Spectrum Supportability Guide
For
Army Combat and Material Developers

Army CIO/G-6
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1. Purpose

The purpose of this Guide is to provide combat developer (CBTDEV) and material developer (MATDEV) decision makers with information to determine whether or not the electromagnetic spectrum necessary to support the operations of a spectrum-dependent system will be available.

The Guide is designed as a methodology to ensure that Army spectrum-dependent systems comply with mandatory Department of Defense (DoD), national, and international spectrum policies[1,2,3] during all phases of the DoD acquisition system (DAS) process[4] as implemented by the Army[5].

Additional goals of this Guide include:

- Assisting Army combat and material developers to determine the optimum parts of the radio frequency (RF) spectrum where material solutions to Army requirements can be met from operational, as well as regulatory, perspectives.
- Identifying spectrum-related challenges early in the life cycle of Army spectrum-dependent systems when changes to their technical parameters architectures are least costly to implement.
- Ensuring that combat and material developers understand and account for mandatory regulatory processes and technical characteristics of intended radio frequency (RF) environments during the development, acquisition and operations of Army spectrum-dependent systems.
- Ensuring that sufficient bandwidth within allocated frequency bands is available to support Army spectrum-dependent system development, acquisition, and operations.
- Ensuring that Army spectrum-dependent systems can operate in all of their intended electromagnetic environments without causing or receiving unacceptable interference.
- Aligning Army spectrum management with combat and material development processes.
- Facilitating CIO/G-6 oversight of Army spectrum-dependent system acquisitions.

2. Applicability

This Guide is written for all Army combat and material developers as well as acquisition professionals who develop, acquire, or operate equipment dependent on use of - or requires access to - the electromagnetic spectrum. The intent of this Guide is to provide detailed

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[1] *Policy for Management and Use of the Electromagnetic Spectrum*, DoD Directive 4650.1, Assistant Secretary of Defense, ASD/NII, Washington, DC, 8 June 2004.
[2] *Department of Defense Electromagnetic Environmental Effects (E3) Program*, DoD Directive 3222.3, Assistant Secretary of Defense, ASD/NII, Washington, DC, 8 September 2004.
[3] *Interoperability and Supportability of Information Technology and National Security Systems*, CJCSI 6212.01D, Chairman, Joint Chiefs of Staff, Washington, DC, 8 March 2006.
[4] *Operation of the Defense Acquisition System*, DOD Instruction 5000.1, Under Secretary of Defense (AT&L), 12 May 2003.
[5] *Army Acquisition Policy*, Army Regulation 70-1, Headquarters, Department of the Army, Washington, DC, 31 December 2003.

guidance on how to navigate the spectrum regulatory and technical processes required to assure spectrum access for Army systems.

3. Spectrum Supportability

Development or acquisition of systems that meet operational requirements, but fail to obtain spectrum supportability, means that the systems will not be allowed to be operated in the United States or in host nations. These systems create a potential for severe mutual interference between the system and other spectrum users, squander resources, and delay fielding warfighting capabilities to field units.

Successful fielding of an Army spectrum-dependent system depends upon CIO/G-6 approval of a program's comprehensive assessment of the operational, regulatory, and technical aspects of the system's use of the RF spectrum.

The term used to denote when a system is able to gain required access to the electromagnetic spectrum as envisioned[6] is "spectrum-supportability." The Army Spectrum Supportability Program (ASSP) is the process by which spectrum-dependent systems achieve this end state.

The security classification or operational function of a spectrum-dependent system shall not exempt a system from the requirement to perform the indicated elements of the ASSP. Spectrum requirements for Special Access Programs (SAP) will be coordinated directly with the Director, ASMO, in the appropriate secured venues.

4. Elements of the Spectrum Supportability Program

a. Introduction.

Obtaining spectrum supportability consists of the following specific actions[7]:

(1) Completion of a spectrum supportability assessment.

(2) Receipt of a spectrum supportability determination from the CIO/G-6 approving the PM's assessment of a system's potential for achieving spectrum supportability and concurrence that the PM can successfully continue with development of a candidate system.

(3) Submission during each phase of the DAS of a technically correct DD Form 1494 to ASMO resulting in approval by the CIO/G-6.

(4) Reasonable assurance of the availability of sufficient frequencies to perform the intended operational mission within:

a. The United States and Possessions (US&P), through the Federal spectrum approval process

b. Host nations, through the Host Nation Coordination process through the Combatant Commands (COCOMs).

[6] This is the Army's implementation of the DoDI 4650.01 definition of spectrum supportability.
[7] *Procedures for Interoperability and Supportability of Information Technology (IT) and National Security Systems (NSS)*, DoD Instruction 4630.8, Assistant Secretary of Defense, NII, Washington, DC, 30 June 2004.

(5) Quantification of relevant electromagnetic compatibility/electromagnetic interference (EMC/EMI) Electromagnetic Environmental Effects (E3)

b. Spectrum Supportability Assessment (SSA) and Determination (SSA/SSD)

The purpose of the spectrum supportability assessment and the spectrum supportability determination (SSA/SSD) is to identify and assess regulatory, technical, and operational spectrum issues with the potential to affect the required operational performance of the candidate system. For example, in addition to determining that a system's bandwidth requirement complies with an individual nation's frequency allocation scheme, a new or modified system must also be evaluated with respect to:

- The system's potential to cause interference to or suffer from other military and civilian RF systems currently in use or planned for operational environments.
- The effect of the system's proposed spectrum use on the ability of the extant force structure to access the RF spectrum without interference.
- How the system's spectrum use conforms to the tables of frequency allocation of intended host nations, ensuring regulatory protection from other national co-band spectrum users.
- If individual host-nation frequency allocations include enough bandwidth to fully support the system's operational mission, for example, required data rate.

When combat developers initiate a requirement that has an RF dependency, they will document the factors included in paragraph 5.b, Role of the Combat Developer in the Spectrum Supportability Process, as part of the Functional Solution Analysis (FSA). The combat developer will consider the overall spectrum-dependent implications of material or non-material solutions and the initiating organization must generate a basic spectrum feasibility analysis (initial SSA).

For example, a requirement to transmit full-motion video over distances greater than 1,500 km should not consider using the High Frequency (HF) part of the RF spectrum as a material solution for many technical reasons, including the lack of wide bandwidth allocations below 30 MHz. As a non-material solution, the Army may consider requesting through ASMO a change in national or international spectrum regulations to obtain sufficient allocated bandwidth for specific operational applications. Although the Army has been successful in obtaining changes to national or international regulations to support non-material solutions enhancing Army spectrum access, the formal approval processes for such changes involve expenditure of considerable time, manpower and fiscal resources.

The material developer initiates the spectrum supportability assessment. The Army CIO/G-6 must approve the spectrum assessment before acquisition of spectrum-dependent devices can be allowed. Approval by the CIO/G-6 constitutes a SSD. The CIO/G-6 will depend on the SSD, and other pertinent spectrum supportability related documents, for input to the Milestone Decision Authority (MDA) during Army Systems Acquisition Review Council (ASARC) meetings.

Requests for approval to use the RF spectrum shall be initiated immediately after entry into the acquisition process for spectrum-dependent systems under development. Requests for spectrum

approval shall identify those host nations into which deployment is planned[8]. At the minimum, the "Application for Equipment Frequency Allocation," DD Form 1494 Stage 2 (i.e., "Experimental", see sub-paragraph c below) equipment spectrum certifications must be obtained prior to a Milestone B decision.

Spectrum-dependent commercial off-the-shelf (COTS), or other non-developmental systems, intended for tactical missions shall not be purchased or procured without required national and host-nation approvals to access the RF spectrum.

The SSA process consists of documenting the spectrum-dependent aspects of a system during each phase of the acquisition life cycle. An SSA should include the following components:

- **Spectrum regulatory component**: Addressing the compliance of the RF system with US national and international tables of frequency allocation as well as with regulatory agreements reached at the International Telecommunication Union, as well as a determination of the compliance of the system with pertinent national and international technical standards[9].
- **Technical component**: Quantifying the mutual interactions between a candidate system and other co-band, adjacent band, and harmonically related RF systems, including the identification of suggested methods to mitigate the effects of possible mutual interference.
- **Operational component**: Identifying and quantifying the mutual interactions among the candidate system and other Army and US military RF systems in the operational environment and identifying suggested methods to mitigate for possible instances of interference. Development of operational scenarios is closely coordinated with the U.S. Army Signal Center Frequency Spectrum Proponent Office (FSPO), the Training and Doctrine Command (TRADOC) Capability Manager (TCM), and other Army schools and centers, as appropriate.

Table 1 shows the type of spectrum supportability assessment required in each phase of the DAS. The detail and scope of individual SSAs depend upon several factors including the system's entry point into the DAS, the complexity of the system, and the intended operational environment. In the case of a single stand-alone radio, e.g., Enhanced Position Location Reporting System (EPLRS), a single SSA during each acquisition phase may be sufficient to address one or more of the above components. However, a complex "system of systems" may require more than one SSA in any of the acquisition phases. For example, a complex sensor system consisting of an air defense radar, digital datalinks, and satellite earth stations may require a separate SSA for the radar, as well as separate SSAs for any associated datalinks and earth stations.

[8] While global use of a capability is expected in most cases, COCOMs usually do not usually coordinate with every nation in their area of responsibility (AOR). Therefore, material developers must identify deployment areas on the DD Form 1494 that are important to the expected mission of the system.

[9] An example of an international technical standard is the European Union's standard for "short range devices," which differs from the technical criteria in Part 15 of the FCC's rules.

Table 1. Spectrum Supportability Assessments Required in DAS Phases

DAS Phase	Concept Refinement	Technology Development	System Development & Demonstration	Production & Deployment	Operations & Support
Spectrum Supportability Assessment	Initial Regulatory SSA Component(s)	Initial Technical SSA Component(s) Initial Operational SSA Component(s)	Detailed Technical SSA Component(s) Detailed Regulatory Component SSA(s)	Updated Detailed Regulatory SSA Component(s) Updated Detailed Technical SSA Component(s)	Operational SSA(s) for specific missions, new host nation deployments, system modifications, etc.

Individual SSAs may have to be accomplished more than once. For example, if the results of an initial regulatory SSA indicate that spectrum supportability is not likely for a candidate system in a particular frequency band throughout a given COCOM, then alternative solutions must be identified and developed.

Material developers will consult with ASMO regarding SSA requirements for specific systems.

c. DoD Application for Equipment Frequency Allocation Approval (DD Form 1494)

The results of spectrum supportability assessments provide an important input to the technical data required by the DD Form 1494 and the CIO/G-6 spectrum supportability determination required for ASARC decisions.

Table 2 shows the DD Form 1494 Stage that is required in each phase of the DAS. As the system progresses through the DAS, the type and detail of system parametric data required to request spectrum access during each acquisition phase becomes more complex.

Table 2. Relationship Between DAS Phases and DD Form 1494 Stages

DAS Phase	Concept Refinement	Technology Development	System Development & Demonstration	Production & Deployment	Operations & Support
DD Form 1494 Stage	Stage 1 Conceptual	Stage 2 Experimental	Stage 3 Developmental	Stage 4 Operational	Stage 4 Notes to Holders

Permission to access the RF spectrum is an internationally recognized sovereign national privilege. Host nations have the sole prerogative to grant – or deny – US requests to access the RF spectrum within their borders. Additionally, permission to operate can be revoked at anytime.

The DoD uses the DD Form 1494 to provide host nation spectrum authorities with the technical parameters of US military RF systems requesting approval to radiate within their territory.

Chapter 3 of AR 5-12 provides details regarding the DoD Application for Equipment Frequency Allocation Approval process. The ASMO forwards all DD Form 1494s to the US national federal and civil spectrum authorities.

For systems with worldwide missions, ASMO will forward Stage 3 DD Form 1494s to host nations through the appropriate COCOM for spectrum supportability comments. In general, this will be done only for major Army systems or systems with a high probability of proceeding to Stage 4.

Electronic warfare systems, including Counter RF-Improvised Explosive Device (IED) Electronic Warfare (CREW) equipment, for example, do not receive Stage 4 certification, and thus are not forwarded for host nation coordination during the development process.

MATDEVs must provide ASMO with a separate DD Form 1494 containing information that is releasable at the appropriate classification level to each envisioned host-nation within a COCOM AOR.

The material developer will use an DD Form 1494[10,11], to forward the system's basic radio frequency parameters and operating locations in each phase of the acquisition process to ASMO. After review, ASMO then assigns each DD Form 1494 a unique "J/F 12" tracking number and forwards the DD Form 1494 to a Joint process to obtain DoD, national, and international

[10] *DD Form 1494 Preparation Guide*, PM Joint Automatic Identification Technology, Newington, VA, http://www.eis.army.mil/AIT/Resources/dd1494/DD1494PreparationGuide.pdf

[11] *DD Form 1494 - Application for Equipment Frequency Allocation*, Defense Acquisition University, Ft Belvoir, VA https://acc.dau.mil/CommunityBrowser.aspx?id=30508&lang=en-US

spectrum approvals. DD Form 1494 information deemed by designated officials to be releasable is provided to host nations for comment by COCOM spectrum offices during the later phases of the acquisition cycle. ASMO gathers and forwards to the material developer the Joint guidance, as well as US national and host nation spectrum supportability comments.

The DD Form 1494 serves two functions:

> (1) Provides a uniform method to capture the basic spectrum-dependent and operational parameters of military spectrum-dependent systems in a format that can be easily provided to US National and host nation spectrum authorities
>
> (2) Standardizes the format of the technical data required to be inserted into DoD and national databases to generate frequency assignment approvals enabling initial EMC analyses, and checks for compliance to military, US national, and host nation spectrum standards.

Material developers will complete and obtain approval for a DD Form 1494 during each phase of the acquisition process for each newly developed spectrum-dependent system. Material developers serving as integrators may find that spectrum-dependent components of a system are already certified. In such a case, re-certification is not necessary unless the emission characteristics of a device are modified. The system integrator must ensure that each spectrum-dependent component is certified before procurement is initiated.

The DD Form 1494 is submitted in stages that coincide with the phases of the DoD acquisition process. A short description of the DD Form 1494 stages follows:

> **Stage 1 - Conceptual**: The initial planning effort has been completed, including identification of proposed frequency bands and other available characteristics. Certification of spectrum support for telecommunication systems at Stage 1 provides initial guidance on the feasibility of obtaining certification of spectrum supportability at subsequent stages.
>
> **Stage 2 - Experimental**: The preliminary design has been completed. Radiation using "bread board" equipment or preliminary models may be required. Certification of spectrum supportability for RF systems at Stage 2 is a prerequisite for receiving a frequency assignment supporting, for example, the experimentation required by TRADOC Regulation 70-20[12].
>
> **Stage 3 – Developmental**: The major design has been completed and radiation may be required from "brass board" models during testing. Certification of spectrum supportability for RF systems at Stage 3 is a prerequisite for US national authorization of radiation in support of developmental testing of systems. It also provides guidelines for assuring certification of spectrum supportability at Stage 4. At this point, the intended frequency band will normally have been determined and certification at Stage 3 will be required for testing of proposed operational hardware and potential equipment

[12] *Concept Development, Experimentation, and Requirements Determination*, TRADOC Regulation 71-20, Headquarters, Training and Doctrine Command, Ft Monroe VA, 2008, URL: http://www.tradoc.army.mil/

configurations. System parameters may be provided to host nations through COCOM spectrum offices for spectrum supportability comments.

Stage 4 – Operational: Identify the final operating constraints or restrictions required to ensure compatibility when development has been essentially completed. Certification of spectrum supportability for RF systems at Stage 4 is a prerequisite for a frequency assignment for operational systems. The system parameters included on the Stage 4 DD Form 1494 are normally provided to host nations through COCOM spectrum offices to obtain spectrum supportability comments.

The end-to-end review process for Stage 1 and Stage 2 DD Form 1494s usually takes from 6-to-18 months. DD Form 1494 Stages 3 and Stage 4 may require more time for approval due to the possibility of requesting spectrum supportability comments directly from the military and civil administrations of host nations in which a system will operate.

Additionally, "Notes to Holders" of DD Form 1494s provide a process to update existing DD Form 1494 forms as operational systems undergo modifications which change the operating parameters of a spectrum-dependent device. Material developers should contact ASMO when such changes to a system are contemplated or executed.

d. Material Developer's Spectrum Responsibilities

Table 3 shows major additional spectrum management events that developers will address in each acquisition phase.

Table 3. Additional Spectrum Management Responsibilities for Developers

DAS Phase	Concept Refinement	Technology Development	System Development & Demonstration	Production & Deployment	Operations & Support
Developer's Spectrum Responsibilities	Ensure that the Functional Solution Analysis identifies operational parameters that the material developer can use to define spectrum parameters Define initial spectrum requirements/ frequency bands/operational areas	Refine spectrum requirements Initiate preliminary spectrum discussions with ASMO, NTIA and FCC Solicit informal COCOM spectrum comments	Perform detailed spectrum signature, receiver degradation and antenna tests Consider obtaining host nation supportability comments through COCOMs Request frequencies needed for US & P testing	Obtain host nation supportability comments through COCOMs	Maintain awareness of impact of FCC and ITU on spectrum access Request Training Frequency Approvals Coordinate Homeland Defense spectrum requirements

e. Electromagnetic Environmental Effects (E3) Program

The Army E3 program includes all processes used by acquisition personnel to successfully design, specify, test, evaluate, field, and maintain spectrum-dependent material systems in all expected electromagnetic environments. The parts of the Army's E3 program focusing on spectrum supportability include the assessment of the system's EMC and EMI in the intended operational environment.

Table 4 shows the type of E3 actions required in each DAS phase.

Table 4. E3 Actions Required in DAS Phases

DAS Phase	Concept Refinement	Technology Development	System Development & Demonstration	Production & Deployment	Operations & Support
E3 Program	E3 Requirements Definition	Address E3 in CDD, JCIDS, TEMP, etc.	Review and update E3 requirements in CPD, ISP and TEMP	E3 tests on production hardware	Monitor changes to system for spectrum impacts

Further details regarding the Army's E3 program may be found in DoDD 3222.3 (Reference 2) and Section III of DA Pamphlet 70-3[13].

5. Relationships Between Spectrum and Acquisition Processes

The following sub-paragraphs provide a detailed overview of the spectrum requirements in each phase of the DAS.

a. Introduction.

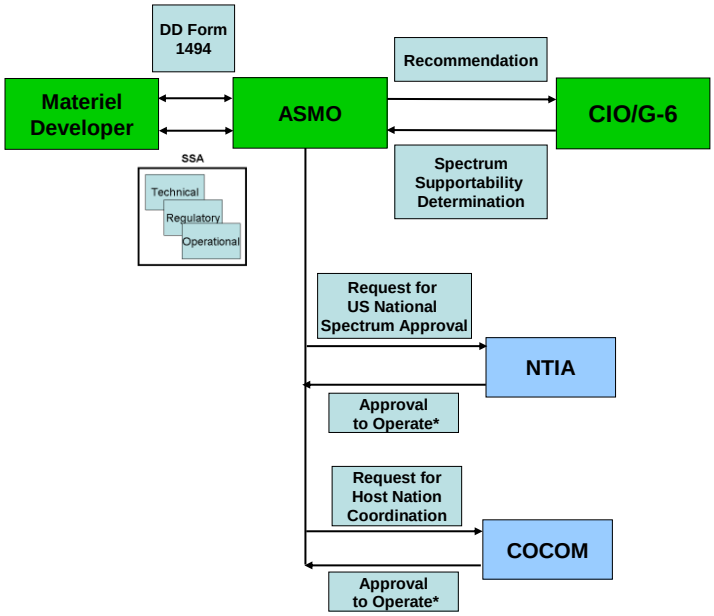
(1) Material developers will complete the elements indicated in each column of Table 5, depending on the phase in which a system enters the acquisition process.

[13] *Army Acquisition Procedures*, DA Pam 70-3, Headquarters, Department of the Army, Washington DC, 28 January, 2008, URL: http://www.army.mil/usapa/epubs/pdf/p70_3.pdf, Accessed 2 April 2008.

Table 5. Overall Combat and Material Developer Spectrum Responsibilities

	Milestone A	Milestone B	Milestone C		
DAS Phase	**Concept Refinement**	**Technology Development**	**System Development & Demonstration**	**Production & Deployment**	**Operations & Support**
Spectrum Supportability Assessments	**Initial Regulatory SSA Component(s)**	**Initial Technical SSA Component(s)** **Initial Operational SSA Component(s)**	**Detailed Technical SSA Component(s)** **Detailed Regulatory Component SSA(s)**	**Updated Detailed Regulatory SSA Component(s)** **Updated Detailed Technical SSA Component(s)**	**Operational SSA(s) for specific missions, new host nation deployments, system modifications, etc.**
DD Form 1494 Stages	**Stage 1 Conceptual**	**Stage 2 Experimental**	**Stage 3 Developmental**	**Stage 4 Operational**	**Stage 4 Notes to Holders**
Developer's Spectrum Responsibilities	**Ensure that the Functional Solution Analysis identifies operational parameters that the material developer can use to define spectrum parameters** **Define initial spectrum requirements/ frequency bands/operational areas**	**Refine spectrum requirements** **Initiate preliminary spectrum discussions with ASMO, NTIA and FCC** **Solicit informal COCOM spectrum comments**	**Perform detailed spectrum signature, receiver degradation and antenna tests** **Consider obtaining host nation supportability comments through COCOMs** **Request frequencies needed for US & P testing**	**Obtain host nation supportability comments through COCOMs**	**Maintain awareness of impact of FCC and ITU on spectrum access** **Request Training Frequency Approvals** **Coordinate Homeland Defense spectrum requirements**
E3 Program	**E3 Requirements Definition**	**Address E3 in CDD, JCIDS, TEMP, etc.**	**Review and update E3 requirements in CPD, ISP and TEMP**	**E3 tests on production hardware**	**Monitor changes to system for spectrum impacts**

(2) Figure 1 shows the overall relationships among major Army, US national and host-nation spectrum processes. The material developer provides ASMO with both the DD Form 1494 and spectrum supportability assessments. ASMO uses the results of the DD Form 1494 process and the conclusions of the SSA to generate a recommendation to the CIO/G-6 regarding the spectrum supportability determination. The DD Forms 1494 are also used by ASMO to request formal US National and host-nation spectrum supportability.



*Approval to operate may be a frequency assignment or authorization to use a pre-agreed upon set of frequencies by the host nation's spectrum management authority

Figure 1. Army, US, and Host-Nation Spectrum Process Relationships

(3) Spectrum supportability assessments will accompany DD Form 1494 submissions for systems under development and will be used by the CIO/G-6 as an input to the Milestone Decision Authority. Table 6 shows the minimum time required for submission of spectrum supportability assessments and DD Form 1494s to CIO/G-6 and ASMO.

Table 6. Time Required for SSA and DD Form 1494 Submissions

Relationship Between Defense Acquisition System Events and Spectrum Processes				
DAS Phase	DD Form 1494 Stage	Event	Acquisition Category (ACAT)	Months Prior to Event Required for SSA and DD Form 1494 Submission to CIO/G-6
Concept Refinement	Stage One Conceptual)	Milestone A	ACAT I / II	9
			ACAT III	6
Technology Development	Stage Two (Experimental)	Milestone B	ACAT I / II	12
			ACAT III	9
System Development & Demonstration	Stage Three (Developmental)	Milestone C	ACAT I / II	18
			ACAT III	12
Production and Deployment	Stage Four (Operational)	Initial Operational Capability	ACAT I / II	18
			ACAT III	12
Operations and Support	Stage Four Note to Holders	Full Operational Capability	ACAT I / II	12
			ACAT III	9
Operations and Support	Note to Holders	Major change in system's RF parameters or deployment areas	ACAT I/II/III	9
ASMO reviews of DD Forms 1494 normally take 6 to 12 months, depending on a system's complexity, operating frequency bands, intended deployment areas and mission.				

(4) For systems with existing spectrum approval to operate, i.e., with a current valid DD Form 1494, MATDEVs will:

- Obtain from ASMO copies of the approved DD Form 1494s containing the system's technical parameters, as well as US and host nation spectrum supportability comments.
- Identify additional host nations of interest that are not included on any existing DD Form 1494.
- Determine if there have been changes to the US national or host-nation tables of frequency allocation in the system's frequency bands.
- Identify new major DoD or civil telecommunication systems allowed to operate in the same frequency band, or adjacent frequency bands.
- Determine if there have been changes to any of the system's technical parameters and if these changes are included in the existing DD Form 1494s.

- Compare the spectrum-dependent technical parameters of the system with any newly adopted national or international technical standards.
- Consult with ASMO regarding the necessity to forward a "Note to Holders" to update any current DD Form1494.

b. Role of the Combat Developer in the Spectrum Supportability Process

Combat developers will ensure the following data that drives spectrum requirements is provided to the material developer:

- The intended radio frequency propagation environment, for example, urban, jungle, desert, earth-to-space, space-to-space relays, ground-to air
- The kind and quality of data or information transmitted, for example, voice-recognition speech, wideband digital data, high quality imagery
- The range of distances over which the transmission will be sent in terms of single-digit kms, 10's of km, 1,000's of km, etc..
- The echelons involved, for example, corps-to-brigade, intra-company, platoon-to-division

The material developer can use the above information, as well as knowledge of technological trends, envisioned operational areas, and the intended operational mission, to better define the initial spectrum requirements, such as the intended frequency bands, required transmitted bandwidths, and antenna type.

c. Milestone A Requirements (Research Development Test and Evaluation (RDT&E) funding categories 6.2 or 6.3)

The following section describes the initial regulatory spectrum supportability assessment, Stage 1 DD Form 1494 and Army E3 elements necessary for the CIO/G6 to determine if the system's Milestone A spectrum responsibilities have been met.

(1) Milestone A Spectrum Supportability Assessments

(a) Milestone A Regulatory SSA

MATDEVs will follow the guidelines in paragraph 5.a. (4) on page 15 for systems with a valid approved DD Form 1494.

For systems under development without spectrum approval or a DD Form 1494, MATDEVs will:

- Determine countries for likely operational deployment within each COCOM AOR.
- Determine the internationally recognized radio service[14] of all pertinent spectrum-dependent systems.

[14] *Manual of Regulations and Procedures for Federal Radio Frequency Management, Chapter 6,* National Telecommunications and Information Administration (NTIA), Washington, DC, URL: *http://www.ntia.doc.gov/osmhome/redbook/6.pdf*

- Obtain the table of frequency allocations for each intended deployment host nation and determine if the allocations table of each host nation allows the radio service of the system across its tuning range[15].
- Determine the relative regulatory status, for example, co-primary or secondary, assigned to the radio service by the host nation's table of frequency allocations.
- Identify portions of the equipment's tuning range supported by the each host nation's table of frequency allocations.
- Obtain national comments on US military systems of the same radio service and with similar technical characteristics submitted for host-nation spectrum approval by accessing the DoD Host Nation Worldwide Database Online[16] or reviewing other co-band approved DD Form 1494s.
- Identify other US military, US civil, and non-US co-band/adjacent-band and harmonically related systems likely to be co-site or in close proximity by querying, e.g., DoD equipment databases[17] or the appropriate National Telecommunications and Information Administration (NTIA) database.
- Complex "family of systems" or "system-of-systems" may require more than one SSA, for example, a separate SSA for earth stations and a separate SSA for terrestrial systems.

(2) Milestone A Application for Equipment Frequency Allocation

Provide to ASMO a completed Conceptual (Stage 1) DD Form 1494 using the procedures contained in, e.g., References 6 and 7.

(3) Milestone A Army E3 Program

The material developer shall ensure that E3 requirements in DoDD 3222.3 (Reference 2), specifically EMC and EMI, are addressed in system requirements documents, for example, the Initial Capabilities Document (ICD). The material developer shall also establish an E3 Improvement Process Team (IPT) IAW DA Pam 70-3 (Reference 13) and budget for continued spectrum supportability analyses, E3 testing, and compliance with appropriate military standards, for example, the latest version of MIL-STD-461.

d. Milestone B Requirements (RDT&E funding categories 6.3 or 6.4)

[15] If the table of frequency allocations for a particular host nation is not available in English, determine the allocations and relevant host-nation footnotes for the relevant ITU region as indicated in "International Table" column of Chapter 4 of the NTIA Manual.

[16] *Host Nation Spectrum Worldwide Database Online (HNSWDO)*, Joint Spectrum Center, 2004 Turbot Landing Annapolis, MD 21402, URL https://hnswdo.jsc.mil/.

[17] *JSC Data Access Web Server (JDAWS)*, Joint Spectrum Center, 2004 Turbot Landing, Annapolis, MD, 21402, URL: http://www.disa.mil/jsc/jdaws.html,.

The following section describes the technical and operational components of spectrum supportability assessments, Stage 2 DD Form 1494 and Army E3 elements necessary for the CIO/G6 to determine if the system's Milestone B spectrum requirements have been met.

(1) Milestone B Spectrum Supportability Assessments

(a) Milestone B Technical Assessment

Determine the following system technical parameters based largely on recommended technology:

- Application: operation only at fixed sites, during motion, transportable
- Host platform (e.g., dismounted soldier, airborne, tactical operations center (TOC), etc.)
- Frequency range of operation
- Required throughput
- Required radiated bandwidth
- Receiver selectivity
- Receiver criteria required for desired operation
- Transmitter power output
- Antenna gain and characteristics
- Anticipated host nations in each COCOM (e.g., United States only, and envisioned host nations in all COCOM AORs

Perform an initial EMC analysis to identify major anticipated electromagnetic interactions that require further detailed study. The analysis should use, as a minimum, the above technical parameters for the candidate system and the technical parameters of systems expected to be in the candidate's operational RF environment. The technical parameters of these systems may be taken from appropriate system characteristics or from frequency assignment databases.

Evaluate the initial system RF parameters with respect to US national and appropriate international spectrum standards and develop plans to bring non-compliant systems into conformance.

Generate initial recommendations regarding mitigation of envisioned regulatory or technical spectrum issues.

(b) Milestone B Initial Operational Assessment

Determine the expected complement of radio frequency-dependent systems for other Army and DoD units anticipated to be in the system's operating environments. Consider that the system may have to operate without experiencing or causing interference as part of the Army's response to domestic disaster relief and public protection scenarios in support of US state and local civil authorities.

Perform a more detailed EMC analysis quantifying the mutual interference between the candidate system and the RF systems used by other Army and DoD units in the operational environment, for example, within a Brigade Combat Team (BCT) or during convoy missions. Inputs to this EMC analysis include the free-space path loss model and system parameters obtained from databases. The results will be expressed in operational terms, e.g., the frequency-distance separation requirements between a transmitter and a receiver that must be maintained to achieve mutual compatibility.

(2) Milestone B Application for Equipment Frequency Allocation

MATDEVs will follow the guidelines in paragraph 5.a. (4) on page 15 for systems with a valid approved DD Form 1494.

For all other RF systems, the material developer must submit an Experimental (Stage 2) Request DD Form 1494 to ASMO before Milestone B using the timeline of Table 6 and the procedures in References 6 and 7.

(3) Milestone B Army E3 Program

The material developer will ensure that program planning includes EMC and EMI assessments, analyses, and testing.

Specifically, documents such as the Capability Development Document (CDD), Test and Evaluation Master Plan (TEMP), etc., shall identify methods to mitigate EMC and EMI risks.

(4) Additional Material Developer Milestone B Spectrum Responsibilities

In consultation with ASMO, the material developer shall define the system's spectrum requirements in greater detail, e.g., radiated and receiver bandwidth information should be known to at least the -40 db point, etc., and document these requirements in a Stage 2 DD Form 1494.

ASMO may determine that preliminary discussions are required with the NTIA regarding, e.g., possible changes to national spectrum policy or technical standards to accommodate the system's spectrum requirements.

Stage 2 DD Form 1494s are not normally sent to host nations through the COCOMs to obtain spectrum supportability comments. However, to identify any major anticipated spectrum issues early in the system's life cycle, ASMO may determine that the system has a sufficiently high probability of being deployed and may begin to solicit informal spectrum supportability comments from COCOM spectrum managers.

CDDs for Army spectrum-dependent systems shall include the following statements:

> "Electromagnetic Environmental Effects. The [system] shall be shown through technical spectrum supportability assessments and tests to be mutually compatible and operate compatibly with other spectrum-dependent systems in all intended operating environments. A candidate RF system shall not be operationally degraded or fail due to exposure to electromagnetic environmental effects, including high intensity radio frequency (HIRF) transmissions or high-altitude electromagnetic pulse (HEMP).

Ordnance systems will be integrated into the platform to preclude unintentional detonation. (THRESHOLD)"

"Equipment Spectrum Certification. The [system] will demonstrate through the regulatory portion of the spectrum supportability assessment (SSA) required by AR 5-12 compliance with applicable DoD, National, and International spectrum management policies and regulations. The system will obtain US national spectrum certification and host-nation spectrum approval to radiate or receive electromagnetic energy during the appropriate phase of the system's life-cycle. An operational Stage 4 spectrum certification which includes host-nation spectrum supportability comments is required prior to operational deployment. A frequency assignment approved by the NTIA is required prior to commencing all developmental, testing, training and Homeland Defense operations. The appropriate DD Form 1494s will be submitted to the Military Communications Electronics Board Joint Frequency Panel via the Army Spectrum Management Office (ASMO). (THRESHOLD)"

e. Milestone C Requirements (RDT&E funding categories 6.4, 6.5 or 6.7)

The following section describes the technical and regulatory spectrum supportability assessments, Stage 3 DD Form 1494 and Army E3 elements necessary for the CIO/G6 to determine if the system's Milestone C spectrum responsibilities have been met.

(1) Milestone C Spectrum Supportability Assessments

(a) Milestone C Detailed Technical Assessment

Perform detailed EMC analyses, based on measured system technical data and the technical parameters of other systems found in the target operational environment taken from appropriate data bases. The goal of these analyses is to quantify the mutual operational degradation caused by interactions between the system being acquired and other co-frequency and adjacent frequency spectrum-dependent systems typically found in the intended operational environment.

Determine the ratio of the received interference level to a given threshold, such as noise level or desired signal power.

The analysis should account for factors such as the frequency-dependent rejection (FDR) based on the frequency offset between the system being analyzed and other spectrum-dependent systems.

The analysis for fixed RF systems should use detailed antenna pattern data, as well as terrain-dependent propagation models.

For mobile RF systems, compute the desired and undesired received signal levels using propagation models developed specifically for mobile communications systems to determine any potential link degradation and blockage due to atmospheric conditions or terrain and building obstructions within intended deployments areas.

Use the appropriate detailed propagation model and the FDR data to generate frequency-distance curves that express the requirements for compatibility during operations as, for example, the minimum frequency-distance separation requirements required to achieve mutual compatibility.

Determine the required availability of link or outage percentage for reliability during a specified period of time, typically a year. Calculate the detailed availability and outage time with - and without – interference by considering path loss, rain attenuation, humidity, climate, temperature, and water and oxygen absorption.

The analysis of digital communication systems should consider how Forward Error Correction (FEC) techniques combat fading and interference to improve a given measure of quality, e.g. , Energy per Bit/Noise Spectral Density (E_b/N_o) for more reliable transfer rates.

For non-communications systems, for example, radar, passive sensors, etc., determine the appropriate measure of operational degradation and how that measure varies as a function of the level of received environmental and co-site interference.

Quantify intra-platform EMC among co-sited emitters and receivers for complex "system-of-system" platforms in terms of the possibility and influence of:

- Inter-modulation
- Transmitter Harmonic Interference
- Transmitter Spurious Output Interference
- Transmitter Noise Interference
- Receiver Desensitization Interference

Compare the measured system RF parameters with US national and appropriate international spectrum standards.

Generate technical recommendations regarding mitigating potential interference by implementing channelization plans, advanced narrow-beam antennas, (e.g., active, spot and contoured-beam), as well as use of passive RF components (filters, diplexers, couplers, etc.).

(b) Milestone C Detailed Regulatory SSA(s)

Review and address the MCEB and national spectrum guidance resulting from the spectrum certification process.

Consult with ASMO regarding changes to US federal or civil telecommunication regulations impacting the system's frequency bands, as well as changes resulting from US implementation of World Radiocommunication Conference (WRC) Final Acts.

Determine if the system meets appropriate military, national and international spectrum standards for radiated bandwidth, transmitter stability, etc.

Quantify the impacts of any changes to US or international spectrum regulations or technical sharing criteria.

(2) Milestone C Application for Equipment Frequency Allocation

MATDEVs will follow the guidelines in paragraph 5.a. (4) on page 15 for systems with an approved DD Form 1494.

For all other RF systems, the material developer will submit the Developmental (Stage 3) DD Form 1494 request to ASMO using the time line of Table 6.

At this juncture in the procurement cycle, all relevant data requested by the DD Form 1494 will be provided from calculations, measurements, or manufacturer's specifications with the knowledge that the data to be provided for the final Stage 4 DD Form 1494 must be obtained solely through measurement.

(3) Milestone C Army E3 Program

The material developer should ensure that E3 requirements[18] are addressed in documents such as the Capability Production Document (CPD).

Testing will be performed to identify, quantify, and mitigate EMC and EMI issues among co-sited, spectrum-dependent systems and ensure that the requirements of the MIL-STD-461 series are met.

(4) Additional Material Developer Milestone C Responsibilities

The material developer will request specific frequencies needed for tests within the US through ASMO.

COCOM frequency managers will only request host-nation spectrum supportability comments for the DD Form 1494s of major systems with a high probability that the system will be deployed within their AOR. Consequently, ASMO will coordinate with the material developer to determine if COCOMs should forward the Stage 3 DD Form 1494s of a major system for host nation spectrum supportability comments.

Capability Production Documents (CPDs) for Army spectrum-dependent systems will include the following statements:

> "10. Electromagnetic Environmental Effects (E3) and Spectrum Supportability. Describe the developmental and operational electromagnetic environments in which the system must operate and coexist with other US, allied, coalition, civilian government and non-government systems. Identify potential technical and regulatory issues and generate a mitigation plan addressing interference from other US and non-US military and civilian RF systems and hostile threat emitters and to ensure adequate access to the electromagnetic spectrum. For systems that communicate or sense via electromagnetic energy, spectrum certification will be obtained for approval to access the RF spectrum within all US and non-US environments scenarios as necessary."

In addition, the "Threat Summary" paragraph of the CPD, Section 4, will include a definition of the EME, generated by both friendly and hostile forces that the device may encounter. Further descriptions of the electromagnetic fields generated by some of these threats can be found in MIL-STD-464[19] and MIL-HDBK-235-1B[20].

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[18] *Electromagnetic Environmental Effects And Spectrum Supportability Guidance For The Acquisition Process*, MIL-HDBK-237D, 20 May 2005, URL: https://acc.dau.mil/CommunityBrowser.aspx?id=131917

[19] *Electromagnetic Environmental Effects Requirements for Systems, MIL-STD-464*, Department of Defense, Washington DC 20360, 18 March 1997.

Material developers will implement paragraph C6.5 of the Interim Defense Acquisition Guidebook, October 30, 2002 as a mandatory part of DoDI 4630.8 Information Support Program (ISP) requirements.

f. Production and Deployment (P&D) Phase (RDT&E funding categories 6.5 and 6.7, as well as Procurement funding)

Compliance with E3 and spectrum management policies is required after the Milestone C decision. The following are the minimum spectrum management and E3 requirements for the P&D acquisition phase.

(1) P&D Phase Spectrum Supportability Actions

(a) P&D Phase Updated Detailed Regulatory Assessment

The material developer will maintain contact with ASMO, e.g., through the ASMO Army Knowledge Online (AKO) website, to determine if updates to previous SSAs are required because of changes to national and international the spectrum regulations or technical standards resulting from:

- World Radiocommunication Conferences
- Private sector petitions to the FCC to change the technical standards or regulatory requirements of the US Table of Frequency Allocations

(b) P&D Phase Technical Assessment

Quantify impact to co-site EMC and E3 of changes to the operational "signals-in-space" RF parameters.

(c) P&D Phase Operational Assessment

The first eight steps of Table 7 outline the overall process to generate an operational SSA once the system is deployed and is performing its intended operational mission in the field.

(2) P&D Phase Application for Equipment Frequency Allocation

The material developer will submit the Stage 4 DD Form 1494 to ASMO using the time line of Table 6 before entering the Production & Deployment phase. All data on this form, e.g., -60 dB radiated emission and receiver selectivity bandwidths, must result from measurements.

The material developer will provide ASMO with a version of the Stage 4 DD Form 1494 with data that has been approved to be released to appropriate host-nations. ASMO will forward the releasable Stage 4 DD Form 1494 to cognizant COCOM spectrum managers to obtain final host nation supportability comments.

(3) P&D Phase Army E3 Program

The material developer should ensure through testing that the baseline production model meets all E3 control requirements.

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[20] *Electromagnetic Environment (Radiated) Considerations for Design and Procurement of Electrical and Electronic Equipment*, Department of Defense, Washington DC 20360, December 2000.

Additionally, the program must be monitored to determine the EMC and EMI impact of any changes to such operational RF parameters such as, tuning range, emission characteristics, antenna gain and height, bandwidth, or output power, etc. Changes to these parameters may require additional E3 analyses or tests.

The E3 Assessment should:

- Identify and resolve co-site EMI issues during system acceptance testing.
- Demonstrate repeatable EMC utilizing appropriate development models.
- Maintain system E3 design integrity during operations.
- Implement procedures for EMI problem reporting.

The material developer should ensure that documentation supporting redevelopment or upgrading of an item incorporates the E3 control requirements needed to correct any existing E3 problems of the current system**.**

(4) Material Developer P&D Phase Responsibilities

The material developer will periodically query ASMO to maintain awareness of the impact of the changes to national or international spectrum policies.

g. Operations and Support (O&S) Phase (Procurement funding)

DA Pamphlet 70-3 (Reference 13) states that "... using, maintaining and testing organizations periodically assess ..." a system's E3 performance characteristics. Spectrum management requirements in this phase include periodic checks of a system's continuing compliance with national and international spectrum policies and standards.

(1) O&S Phase Spectrum Supportability Actions

National, International, and host-nation spectrum regulations constantly change. Material developers should maintain awareness through ASMO of proposed changes to spectrum regulations and standards.

Requests for specific frequencies to allow continued system tests and proficiency training should be made through the cognizant DoD Area Frequency Coordinator or Installation Frequency Manager.

The spectrum requirements of Army NORTH (ARNORTH) units and Army units required for Homeland Defense (HLD) or Defense Support of Civil Authorities (DSCA) operations will be provided to ASMO through United States Northern Command (USNORTHCOM).

(2) O&S Phase "Notes to Holders"

A "Note-to-Holders" is a mechanism within the military spectrum approval process to permit minor changes to an existing DD Form 1494 without generating a new, separate allocation. The types of modifications permitted for Note to Holders include:

- Adding the nomenclatures(s) of equipment which have essentially identical technical and operating characteristics as a currently allocated item,

- Adding additional spectrum supportability comments from the NTIA or host nations,
- Documenting minor modifications, or improvements to equipment that do not essentially alter its operating characteristics e.g., an increase in the effective isotropic radiated power of 3 dB or less, the proposed deployment of a system to a new host-nation, etc.

MATDEVs should consult with ASMO regarding the need to initiate a Note-to-Holders.

(3) O&S Phase Army E3 Program

The material developer will monitor the system for changes to the spectrum-dependent parameters, e.g., an increase in the transmitter output power, or a change to the type of antenna.

In addition to forwarding the parameter changes to ASMO on a 'Note to Holders," the material developer should redo any previous EMC/EMI tests, such as MIL-STD-461.

6. Summary of Tasks for Spectrum Supportability Assessments

Table 7 summarizes the description and required actions for spectrum supportability assessments.

Table 7. Summary of Spectrum Supportability Requirements

Step	Task Description	Required Actions
1	Determine the spectrum requirements of each operational mission in coordination with mission planners.	Determine technical parameters and operational information: • Operational Frequency Range • Bandwidth. Power, etc. • Radio service (Fixed or Mobile) • Location • Operating radius, route, etc.
2	Review the baseline mission for concept of operations.	The baseline mission focuses on deployment of the missions assets and identifies where the mission plans on being deployed (i.e., COCOM, CONUS, Test and Training sites)
3	Examine spectrum supportability of each system or equipment in use individually on the basis of Host Nation spectrum policy and supportability comments for similar US RF systems.	Identify the intended area of operation and the Host Nation spectrum allocation and regulatory status. Host Nation comments can obtained from the COCOM in coordination with ASMO and the Joint Staff or from pertinent DoD databaes, e.g., HNSWD-Online.
4	Examine spectrum supportability of each system or equipment in use individually on the basis of spectrum availability.	Review existing DD Forms 1494 for similar systems in the required frequency range and operating locations

Table 7. Summary of Spectrum Supportability Requirements (Continued)

Step	Task Description	Required Actions
5	Examine spectrum supportability of the aggregate mission assets in theater by taking into account spectrum availability: • Identify any proposed frequencies that overlap, or are in an adjacent band to, other systems in deployment or mission areas. • Determine if these frequencies need to be used in the same location at the same time in accordance with the concept of operations (CONOPS).	Determine the RF parameters of other spectrum-dependent systems that can operate simultaneously within the AOR-based current CONOPS and "Army-allocated" resources and quantify the mutual interactions between all spectrum-dependent systems
6	Construct and evaluate plausible interference scenarios that involve identified frequencies in the case of overlapping frequency usage and potential interference to a system with primary use.	Obtain detailed information about the mission profile as well as detailed information of in-theater RF equipment, e.g., • Power Output • Antenna Gain • Bit Rate • Emission Requirements • Modulation (Waveforms) • Receiver Selectivity • Frequency Dependent Rejections
7	Determine through technical analysis if spectrum sharing is plausible using techniques such as operational frequency reuse, spatial separation, directional antennas, time sharing, etc.	
8	Consider options if spectrum supportability cannot be obtained and all regulatory, technical, operational interference mitigation techniques have been implemented without success.	Options may include: • Change equipment parameters • Reduce emissions bandwidth requirements • Time Share the environment • Change operating locations

Table 7. Summary of Spectrum Supportability Requirements (Continued)

Step	Task Description	Required Actions
9	Quantify the regulatory and technical impacts of incremental, evolutionary or spiral development changes to the system's RF parameters.	Contact ASMO for guidance regarding the necessity of forwarding a "Note to Holders" to document and request approval for the new RF parameters Update any previous detailed SSAs to quantify interactions with co-band and adjacent band RF systems For systems located on platforms, quantify the potential effects of the new RF parameters on other co-sited RF systems Identify and implement techniques to mitigate potential interference cause by the new RF parameters
10	Deployment required to host nations not included in the DD Form 1494.	Forward ASMO a "Note to Holders" identifying the new host nations Request ASMO initiate the host nation spectrum approval process Perform an SSA identifying the system's compliance with host nation spectrum policies
11	Determine if the system may be required to support ARNORTH, the Army element of USNORTHCOM, for HLD or DSCA incidents.	Coordinate spectrum requirements through ARNORTH

7.0 Additional Resources

In addition to the references cited in the footnotes, additional spectrum management and E3 related material pertaining to the acquisition process available from the Defense Acquisition University web site includes:

Early Consideration of Spectrum Supportability in Spectrum Dependent System Acquisitions, Renee Carter, Defense Spectrum Office, Alexandria, VA, 27 September 2005, URL: https://acc.dau.mil/GetAttachment.aspx?id=173013&pname=file&lang=en-US&aid=30962

Defense Acquisition Guidebook, Chapter 7.6.3, Department of Defense, Washington, DC, URL: https://akss.dau.mil/dag/welcome.asp

E3 and SM Assessment Guide for Operational Testing, Director Operational Testing and Evaluation, Department of Defense, Washington, DC 13 June 2001**.** URL: https://acc.dau.mil/CommunityBrowser.aspx?id=128254