW will consider the following safety critical functions:

4.4.1.1. Safing: Ensures the DEW is incapable of arming, firing or initiating the process of arming or firing to include initiation of chemical, electrical, or mechanical energy related to the arming process.

4.4.1.2. Targeting: Used to identify, select, and target an object or person.

4.4.1.3. Arming: Prepares the weapon for propagating energy short of the actual firing.

4.4.1.4. Firing: Used to release directed energy (post arming).

4.4.1.5. Terminating: Halt directed energy propagation.

4.4.1.6. Energy Munition Containment: Contain energy munition, control its flow, conversion or delivery.

4.4.1.7. Monitoring: Provides status of the other safety critical functions.

4.4.1.8. Transitions between system states: e.g. transition from inactive state to ready state.

4.4.1.9. Any functions designated safety critical by the PM.

4.4.2. Safety critical components are those components (hardware or software) whose failure or fault would compromise safe operation of the entire system. The hazard mitigation and control shall be appropriate to the potential hazard of the DEW or its components. Use the following guidance to determine which DEW components are safety critical:

4.4.2.1. A component that controls a safety critical function is a safety critical component.

4.4.2.2. A component that controls a system state transition is a safety critical component.

4.4.2.3. A component whose failure produces a hazard with a catastrophic or critical mishap rating IAW MIL-STD-882D is a safety critical component.

4.4.2.4. Any components designated safety critical by the PM.

4.5. General Safety Requirements.

4.5.1. Exposure limits. The safety criteria will use, to the maximum extent practical, procedures and controls based upon sound radiation protection IAW DoDI 6055.8, *Occupational Radiation Protection Program*, DoDI 6055.11, *Protection of DoD Personnel from Exposure to Radiofrequency Radiation and Military Exempt Lasers*, DoDI 6055.15, *DoD Laser Protection Program*, AFI 48-148, *Ionizing Radiation Protection*, AFOSH-STD 48-139, and AFOSH-STD 48-9. Standards for acoustic systems can be found in AFOSH-STD 48-20, *Occupational Noise and Hearing Conservation Program*.

4.5.1.1. Engineering Controls.

4.5.1.1.1. Engineering controls are the preferred method of controlling hazards. Use first and foremost to control hazards of DEW to DoD personnel and local community.

4.5.1.1.2. Design and build adjustable power levels as appropriate to mission of the DEW.

4.5.1.1.3. Terminate the beam at the end of its useful path or establish exclusion zones commensurate with the expected hazard region surrounding the target.

4.5.1.1.4. System program managers should consider the suitability of limited aerospace and range areas available for training with the DEW and whether a training mode is required.

4.5.1.1.5. Control measures should be implemented to mitigate or reduce hazards IAW AFI 90-901, *Operational Risk Management*, AFI 91-202, *The US Air Force Mishap Prevention Program,* and MIL-STD-882D.

4.5.1.2. Personal Protective Equipment (PPE).

4.5.1.2.1. Where engineering and other controls are not adequate to mitigate DEW hazards/ emissions to below Permissible Exposure Limit (PEL), wear PPE as appropriate. Ensure PPE is certified through Bioenvironmental Engineering and adequate training on wear and limitations of the PPE is administered to all personnel wearing the PPE.

4.5.1.2.2. The PM must evaluate the effectiveness and make recommendations for PPE against the DEW emissions or other physical or chemical hazards inherent to the system. If adequate PPE doesn't exist, then the PM should contact AFRL to initiate research into appropriate PPE or to determine alternate methods to protect personnel if they must be occupationally exposed.

4.5.1.3. Administrative Controls.

4.5.1.3.1. Training is critical to insure safe operation of DEW. Personnel must be trained prior to using or maintaining DEW systems. See section 5.2.4.12 for training topics.

4.5.1.3.2. System documentation including training manuals, TOs, and operating checklists can increase user awareness and prevent hazards. To the greatest extent possible, hazards and hazardous effects should be identified in system TOs or the equivalent and cover use, storage, and maintenance.

4.5.1.3.3. Use the minimum power level for the application being performed, if applicable.

4.5.1.3.4. Occupational health exam requirements for personnel engaged in DEW operations are determined by the base Occupational Health Working Group IAW AFI 48-145, AFI 48-148, AFOSH-STD 48-9, and AFOSH-STD 48-139.

4.5.1.3.5. Use a "training mode" where applicable to ensure personnel are not harmed.

4.5.1.3.6. If a DEW system is to be shipped to/from other locations aboard transport aircraft or ship, it should be configured in a non-energized system state with minimum fuel/chemicals. The hazards in shipping configuration may limit the mode of transportation. Establish shipment procedures and safety checklists for use with transportation units, as applicable and IAW 32-7086.

4.5.1.4. Special Controls. This section is not an all inclusive list, but meant to provide examples of additional special controls that may be required, given the type of DEW.

4.5.1.4.1. Install visual or audible beam-warning devices independent of DEW system in areas where personnel may be exposed to radiation in excess of the Maximum Permissible Exposure (MPE)/PEL/Threshold Limit Value (TLV), when it will not compromise the mission. Use appropriate warning signs on all outdoor ranges approved for DEW use.

4.5.1.4.1.1. Install a manually operated audible alarm in each DEW maintenance, operating or testing location. The alarm must have two pull stations or initiation locations in each area, (room or maintenance bay) where DEW operations occur.

4.5.1.4.2. Observe high voltage safety criteria IAW AFOSH-STD 91-50, *Communications Cable, Antenna and Communications Electronic (C-E) Systems*.

4.5.1.4.3. Be aware that ionizing and non-ionizing radiation from source generation may exceed allowable limits. Ionizing radiation exposure may require additional monitoring IAW AFI 48-125, *Personnel Ionizing Radiation Dosimetry* and AFI 48-148.

4.5.1.4.4. Use Energy Isolation Devices to isolate (lock out/tag out) energy sources prior to the start of inspection, maintenance, or servicing actions until such activities are complete IAW AFOSH-STD 91-501, *Air Force Consolidated Occupational Safety Standard*.

4.5.1.5. Sensor and Electronic Equipment Safety. As appropriate, safety criteria will consider creating requirements to protect sensors from damage and other implications on electronic equipment IAW Department of Defense Directive (DoDD) 3222.3, *DoD Electromagnetic Environmental Effects Program*. Methods to protect other systems could include operational clear zones, controlling beam widths, sensor hardening, etc.

4.5.2. Environmental Impact. The safety criteria will consider the environment in areas such as: air quality, hazardous materials and waste, noise, water and biological resources, geology and soils IAW 32 Code of Federal Regulations (CFR) 989, *Environmental Impact Analysis Process (EIAP).*

Chapter 5

OPERATIONAL UNIT DIRECTED ENERGY WEAPON SAFETY PROGRAM GUIDANCE

5.1. Implementation.

5.1.1. Each MAJCOM with a DEW mission will establish a DEWSP. Ensure MAJCOM/NAF SEWs receive same training as DEWSOs.

5.1.2. Each unit conducting or directly supporting DEW research, development, operations, testing, or training must execute a DEWSP.

5.2. Program Requirements.

5.2.1. The DEWSP must be a component of the operational unit safety program as required by AFPD 91-2, *Safety Programs* and AFPD 91-4.

5.2.2. DEW Safety Criteria.

5.2.2.1. The DEWSP attempts to mitigate hazards by following the safety criteria as described in **Chapter 4**.

5.2.2.2. The safety criteria will be applied through the entire lifecycle of the DEW system.

5.2.3. Program Functions.

5.2.3.1. The unit DEWSO will review the DEWCP at least annually for each type of DEW operated by the unit.

5.2.3.2. The unit DEWSO will ensure operational risks, not identified by the DEW PM in the PESHE, are accepted at the appropriate level of responsibility by using AFI 90-901, Air Force Pamphlet (AFPAM) 90-902, Operational Risk Management (ORM) Guidelines and Tools, and AFI 91-202. Use ORM to assess risks associated with safety violations and other safety inspection findings.

5.2.3.3. In rare circumstances, a DEW system may be needed for operational use prior to certification using a waiver process (see **Chapter 3**). The unit DEWSO will review waivers to established safety criteria.

5.2.3.3.1. The unit DEWSO will advise commanders of the increased or decreased risk should waivers be accepted.

5.2.3.4. The operational unit DEWSO will conduct DEW unit inspections as described in AFI 91-202, Chapter 3. Initial inspection checklists will be provided by AFSC/SEW.

5.2.3.5. The operational unit DEWSO will develop emergency response plans for handling DEW-related emergencies.

5.2.3.6. The operational unit DEWSO will monitor facilities and operations involving DEW IAW with applicable safety standards.

5.2.3.7. The operational unit DEWSO will develop and annually review a DEW operations and maintenance location map. Review the map in conjunction with the base explosive site plan to identify potentially hazardous DEW effects to ordnance or fuel.

5.2.3.8. The operational unit DEWSO will review hazards mentioned in DEW system TOs or equivalent for use, storage, transport, and maintenance (at a minimum).

5.2.3.9. The operational unit DEWSO will evaluate and document to the user the unit's radio frequency weapons, laser weapons, and other DEWs for operational compatibility with ordnance, electronics, and fuel storage likely to be in the operating and maintenance environment of the DEW, IAW DoDD 3222.3, and AFMAN 91-201.

5.2.3.10. The MAJCOM shall coordinate clearances with required agencies and other safety elements. The unit DEWSO shall ensure clearance is obtained prior to use.

5.2.3.10.1. Obtain clearance from the US Strategic Command Laser Clearinghouse per DoDI 3100.11 (O), *Illumination of Objects in Space by Lasers,* for laser weapons that point above the horizon. This may be a blanket approval or a by-use approval depending on the extent of hazard to spacecraft.

5.2.3.10.2. Contact other federal agencies as required, (e.g. Federal Aviation Administration (FAA) Order 7400.2E*, Procedures for Handling Airspace Matters, Chapter 29: Outdoor Laser Operations,* or Federal Communications Commission (FCC) for frequency allocation).

5.2.3.10.3. Obtain written legal review by the MAJCOM Office of the Staff Judge Advocate (SJA) concerning the applicability of domestic and foreign laws to US forces and US personnel use and possession of DEW during OCONUS missions.

5.2.3.10.4. Establish CONOPS and training programs in accordance with DoD Policy prohibiting the use of lasers specifically designed to cause permanent blinded (11 Jan 97). The MAJCOM will ensure all operators are trained on those aspects particular to the use of DEW. The MAJCOM SJA will review guidance to ensure compliance with DoD policy and confirm the required reviews have been completed in accordance with DoDD 2311.01E, *DoD Law of War Program*, DoDD 3000.3, *Policy for Non-Lethal Weapons*, AFPD 51-4, *Compliance with the Law of Armed Conflict*, and AFI 51-402, *Weapons Review.*

5.2.3.11. The operational unit DEWSO shall develop and implement a training syllabus.

5.2.3.11.1. Document existing DEW hazards and potential hazards due to local area infrastructure (e.g. fuel farms, weapon storage) and provide as a component of initial and annual personnel safety training.

5.2.3.11.2. Personnel conducting or directly supporting DEW operations, maintenance, testing, or training must receive training prior to use and within 30 days of assignment to unit and every 15 months thereafter.

5.2.3.11.3. Training topics include but are not limited to fundamentals of laser/radio frequency (RF) and other DEW operations, system CONOPS, use of all operating modes, hazardous effects (see **Chapter 4**), bioeffects of laser/RF radiation on the eye and skin, significance of specular and diffuse reflections (lasers), non-beam hazards (e.g. electrical, chemical, reaction by-products, etc.), ionizing and non-ionizing radiation hazards, laser classifications as applicable, control measures, safety critical functions/components, personal responsibilities, DEW transportation/shipping issues, MPE/PEL/TLV as applicable, medical surveillance requirements, and CPR for high-voltage environments. The training will include any system-level or platform hazards as a result of the DEW.

5.2.3.11.4. Document completion of training and maintain documentation for 3 years.

5.2.3.11.5. Annually review material covered in the syllabus for accuracy.

5.2.3.12. The unit DEWSO will inform the DEW Program Manager of any system-related hazards not previously identified and work with the Program Office to assess the risks, identify and implement mitigation measures, and ensure the residual risks are accepted in accordance with DoDI 5000.2

5.2.4. Program Inspections

5.2.4.1. Since DEW systems could number only a few devices for strategic defense system (e.g. Airborne Laser) to in the thousands for non-lethal DEW devices (e.g. laser dazzler), the Air Force Safety Center (AFSC), in coordination with MAJCOM/SEWs, will conduct annual inspections of fielded lethal DEW systems and less frequent spot-inspections of fielded non-lethal DEW systems on an as needed basis.

5.2.4.2. The unit DEWSP will be evaluated based on the requirements of this section (**5.2.**).

5.2.5. Mishap Prevention, Reporting, and Investigation.

5.2.5.1. A complete program must include training, inspecting and monitoring, hazard identification, mishap reporting, and data analysis. These functions must be performed IAW AFI 91-202.

5.2.5.2. DEW mishaps must be reported and investigated according to the requirements and timelines defined in AFI 91-204, and AFMAN 91-221. When the mishap is categorized as a space, flight, or ground mishap, use the appropriate guidance (e.g. AFMAN 91-222, *Space Safety Investigations and Reports*, AFMAN 91-223, *Aviation Safety Investigations and Reports*, or AFMAN 91-224, *Ground Safety Investigations and Reports*). All DEW mishaps must be reported in Air Force Safety Automated System (AFSAS). The following scenarios will be reported:

5.2.5.2.1. If the DEW system doesn't perform as designed, or if procedures are not followed, resulting in injury and/or property damage.

5.2.5.2.2. If a mishap occurs with another system within the range of the DEW which might be related to DEW operations.

5.2.5.3. Injuries, resultant from a DEW system mishap, must also be reported per AFOSH-STD 48-139 or 48-9 as applicable.

5.2.5.4. Over-exposures to RF radiation must also be reported per AFOSH-STD 48-9.

5.2.5.5. Include the DEW PM in the mishap investigation process to assist in assessing mishap causes and potential design changes needed to reduce or eliminate the risk of the mishap occurring again.

5.2.6. Post-mishap Data.

5.2.6.1. Required data.

5.2.6.1.1. Include weapon engagement parameters such as operational state, time, platform location, weather, orientation and vector, beam intensity and duration, and beam angles if available, as applicable.

5.2.6.1.2. Data on other systems involved, including pre-mishap state, location, and extent of disruption and/or damage.

5.2.6.1.3. For airborne DEW platforms, (e.g. Airborne Laser), determine which DEW data, if any, is included and which recording mechanisms are used IAW AFPD 63-14, *Aircraft Information Programs*.

5.2.6.2. Personnel Exposure Reporting Data.

5.2.6.2.1. Potential Damage Factors. Size of irradiated area; absorption, reflection, scattering properties and locations of nearby material contributing to total exposure at DEW wavelength; intensity of beam on personnel; distance from source; presence on any shield or PPE; duration of exposure; and pulse repetition. Refer to AFOSH-STD 48-9 and AFOSH-STD 48-139 for potential personnel overexposure.

5.2.7. Non-mishap Exposures

5.2.7.1. There may be times when, due to critical operational need (training, system evaluation, CONOPs development, etc), AF personnel will be intentionally exposed to a DEW. The unit DEWSO must ensure these exposures are done in accordance with the limits established in AFOSH-STD 48-9, AFOSH-STD 48-139, and other guidance as appropriate. Additionally, commanders must ensure that risks are appropriately weighed against their operational requirements. For those rare cases where, because of the operational requirements of a system, the exposure may be above accepted limits, the DEWSO must ensure that the appropriate policy exemptions have been obtained (see **3.4.3.11.2.**) and that alternative exposure requirements are met. In addition, exposures above established limits need to be recorded as per AFI 48-145 and become a part of the individual's occupational exposure record.

5.2.8. Information Collection, Records, and Forms.

5.2.8.1. Information Collections. No information collections are created by this publication.

5.2.8.2. Records. The program records created as a result of the processes prescribed in this publication are maintained in accordance with AFMAN 33-363 and disposed of in accordance with the AFRIMS RDS located at **https://afrims.amc.af.mil/rds_series.cfm**.

5.2.8.3. Forms (Adopted and Prescribed).

5.2.8.3.1. Adopted Forms. AF IMT 847, *Recommendation for Change of Publication*.

5.2.8.3.2. Prescribed Forms. No prescribed forms are implemented by this publication.

WENDELL L. GRIFFIN, Major General, USAF
Chief of Safety

Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References

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DoDI 6055.15, *DoD Laser Protection Program*, 4 May 2007

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AFI 90-901, *Operational Risk Management,* 1 April 2000

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AFI 91-204, *Safety Investigations and Reports,* 14 February 2006

AFI 91-205, *Nonnuclear Munitions Safety Board,* 1 July 1998

AFI 99-103, *Capabilities Based Test and Evaluation,* 26 February 2008

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AFMAN 33-363, *Management of Records*, 1 March 2008

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AFMAN 63-119, *Certification of System Readiness for Dedicated Operational Test and Evaluation,* 22 February 1995

AFMAN 91-201, *Explosives Safety Standards,* 18 October 2001

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AFMAN 91-222, *Space Safety Investigations and Reports,* 9 August 2005

AFMAN 91-223, *Aviation Safety Investigations and Reports,* 6 July 2004

AFMAN 91-224, *Ground Safety Investigations and Reports,* 1 August 2004

AFOSH-STD 48-9, *Radiofrequency Radiation (RFR) Safety Program,* 1 August 1997

AFOSH-STD 48-20, *Occupational Noise and Hearing Conservation Program*, 30 Jun 2006

AFOSH-STD 48-139, *Laser Radiation Protection Program,* 10 December 1999

AFOSH-STD 91-50, *Communications Cable, Antenna and Communications Electronic (C-E) Systems,* 1 August 1998

AFOSH-STD 91-501, *Air Force Consolidated Occupational Safety Standard,* 7 July 2004

AFPAM 90-902, *Operational Risk Management (ORM) Guidelines and Tools,* 4 December 2000

AFPD 51-4, *Compliance with the Law of Armed Conflict*, 26 April 1993

AFPD 63-14, *Aircraft Information Programs,* 6 February 2001

AFPD 91-2, *Safety Programs,* 28 September 1993

AFPD 91-4, *Directed Energy Weapons (DEW) Safety,* 11 July 2003

32 CFR 989, *Environmental Impact Analysis Process (EIAP),* 1 July 2000

FAA Order 7400.2E*, Procedures for Handling Airspace Matters, Chapter 29: Outdoor Laser Operations,* 16 February 2006

MIL-STD-882D, *DoD Standard Practice for System Safety,* 10 February 2000

AFRIMS RDS, **https://afrims.amc.af.mil/rds_series.cfm**

Helpful Guidebooks and Standards

ANSI Z136.1, *American National Standard for Safe Use of Lasers,* 2007

ANSI Z136.6, *American National Standards for Safe Use of Lasers Outdoors,* 2005

American Conference of Governmental Industrial Hygienists Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices (current year)

Institute of Electrical and Electronics Engineers (IEEE) 95.1-1999, *IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz*

29 CFR 1910.95, *Occupational Noise Exposure*, 3 April 2006

Abbreviations and Acronyms

AAC—Air Armament Center

ACC—Air Combat Command

ACTD—Advanced Concept Technology Demonstration

AFI—Air Force Instruction

AFJMAN—Air Force Joint Manual

AFMAN—Air Force Manual

AFMC—Air Force Materiel Command

AFOSH-STD—Air Force Occupational Safety and Health Standard

AFOTEC—Air Force Operational Test and Evaluation Center

AFPAM—Air Force Pamphlet

AFPD—Air Force Policy Directive

AFRC—Air Force Reserve Command

AFRL—Air Force Research Laboratory

AFSAS—Air Force Safety Automated System

AFSOC—Air Force Special Operations Command

AFSPC—Air Force Space Command

AMC—Air Mobility Command

ANG—Air National Guard

ANSI—American National Standards Institute

CFR—Code of Federal Regulations

CONOPS—Concept of Operations

COTS—Commercial off the shelf

DEW—Directed Energy Weapon(s)

DEWCB—Directed Energy Weapon Certification Board

DEWCP—Directed Energy Weapon Certification Plan

DEWCR—Directed Energy Weapon Certification Recommendation

DEWSO—Directed Energy Weapons Safety Officer

DEWSP—Directed Energy Weapon Safety Program

DoD—Department of Defense

DoDD—DoD Directive

DoDI—DoD Instruction

DRU—Direct Reporting Unit

EIAP—Environmental Impact Analysis Process

ESC—Electronic Systems Center

ESOH—Environment, Safety, and Occupational Health

EOC—Emergency Operational Capability

FAA—Federal Aviation Administration

FCC—Federal Communications Commission

FOA—Field Operating Agency

IAW—in accordance with

HAZMAT—Hazardous Materials

JCTD—Joint Capability Technology Demonstrator

MAJCOM—Major Command

MPE—Maximum Permissible Exposure

OPR—Office of Primary Responsibility

ORM—Operational Risk Management

PEL—Permissible Exposure Limit

PESHE—Programmatic Environment, Safety, and Occupational Health Evaluation

PM—Program Manager

PPE—Personal Protective Equipment

RDS—Record Disposition Schedule

RF—Radiofrequency

RFR—Radiofrequency Radiation

RRA—Residual Risk Analysis

RTO—Responsible Test Organization

SRB—Safety Review Board

SSG—System Safety Group

TLV—Threshold Limit Value

TO—Technical Order

WSM—Weapons Safety Manager

Terms - Consider calling the Air Force Laser Safety Hotline at 1-800-473-3549 for clarification.

Component—Subsystem, item or element. A component is hardware, software, procedures, interfaces, or a combination of any of the four.

Damage—Non-transitory upset or burnout of a target sufficient to reduce its operational utility

Directed Energy—An umbrella term covering technologies that relate to the production of a beam or field of concentrated electromagnetic energy, atomic or subatomic particles.

Directed Energy Mishap—An Air Force mishap fitting one of the following subcategories:

1) Directed Energy Weapon. A mishap involving a directed energy weapon and/or unique directed energy weapon support equipment.

2) Directed Energy Device. A mishap involving a directed energy device. An example would be damage to an optical device by an aircraft laser range finder.

Directed Energy Weapon—A weapon system using directed energy primarily as a direct means to deny, disrupt, degrade (damage), or destroy enemy equipment, facilities, or personnel. Note that this differs slightly from the Joint definition by including deny and disrupt in order to cover additional systems and capabilities.

Emergency Operational Capability—The ability of a system currently under development (a system with limited capabilities or a limited number of systems) that could be deployed in an operational mode by warfighters during a crisis situation. The fielding of JSTARS during Desert Storm is an example.

Energy Munitions—Anything used to power, fuel, or provide energy for a DEW. Any source, which may be used for both DEW and another activity, becomes energy munitions when it is loaded and consumed for exclusive DEW use. Examples of energy munitions include chemical, electrostatic, electrodynamic, explosive, gas, light, or ionizing sources. An example of a source becoming energy munitions are chemicals that may be used for industrial or DEW use. Certain ground safety and occupational health standards govern the industrial use of the chemicals; however, once the chemicals are loaded into a weapon for the sole purpose of providing energy for beam generation, they become energy munitions. For energy munitions, DEW safety rules take precedence over other safety rules.

Ionizing Radiation—Any electromagnetic or particulate radiation capable of producing ions directly or indirectly in its passage through matter. Ionizing radiation includes gamma rays, X rays, alpha particles, beta particles, neutrons, protons, and other particles and electromagnetic waves capable of producing ions.

Maximum Permissible Exposure—The level of laser to which a person may be exposed without hazardous effect or adverse biological changes in the eye or skin. Laser MPE values for eyes and skin are listed in ANSI Z136.1. Also refer to AFOSH-STD 48-139. Radio Frequency Radiation Standards are listed in IEEE C95.1-1999.

Modification—All physical and functional configuration changes to existing certified hardware and software; addition of new equipment; and new operational uses for existing equipment.

Nonionizing Radiation—Any electromagnetic radiation incapable of producing ions directly or indirectly. Microwaves and radiofrequency energy are forms of nonionizing radiation.

Permissible Exposure Limit—PELs are Occupational Safety and Health Administration (OSHA) regulatory limits to protect workers from inhalation, skin contact, and skin absorption hazards due to airborne substances. For example, many RF PELs are 10 times below the level at which the RF damage can be detected. Often these levels do not produce "damaging biological effects."

Permissible Exposure Limit (RFR)—The PEL for RFR is that exposure value to which an individual may be exposed without exhibiting damaging biological effects (AFOSH-STD 48-9). It is equivalent to the Maximum Permissible Exposure as defined in IEEE C95.1-1999.

Safety Critical Functions—Functions that control the sequence leading to DEW activation and subsequent termination, (e.g. Targeting, Arming, Firing, Terminating, Monitoring, etc).

Safety Critical Components—System components that control safety critical functions, produce extreme hazards, or components whose failure or fault would compromise safe operation of the entire system.

Safety Critical Software—Those computer software components and units whose errors can result in a potential hazard, or loss of predictability or control of a system.

System Program Manager—The single individual specifically designated, under the integrated weapon system management architecture, to be responsible for the life cycle management of a system or end-item. The system program manager is the person vested with full authority, responsibility, and resources to execute and support an approved Air Force program.

System States—Control the safety critical functions and prevent the inadvertent or improper propagation of directed energy by the weapon, (e.g. Inactive, Ready, Active, and Maintenance). Alternate names and additional states may be employed.

Threshold Limit Value—The limits of occupational exposure to physical agents of acoustic, electromagnetic, ergonomic, mechanical, and thermal nature, that represent conditions under which it is believed that nearly all workers may be repeatedly exposed day after day, over a working lifetime without adverse effect.

Attachment 2

DEW CERTIFICATION BOARD MEMBERSHIP

A2.1. Purpose. This independent board evaluates the program-specific DEW certification efforts and provides AFSC/SEW with the information required to grant certification prior to the fielding of the system.

A2.2. Responsibilities.

A2.2.1. The DEWCB evaluates the DEWCP and approves DEW certification.

A2.3. Membership. Each DEWCB consists of standing members and program-specific technical advisors to the standing board membership. Standing board members provide certification continuity and safety criteria expertise to the board.

A2.3.1. Membership. The DEWCB consists of two components: voting and non-voting members.

A2.3.1.1. The voting members will be comprised of safety, technical, or warfighter representatives from the MAJCOMs and Air Force level offices. Other MAJCOMs as using commands may be added as required.

A2.3.1.1.1. HQ AFSC/SEW. DEWCB chair

A2.3.1.1.2. AF/SG

A2.3.1.1.3. Air Combat Command (ACC)

A2.3.1.1.4. Air Force Materiel Command (AFMC)

A2.3.1.1.5. Air Force Space Command (AFSPC)

A2.3.1.1.6. Air force Special Operations Command (AFSOC)

A2.3.1.1.7. Air Force Operational Test and Evaluation Center (AFOTEC)

A2.3.1.1.8. Air Mobility Command (AMC) (if DEW systems are to be transported on AMC aircraft)

A2.3.1.2. The non-voting members will be comprised of technical experts from the Air Force research, development, test and evaluation communities.

A2.3.1.2.1. AFRL

A2.3.1.2.2. Air Armament Center (AAC)

A2.3.1.2.3. Electronic Systems Center (ESC)

A2.3.1.2.4. PMs

A2.3.2. Program-Specific Technical Advisors. Program-specific technical advisors are individuals with expertise uniquely suited to the program's technical and operational specifications. The following areas should typically be represented.

A2.3.2.1. Directed Energy Weapon Safety

A2.3.2.2. Directed Energy Bioeffects

A2.3.2.3. Directed Energy Material Effects

A2.3.2.4. System Operations and Maintenance

A2.3.2.5. Range Testing

A2.3.2.6. Test & Evaluation Safety Planning

A2.3.2.7. As required: includes representatives (e.g. military, government civilians, advisory and assistance services contractors, contractors) with expertise deemed important by the PM or any of the standing board members.