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14. ABSTRACT
This Test Operations Procedure (TOP) provides the Electromagnetic (EM) Radiation Hazards (RADHAZ) (EMRADHAZ) measurement procedures for determining the Hazards of Electromagnetic Radiation to Ordnance (HERO), Personnel (HERP), and Fuel (HERF) protection guidance for intentional non-ionizing Radio Frequency (RF) transmitting equipment as stated in military standard (MIL-STD)-464 "Electromagnetic Environmental Effects Requirement for Systems".

15. SUBJECT TERMS

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US ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

*Test Operations Procedure (TOP) 03-2-616A 19 December 2012
DTIC AD No.

ELECTROMAGNETIC RADIATION HAZARDS TESTING FOR NON-IONIZING RADIO FREQUENCY TRANSMITING EQUIPMENT

*This TOP supersedes Material Test Procedure (MTP) 3-2-616, dated 12 June 1968.

Approved for public release; distribution unlimited.

1. SCOPE.

This Test Operations Procedure (TOP) provides the Electromagnetic (EM) Radiation Hazards (RADHAZ) (EMRADHAZ) measurement procedures for determining the Hazards of Electromagnetic Radiation to Ordnance (HERO), Personnel (HERP), and Fuel (HERF) protection guidance for intentional non-ionizing Radio Frequency (RF) transmitting equipment as stated in Military Standard (MIL-STD) 464C[1*].

1.1 Objective.

The objective of this TOP is to provide technical guidance to determine the safe separation distance (SSD) from the non-ionizing RF transmit antenna at which RF radiation is no longer harmful to ordnance, personnel, or fuel.

1.2 Applicability.

This TOP is applicable for complete systems and platforms, both new and modified, and applies to engineering development, production, and sustainment phases of the system utilizing non-ionizing RF transmit equipment.

1.3 Background.

a. RF Hazards to Personnel. Non-ionizing radiation from high-powered RF transmitters has the potential for injuring personnel present in the vicinity of the radiating antennas. Transmitters on vehicles, on aircraft, aboard ships, on permanent structures, and handheld by personnel are potential sources of harmful non-ionizing radiation. Non-ionizing radiated energy can also result in high levels of induced and contact current through the body when in close proximity to high-power RF transmitting antennas below 100 megahertz (MHz).

b. RF Hazards to Fuel. Non-ionizing radiation from high-powered RF transmitters has the potential for igniting fuel vapors through RF-induced arcs during fuel-handling operations. Transmitters on vehicles, on aircraft, aboard ships, on permanent structures, and handheld by personnel are potential sources of harmful non-ionizing radiation. Diesel fuel and aviation jet fuel (JP-5/JP-8) present minimal fuel hazard from electromagnetic radiation. However, the more volatile JP-4 fuel, motor vehicle gasoline (MOGAS), and aviation gasoline (AVGAS) present a fuel hazard from electromagnetic radiation during fuel-handling operations.

*Superscript numbers correspond to Appendix B, References.

c. RF Hazards to Ordnance. Electroexplosive devices (EEDs), electrically initiated devices (EIDs), and ordnance electrical systems may be affected when exposed to non-ionizing RF energy. An affected system or item might have sufficient current/voltage/energy induced by the non-ionizing RF field to result in premature firing, explosion, or dudding. Transmitters on vehicles, on aircraft, aboard ships, on permanent structures, and handheld by personnel are potential sources of harmful non-ionizing radiation.

2. FACILITIES AND INSTRUMENTATION.

2.1 Facilities.

a. The measurement facility must be capable of accommodating the test item in all of its applicable configurations and must allow for sufficient measurement areas in and around the test item to accomplish accurate field measurements.

b. Ideally, the field measurements should be accomplished in a shielded anechoic chamber facility. The shielded anechoic chamber minimizes the measurement inaccuracies by eliminating external non-ionizing RF sources from the measurement process and by reducing multipath influences to the measured field due to reflections of the incident RF waveform.

(1) The absorber material of the anechoic chamber should be sufficiently rated to handle the maximum output power densities of the non-ionizing RF transmitting equipment. Failure to recognize the power density limitations of the absorber material will result in catastrophic failure (fire) of the absorber material.

(2) The absorber material of the anechoic chamber should be sufficiently rated to handle the frequency range of operation of the non-ionizing RF transmitting equipment. Failure to recognize the operating frequency range limitations of the absorber material can result in inaccuracies of the field measurements and the subsequent associated RADHAZ guidance assessment.

(3) The size of the shielded anechoic chamber shall be sufficient to allow the desired field measurements in and around the non-ionizing RF transmitting equipment to include the platform. It is critical to know the spatial region of radiation in which the field measurement is accomplished for the non-ionizing RF transmitting equipment in order to properly extrapolate the field measurement into safe separation distance guidance. The size of the shielded anechoic chamber may dictate the specific spatial region of radiation that can be accomplished and subsequently if the shielded anechoic chamber can be utilized for the desired measurements. Typically, three regions exist for antennas: the reactive near-field region, the radiating near-field region, and the far-field region. Therefore, a correction factor for the field measurement may have to be used to accurately extrapolate the field measurement into safe separation distance guidance.

c. Open Air Test Sites (OATS) can be utilized to accomplish the field measurements. Critical factors in obtaining accurate measurements at OATS shall be taken into consideration.

(1) Determination of the “ambient conditions” of the OATS and recognizing natural and man-made structures that may modify the resultant field measurements due to multipath influences and ground reflectivity variances (desert soil conditions versus tropical soil conditions, etc.). Failure to document the ambient conditions at the OATS can result in inaccuracies of the field measurements and the subsequent RADHAZ guidance calculations.

(2) Uncontrolled non-ionizing RF sources in the area of the OATS may render field measurements unusable. The source of uncontrolled non-ionizing RF sources shall be determined. Resolution of such uncontrolled non-ionizing RF sources may require coordination to silence the source or conducting the OATS measurements during “off hours” to minimize uncontrolled non-ionizing RF source interference.

(3) Another important factor in utilizing OATS for field measurements is getting approval to operate the non-ionizing RF sources. Restrictions at various OATS may disallow operation of some non-ionizing RF sources. Field measurements at OATS may have to be coordinated during “off hours” to minimize interference.

2.2 Instrumentation.

a. All test equipment must be calibrated periodically, if applicable, with approved calibration procedures traceable to the National Institute of Standards and Technology (NIST). Calibration records shall be maintained and documented.

b. Field measurement systems shall be chosen to accurately measure the field generated by the non-ionizing RF source and to support the specific RADHAZ assessment. Non-ionizing RF sources have a variety of operating characteristics that requires versatility of the field measurement systems to accurately measure the RF field. Failure to utilize the proper field measurement system can result in gross inaccuracies of the field measurement and the resultant RADHAZ guidance assessment.

(1) The frequency range of operation of the field measurement system shall be sufficient to measure frequency range of operation of the non-ionizing RF source.

(2) The minimum sensitivity of the field measurement system shall be at least 3 decibels (dB) below the critical field level of interest (HERO UNSAFE field limit, Maximum Permissible Exposure, etc.) for power density measurements or 6 dB below the critical field level of interest for electric field measurements and shall be documented.

(3) The maximum average power and maximum peak power ratings of the field measurement system should be considered prior to field measurement system selection and observed during the measurement. Failure to observe the operational limitations of the field measurement system can result in oversaturation of field measurement device and/or damage to the field measurement device. Oversaturation of the field measurement device can result in

gross inaccuracies of the field measurement and the resultant RADHAZ guidance assessment. Depending on the duty cycle of the non-ionizing RF source, it may be possible to damage the field measurement probe/antenna by high peak power without exceeding the average power limit of the field measurement device.

(4) The limitations of the response time of the field measurement system should be observed. The response time is the time required for the meter indication of the field measurement system to reach 90 percent of its final steady-state value. Failure to recognize the limitations of the response time of the field measurement system can result in gross inaccuracies of the field measurement and the resultant RADHAZ guidance assessment.

(5) The field measurement system or personnel using equipment shall minimize influence of the measurement results. Non-conductive field measurement probe/antenna support structures shall be utilized to the extent possible to minimize field perturbations at the measurement point.

(6) The field measurement system should utilize battery power and fiber optic cable to transmit measurement values to the measurement recording device. Utilization of power cables and conductive signal cables can couple RF energy into the measurement system; thereby, causing electromagnetic interference (EMI) on the field measurement system and resulting in inaccurate field measurements. Utilization of power cables and conductive signal cables can also perturb the field in the vicinity of the measurement resulting in inaccurate field measurements. If utilization of power cables or signal cables cannot be avoided then the cables shall be routed in a manner to minimize EMI to the field measurement system and to minimize field perturbations. Care should be taken to orient the cables in the opposite polarization as the radiating non-ionizing RF source.

3. REQUIRED MEASUREMENT CONDITIONS.

3.1 System Under Test.

The System Under Test includes the non-ionizing RF transmitter, the associated transmit antenna, and the platform of integration (if applicable). All configurations of the system must be assessed. Relocation of antennas on the system is a configuration change and must be assessed.

a. Description of the non-ionizing RF transmitter to include nomenclature, manufacturer, part number, serial number, output power (peak and average), modulation type, modulation parameters, frequency range, transmit mode (single frequency, frequency hopping, spread spectrum, etc.), and a description of utilization detailing special operating characteristics (signal burst length, transmission rates, etc.) and other pertinent operating information.

b. Description of the transmit antenna to include nomenclature, manufacturer, part number, serial number, type of antenna, antenna gain (main beam and side lobe) relative to an isotropic antenna (dBi), frequency range, deployment mode (stand alone, manpack, vehicular mount, etc.), and a description of utilization detailing special operating characteristics (antenna rotation rate, sector blanking, etc.) and other pertinent operating information such as the information included in the DD Form 1494, Application for Equipment Frequency Allocation.

c. Description of the platform, if applicable, to include nomenclature, manufacturer, part number, serial number, non-ionizing RF transmit antenna mount location, and other pertinent platform information. The mounting location on the platform is critical to the measurement process in that resultant internal and external field levels will be directly influenced by the platform and the particular location of the non-ionizing RF source antenna.

3.2 Pre-Test Evaluation.

A pre-test evaluation is necessary to ascertain measurement parameters and limitations vital in the development of the measurement test plan.

a. Determine the reactive near-field zone, the radiating near-field zone, and the far-field zone for the transmit antenna from the operational characteristics of the RF transmitter and the transmit antenna. Identification of the spatial regions of radiation is necessary for test planning purposes to determine measurement points in and around the transmit antenna, to determine correction factors to accurately extrapolate field measurements into safe separation distances, and to determine the limitations, if any, of anechoic chamber measurements.

b. Determine the theoretical safe separation distances based on the RF transmitter and transmit antenna operating parameters. Identification of the theoretical safe separation distances is necessary for test planning purposes to determine measurement points, RF hazards to test measurement personnel, and to determine the physical limitations, if any, of anechoic chamber measurements.

c. Determine all modes of operation of the non-ionizing RF transmitter.

d. Determine all measurement points for external and internal, if platform integrated, field measurements. Points of measurements shall include all operator locations, personnel common areas (entry points, etc.), ordnance storage locations, and ordnance platform loaded (launcher) locations.

e. Determine all transmit antenna configurations (vertical, on-the-move, etc.).

f. Perform an energy coupling analysis to identify the type and capability requirements for the field measurement system. Sensitivity of the measurement system as well as the maximum average power and maximum peak power ratings of the field measurement system is critical in identifying the ability of the field measurement system to successfully and accurately accomplish the measurements.

g. Determine the non-ionizing RF transmitter operating procedures. The operating procedures shall be exercised at the maximum output power and at all pertinent modes and configurations. Other optional output power levels may be measured in order to establish operational guidelines for use of the non-ionizing RF transmitter.

h. Pre-existing analyses and measurement data from previous tests may be evaluated and incorporated into the test planning and pre-test analysis in order to enhance and reduce the scope of the new measurements.

3.3 Measurement Area.

Utilization of a shielded anechoic chamber or OATS for the field measurements will dictate the test area requirements.

a. Shielded anechoic chamber.

(1) Determine if the physical size of the shielded anechoic chamber is sufficient to support the field measurements based on the spatial regions of radiation, physical size of the RF transmitter (and platform), and the necessary measurement locations.

(2) Determine if the ambient RF condition within the shielded anechoic chamber is sufficient to meet the field measurements based on the most stringent critical field levels. Ambient field levels in excess of the critical field levels may render field measurements unusable. Deficiencies of the shielded anechoic chamber shall be remedied prior to RF transmitter field measurements.

(3) Determine if the absorber material is sufficiently rated to handle the maximum output power densities and the frequency range of operation of the non-ionizing RF transmitting equipment.

b. OATS.

(1) Acquire the approval to operate the non-ionizing RF transmitter.

(2) Determine if the ambient RF condition at the OATS is sufficient to meet the field measurements based on the most stringent critical field levels. Ambient field levels in excess of the critical field levels may render field measurements unusable. Based on the offending RF source, coordination (controlling the operation) of the offending RF source or conducting the field measurements at off-hours will be required.

(3) Determine if natural and man-made structures may modify the resultant field measurements or interfere with the measurement process.

3.4 Measurement Calibration.

a. The field measurement system shall be calibrated regularly by a calibration laboratory using procedures traceable to the NIST. Current documentation of the calibration records shall be maintained.

b. Specially designed laboratory specific measurement probes/antennas may be necessary due to non-availability of commercial probes/antennas to sufficiently measure the fields. In this case, the laboratory shall calibrate the special probe/antenna through methods consistent with NIST policies based on the type of probe/antenna. The methodology and calibration records shall be documented and maintained.

c. In the event the ambient RF condition in the shielded anechoic chamber is originally insufficient to support field measurements but subsequently corrected; then, the corrective action and subsequent validation calibration process of the shielded anechoic chamber shall be documented and maintained.

4. MEASUREMENT PROCEDURES.

The types and properties of the field measurements to be measured are so varied that no one field measurement system or field measurement technique is sufficient to cover the wide spectrum of field types and frequency ranges. Therefore, it is critical that the field measurement system and the field measurement technique be optimally matched to the type and frequency of the non-ionizing RF transmitter system to accurately measure the field and to support the specific RADHAZ assessment.

4.1 RF Hazards to Personnel.

a. The biological hazards and maximum permissible exposure (MPE) limits associated with electromagnetic non-ionizing radiation for personnel is established by the Institute of Electrical and Electronics Engineers (IEEE) C95.1 Standards Committee in IEEE Standard C95.1-2005[2] and is adopted for use for the Department of Defense (DoD) by the Tri-Service Electromagnetic Radiation Panel. This guidance is presented in DoD Instruction (DODI) 6055.11[3].

b. The US Army Public Health Command (PHC), Aberdeen Proving Ground, MD, is the technical agent for the US Army for HERP.

c. The HERP measurement procedures and techniques are recommended in IEEE Standard C95.3-2002[4] as basic guidance. Other approved electromagnetic measurement and evaluation methodologies may be utilized to supplement the basic guidance in IEEE Standard C95.3-2002.

d. HERP measurements shall be accomplished at all operator locations and personnel common areas to include entry/exit points, and all personnel high traffic areas. For personnel standing areas, measurements up to two meters off the ground shall be conducted to simulate personnel height.

4.2 RF Hazards to Fuel.

a. The combustible hazards associated with fuels and the subsequent non-ionizing transmitter HERF restrictions for fuel-handling areas and fueling operations are detailed in Naval

Sea (NAVSEA) Systems Command and the Naval Air (NAVAIR) Systems Command technical manual NAVSEA OP 3565/NAVAIR 16-1-529 Volume 1[5].

b. The HERF measurement procedures and evaluation technique is specified in NAVSEA OP 3565/NAVAIR 16-1-529 Volume 1.

4.3 <u>RF Hazards to Ordnance</u>.

a. The precautions and procedures for safe handling, transporting, storing, and use of electrically initiated ordnance in electromagnetic non-ionizing radiation are detailed in NAVSEA OP 3565/NAVAIR 16-1-529 Volume 2[6].

b. The HERO measurement procedures for non-ionizing radiation transmitters are discussed in NAVSEA OP 3565/NAVAIR 16-1-529 Volume 1. The HERO evaluation technique for the worst-case conditions is specified in NAVSEA OP 3565/NAVAIR 16-1-529 Volume 2.

c. Ordnance specific guidance may be developed by utilizing the specific ordnance susceptibility data and the evaluation technique specified in NAVSEA OP 3565/NAVAIR 16-1-529 Volume 2.

5. <u>DATA REQUIRED</u>.

A detailed description of the system under test should include the following:

a. Non-ionizing RF transmitter.

(1) Nomenclature.

(2) Manufacturer.

(3) Part number.

(4) Serial number.

(5) Output power (peak and average).

(6) Modulation type.

(7) Modulation parameters.

(8) Frequency range.

(9) Transmit mode (single frequency, frequency hopping, spread spectrum, etc…)

(10) Description of utilization detailing special operating characteristics (signal burst length, transmission rates, etc…).

(11) Other pertinent operating information.

b. Transmit antenna.

(1) Nomenclature.

(2) Manufacturer.

(3) Part number.

(4) Serial number.

(5) Type of antenna.

(6) Antenna gain (main beam and side lobe).

(7) Frequency range.

(8) Deployment mode (stand alone, manpack, vehicular mount, etc…).

(9) Description of utilization detailing special operating characteristics (antenna rotation rate, sector blanking, etc…).

(10) Other pertinent operating information.

c. Platform.

(1) Nomenclature.

(2) Manufacturer.

(3) Part number.

(4) Serial number.

(5) Non-ionizing RF transmit antenna mount location.

(6) Relative location of operators, entry/exit points, and personnel high traffic areas.

(7) Other pertinent platform information.

6. <u>PRESENTATION OF DATA</u>.

Due to the multiplicity of subtests, this TOP does not include specific data forms or formats. In all cases, the test data must be presented in formats that are factual, comprehensive, and easy to understand. The data should be reduced to tables, graphs, images, and photographs where possible. A sample of a typical test equipment data sheet is provided as Table 1. A sample of data from a typical HERO safe separation distance test is provided as Table 2. A sample of data from a typical HERP limits at personnel locations test is provided as Table 3.

TABLE 1. SAMPLE TEST EQUIPMENT DATA SHEET.

HARDWARE	MODEL NUMBER	SERIAL NUMBER	CALIBRATION DATE	MANUFACTURER	COMMENTS
Field monitor	XX 5004	0091038	4 January 2012	ACME	Used for E-field calibration
Field probe	XX 5000	308930	4 January 2012	ACME	Used for E-field calibration
Signal generator	8648X	3847M00633	7 February 2012	Widget	Sets frequency and drives amplifier
Bounded wave chamber	None	None	None	In-house	10 kilohertz (kHz) - 30 MHz
Amplifier	100000	309252	None	Widget	Used to drive wave chamber from 0.010 - 30 MHz

TABLE 2. SAMPLE HERO SAFE SEPARATION DISTANCE DATA SHEET.

TRANSMITTER / ANTENNA	HERO UNSAFE/UNRELIABLE ORDNANCE		HERO SUSCEPTIBLE ORDNANCE		HERO SAFE ORDNANCE	
	meters	feet	meters	feet	meters	feet
Frequency modulation (FM) / very high frequency (VHF) monopole	27.51	90.43	6.88	22.61	3	10
FM / VHF/ultra high frequency (UHF) monopole	30.86	101.46	7.72	25.37	3	10
Amplitude modulation (AM) / VHF/UHF monopole	17.35	56.90	4.34	14.22	3	10

TABLE 3. SAMPLE HERP LIMITS AT PERSONNEL LOCATIONS DATA SHEET

TRANSMITTER/ANTENNA	OPERATOR POSITIONS/PERSONNEL POINTS (W/m^2)			
	Driver Seat	Commander Seat	Roadside Door	Curbside Door
AM Radio/EMR-3	0.23	0.58	0.27	0.87
FM Radio/XM-3356	0.03	0.18	0.08	0.26
Big Zapper/QW-34A	0.34	0.37	0.57	0.68

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APPENDIX A. ACRONYMS.

AM	amplitude modulation
AVGAS	aviation gasoline
dB	decibels
dBi	decibels relative to an isotropic antenna
DoD	Department of Defense
DoDI	Department of Defense Instruction
EED	electroexplosive device
EID	electrically initiated device
EM	electromagnetic
EMI	electromagnetic interference
EMRADHAZ	electromagnetic radiation hazards
FM	frequency modulation
HERF	Hazards of Electromagnetic Radiation to Fuel
HERO	Hazards of Electromagnetic Radiation to Ordnance
HERP	Hazards of Electromagnetic Radiation to Personnel
IEEE	Institute of Electrical and Electronics Engineers
kHz	kilohertz
MHz	megahertz
MIL-STD	Military Standard
MOGAS	motor vehicle gas
MPE	maximum permissible exposure
MTP	Material Test Procedure
NAVAIR	Naval Air
NAVSEA	Naval Sea
NIST	National Institute of Standards and Technology
OATS	Open Air Test Site
PHC	US Army Public Health Command
RADHAZ	radiation hazards
RF	radio frequency
SSD	safe separation distance

APPENDIX A. ACRONYMS.

TOP	Test Operations Procedure
UHF	ultra high frequency
VHF	very high frequency

APPENDIX B. REFERENCES.

1. MIL-STD-464C, Department of Defense Interface Standard: Electromagnetic Environmental Effects, Requirements for Systems, 1 December 2010.

2. IEEE Std C95.1-2005, IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz, 19 April 2006.

3. DoDI 6055.11, Department of Defense Instruction, Protecting Personnel from Electromagnetic Fields, 19 August 2009.

4. IEEE Std C95.3-2002, IEEE Recommended Practice for Measurements and Computations of Radio Frequency Electromagnetic Fields with Respect to Human Exposure to Such fields, 100 kHz - 300 GHz, 12 June 2008.

5. NAVSEA OP 3565/NAVAIR 16-1-529 Volume 1 Sixth Revision, Naval Sea Systems Command and Naval Air Systems Command Technical Manual, Electromagnetic Radiation Hazards (Hazards to Personnel, Fuel and Other Flammable Material), 1 February 2003.

6. NAVSEA OP 3565/NAVAIR 16-1-529 Volume 2 Seventeenth Revision, Naval Sea Systems Command and Naval Air Systems Command Technical Manual, Electromagnetic Radiation Hazards (Hazards to Ordnance), 1 July 2008.

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APPENDIX C. APPROVAL AUTHORITY.

CSTE-TM 22 January 2013

MEMORANDUM FOR

Commanders, All Test Centers
Technical Directors, All Test Centers
Directors, US Army Evaluation Center
US Army Operational Test Command

SUBJECT: Test Operations Procedure (TOP) 03-2-616A, Electromagnetic Radiation Hazards Testing for Non-Ionizing Radio Frequency Transmitting Equipment, Approved for Publication

1. TOP 03-2-616A, Electromagnetic Radiation Hazards Testing for Non-Ionizing Radio Frequency Transmitting Equipment, has been reviewed by the US Army Test and Evaluation Command (ATEC) Test Centers, the US Army Operational Test Command, and the US Army Evaluation Center. All comments received during the formal coordination period have been adjudicated by the preparing agency. The scope of the document is as follows:

This TOP provides the Electromagnetic Radiation Hazards measurement procedures for determining the Hazards of Electromagnetic Radiation to Ordnance, Personnel, and Fuel protection guidance for intentional non-ionizing Radio Frequency (RF) transmitting equipment as stated in Military Standard 464. The objective of this TOP is to provide technical guidance to determine the safe separation distance from the non-ionizing RF transmit antenna at which RF radiation is no longer harmful to ordnance, personnel, or fuel.

2. This document is approved for publication and has been posted to the Reference Library of the ATEC Vision Digital Library System (VDLS). The VDLS website can be accessed at https://vdls.atc.army.mil/.

3. Comments, suggestions, or questions on this document should be addressed to US Army Test and Evaluation Command (CSTE-TM), 2202 Aberdeen Boulevard-Third Floor, Aberdeen Proving Ground, MD 21005-5001; or e-mailed to usarmy.apg.atec.mbx.atec-standards@mail.mil.

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Forward comments, recommended changes, or any pertinent data which may be of use in improving this publication to the following address: Range Infrastructure Division (CSTE-TM), US Army Test and Evaluation Command, 2202 Aberdeen Boulevard, Aberdeen Proving Ground, Maryland 21005-5001. Technical information may be obtained from the preparing activity: Electromagnetic Environmental Effects (E3) Test Division (TEDT-RT-ECE), US Army Redstone Test Center, Redstone Arsenal, Alabama 35898-8052. Additional copies can be requested through the following website: http://itops.dtc.army.mil/RequestForDocuments.aspx, or through the Defense Technical Information Center, 8725 John J. Kingman Rd., STE 0944, Fort Belvoir, VA 22060-6218. This document is identified by the accession number (AD No.) printed on the first page.