Electromagnetic warfare\textsuperscript{40} (EW) planning is seldom used by itself when planning coordinated attacks. Electromagnetic attack\textsuperscript{41} (EA) is used in coordination with space and cyberspace capabilities, and as a delivery mechanism for specific information operations (IO). Preplanning, timing and synchronization, and near real time assessments are critical for ensuring successful operations.

Planning

Offensive EA planning begins with intelligence-based targeting derived from the commanders’ intent. EW planners should be familiar with the target set and tactical problem and be a part of the initial planning team and target development teams to assess the threats and develop requirements. Planning should be conducted as part of the Joint Planning Process (JPP), accomplished as part of campaign planning or contingency planning. For more on the JPP see Joint Publication (JP) 5-0, Joint Planning, Chapter 5.

In many cases air operations centers’ (AOC’s) electromagnetic warfare cells have been folded into the larger non-kinetic construct, executing as part of a Non-kinetic Operations Coordination Cell (NKOCC) or information operations (IO) team, where many functions of EMSO are resident in these teams.

General Planning Considerations

The joint planning process for air (JPPA) is the desired method to enable the best usage of EA to support and enable kinetic and non-kinetic operations. When planning effects based operations, an AOC’s strategy division leads the target effects team development of a strike plan. In this planning process, EW experts require support from the intelligence, surveillance, reconnaissance division (ISRD) and the A-6 to assess the adversaries’ use of the EMS and understand where friendly operations in the spectrum

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\textsuperscript{40} For the reason these terms have been changed from “electronic” to “electromagnetic,” see “Note on the Terms ‘Electronic’ vs. ‘Electromagnetic’” in, “Introduction to Electromagnetic Spectrum Operations,” this annex.

\textsuperscript{41} Ibid.
reside. The joint restricted frequencies list (JRFL) will need to be validated with national agencies in order to determine what adversary spectrum is valid for targeting. During this process of selecting and pairing capabilities the synchronization of air, space, cyberspace, and other operations will begin to come together into an operation plan (OPLAN) in order to deliver effects that influence the enemy to operate in a manner that will enable the joint force to achieve their objectives. The need for EW spans across all airpower operations leveraging EA, electromagnetic warfare support\(^{42}\) (ES), and electromagnetic protection\(^{43}\) (EP) in different forms as specified earlier. The detail required for this planning should be specific enough to drive valid requests for forces; examples of this include jamming pods to include specific bands used by Navy EA-18G, MALD-J, EC-130H COMPASS CALL, airborne signals intelligence (SIGINT), cyberspace, the Counter-Communications System, and EC-130J COMMANDO SOLO.

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**General Planning EMS inputs and outputs**

EW planners in concert with the greater non-kinetic planning effort, develop collection requirements in coordination with the AOC’s ISRD to determine measures of performance (MOPs) and measures of effectiveness (MOEs) to provide near real time feedback of ongoing operations as this may impact the acceptable level of risk. The best planning practices simultaneously develop non-kinetic and intelligence objectives to support each other, and to maximize intelligence collection aiding in developing effective MOEs and MOPs before the execution of operations. Intelligence gain or loss discussions between EW planners and the ISRD should occur to assess that the plans in place support intelligence building when required and shift as appropriate to

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\(^{42}\) For the reason these terms have been changed from “electronic” to “electromagnetic,” see “Note on the Terms ‘Electronic’ vs. ‘Electromagnetic’” in, *Introduction to Electromagnetic Spectrum Operations,* this annex.

\(^{43}\) Ibid.
maximize the protection of those in harm’s way.

During the EMSO planning process, EW experts should adhere to guidance and rules of engagement (ROE) or request changes when required. EW planners will need to develop direction through special instructions (SPINS) development to support theater campaign plans to provide forces with clear ROE and direction for execution of the planned missions. Furthermore, EW planners should ensure the air tasking order (ATO) tasks the correct airborne assets at the required times to ensure appropriate airspace is coordinated through the airspace control order (ACO) development.

Adversaries may possess capabilities that can degrade positioning, navigation, and timing and communications systems, which will require EW planners to work with command and control (C2) planners to ensure communications requirements and support are in place to provide adequate C2 and maneuver within the spectrum.

At the conclusion of the planning process, training requirements for supporting crews (space, cyberspace, and airborne) should be developed and communicated from the commander, Air Force forces (COMAFFOR) to the joint force commander (JFC), then down to the supporting commands. If there are any material deficiencies or capabilities requirements that are determined during the planning process as crucial to the success of the mission, this should also be communicated from the COMAFFOR to the JFC for inclusion into urgent operational need processes as appropriate.

**Steady-State EMS Operations**

To enable effective steady-state operations planning, joint planning should be completed regularly to ensure the organization is poised to support normal operation plan (OPLAN) development or respond to a crisis event.

With EMS operations absorbed into the non-kinetic team construct, EW members should ensure the following functions are fulfilled:

- JRFLs regularly updated and coordinated across the Services.
- EW strategy is written to support OPLANs.
- EW SPINS are supportive of OPLANs.
- Related communications security and emission control (EMCON) guidance is reviewed.
- The status of EW assets in theater are ascertained.
- Beddown requirements are facilitated.
Contingency Planning

In times of crisis, planning processes follow the same methods working from intelligence-derived targeting looking outward. The significant differences in the planning process are that the timeline is reduced; planners are unlikely to request additional forces not already in theater; and ACO, ATO, joint space tasking order, and SPINS changes not co-located could prove challenging to communicate and approve. EMS inputs and outputs to contingency planning are illustrated in the figure, “Contingency Planning: EMS Inputs and Outputs.”

Additionally, not having a current JRFL in place could hamper operations or, at worst, impede friendly capability. Authorities and permissions should be clearly defined or this could hinder employment.
Electromagnetic Spectrum Operations Planning

JFCs centralize EMSO planning under the designated EMS control authority (EMSCA), EW control authority, or jamming control authority and decentralize execution to ensure EMSO unity of effort while maintaining tactical flexibility. Viewed holistically, EMSO across all functions and domains are often complex and interwoven. This requires detailed integration and synchronization to avoid friendly fire and achieve the desired degree of EMS control. The complex EM operational environment (EMOE) that the joint force may experience makes this integration more difficult. EMSO planning provides the basis for the prioritization, integration, and synchronization of Air Force EMS activities between the staff functions (primarily A-2, A-3, and A-6), other components, and multinational partners. As all joint functions are heavily dependent on the EMS, EMSO should be a key planning consideration across all phases of military operations. The Non-kinetic Operations Coordination Cell (NKOCC) is the lead staff element for EMSO planning.

The commander's guidance and estimate form the basis for determining joint force objectives. During mission analysis, EMSO planners develop a staff estimate which forms the basis for an EMS control strategy. The EMSO staff estimate is used during course of action (COA) development and analysis to determine EMS supportability. When a COA is chosen, it becomes the basis to develop the EMSO annex which outlines EMSO missions, priorities, policies, processes, and procedures across all phases of the operation. The joint force components develop component EMSO plans and submit them to the joint electromagnetic spectrum operations center (JEMSOC) for integration into the overall EMSO appendix. During planning and execution, the NKOCC consolidates component EMSO plans and attendant requirements, prioritizes, integrates, and synchronizes them, and produces an EMS control plan (EMSCP) to provide to the JEMSOC. An updated EMSCP begins the EMSO execution cycle resulting in an EMS control order (EMSCO) directing joint force EMS use. For information on joint planning, refer to JP 5-0, Joint Planning, and Chairman of the Joint Chiefs of Staff (CJCS) Manual 3130.01A, Campaign Planning Procedures and Responsibilities. For more information on EW planning, see JP 3-13.1, Electronic Warfare, Air Force Tactics, Techniques, and Procedures (AFTTP) 3-3.AOC, Air Operations Center, and AFTTP 3-3.IPE, Integrated Planning and Employment.

**EMSO Staff Estimate.** A primary product of mission analysis, planners use staff estimates to prepare evaluation request messages to solicit COA input from subordinate units and subsequently develop preliminary COAs. The EMSCA uses the commander’s mission, commander’s estimate and objectives, commander’s intent, concept of operations, and the components’ inputs to develop COAs. The JEMSO staff estimate informs the commander, staff, and subordinate commands how JEMSO supports mission accomplishment and COA development and selection. During COA development and selection, EMSO planners fully develop their estimate, providing an EMS analysis of the COAs, as well as recommendations on which COAs are JEMSO supportable. Planners should identify critical shortfalls or obstacles that impact mission accomplishment. The JEMSO staff estimate should
be continually updated based on changes in the situation. For information on staff
estimates, refer to JP 5-0.

EMS Superiority Strategy. An EMS superiority strategy outlines how the
COMAFFOR will execute the JFC’s guidance to achieve EMS superiority. This
strategy ensures joint forces achieve the advantage in the EMS that permits the
conduct of operations at a given time and place without prohibitive interference,
while affecting an adversary’s ability to do the same. The strategy is comprised
of the mission analysis and mission statement portions of the JEMSO staff
estimate and is usually located in the EMSO section of the OPLAN, concept
plan, or operation order. It outlines the key missions and tasks the joint force
components carry out to achieve EMS superiority and establishes the basic
relationships between the exploit, attack, protect, and manage activities the
joint force will accomplish. The strategy identifies key EMS users, both
functionally, such as air, space, and cyberspace operations, as well as
organizationally, such as multinational partners. It provides the framework for
detailed JEMSO planning. Key elements of the EMS superiority strategy
include:

EMS missions that forces are expected to perform. This includes such
activities as mitigating an adversary’s ability to contest friendly force
operations through the EMS, degrading or denying the adversary from
maneuvering in the EMS to support their operations, optimizing friendly
force EMS use, coordinating through the frequency management office
the necessary joint force EMS-use authorities with host nation (HN) and
relevant adjacent nations according to treaties and international
agreements.

Assumptions (e.g., HN EMS-use authorizations).

Key considerations based on the expected EMOE.

Anticipated scale of operations and the number and type of friendly
forces (to include multinational partners).

Establishment of EMSO organizations.

Relationships between EMS organizations both internal and external to
the joint force.

Define and Characterize the EMOE.

The situation analysis portion of the JEMSO staff estimate is where the
EMOE is initially defined and characterized, forming the foundation for
the EMSO aspects of COA development, analysis, and selection.
NKOCC planners should provide a mechanism to periodically
characterize the EMOE to ensure relevant EMS-systems and activities
implying joint force operations are captured and planned.

Characterizing the EMOE is an iterative process that employs many of the tasks and methodologies associated with joint intelligence preparation of the operational environment (JIPOE). An EMOE tends to be dynamic, requiring the associated databases and analyses be updated periodically, often on a very short timeline. The physics of the EMS dictate that the military usefulness and properties of a given set of frequencies may vary periodically based on environmental factors outside of JFC control. JEMSO planners should not only allow for changes in both neutral and adversary operations in the EMS but need to consider potential naturally occurring EMOE changes as well.

EMOE information should be current, accurate, and accessible to authorized users. JEMSO planners should designate primary EMOE data sources to facilitate this. This source designation should be accompanied by information on the organization(s) responsible for maintaining the data sources, the associated processes and timelines for source population, requirements for access (user clearances and timelines), and the processes for dealing with data source conflicts.

Meteorological and Oceanographic (METOC) Data. JEMSO planners should include the effects of atmospherics and space weather on both the EMOE as well as friendly and adversary EMS-dependent systems. The various types of atmospheric conditions and phenomena can positively or negatively affect these systems. For example, atmospheric temperature inversions can increase the propagation of radio transmissions; high humidity and rainy climates are detrimental to infrared systems; and ionospheric scintillation can adversely affect the Global Positioning System (GPS) satellites. Some atmospheric effects are well known and are categorized by season and location. Planners should consult with the combatant command’s METOC officer to determine the type of support available for their operation.

Determine Friendly EMS-Use Requirements.

The Air Force supports joint operations by employing EMS-dependent systems across almost all functions and activities. Components identify the EMS-dependent systems they will employ in the joint operations area (JOA), describing their capabilities and associated EMS-use requirements, and registering them with the NKOCC. The NKOCC then coordinates with the JEMSOC to establish the process to solicit, compile, and process joint EMS-use requirements. The resultant data is used to inform the EMS superiority strategy, characterize the EMOE, determine COA EMSO supportability, and build the EMSCP and EMSCO which authorizes component EM transmissions.
EMSO planners at all echelons and components should account for any special classification requirements and communicate them to the JFC’s JEMSO staff to ensure proper clearances and “need to know” are established. Proliferating network-enabled joint warfighting capabilities have increased the number of EMS-dependent links between previously autonomous capabilities. JEMSO planners should review EMS-use requirements submissions to ensure that cross-capability and cross-functional EMS links have been properly captured.

The EMSCA issues guidance to the joint force staff elements, components, and supporting agencies on how to request JEMSO support for EMS-dependent systems that operate under their control within the joint force’s JOA. The guidance includes requirements for all EMS-dependent systems, including those that are receive-only. The message requires units to submit their EMS-use requirements to the NKOCC, who then validates as passes to the JEMSOC. The EMSCA guidance typically includes the following:

- Joint force JEMSO policy and guidance.
- Security classification guidance.
- Procedures for submitting EMS-use requests to support EMS-dependent equipment or request non-organic JEMSO support, including lead times and request format.
- Electromagnetic battle management (EMBM) guidance and processes.
- Master net list requirements collection process, including the need for identifying nets requiring call signs, call words, and possible frequency sharing.
- EMS coordination measure (e.g., JRFL) submission procedures, including lead times and restrictions.
- Air Force spectrum interference resolution (AFSIR) reporting requirements and routing procedures.

EMSO Appendix.

Once a COA is chosen, the AOC develops the EMSO appendix within the operations annex for the COMAFFOR’s approval. The EMSO appendix establishes procedures for EMBM system use in the operational area and includes EMS coordination measures, specifying procedures and ROE for joint force EMS use. In order to provide effective operational procedures, the EMSO appendix should be integrated across all portions of the COMAFFOR’s orders.
The JEMSO appendix considers procedures and interfaces with the international or national frequency control authorities and systems necessary to effectively support EMSO, augmenting forces, and COMAFFOR objectives. Consequently, the JEMSO appendix should be preplanned to the highest degree possible and maintained in a basic, understandable format.

The EMSO appendix should be coordinated with HN representatives, if appropriate and feasible.

Planning factors to be addressed when developing the EMSO appendix include familiarity with the basic OPLAN or OPORD; knowledge of both HN and multinational considerations; consideration of lessons learned; an understanding of the operational and mission variables; familiarity with the capabilities and procedures of EMS control and military and civil Federal Communications Commission-equivalent agencies; and the general locations of friendly, neutral, and enemy forces.

The EMSO appendix supports transitions across the range of military operations. Such transitions may occur during a period of increasing or decreasing tensions, or suddenly without warning. The EMSO appendix should support all phases of an operation with flexibility to respond to current requirements.

Policy and ROE. EMSO activities frequently involve a unique set of complex issues. There are Department of Defense (DOD) directives and instructions, the law of war, and ROE that may affect them. Laws, rules, policies, and guidelines become especially critical during peacetime operations when international and domestic laws, treaty provisions, and agreements (e.g., status of forces agreements) may affect EMSO planning and execution. Commanders should seek legal review during all phases of EMSO planning and execution, to include development of theater ROE. While ROE should be considered during the planning process, it should not inhibit developing a plan that employs available capabilities to their maximum potential. If, during the planning process, an ROE-induced restriction is identified, planners should work with staff legal advisors to clarify the ROE or develop supplemental ROE applicable to EMSO. EMS policy and ROE requirements are promulgated through the EMSCP and EMSCO as they become effective.

Prioritization. COMAFFOR EMS-use prioritization guidance is a key planning factor used by the NKOCC to rank EMS-use requests in congested EMOEs and by the components to rank assigned tasks, and pass to the JEMSOC. The NKOCC regularly reviews the JFC’s priorities, solicits component inputs, and recommends EMS-use prioritization changes to the JFC.

EMS-Use Requests. EMS-use requests represent joint force requirements for conducting operations in the EMS in support of their assigned missions and tasks. To be properly prioritized and integrated, they include the following
information:

- The activity to be conducted in the EMS (sense, communicate, attack).
- The purpose of the activity.
- The relative priority of the activity.
- The platform or system conducting the activity.
- Missions supported by the activity.
- Required EMS-use parameters (e.g., time, location, frequencies, power, waveform).

EMS Coordination Measures. EMS coordination measures are rules, mechanisms, and directions governed by joint doctrine and defined in the EMSO appendix. These measures direct maneuver within the EMS in specified dimensions (e.g., space, time, frequency, power, waveform). The EMSO appendix specifies EMS coordination measures (e.g., JRFL) to be used in the JOA and how these measures will be distributed and implemented. During execution, the EMSCP should provide guidance on what EMS coordination measures will be activated in the EMSCO. EMSO elements establish EMS coordination measures to accomplish one or more functions during specific time windows and geographical areas:

- Establish reserved EMS bands for specific EMS activities.
- Restrict the actions of some EMS users.
- Create EMS bands in which units can use EMS-dependent systems with minimal risk of EMI.
- Require EMS users to accomplish specific actions.

JRFL. The JRFL is an EMS coordination measure that operational, intelligence, and support elements use to identify the level of protection desired for various networks and frequencies. The JRFL is a time, frequency, and geographically oriented listing of functions, nets, and frequencies requiring protection from friendly EM transmissions and is limited to the minimum number of frequencies necessary for friendly forces to accomplish joint force objectives. Although the JRFL is the primary coordination method, it may be necessary to coordinate the protection of intelligence collection frequencies via the immediate joint EMS-use request process to meet the time-sensitive needs of collection activities. The JRFL is developed prior to initiating joint force operations and is continually modified during operations.
EMBM-Related Capabilities. The systems and tools that facilitate EMBM and provide EMSO-related planning capabilities. EMBM guidance establishes which capabilities and related databases will be used and how they should exchange data using approved DOD architectures for vertical and horizontal interoperability. This interoperability facilitates timely and routine EMSO data exchanges. This exchange may be conducted in either non-real time or near real time (NRT) via common, secure, jam-resistant radios and data links. The ability to exchange NRT data (such as targeting information) to enhance situational awareness and combat coordination between various force elements is a critical combat requirement. EMBM guidance should include:

- Type or version of EMSO planning tools used.
- Secure connectivity to components.
- Availability of C2 networks.
- Compatible data exchange format and processes.
- EMS coordination processes (e.g., frequency assignment, EM targeting, EMI resolution).
- Interfaces to national and intelligence databases.
- Interfaces to battlefield sensors.

EM Signature Control. EMSO planners determine adversary EMS capabilities and potential impacts on EMSO to establish the necessary level of emission control (EMCON) signature control includes:

- Assessing adversary electromagnetic warfare support\(^4\) (ES) and signals intelligence (SIGINT) capabilities against friendly forces.
- Planning and implementing appropriate EMCON measures by task and phase.
- Providing EMCON guidance and direction to components.
- Nominating adversary ES and SIGINT systems for targeting.

Electromagnetic Warfare. The EMSO appendix EW section outlines the EW requirements for achieving EMS superiority. Specific planning actions include:

\(^4\) For the reason these terms have been changed from “electronic” to “electromagnetic,” see “Note on the Terms 'Electronic' vs. 'Electromagnetic'” in, “Introduction to Electromagnetic Spectrum Operations,” this annex.
Reviewing EMS superiority strategy.

Identifying the purpose and intent of performing EW, the immediate desired effects, and enabling conditions for authorizing EW.

Determining the status of EW capability of available forces relative to adversary capability and determining if sufficient assets are available to perform the identified EW tasks. Draft requests for support if in-place assets are insufficient.

Considering friendly EMS use with respect to the anticipated operations, tactical threat expected, and EMI possibilities. Once identified, these requirements should be entered into the JRFL under appropriate categories (e.g., TABOO frequencies).

Identifying measures to deny operations security indicators to adversary passive EM sensors.

Establishing and updating appropriate EMS coordination measures (e.g., JRFL TABOO).

Determining the processes necessary to eliminate or mitigate EM interference (EMI) from EW activity with other JEMSO.

Identifying the EMS-related commander’s critical information requirements (CCIRs). These CCIRs should be included in the intelligence annex (normally annex B) of the OPLAN or OPORD to facilitate timely and comprehensive ES.

Coordinating and establishing procedures to ensure fulfillment of EW planning tasks.

Reviewing ROE and applicable legal factors to determine the authorities needed or the restrictions, if any, that apply to EW operations.

Identifying EM target element categories in order to guide collections priorities and support EM target element development.

Analyzing the vulnerabilities of friendly force EMS-dependent systems, determining the ability of the adversary to exploit those vulnerabilities, and evaluating the resulting mission impact.

Analyzing the vulnerabilities of adversary EMS-dependent systems and networks, determining the ability of friendly forces to exploit those vulnerabilities, and evaluating the resulting mission impact.

Navigation Warfare (NAVWAR). Due to the dual civil and military nature of
GPS, global navigation satellite system (GNSS), and other PNT services, potential impacts from NAVWAR efforts on non-military users and the civil and commercial critical infrastructure must be thoroughly analyzed during COA development and may need to be coordinated with HN EMS authorities. NAVWAR considers the impact of adversary GPS jammers on friendly force systems, provides guidance on the type of GPS receivers needed to support mission execution, aids in determining the quantity and types of GPS-aided munitions required to execute a COA, and recommends GPS jammers as targets.

**Interoperability.** Interoperability is essential in order to use EMSO effectively as an element of joint military power. EMSO planners must know and integrate the EMS-dependent capabilities in theater and how they will interact during execution to minimize EMS conflicts and enhance EW effectiveness.

All EMSO are subject to the EMSCP and the EMSCO. The EMSCP and EMSCO provide direction to prioritize, integrate, coordinate, direct, and deconflict all joint force EMS-use within the JOA. (Note: This does not imply any level of command authority over EMS assets or their self-defense [defensive EA] capabilities.)

**EMSCP.** The EMSO appendix (approved by the commander as part of the operations annex) provides overarching guidance for the control of the EMS. The NKOC issues an EMSCP at the beginning of the EMSO execution cycle containing updated EMSO guidance for that cycle.

**EMSCO.** The EMSCO is an order that provides the details of the approved EMS-use requests, EMS control procedures, and EMS coordination measures for a given time period. Joint forces unable to comply with EMS coordination measures, specified transmission authorization, or ROE, are not authorized to transmit EM energy in the JOA. The EMSCO 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 EMSCO may include coordination measures such as JRFL. Timely EMSCO change alerts and promulgation of EMSCO changes to all EMS users, to include multinational forces, is essential to avoid friendly EMI and unintended engagements against civil and neutral receivers, and to increase operational effectiveness.

**Specified Transmission Authorization.** Certain regions of the EMS may require finer control of joint force EMS transmissions than EMS coordination measures provide for a variety of reasons (e.g., excessive congestion, potential collateral effects). The EMSCO will identify and publish specified transmission authorizations.

**EMSCO Development.** The EMSCO is normally published and distributed daily and contains coordination measures, procedural control instructions, and the portions of the EMS required to implement the
EMSCP. The EMSCO activates and deactivates control measures. Procedures to develop and update the EMSCO are included in the EMSCP. Normally, component commanders consolidate, prioritize, deconflict, and forward their EMS-use requests to the EMSCA by a specified time for further consolidation with other inputs. Guidance should be given, depending on the level and the number of forces in the OA, on what other information should be included (e.g., EMS and other coordination measures). The EMSCA is responsible for EMS control for the entire OA, but may delegate specific authority for EMS control to the component commanders through EMSCP guidelines. The JFC may also elect to task the component commanders to generate EMSCO annexes for their assigned sectors. Regardless, the JEMSOC is tasked with providing continuity along sector boundaries and ensuring integration of each sector authority’s EMSCO within the EMSCP guidelines.

Communications-Electronics Operating Instructions (CEOI). The CEOI is the portion of the EMSCO which provides the commander the voice and data network EMS-use authorizations necessary to support operations. It contains the technical characteristics of communications networks. The CEOI consists of the following subsections: directory of radio nets or units and their associated frequencies, call signs, call words, and network identifications listed by time period, supplemental procedures for electromagnetic, visual, and verbal interactions, such as sign and countersigns, smoke and pyrotechnics and suffix and expanders. It is usually further subdivided into different sections, or layers (e.g., joint layer, components, corps, fleet, wing). Additionally, the CEOI 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.

For information on joint CEOI, refer to CJCS Instruction 3320.03, Joint Communications, Electronics Operating Instructions.