AIR FORCE DOCTRINE PUBLICATION 3-85

ELECTROMAGNETIC SPECTRUM OPERATIONS

U.S. AIR FORCE

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Air Force Doctrine Publication 3-85, *Electromagnetic Spectrum Operations*

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"The Air Force organizes, trains, and equips forces to be an air component to a joint force commander (JFC). As part of the joint force's air component, our forces must be prepared to accomplish JFC objectives**.** The air component commander's administrative authorities are derived from Title 10, U.S. Code, and exercised as the commander, Air Force forces (COMAFFOR). The air component commander's operational authorities are delegated from the JFC and exercised as both the COMAFFOR, over Air Force forces, and as the functional joint force air component commander (JFACC), over joint air forces made available for tasking. Thus, the air component commander leads Air Force forces as the COMAFFOR and the JFC's joint air operations as the JFACC. This duality of authorities is expressed in the axiom: Airmen work for Airmen and the senior Airman works for the JFC."

-- Air Force Doctrine Publication (AFDP) 1, *The Air Force*

Since the COMAFFOR and JFACC are nearly always the same individual, this AFDP will use the term "air component commander" when referring to duties or functions that could be carried out by either or both, unless explicit use of the term "COMAFFOR" or "JFACC" is necessary for clarity.

FOREWORD

Global dependence on the electromagnetic spectrum (EMS) offers increasing opportunities to exploit new attack vectors during operations, but also creates vulnerabilities and limited access for EMS-dependent systems. The joint force requires an overmatching, offensive approach to electromagnetic spectrum operations (EMSO) to enhance competitive advantage and create multiple dilemmas for adversaries in all domains. Airmen should develop EMS awareness, engagement, and maneuver capabilities that span and connect all domains and enable successful friendly operations. Dominant EMS expertise and capabilities can render adversary sensors, situational awareness, command and control, networks, and decision processes ineffective, preventing adversaries from attaining their objectives. The USAF supports the joint force's endeavors to exploit broad portions of the EMS and employ adaptive technology to diminish adversary capabilities.

CHAPTER 1: INTRODUCTION TO ELECTROMAGNETIC SPECTRUM

The movement, maneuver, and employment of joint forces, and the achievement of strategic and operational objectives, is highly dependent on the electromagnetic spectrum (EMS). As adversaries increasingly challenge forces in this area, a degree of EMS superiority is required to gain and maintain control in all domains. Accordingly, a comprehensive understanding of the EMS is critical to gaining and maintaining the desired degree of EMS control.

> *"In order to align with the National Defense Strategy, the Air Force will need to embrace new concepts for EW and increased emphasis on the broader EMS."*
>
> **-- General David Allvin, Air Force Vice Chief of Staff (2023)**

ELECTROMAGNETIC SPECTRUM CHARACTERISTICS

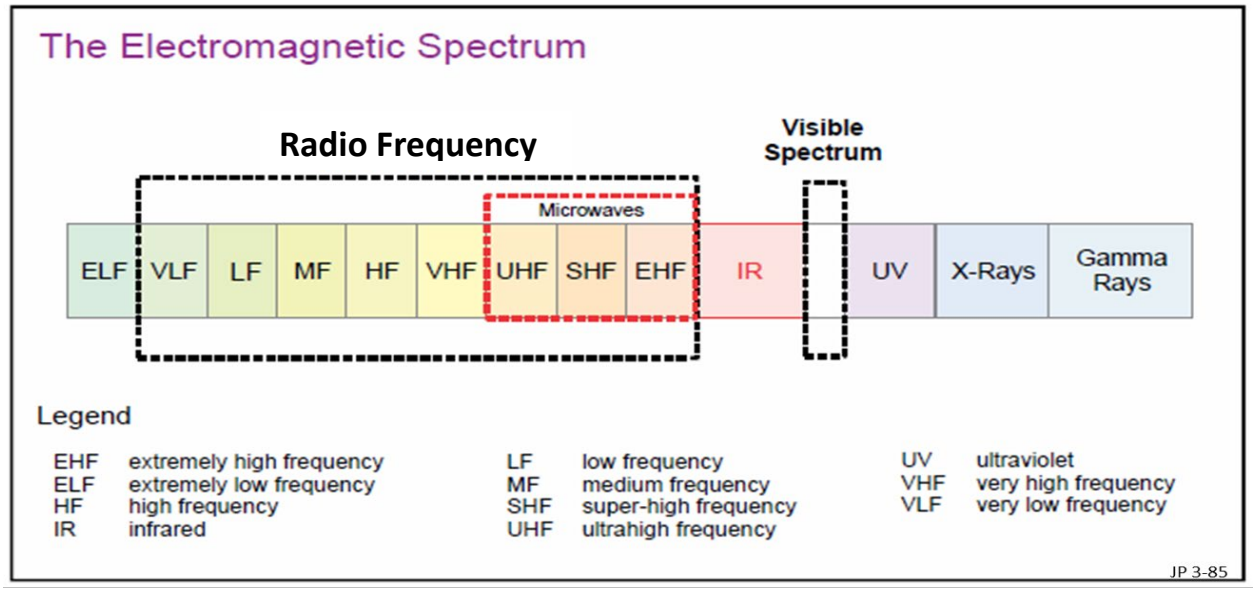
Like the warfighting domains, the EMS is a physical domain that exists regardless of human interaction and has physical and temporal properties which we operate in, from, and through. The EMS is comprised of all manmade and naturally occurring electromagnetic (EM) energy, arranged according to wavelength and frequency—from zero to infinity—into 26 alphabetically designated bands to classify the types and categories of radiation according to each band's distinct characteristics. Common bands include radio waves, infrared (IR) radiation, visible light, ultraviolet radiation, x-rays, and gamma rays. This includes all EM radiation, from below the earth's surface (e.g., extremely low-frequency radio to communicate with submarines) and continuing deep into space (e.g., X-band communications with deep space probes).

The EMS is:

- **Physical.** It is part of the physical environment characterized by frequency, waveform, power, and time. It can be managed, occupied, and selectively controlled like other physical domains. Natural and manmade factors affect actions in and through the EMS.
- **Pervasive.** The EMS is pervasive and permeating, linking all domains.
- **Congested.** Due to military and nonmilitary use, the EMS has had a commensurate increase in the number and density of EM emitters.
- **Constrained.** The EMS is framed by physics, policy, and technology. Each type of EM radiation has unique physical properties that dictate its use. EMS use is subject to domestic and international law and policy. Additionally, technology and the continually changing environment bounds those portions of the EMS that are accessible and exploitable.
- **Contested.** Our adversaries aim to deny our ability to use the EMS successfully.

- **Dynamic.** Relied on for both civil and military purposes, the state of the EMS from day-to-day is not static. Rather, use of the EMS is subject to rapid and varying fluctuation. Maintaining accurate EMS awareness is critical to achieving positions of advantage, enabling commanders to make decisions, conduct operations, and create effects more rapidly than the adversary.

THE ELECTROMAGNETIC OPERATIONAL ENVIRONMENT

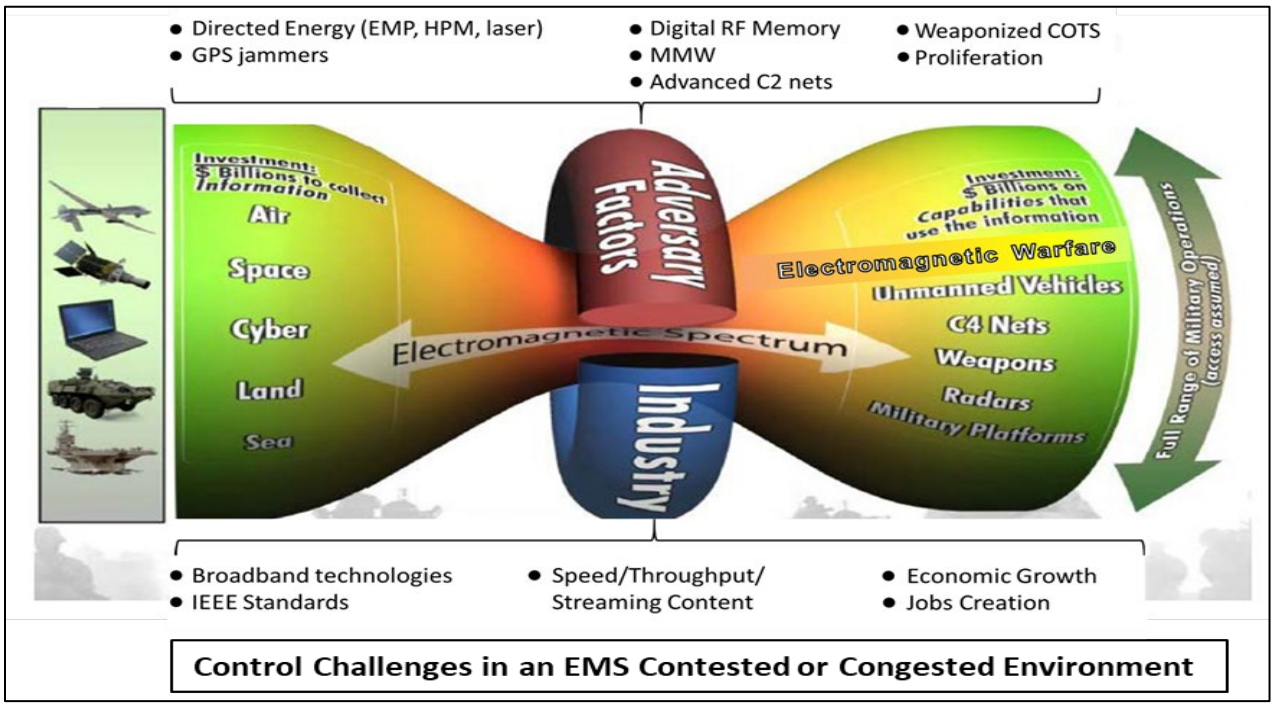


THE ELECTROMAGNETIC SPECTRUM

The electromagnetic environment is the actual EM radiation encountered in a particular operational area (OA). Importantly, not all EM radiation encountered by forces will impact operations. The electromagnetic operational environment (EMOE) is a composite of the actual and potential EM radiation, conditions, circumstances, and influences that affect the employment of capabilities and the decisions of the commander. Two areas that influence the EMOE are:

- **Electromagnetic Environmental Effects (E3).** E3 is the effect the EMOE has on the operational capability of military forces, equipment, and systems. All systems operating in the EMOE are susceptible to E3. The EMOE experienced by the USAF is continuously changing as new systems are developed, existing systems are modified, locations of systems change, and policies change. Continuous review of EMS-dependent systems for E3 vulnerability should be accomplished. Additionally, EMI, electromagnetic pulse (EMP), and EM radiation could affect personnel, ordnance, and fuels.

- **The Electromagnetic Threat.** Current EMS threats include systems that can detect, exploit, degrade, disrupt, and deceive operational capabilities, including navigation, communications, and sensors. Enemies seek access to secure communications, navigational, and sensing systems. The use of commercial systems without regard to legal constraints creates an operational challenge. This challenge can reduce US freedom of action in the EMS while being concealed by civilian EMS use. This concealment complicates the identification, mitigation, and targeting of these systems.



Control Challenges in an EMS Contested or Congested Environment

The above figure, "Control Challenges in an EMS Contested or Congested Environment," shows the range of factors that influence the joint force's ability to exercise control of the EMS. These factors are common to all operational environments. Friendly forces should expect to operate in highly contested and non-permissive EMOE. Intentional and unintentional emissions from military forces, as well as the natural environment, may aggravate the EMOE's contested nature. In addition, EM interference (EMI) and hazards to personnel, ordnance, and volatile materials may be experienced. Interference examples include:

- IR and visible spectrum may be degraded by clouds, sun glint, ground reflections, moisture, and dust.
- Radio spectrum can be distorted by atmospheric conditions or harmonics.
- Microwaves are affected by rain and frozen precipitation.
- Global Navigation Satellite System (GNSS), radar and satellite links, and high-frequency radio: sun and upper atmosphere disturbances can create interference and degrade accuracy.

- ✪ Radio waves, visible light, and other parts of the EM spectrum can be blocked by simple physical barriers.

Space and Terrestrial Weather

Terrestrial and space environmental forecasts and conditions should be reviewed to determine effects on operations and exploitation opportunities or to create an advantage over an adversary.

ELECTROMAGNETIC SPECTRUM OPERATIONS

Electromagnetic spectrum operations (EMSO) are military actions to exploit, attack, protect, and manage the EMOE. These actions include and impact all joint force transmissions and receptions of EM energy. The goal of EMSO is to achieve EMS superiority, contributing to gaining and maintaining information advantage and decision advantage to achieve the JFC's objectives. Restricted access to the EMS can affect weapon systems employment, and critical asset protection, and degrade effective decision making. EMSO are conducted using EM energy propagating through free space as well as EM signals transmitted through contained mediums. As such, EMSO can be hindered by enemy action, environmental factors, or interference with friendly EMI. These factors should be considered for EMSO to ensure proper mitigation, deconfliction, integration, and countermeasures are in place for uninterrupted operations.

EMSO includes electromagnetic warfare (EW) and electromagnetic spectrum management (ESM). EW and ESM enable the joint force to sense, communicate, and attack the enemy. EW can protect spectrum-dependent systems, networks, and operations; tactically sense the operational environment (OE); and attack where and when necessary. ESM involves the operational, engineering, and administrative procedures to plan and coordinate operations within the electromagnetic operational environment.

EMSO are also one of six principal capabilities of USAF information warfare leveraged through operations in the information environment (OIE).[1] EMSO are versatile and capable of enabling and achieving effects within all domains. For example, offensive jamming of an adversary radar system, thereby denying the use of that system is a direct EMS effect. Likewise, broadcasting an influence message is an EMSO enabling effect. Airmen should be aware of their EMS activities and understand how those activities affect friendly and adversary systems. An understanding of how USAF EMSO fits into joint electromagnetic spectrum operations (JEMSO) is also vital to leverage joint capabilities and integrate and synchronize EMS activities.

EMSO are employed in both an offensive and defensive manner in, from, and through the EMS in support of the commander's objectives.

[1] For more information about EMSO in OIE, see AFDP 3-13, *Information in Air Force Operations*.

- **Offensive EMSO** are used to deceive, disrupt, degrade, or destroy the enemy's ability to use the EMS.
- **Defensive EMSO** can provide protection from physical attack or defend friendly EMS systems from enemy offensive EMSO.

THE RANGE OF ELECTROMAGNETIC SPECTRUM CONTROL

EMSO integrates offensive and defensive operations across all domains to attain and maintain a desired degree of control of the EMS, described as the level of influence in the EMS relative to that of an enemy. The lack of EMS control may allow adversaries to deny joint forces access to the EMS, degrade the capabilities of EMS dependent systems, and disrupt all operations.

Accomplished through applications of EA, electromagnetic support (ES), electromagnetic protection (EP), and electromagnetic battle management (EMBM), control of the EMS allows friendly forces to exploit or attack the enemy and protect friendly systems from exploitation or attack.

Electromagnetic Battle Management

EMBM is the dynamic monitoring, assessing, planning, and directing of EMSO to ensure effective utilization of the EMOE. While control of the EMS through the proper application of EW is advantageous, improperly using EW without joint force and partner nation (PN) coordination may result in EMI or EM friendly fire incidents. in support of the commander's scheme of maneuver. EMBM proactively harnesses multiple platforms and diverse capabilities into a networked and cohesive sensor-decision-target-engagement system, as well as protects the friendly use of the EMS, while strategically denying benefits to the enemy. The goal is a balance among the needs of the intelligence, operations, and communications communities to prioritize, deconflict, and maximize the advantage of our EMS capabilities to dominate through EMSO.

The joint force should place a high priority on achieving the degree of EMS control required to ensure the freedom of action necessary to compete and win. The required degree of EMS control should be determined by the level required to enable successful execution of EMSO and may range from parity, superiority, or supremacy, depending on the situation and the JFC's concept of operations (CONOPS). The JFC's objectives and desired effects determine when, where, and how these operations are conducted.

- **EMS Parity.** The degree of control in which no force has control of the EMS. This represents a situation in which both friendly and enemy EMS operations may encounter significant interference by the opposing force. Parity is not a standoff, nor does it mean maneuver has halted. On the contrary, parity may be typified by fleeting, intensely contested battles at critical points during an operation with maximum effort exerted between combatants in their attempt to achieve some level of control.

- **EMS Superiority.** The degree of control that permits secure, reliable conduct of operations at a given time and place in the EMS without prohibitive interference from the opposing force. EMS superiority may be the critical enabler to superiority in other warfighting domains. EMS superiority may be managed by location, system, frequency, and time, or it may be broad and enduring.

- **EMS Supremacy.** The degree of control that permits operations wherein the opposing force is incapable of conducting effective EMSO to friendly forces. EMS supremacy may be managed by location, system, frequency, and time, or it may be broad and enduring.

While EMS supremacy is most desirable, it may not be operationally feasible. EMS superiority, even localized in time or space, may be sufficient to create desired effects for mission accomplishment. Therefore, commanders should determine the minimum level of EMS control required to accomplish their mission and assign an appropriate level of effort to achieve it.

CHAPTER 2: ELECTROMAGNETIC WARFARE

EW is waged to secure and maintain a desired degree of control and freedom of action in the EMS. Military forces and other entities are dependent on the EMS to sense, communicate, strike, and dominate offensively and defensively across all warfighting domains. EW is essential for protecting friendly operations and denying adversary operations within the EMS.

EW encompasses military actions using electromagnetic and directed energy (DE) to control the EMS or to attack the enemy. This includes radio or radar frequencies, IR, visible, ultraviolet, and any other free-space electromagnetic radiation such as wireless cyberspace applications. EW is critical in gaining the necessary degree of control to ensure freedom of action within contested and congested environments and all three divisions of EW contribute to operational success in all domains. Proper employment of EW capabilities produces the effects of detect, exploit, deceive, deny, disrupt, degrade, destroy, and protect and must be coordinated through EMBM.

Principal EW Activities

EMBM	EM masking	Countermeasures
EM compatibility	EM probing	Emission control
EM deception	EM pulse (EMP)	Low observability
EM hardening	EM reconnaissance	Meaconing
EM intel collection	EM security	Navigation warfare
EM intrusion	EMI resolution	Precision geolocation
EM jamming	EMS control	Stealth
	EW reprogramming	Wartime reserve mode

EW can enhance the ability of commanders to achieve an advantage over adversaries. Unfettered access to selected portions of the EMS is vital for weapon system effectiveness and the protection of critical assets. Air Force EW operations embody the art and science of employing military EMS capabilities to achieve objectives. EW exploits weaknesses in an adversary's ability to operate and applies force against the adversary's offensive, defensive, and supporting capabilities across the EMS. An effective EW strategy requires an integrated mix of passive, disruptive, and destructive systems to protect friendly weapon systems, components, and communications systems from enemy threat systems.

Commanders should know their own EW capabilities and those of potential enemies. Adversaries recognize potential vulnerabilities of US EMS-dependent systems. Seeking to take advantage of this fact, some potential adversaries have organized to attack our critical weapons systems control functions and associated communications nodes. To mitigate these possibilities, commanders and their staffs should become well-versed in the development and employment of weapons systems, EW capabilities, and navigation warfare to support EW objectives. EW is task oriented, and the level of EW involvement will depend on the specific requirements of the mission. EW capabilities and appropriate

application are determined by operational objectives, tactical situations, and the effectiveness and availability of combat systems. In addition, the policies, applicable authorities, and prevailing domestic and international political climate affect EW response options. Every task may require a specific EW response to create a desired effect.

ELECTROMAGNETIC EFFECTS

EW has offensive and defensive aspects that work in a "move-countermove" cycle. These aspects are often used simultaneously and synergistically. In the same way air superiority allows friendly forces the freedom from attack, freedom to maneuver, and freedom to attack, the properly coordinated use of EW offers friendly forces the same options in the EMS. The proper employment of EW involves various applications of control to achieve the effects of detect, exploit, deceive, deny, disrupt, degrade, destroy, and protect.

RC-135 V/W Rivet Joint

The Rivet Joint provides ES to detect, identify, locate, and disseminate enemy integrated air defense system structures.

DETECT

Detection is the identification of potential enemy EM emissions through use of ES measures. It involves assessing the EMOE using active and passive means. The first step in EW is detection and effective mapping of the EMOE to develop an accurate electronic order of battle (EOB). The EOB is critical for EW decision making and meeting mission objectives. The various means of detection include collection systems on manned and unmanned aircraft; space-based systems; communications intelligence; and ground-based detection and collection systems. Detection supports all EW divisions and provides data for commanders to decide to control and exploit the EMS of enemy systems.

EXPLOIT

Exploitation is taking full advantage of any obtained information for tactical, operational, or strategic purposes. This entails using enemy EM radiation for friendly advantage. EM energy may provide tactical, operational, and strategic situational awareness, and is used to develop an EOB. Data transmissions can be vulnerable to exploitation by signals intelligence and provide targeting for current and future operations.

DECEIVE

Deception measures are designed to mislead the adversary by manipulation, distortion, or falsification of information to induce the adversary to react in a manner prejudicial to their interests. There are three types of EM deception: manipulative, simulative, and imitative. Using the EMS, EW manipulates the decision-making loop of the opposition,

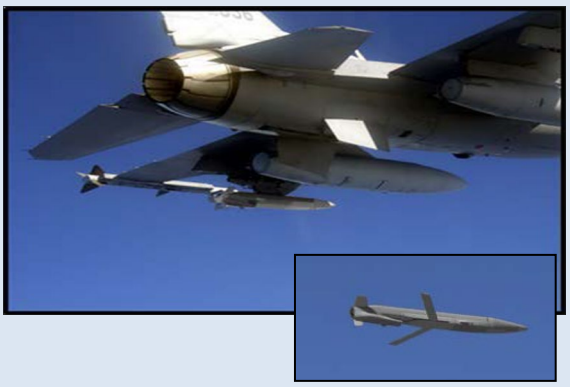
making it difficult to distinguish between reality and the perception of reality. If an adversary relies on EM sensors to gather intelligence, deceptive information can be channeled into these systems to mislead and confuse. Deception efforts should simulate as many adversary information sources as possible to create the desired effects. Multi-sensor deception can increase the adversary's confidence about the "plausibility" of the deception story. Deception efforts should be coordinated with the military deception (MILDEC) efforts and considered during the development of a deception plan, the messaging plan, and the overall operations or campaign plans. Operations security is critical to an effective deception plan.

Manipulative. Manipulative EM deception involves an action to eliminate revealing or convey misleading EM indicators that may be used by an enemy. EM manipulation may involve low observable technology used to reduce radar returns, simulation of threat signatures from nonlethal platforms, and communication and non-communication signals used to splinter displays or convey threat activity. Manipulative EM deception can be used to cause the enemy to misdirect actions and therefore, reduce friendly transmission interference. In this application, it is an EP technique.

Simulative. Simulative EM deception is the action of simulating friendly, notional, or actual capabilities to mislead enemy forces. Simulative EM may involve using airborne expendables to simulate false targets or transmitting deceptive electromagnetic attack (EA) techniques to mask true friendly forces or systems.

Imitative. Imitative EM deception introduces EM energy into enemy systems that imitate enemy emissions. Any enemy receiver can be the target of imitative EM deception. This could be used to screen friendly operations using repeater jamming techniques.

Miniature Air-Launched Decoy (MALD)



The MALD and MALD-Jammer variant can achieve a variety of effects employing EA.

DENY

Denial encompasses the three effects of destroy, degrade, and disrupt. These three effects can be placed on a denial continuum from temporary to permanent or partial to complete.[2]

[2] The term “deny” was removed as a specific effect and used as a blanket term to cover the three specific effects of disrupt, degrade, and destroy in the 2020 update to JP 3-85, *Joint Electromagnetic Spectrum Operations*. “Deny” is still listed as a strategic effect term in the DoD Dictionary.

DISRUPT

Disruption can temporarily interrupt the operations of enemy EMS-dependent systems. Effective disruption limits adversary combat capabilities by interfering with the adversary's use of the EMS. Disruption can confuse or delay enemy action and act as a force multiplier to enhance attacks against enemy forces.

Counter-Communications System

The counter-communication system employs EA to disrupt or degrade satellite communications.

DEGRADE

Degradation reduces the effectiveness or efficiency of enemy EMS-dependent systems. Effective degradation can stimulate the enemy to reveal previously unknown alternate capabilities or responses and might be adequate to achieve overall mission success.

DESTROY

Destruction is the physical damage to a target so that it can neither function nor be restored to a usable condition in a time frame relevant to the current operation. Destruction can use EA to eliminate enemy personnel, facilities, or equipment. The destruction of high value targets such as target tracking radars and C2 nodes can seriously hamper an enemy's effectiveness. Destruction of EM capabilities may be the best means of denying adversary use of the EMS. The duration of the destructive effects depends on an enemy's reconstitution capability.

PROTECT

Protection is ensuring forces can operate despite any potentially adverse effects of EM radiations regardless of the source (friendly, neutral, enemy, or natural). This includes ensuring EW activities do not produce EMI that can destroy or degrade friendly capabilities. Component hardening is the best method of achieving EMS protection. EMCON, EMS management, and deconfliction are other means to counter and defeat enemy attempts to exploit the EMS.

ELECTROMAGNETIC ATTACK

EA uses EM energy, DE, or anti-radiation weapons to attack personnel, facilities, or equipment to deceive, disrupt, degrade, or destroy enemy operational capabilities. EA is considered a form of joint fires and can prevent or reduce an enemy's use of the EMS for offensive or defensive purposes.

- **Offensive EA.** Used to suppress a threat for a specified period. Examples such as EM jamming; meaconing and intrusion; expendable decoys; anti-radiation missiles;

DE and high-energy weapons including lasers, radio-frequency weapons, high-power microwave, and EMP; EMS-enabled cyberspace attacks; and navigation warfare.

- **Defensive EA.** Uses the EMS to protect personnel, facilities, capabilities, and equipment. Examples include employing flares, chaff, low-observable technologies, towed decoys, DE, and IR countermeasures.

AIRBORNE ELECTROMAGNETIC WARFARE

The USAF's primary application of EW is through airborne EW conducted with EA, ES, and EP. The USAF conducts EW operations integrated with all joint, allied, and coalition air forces that are made available to the air component commander. Airborne EW should be meticulously planned and integrated but allow for flexible response options.

AIRBORNE ELECTROMAGNETIC ATTACK

The objective of airborne EA is to use offensive EA to mitigate an enemy's EMSO capability, therefore enabling joint force operations. Offensive and defensive EA can be employed together to support mission objectives, but planners should verify such employment can produce the desired effects before integrating this method into planning.

AIRBORNE OFFENSIVE ELECTROMAGNETIC ATTACK

Typically, offensive EA (off-board EA) is employed by air assets in a **supporting** role to operations, e.g., escort jamming for a strike package. However, offensive EA aircraft can be the **supported** asset when tasked to strike targets. In supporting joint forces, offensive airborne EA should focus on any exploitable domain EMS node or pathway. This includes enemy communications, enemy radars and ground based-space facilities, and missile warning radars. Examples of offensive airborne EA systems are:

- Electromagnetic jamming.
- Anti-Radiation Missiles.
- Air-launched decoys.
- Electromagnetic Intrusion.
- Meaconing.
- EMP.
- DE.

AIRBORNE DEFENSIVE ELECTROMAGNETIC ATTACK / SELF-PROTECTION

Airborne defensive EA/self-protection (DEA/SP) activities use onboard EA with electromagnetic-type countermeasures. There may be DEA/SP capabilities that can provide survival benefits for other aircraft (e.g., chaff corridors or self-protection jammers) but generally, airborne DEA/SP equipment is developed to provide platform self-protection. Examples of defensive airborne EA are:

- Radar Warning Receivers.
- Chaff.
- DE.
- Towed Decoys.
- Low observable technologies.

ELECTROMAGNETIC PROTECTION

EP involves passive and active actions taken to reduce or prevent personnel, facilities, and equipment from intentional and unintentional EMS effects. Successful EP needs to be incorporated into the design and acquisition of equipment. Examples of EP include shielding, frequency agility (HAVEQUICK, Link 16), variable pulse repetition frequency, spread-spectrum processing, EM hardening, wartime reserve modes, multispectral low observable attributes, GNSS anti-jam/anti-spoof, and emission control (EMCON). Integration of EP and system security measures can protect from adversary actions and ensure the ability to operate in a congested and contested EMOE.

ELECTROMAGNETIC SUPPORT

The passive nature of ES allows it to be effectively employed across the competition continuum. ES data can be used as a source to create intelligence products (i.e., signals intelligence [SIGINT]) to develop accurate, more complete pictures and understanding of the OE. ES actions are tasked by or under the direct control of an operation commander to search, intercept, identify, and locate sources of intentional and unintentional radiated EM energy for the purpose of immediate threat recognition, targeting, planning, and conduct of future operations. ES information contributes to the development of the EOB and electromagnetic countermeasures.

ES information updates the Electromagnetic Warfare Integrated Reprogramming (EWIR) database and supports the development of EMS countermeasures. The EWIR process enables EW system reprogramming to provide commanders with a timely and accurate means to respond to EMS changes and maintain the capability to effectively detect, classify, and counter enemy threats. See Appendix C: Reprogramming.

AIRBORNE ELECTROMAGNETIC SUPPORT

Airborne ES operations can contribute to joint operations such as joint intelligence preparation of the operational environment (JIPOE), combat search and rescue (CSAR), EMBM, and direct support to offensive operations in all domains (e.g., targeting or threat warning). ES operations should begin as early as possible to build an accurate picture before any joint force operations.

ES identifies, locates, and reports enemy threats and positions in near-real time (NRT) to C2 and warfighters to support decision making and employ effects. Enemy reactions are

monitored to provide battlespace awareness to friendly forces and imminent threat warning (ITW).

ES information is a significant contributor to operations by collecting and passing information on enemy activity and condition of isolated personnel to the CSAR task force, and joint personnel recovery center (JPRC), as well as providing data and communications relay to C2 elements.

ES enables fires such as OIE, airborne electromagnetic attack, space, cyberspace, and special technical operations which can create desired lethal and non-lethal effects in the OE. These operations are facilitated by the ability of airborne platforms conducting ES to make and disseminate rapid assessments of the environment/measures of performance (MOP)/measures of effectiveness (MOE) while providing direct targeting support to operational forces. Making such operations effective often hinges on the most current and accurate intelligence and enemy EM activity typically provided by USAF airborne ES platforms.

EA can support ES operations by influencing enemy activity to achieve a collection of desired EM information. For example, ***jam-to-exploit*** is a technique whereby jamming an enemy C2 frequency causes the enemy to change communications frequencies or methods to a more exploitable means. However, consequence management must be considered when employing EA for ES operations so as not to encourage undesired reactions from the enemy. An airborne non-kinetic package commander with electromagnetic attack control authority (EACA) has the authority to direct EA fires and deconflict against the joint restricted frequency list (JRFL) ensuring effective management of ES and EA non-kinetic assets.[3]

[3] Although joint doctrine does not use the terms “kinetic” and “non-kinetic,” the USAF still retains the terms based on common, historical usage. For more information about using these terms in doctrine, see AFDP 3-0, *Operations and Planning,* and JP 3-85, *Joint Electromagnetic Spectrum Operations*.

CHAPTER 3: ORGANIZATION AND RESPONSIBILITIES

This chapter discusses nominal organization and staff functions associated with JEMSO. The air component commander normally exercises operational control (OPCON) over assigned and attached USAF EW forces. The JFACC exercises tactical control (TACON) over Air Force EW forces and other joint EW forces made available.

EW forces are task organized on the doctrinal tenet of mission command. USAF EW is normally planned at the air component level and executed at the appropriate level providing responsiveness to JFACC direction.[4] Appropriate EMS expertise should be available at all levels of C2 where EW coordination, planning, and execution occur.

ELECTROMAGNETIC SPECTRUM CONTROL AUTHORITY

There are multiple joint force level EMS authorities and responsibilities that establish EMS guidance and policy. These authorities and the responsibilities are normally led by the EMS control authority (EMSCA) through the JEMSO cell, or JEMSOC, which resides at either the command (CCMD) or Joint Task Force (JTF) level. The air operations center (AOC) information warfare team (IWT)[5] coordinates USAF forces EMSO plans and operations with the JEMSOC.

EMSCA is the coordinating authority to facilitate component participation with the JFC's staff for EMSO when planning. On behalf of the JFC, the EMSCA determines the joint force's priorities for EMS activities; coordinates and integrates EMS capabilities in the joint operations area (JOA), including those not geographically bound to the JOA, such as cyberspace (see Appendix A) and space (see Appendix B) capabilities, to facilitate EMSO unity of effort; and assists the JFC's staff and components to plan, execute, and assess their EMS activities. Normally the JFC delegates EMSCA to the joint staff J3 who approves direct liaison authority to the JEMSOC director for the execution of JEMSO.

The EMSCA uses two methods to coordinate EMSO with component forces:

- EMS operations directive that provides instructions and guidance on the employment of EMS capabilities within a defined geographic area over a specific period.
- The EMS operations order to modify or change guidance to execute a branch, sequel, or modification of a task as applied to EMS activities. EMS operation orders may also contain tasks to components that require immediate or near-term execution. EMS operation orders provide the authoritative direction and details needed for components to execute EMS activities as directed in the EMS operations directive but for a more specific execution period. It identifies approved EMS activities and their EMS parameters, times, and locations; approved EMS support requests and tasking to components; and EMS allotments assigned to the components. It further provides updates to rules of engagement (ROE), the JRFL, and EMS coordination measures.

[4] For more information about Air Force C2, see AFDP 3-30, *Command and Control.*
[5] The former non-kinetic team (NKT) is now called the IWT per AFTTP 3-1.AOC, 29 Sep 2023.

EMS management functions are normally performed by the joint frequency management office (JFMO), which can either be assigned to the J6 or the JEMSOC. JFMO personnel lead or coordinate EMS management efforts on behalf of the EMSCA and the JEMSOC.

EACA is the authority delegated to a person or position to issue fire/cease fire commands to a unit employing the intentional transmission of EM energy to engage a target and is inherent for commanders with assigned EA capabilities. EACA should be delegated from the JFC to the JFACC's lowest echelon possible that has situational awareness of the EMOE where the EA effects will occur. At this tactical level, EA engagement authority normally resides with the EACA for planned events on the air tasking order (ATO) being executed, following the principles of distributed control and decentralized execution.

The EACA should be able to:

- Maintain positive communications with the entity controlling the EA capability.
- Maintain positive communications with the supported commander to enable corrective actions when necessary.
- Monitor and assess the EA transmission activity for determining corrective actions (e.g., CEASE BUZZER remediation).
- Facilitate the correct delegation of EACA; components should identify their EACA candidates for each of their EA missions during EMSO mission planning.

Routine execution of EACA responsibilities is normally delegated to the IWT director and may be temporarily delegated to components for the purpose of local or tactical mission refinement and interference remediation. Normally the airborne non-kinetic package commander exercises EACA to direct and resolve EA operations.

AIR OPERATIONS CENTER

The JEMSOC normally delegates authorities to the component that has the C2 ability over EMSO. If the air component commander is designated as the EMSCA, the IWT should assume overall responsibility for EMSO. The IWT should conduct EMSO prioritization, planning, coordinating, monitoring, and assessing execution, as well as publishing the EMSO guidance and conducting EMBM. The EMSCA plans and tasks the IWT, through the normal orders process, for incorporation into respective plans and guidance. EMSCA should ensure EMSO orders and plans are coordinated with the JEMSOC to ensure synergistic effects and deconfliction of the EMS with other services and functions.

EMSO planning coordination is distributed across the Combat Plans Division (CPD), Combat Operations Division (COD), the Strategy Division (SRD), and the Intelligence Surveillance Reconnaissance Division (ISRD) of the AOC. The SRD and CPD conduct EMSO planning with input from the ISRD, and the COD executes the EMSO plan. The air component commander may form an IWT within the AOC. The IWT provides the fires expertise to the AOC divisions to enable EMSO coordination. The IWT also assesses air component EW operations and ensures effective coordination and synchronization with

other joint force components and the JEMSOC. The IWT is responsible for ensuring EMS control, access, and management via EMBM. EW planners should be associated with all mission type planning. IWT personnel integrated with all AOC divisions can promote unity of effort and prevent EMS interference. IWT EW personnel should provide these functions to the divisions:

COMBAT OPERATIONS DIVISION (COD)

- Organize the operational EW aspects of the headquarters staff.
- Advise air component commander on concepts of EW employment, force planning, and management of EW resources for which the commander has OPCON or has established supported or supporting relationships.
- Coordinate operational EW issues with the JFC, JEMSOC, and component staffs.

COMBAT PLANS DIVISION (CPD)

- Deconflict frequencies and coordinate with the JEMSOC on the JRFL.
- Develop, coordinate, and integrate the EW plan with OIE for submission to the JEMSOC to support the JFC's objectives.
- Coordinate operational EW issues with the JEMSOC, JFC, and component staffs.
- Develop rules of engagement for EW air component forces.
- Develop EW requirements, based on JEMSOC guidance, for ATO and airspace control order (ACO).
- Provide requirements for additional EW forces and capabilities.
- Provide communications-electromagnetics operating instructions for air component forces.
- Plan, coordinate, and monitor EW related communications security procedures and assets.
- Provide requirements for force protection.
- Assist in unit beddown requirements for EW forces.
- Identify service-specific EW training requirements and coordinate joint training with other components.

STRATEGY DIVISION (SRD)

- Coordinate with JEMSOC to ensure frequency allocations and assignments meet technical parameters under host nation agreements.
- Provide information on the number and location of all EW assets.

- Identify service-specific EW training requirements and coordinate joint training with other components.

INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE DIVISION (ISRD)

- Provide EW objectives, intent, and plans to the ISRD and A2 staff.
- Coordinate ISR support to EW operations from JFCs' fusion centers, JEMSOCs, USAF major command ISR staffs, theater intelligence agencies, national intelligence agencies, and coalition ISR sources.
- Identify EW capabilities and limitations of all components and the potential effects on operations.
- Assist ISR team chief with ISR support requirements to EW operations of subordinate units.
- Identify essential elements of information (EEI).

INFORMATION WARFARE TEAM

The IWT establishes prioritized EMS user requirements and frequency authorizations and provides them to the JEMSOC. The IWT is the air component commander's non-kinetic capabilities integrator. The IWT coveys the air component commander's plan for achieving control of the EMS across the force and works within the AOC.

The air component commander implements command policy and guidance for EMSO planning and execution and obtains EMS clearance (or approval) from host nations through the JEMSOC. The air component commander with clearance or approval authorizes EMS use by assigned military forces to execute missions. Processes and directives should be determined as necessary for operations specific to the area of responsibility. All aspects of EMSO should be coordinated closely with the JFC, JEMSOC, and functional components.

The air component commander conveys guidance for achieving the desired degree of EMS control through the respective CONOPS. The air component commander should provide an operational approach; mission statement; planning guidance, intent, and commander's critical information requirements (CCIRs). Air component commander responsibilities include:

- Ensure all plans address EMSO coordination among forces operating in the JOA to enable data exchange, eliminate duplication of effort, achieve mutual support, and minimize friendly EMI.
- Ensure plans address any necessary augmentation of the IWT to support EMSO.
- Resolve EMS user prioritization issues not resolved at a lower level.

- Maintain close contact with appropriate PN military forces and civilian administrations to ensure that mutual EMS support is considered in combined planning, operations, training, and exercises.
- Ensure procedures and policies are in place for the safeguarding, use, and transfer of reprogrammable EMS-dependent system waveforms.
- Establish USAF policy and guidance for EMS coordination measures (e.g., JRFL).

EMS USERS

User responsibilities are:

- Provide the IWT prioritized EMS-use requirements through their EMSO element. Inputs include receive only and EA systems.
- Obtain frequency authorization through their EMSO element for each EMS-dependent system. EA users must ensure compliance with applicable EACA processes and ROE.
- Operate systems in accordance with parameters authorized by the FM (e.g., frequency, bandwidth, power, and waveform).
- Ensure EMS-dependent equipment is properly maintained to preclude unintentional violation of authorized EMS-use parameters.
- Make recommendations for best force contributions and utilization to gain and maintain control of the EMS within the JOA.
- Use USAF spectrum interference report (AFSIR) procedures to report adverse EMS effects on operations. AFSIR contributes to the joint spectrum interference report (JSIR).

CHAPTER 4: OPERATIONS

PLANNING

The air component commander usually develops a joint air operations plan (JAOP) using the joint planning process for air (JPPA)[6] during contingency or crisis planning. The JAOP guides the employment of joint air capabilities to integrate and coordinate forces made available to meet JFC objectives and describes the best usage of EMS to support and enable operations (normally found in the JEMSO appendix under annex C of the JAOP).

The JFC centralizes EMSO planning under the designated EMSCA and decentralizes execution to ensure JEMSO unity of effort while maintaining tactical flexibility (JP 3-85). EMSO should be coordinated with all relevant services and components operating in the JOA.

INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE

Accurate and timely intelligence support is key to planning. Intelligence can provide an understanding of the EMOE and the EOB. EMSO planners should request support from the ISRD and the A6 to assess adversary use of the EMS to understand where friendly EMSO operations should be planned and conducted. ISR and ES operations rely on the EOB and the JRFL for planning and operations.

ISR is a critical enabler of military operations. It provides knowledge of adversary capabilities derived from near real time ES and SIGINT, focused for the operational commander, as well as long term operational, scientific, and technical intelligence information. Accurate and timely ISR is essential for defining and characterizing the EMOE for EMS planning and employment. Clearly defined intelligence requirements are necessary to ensure pertinent data is supplied to EMSO planners and decision makers. Intelligence gain or loss discussions between EMSO planners and the ISRD should verify that plans support intelligence collection when required and shift to maximize force protection when appropriate.

ISR supports EMSO with:

- Analysis support by scientific and technical centers guarding against hostile technical surprise (see Appendix D).
- Indications and warning centers providing tactical, operational, and strategic warning to friendly forces.
- Continuous monitoring of threat systems to support programming and reprogramming of all systems.
- Providing the parametric and employment data, modeling and simulation tools, and mission planning tools to prioritize targets and defense tasks.

[6] For more information about the JPPA, see JP 3-30, *Joint Air Operations*.

- Establishing and maintaining comprehensive support databases as well as scientific, technical, and general military intelligence capabilities.

ES and SIGINT are differentiated by purpose, scope, and context. ES responds to an immediate operational requirement and are tasked by operational commanders. SIGINT is tasked by the Director, National Security Agency (DIRNSA) or an operational commander under SIGINT operational tasking authority delegated by the DIRNSA. ES and SIGINT operations often share the same or similar assets and may be tasked to simultaneously collect information that meets both requirements. Platforms associated with SIGINT production may be tasked and employed primarily to perform ES based on the signals intelligence operational tasking authority (SOTA) holder's requirements. For example, data collected for intelligence purposes can meet immediate operational requirements, just as data collected for ES purposes can be processed by the intelligence community for further exploitation. SIGINT and intelligence derived from ES supports mission planning, development of MOE and MOP to measure EMBM, and threat systems identification to support reprogramming and planning.[7]

ELECTROMAGNETIC SPECTRUM OPERATIONS PLANNING

EMSO across all functions and domains are often complex and interwoven. EMSO planning provides the basis for the prioritization, integration, and synchronization of Air Force forces EMS activities between the ISRD and other AOC divisions, other components, and multinational partners. The AOC's IWT is the lead staff element for air component EMSO planning. The IWT participates in the JEMSO working group (JEMSOWG) and coordinates air component EMSO.

JEMSO planning is the responsibility of the designated EMSCA who ensures all joint EMSO are prioritized, integrated, and synchronized to attain EMS superiority, achieve the commanders' objectives, mitigate EMI, and avoid friendly EA incidents. The commander's guidance and estimate form the basis for determining component objectives.

EMSO planning should be based on the EMS operations directive and component commander guidance detailing EMS requirements and planned EMS activities in their respective AOs. EMSO planners identify and review existing EMS management guidance, such as existing JRFLs, joint communications-electronics operating instructions (JCEOI), and JSIR procedures. Component plans are submitted for the specific execution period to the JEMSOC during the JEMSOWG. The JEMSOC then prioritizes, synchronizes, and deconflicts proposed component EMS activities, consolidates them into an EMS operations order, obtains commander approval, and disseminates the order. The IWT uses this guidance to plan air component EMSO.

Air component EMSO plans are updated based on the EMS operations order. The IWT conducts sufficiently detailed EMSO planning to identify changes in their EMS

[7] For more information about MOE and MOP, see AFDP 3-0, *Operations and Planning*.

requirements along with any EMSO shortfalls and generate prioritized EMS-use requests, which are passed to the JEMSOC.

- **EMS-Use Request.** Components submit EMS-use requests to the frequency assignment manager to obtain authorization to transmit EM energy or reserve EMS frequencies and bands for sensing. EMS-use requests are not necessary for units operating equipment in accordance with established EMS coordination measures.
- **Non-Organic EMS Support.** Components needing to conduct EMSO but lacking required organic capabilities or EMS-use allocations may submit EMS-use requests to the IWT for prioritization and approval.

Prepare EMSO Plan. The IWT consolidates, prioritizes, integrates, and synchronizes the EMSO plan and attendant EMS-use requests to produce an integrated EMSO plan, to pass to the JEMSOC. It conducts EM policy and engineering analyses on the EMSO plan to ensure compliance and feasibility.

EMS Operations Order Development. The EMS operations order is normally published and distributed daily. The EMSCA is responsible for control for the entire JOA but may delegate specific authority for EMS control to the component commanders through EMS operations directive guidelines. The JFC may also elect to task the component commanders to generate EMS operations directive annexes for their assigned sectors. Regardless, the JEMSOC is tasked with providing continuity along sector boundaries and ensuring integration of each sector authority's EMS operations order within the EMS operations directive guidelines. The EMS operation order contains the following information:

- EMS operations order period objectives.
- EMOE boundary changes.
- ROE and special instructions (SPINS).
- EMS-use prioritization.
- EACA and FM delegation.
- EMS frequency allotments (including EM-parametric restrictions).
- Specific transmission authorizations. Certain regions of the EMS may require finer control than EMS coordination measures provide for a variety of reasons (e.g., excessive congestion, and potential collateral effects). The EMS operations order identifies and publishes specified transmission authorizations.
  - **JCEOI**, or others, as required. The JCEOI is the primary controlling document and net directory for frequency hopping radio communications in joint operations. The JCEOI details radio information pertaining to daily changing and static frequency assignments, call sign assignments, prowords, sign and countersign words, document handling instructions, controlling authority data, effective dates, and reproduction instructions. It contains the technical characteristics of

communications networks. The JCEOI provides procedures for conducting electromagnetic, visual, and verbal communications methods (e.g., sign or countersign, smoke or pyrotechnics, suffix, and expanders) to supplement or enhance radio communications.[8]

- Activate and deactivate EMS coordination measures (JRFL or others as required).
- EMSO support activities.
- EMBM reporting procedures.
- EW reprogramming considerations.

At the conclusion of the planning process, training requirements for supporting crews should be developed and communicated from the air component commander to the JFC, then down to the supporting commands. If any material deficiencies or capabilities requirements are determined during the planning process as crucial to the success of the mission, this should also be communicated from the air component commander to the JFC for submission of a joint urgent operational need (JUON) as appropriate. Additionally, planning should consider phase transitions, decision points, conflict termination, redeployment, and procedures to capture lessons learned. Planning should also consider the possibility of USAF surge operations. Incomplete planning for conflict termination and the end state can result in the waste of valuable resources, aggravate a tenuous peace, cause a return to hostilities, or lead to unintended consequences.[9]

JOINT AND MULTINATIONAL FORCES

Effective EMS management is essential to integrate and deconflict multinational force (MNF) use of the EMS. The number, sophistication, and variety of systems operated by PNs make EMS management far more demanding in multinational operations. The differences in cryptographic equipment, training, languages, and security barriers make planning and executing EW more difficult. An increasing dependence on the EMS requires close coordination among all joint force and MNFs.

The multinational force commander (MNFC) provides guidance for planning and JEMSO to the MNF through the operations directorate of a joint staff's combined electromagnetic warfare coordination cell (CEWCC).[10]

EXECUTION

JEMSO are planned, executed, and assessed based on the joint air tasking cycle and internal AOC processes. The targeting process integrates lethal and non-lethal effects

[8] For information on JCEOI, see Chairman of the Joint Chiefs of Staff Manual CJCSM 3320.01, Joint Electromagnetic Spectrum Management Operations in the Electromagnetic Operational Environment.
[9] For additional references on joint planning and EMS operations, see Air Force Tactics, Techniques, and Procedures (AFTTP) 3-3.IPE, *Integrated Planning and Employment*. (Common Access Card [CAC] required).
[10] North Atlantic Treaty Organization (NATO) and multinational terminology refers to the CEWCC and not the JEMSOC. See JP 3-16, *Multinational Operations*.

and is led by the AOC's combat plans division targeting effects team (TET) to ensure full-spectrum operations. The TET validates targets, links them to the tactical tasks in the air operations directive (AOD), determines appropriate weapons to create desired effects, and verifies MOE and MOP. The TET also coordinates and integrates effects with joint force operations. The IWT participates in key AOC battle rhythm processes throughout the entire EMSO cycle, to ensure effective and efficient production, dissemination, and execution of each assigned EMS operations order.

JEMSO order. A JEMS operations order provides the details of the approved JEMS use requests, JEMS control procedures, and JEMS coordination measures for a given period, typically aligned with an ATO period. Joint forces unable to comply with JEMS coordination measures, specified transmission authorization, or ROE, are not authorized to transmit EM energy in the JOA. A JEMSO order defines and establishes the portions of the EMS for military operations as approved by the JFC. It notifies all agencies of the effective time of activation and the composite structure of the EMS to be used. The JEMSO order may include coordination measures such as JRFL. Timely order change alerts all EMS users, including MNFs, of JEMSOs to avoid friendly EMI and unintended engagements against civil and neutral receivers, and to increase operational effectiveness.

Conduct Detailed JEMSO Execution. If delegated authority for specific portions of the EMOE, the air component conducts EMSO prioritization, integration, and synchronization. Appropriate EMSO orders and fragmentary orders (FRAGORDs) should generated and forwarded to the IWT for distribution across the AOC for situational awareness.

Monitor and Direct JEMSO. During the period an EMS operations order is active, the IWT should monitor execution and direct changes in EMSO prioritization and tasking based on air component commander direction and inputs using EMBM processes. The IWT distributes these changes via FRAGORD across the force for situational awareness. The IWT should process immediate dynamic support requests and AFSIRs.

Immediate EMSO Requests. EMS-use requests that arise after the JEMSO planning cycle is completed should be submitted directly to the IWT. The IWT conducts an abbreviated analysis cycle and staff coordination to determine priority and feasibility. The IWT should immediately distribute approved requests across the force via FRAGORD through EMBM processes for situational awareness and notify impacted units directly.

Immediate EW Requests. Dynamic EW requests are targets that are identified when detected or located and may not have been included in deliberate targeting. Dynamic EW target requests also include actions to utilize EA to support ES (***jam-to-exploit***). This capability uses EA to affect adversary EMSO to cause the adversary to shift to another frequency or system that is exploitable by friendly forces. Dynamic ES requests can provide indications and threat warnings to the joint force or provide CSAR support. Reporting format and methods should be detailed in theater SPINS.

ITW. Real-or near-real time threat report provides indications and warnings to friendly forces unknowingly within, or transitioning to, threat engagement zones.

AFSIR. The IWT assists with EMI incidents submitted by tactical units. If the IWT cannot resolve or mitigate the EMI, a determination is made to reprioritize EMS-use or tasking. IWT coordinates resultant immediate EMS-use and EMS support requests as required.

ASSESSMENT

At the end of the ATO cycle, the IWT collates feedback and assesses EMSO using the MOE and MOP in the EMSO appendix. The IWT produces a list of shortfalls, best practices, and lessons learned to be applied to future operations.

Update EMOE data repository. The EMOE encountered is analyzed and compared to the estimate. Differences are evaluated, validated, and updated in EMOE estimate.

EMSO Effectiveness/Shortfalls. The IWT uses the assessment information to update the EMSO effectiveness, process efficiency, capability shortfalls, and recommended EMS operations directive changes. All data should then be provided to the JEMSOC.

Intelligence Updates. Assessment data is needed to update intelligence support to EMSO. Assessment data ensures timely EMSO activity feedback is distributed across the joint force. It is also used to update automated correlation and analysis algorithms increasing accuracy, reducing ambiguity, and enhancing situational awareness, effectiveness, and efficiency.

Lessons Learned. The IWT develops lessons learned for dissemination to the components as well as the relevant joint and Service organizations. Lessons learned can be used for current operations, but also form the basis for future planning. EMSO observations are reported into the Joint Lessons Learned Information System (JLLIS) at https://www.jllis.mil (CAC required) or http://www.jllis.smil.mil on SIPRNet.[11]

[11] For more information about the lessons learned process, see Chairman of the Joint Chiefs of Staff Instruction (CJCSI) 3150.25, *Joint Lessons Learned Program*.

APPENDIX A: INTEGRATION OF CYBERSPACE AND ELECTROMAGNETIC SPECTRUM OPERATIONS

Cyberspace operations is the employment of cyberspace capabilities where the primary purpose is to achieve objectives in or through cyberspace. Cyberspace operations require access to the EMS. This necessitates coordination and synchronization between EW and USAF information network operations and US Cyber Command (USCYBERCOM) to maximize and achieve synergistic effects. Integration of EMSO and cyberspace capabilities ensures prioritization, synchronization, and deconfliction.

Most EMS activities occur outside of cyberspace; however, many CO require the use of the EMS to establish a communications path to the targets, especially at the tactical level. Examples of EMSO activities in support of CO include:

- Exploit capabilities to identify the antenna locations and EM waveforms supporting threat CO.
- Attack capabilities to facilitate cyberspace attack objectives by delivering autonomous or interactive executable CO payloads into targets.
- Management capabilities to ensure the CO activity is deconflicted with other military EMS activities in the EMOE.

Cyberspace attacks via the EMS should be deconflicted with other EAs to optimize each type of fires. Depending on power levels, the geographic terrain, and the nature of the system targeted, unintended EW effects may propagate outside of the local commander's operating area. Planners should consider different coordination requirements for the various types of fires that depend on the EMS. Vigilant timing, integration, coordination, and synchronization ensure collaborative efforts to prevent effects in one theater of operations from affecting other theaters or friendly or neutral forces and are intentional and supportive rather than collateral.

To minimize overlap, the primary responsibility for cyberspace attack coordination begins with the AOC's IWT along with appointed cyberspace operations coordinators and planners typically also part of the director of cyberspace forces (DIRCYBERFOR) team. Cyberspace Operations EMS-use requests are addressed in the same manner as any other EMS requirements. EMSO planners review the requirements and integrate them into the EMSO guidance and EMS operating instructions. The JEMSOC should then provide this approved allotment of frequencies to cyberspace operations in the same DOD approved format. JEMSO planners review cyberspace operations plans to ensure they are synchronized with EP activities.

APPENDIX B: ELECTROMAGNETIC WARFARE IN THE SPACE DOMAIN

Air Force forces support preserving freedom of action in space through integration with Space Force forces, much like Space Force forces can support associated Air Force missions. This integration is vital to the conduct of JADO across the competition continuum. Assets conducting EW in the space domain may support worldwide operations, which can drive competition between combatant commander requirements.

Space operations are highly dependent on access to and freedom of maneuver within the EMS. EW may be used to degrade satellite communications used by enemy C2, integrated air defense systems, or other forces. EW can also be used to disrupt or degrade adversary control of their own space assets. EW considerations for the space domain include persistence, standoff, regional effects, approval authorities, and effects synchronization:

- **Persistence.** EW assets targeting space-based receivers benefit from exceptional dwell times that allow for extended operations.
- **Standoff.** EW capabilities targeting spacecraft receivers allow the possibility to affect terrestrial users from a greater standoff distance than airborne EW assets.
- **Regional Effects and Implications.** Targeting uplink signals to spacecraft brings the potential for collateral effects across large terrestrial areas, potentially across multiple areas of responsibility. This capability also allows EW in the space domain to potentially provide effects across multiple theaters, and therefore control might not rest with a single combatant commander. Command relationship authorities should be clarified early on during operational planning.

EA in the Space Domain

EA may target enemy space systems by using EM energy, originating in any domain, to attack link segments (e.g., uplink, downlink, and crosslink signals). DE weapons, such as lasers, can be used to provide a wide range of effects against on-orbit spacecraft, including heating, blinding optics, degradation, and destruction. Under certain circumstances, lasers could also be effective against space launch vehicles while in flight.

- **Approval Authorities.** Satellite systems are often multi-use, with multiple users relying on tactical and strategic communications and other uses of a single spacecraft. This increases the potential for collateral effects on neutral or allied nations and/or escalation of the conflict and drives approval authorities for space EW to the very senior levels of command.
- **Effects Synchronization.** When planning operations, space-based EW effects should be synchronized with other EW platforms and lethal operations as necessary. EW in the space domain should be rarely used independently.

Responsibilities of Space Force personnel include:

- Recommend the proper employment of space EW planning and operational requirements.
- Develop a daily space EW battle rhythm that supports EW as well as general planning and operations requirements.
- Accomplish specified and implied space EW tasks.
- Represent space EW within the IWT.
- Maintain current assessment of resources available for conducting EW in the space domain (to include number, type, and status of assets) and recommend resources necessary to accomplish operational objectives.
- Develop, coordinate, and integrate operations to achieve EW effects in the space domain, based on the JFC's objectives.
- Predict effects of friendly and adversary space-based EW activity on joint and multinational operations.
- Assist in frequency management to include deconflicting frequency requirements and assignments.
- Coordinate and monitor space EW programming and reprogramming by identifying where EW reprogramming decisions and reprogramming actions affect operations.
- Conduct reachback to organizations supporting space-based EW operations.
- Provide liaison to other Service and functional components of joint and MNFs for space EW issues.
- Integrate space-based EW into combat power projection operations.
- Coordinate space-based EW support for CSAR.

APPENDIX C: REPROGRAMMING

EW REPROGRAMMING

EW reprogramming maintains and enhances the effectiveness of EW and target sensing system (TSS) equipment in a rapidly evolving, congested, and contested EMOE. EMOE changes may be the result of deliberate actions on the part of friendly, adversary, or third parties, or may be brought about by EMI or other inadvertent phenomena. EW reprogramming includes changes to self-defense systems, offensive weapons systems, ES, and intelligence collection systems. The reprogramming of EW and TSS equipment is the responsibility of each Service or organization through its respective EW reprogramming support programs. USAF reprogramming efforts should include coordination from the JEMSO staff to ensure those reprogramming requirements are identified, processed, deconflicted, and implemented promptly by all affected friendly forces.

A-10C Thunderbolt II

A-10C dispensing chaff and flares.

SOFTWARE REPROGRAMMABLE EMS-DEPENDENT SYSTEM WAVEFORMS

There is a need to provide software control of a variety of modulation techniques, wide-band or narrow-band modulation, communications security functions, and waveform requirements of current and evolving standards over a broad frequency range. The purpose of a software defined radio policy update is to maintain or enhance the effectiveness of automated communications equipment in a rapidly evolving, congested, and contested EMOE. EMOE changes may be the result of deliberate actions on the part of friendly, adversary, or third parties, or may be brought about by EMI or other inadvertent phenomena.

PROGRAMMING AND REPROGRAMMING SUPPORT

Operational mission data programming and reprogramming take advantage of the EWIR process defined in Department of the Air Force Manual (DAFMAN) 10-703, Electromagnetic Warfare Integrated Reprogramming. The EWIR process uses a suite of software-definable tools that enables aircrew survivability and mission success while operating in an environment characterized by friendly, neutral, and hostile threat systems that use the EMS. EWIR provides a capability to characterize the EM emissions of hostile and other systems, analyze and model their impact on operations, and incorporate these characteristics to enable rapid detection, accurate identification, and appropriate response within the EM spectrum. The 350th Spectrum Warfare Wing (SWW) is the Operational Reprogramming Center for the combat air force (CAF), Combat Search and Rescue, and selected foreign military sales-supported aircraft.

The air component commander's A3 staff should work with the USAF's major command's wing weapons shops to collect EW programming and reprogramming requirements. The urgency of the warfighters' need will drive the routine, urgent, or emergency (yearly, 72 hours, 24 hours) binning of the request.[12]

[12] For more information regarding joint EW reprogramming, see JP 3-85 or contact the 350 SWW located at Eglin AFB, FL.

APPENDIX D: ELECTROMAGNETIC WARFARE SUPPORT AGENCIES

EW relies on support organizations and agencies that provide analysts with in-depth knowledge and data about regions, nations, leadership, and EMS systems including weapons. Their information is vital to successful EOB and course of action development. The IWT should coordinate with these assets frequently as appropriate. Some of these organizations have personnel in the AOC or collocated with the JFC staff. Their comprehensive expertise should be useful to EMS and EW planners when developing multi-domain objectives, effects, and assessments.

AIR FORCE

HAF A2/6L Electromagnetic Spectrum Superiority Directorate. A2/6L, located within the Headquarters Air Force at the Pentagon, VA, is responsible for all matters pertaining to gaining and maintaining EMS superiority for Air Force forces in accordance with the National Defense Strategy, DoD EW Strategy, and DoD EMS Strategy. HAF A2/6L orchestrates enterprise-wide actions and unity of effort in developing and synchronizing multi-domain EMS doctrine, strategy, policy, capability development, sustainment, planning and programming, budgeting, and execution across all USAF missions.

National Air and Space Intelligence Center (NASIC). NASIC, headquartered at Wright-Patterson Air Force Base, OH, serves as the Air Force's service intelligence center and is a field operating agency that reports directly to the Deputy Chief of Staff for ISR and Cyber Effects Operations (HAF A2/6). NASIC produces integrated and predictive air, space, and specialized intelligence supporting military operations while also enabling forces to avoid technological surprise by countering existing and evolving air and space threats.

Sixteenth Air Force (16 AF). 16 AF, headquartered at Joint Base San Antonio-Lackland, TX, is the Air Force's information warfare numbered air force and leverages ISR, cyberspace warfare, EW, weather, public affairs, and information warfare capabilities to ensure that the USAF is fast, lethal, and fully integrated in competition, crisis, and conflict. 16 AF provides mission integration of information warfare at operational and tactical levels via the 616th Operations Center.

70th ISR Wing (ISRW). The 70th ISRW, headquartered at Fort Meade, MD, executes global ISR operations in air, space, and cyberspace to enable strategic, operational, and tactical effects for the National Command Authority, the joint warfighting team, air component operations, and USAF mission partners. The 70 ISRW serves as the Air Force's designated lead wing for National Tactical Integration (NTI) operations and synchronization and executes global ISR missions in support of combatant command and air component operations via the USAF Distributed Common Ground System (DCGS) and the global cryptologic enterprise. Additionally, the 70 ISRW is the Air Force's designated lead wing for ISR operations enabling both cyberspace effects and space superiority operations.

9th Reconnaissance Wing. The 9th Reconnaissance Wing, headquartered at Beale AFB, CA, is responsible for providing national and theater command authorities with timely, reliable, high-quality, high-altitude U-2 and RQ-4 reconnaissance support.

55th Wing. The 55th Wing, headquartered at Offutt AFB, NE, provides ISR, EW, and nuclear command, control, and communications to national leadership and warfighters while delivering information dominance across the full spectrum of conflict. The wing provides the foundation for airborne non-lethal operations training to the USAF and operates the USAF information warfare training and research environment facilitating the development of non-lethal capabilities.

480th ISR Wing. The 480th ISRW, headquartered at Langley AFB, VA, is the lead wing for the DCGS and provides national cryptologic, information technology, cyberspace ISR, tactical analysis, air component command support, and national-to-tactical signals intelligence integration.

The 67th Cyberspace Wing. The 67th Cyberspace Wing, headquartered at Joint Base San Antonio-Lackland, TX, presents combat cyberspace capabilities to the Service, Cyber Command, and the Joint Force while also acting as the Air Force's cyber execution arm for conducting global cyberspace operations.

The 350 Spectrum Warfare Wing. The 350th Spectrum Warfare Wing, headquartered at Eglin AFB, FL, and activated in 2021, is responsible for providing operational, technical, and maintenance electromagnetic warfare expertise for the CAF and for systems engineering, testing, evaluation, tactics development, employment, capability, and technology assessment. This includes the wartime responsibility for emergency reprogramming and dissemination of EW system mission data software for CAF aircraft. The wing manages the Air Force COMBAT SHIELD Electromagnetic Warfare Assessment Program for CAF aircraft EW systems. COMBAT SHIELD provides operational units a system-specific capability assessment for their radar warning receivers, electromagnetic attack pods, and integrated EW systems.

The 363rd ISR Wing. Formerly known as the Air Force Targeting Center, the 363rd ISRW, headquartered at Langley AFB, VA, provides operations planning and execution support to major commands, component numbered air forces, and theater AOCs. The wing provides targeting-related intelligence to air component forces, including non-lethal targeting support.

492 Special Operations Wing Detachment 1. This detachment, located at Robins AFB, GA, serves as Air Force Special Operations Command's (AFSOC) EW Reprogramming Center and provides operational EW reprogramming of special operations-specific programs and equipment through research, testing, and development of mission data.

Air Force Research Laboratory (AFRL). AFRL, headquartered at Wright-Patterson AFB, OH, conducts research and development activities addressing technology and capability gaps across the Department of the Air Force.

SPACE FORCE

Space Delta 3 (DEL 3). DEL 3, headquartered at Peterson Space Force Base, CO, is the Space Force's EW Delta and is responsible for presenting combat-ready Space EW professionals to integrate, synchronize, and execute fires for US, Allied, and Coalition forces.

Space Delta 7 (DEL 7). DEL 7, headquartered at Peterson Space Force Base, CO, is the operational ISR element of the Space Force. The ISR Delta provides critical, time-sensitive, and actionable intelligence for space domain operations to allow for the detection, characterization, and targeting of adversary space capabilities. DEL 7 employs a variety of fixed and mobile sensors across the globe operated by ISR professionals to enable the Space Force to gain and maintain space superiority.

COMBATANT COMMAND ORGANIZATIONS

Theater Joint Intelligence Operations Center (JIOC), or Joint Intelligence Operations Center Europe Analytic Center (JAC). JIOCs and JAC are central points for theater intelligence tasking, collection, analysis, and production. Both have targeting offices that produce target folders based on deliberate planning and taskings. In addition, they coordinate with theater J2s, maintain the joint target list (JTL), no-strike list (NSL), and restricted target list (RTL) for specific operations plans (OPLANs) or contingency plans (CONPLANs). JIOCs and JAC have liaisons from the major national intelligence agencies to facilitate effective national intelligence support to the theaters. These liaisons typically include personnel from the Defense Intelligence Agency (DIA), National Geospatial-Intelligence Agency (NGA), the National Security Agency (NSA), and the Central Intelligence Agency (CIA).

Joint EMS Operations Center (JEC). The JEC, located at Offutt AFB, NE, was established in 2023 by U.S. Strategic Command to advance the Joint Force's ability to operate and prevail in contested, congested, and constrained EMS environments through focused training, education, and assessment. The objectives of the JEC are to provide JEMSO support to other CCMDs and partner nations; establish, maintain, assess, and support Joint Force training and exercises; assess and develop recommendations for the Chairman of the Joint Chiefs of Staff to provide military advice regarding JEMSO capabilities and guidance. Both the JCER and JEWC fall under the JEC.

Joint Center for Electromagnetic Readiness (JCER). Originally known as the Joint Electronic Protection for Air Combat (JEPAC), JCER is located at Nellis AFB, NV, and is aligned under U.S. Strategic Command's JEC. In accordance with combatant command priorities, JCER evaluates JEMSO readiness for deployment, identifies gaps and limitations, and develops mitigation strategies and solutions.

Joint Electromagnetic Warfare Center (JEWC). The JEWC, located at Joint Base San Antonio-Lackland, TX, is also aligned under U.S. Strategic Command's JEC and enables EMS superiority through joint training, planning, operations support, and assessment. The JEWC identifies and assesses current and emergent EW and EMS-superiority requirements, technologies, and capabilities to enable global access and freedom of

maneuver across all domains and joint functions throughout the competition continuum. The JEWC assists combatant commands and components to plan, execute, and assess EW and EMS superiority while also providing joint training and training oversight to meet joint force requirements.

Joint Warfare Analysis Center (JWAC). JWAC, located in Dahlgren, VA, is a functional component of U.S. Strategic Command that provides combatant commands, Joint Staff, and other customers with effects-based, engineering, and scientific analysis and precision targeting options for selected networks and nodes to carry out the national security and military strategies of the United States during peace, crisis, and war.

JEMSO Cells (JEMSOCs). The JEMSO Cells develop and execute the processes to integrate command EMS related staff actions, offices, and activities to support mission requirements and to carry out JEMSO related responsibilities for each, specific CCMD. Typically, JEMSOCs will be located within the CCMD J3.

DEPARTMENT OF DEFENSE

Defense Information Systems Agency (DISA), Program Executive Office (PEO) Spectrum. PEO Spectrum located in Annapolis, MD, is a direct support agency subordinate to DISA that delivers and assures electromagnetic spectrum C2 and information-sharing capabilities and a globally accessible enterprise information infrastructure in direct support to joint warfighters, national-level leaders, and other mission and multinational partners. PEO Spectrum also provides direct support to combatant commands and Joint Task Forces (JTFs), including strategic EMS planning, engineering analysis, and enterprise capabilities and services to enable effective global spectrum operations for joint warfighters, national-level leaders, and multinational partners.

REFERENCES

All websites accessed 13 November 2023.

Doctrine can be accessed through links provided at: https://www.doctrine.af.mil/

US AIR FORCE DOCTRINE

- AFDP 1, *The Air Force*
- AFDP 3-0, *Operations and Planning*
- AFDP 3-13, *Information in Air Force Operations*
- AFDP 3-30, *Command and Control*

JOINT DOCTRINE

Joint Electronic Library (JEL): https://www.jcs.mil/Doctrine/

JEL +: https://jdeis.js.mil/jdeis/index.jsp?pindex=2

- JP 3-16, *Multinational Operations*
- JP 3-30, *Joint Air Operations*
- JP 3-85, *Joint Electromagnetic Spectrum Operations*

DOCTRINE FROM OTHER SERVICES

US Space Force:

https://www.starcom.spaceforce.mil/About-Us/STARCOM-Deltas/Space-Delta-10-Doctrine-Wargaming/

- *Space Capstone Publication*
- *Space Doctrine Publication 2-0, Intelligence*
- *Space Doctrine Publication 3-0, Operations*
- *Space Doctrine Publication 5-0, Planning*

TACTICAL DOCTRINE

Air Force Weapon System TTPs (AFTTPs):

https://intelshare.intelink.gov/sites/561jts/SitePages/Home.aspx

- AFTTP 3-3.AOC, *Air Operations Center*
- AFTTP 3-3.IPE, *Integrated Planning and Employment*

CHAIRMAN OF THE JOINT CHIEFS OF STAFF

- CJCSM 3320.01C, *Joint Electromagnetic Spectrum Management Operations in the Electromagnetic Operational Environment*
- CJCSI 3150.25H, *Joint Lessons Learned Program*

MISCELLANEOUS PUBLICATIONS

✪ DAFMAN 10-703, *Electromagnetic Warfare Integrated Reprogramming*