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14. ABSTRACT
This Test Operations Procedure (TOP) provides the foundation to run Electromagnetic Environmental Effects (E3) testing with a moving target simulator (MTS) on fire control systems. The focus of this TOP will be on Military Standard (MIL-STD)-464 Intra-System Compatibility Victim/Source testing as well as external radio frequency Electromagnetic Environment testing of ground vehicles while in the MTS on the fire control system.

15. SUBJECT TERMS
EME; EMC; MTS; RF; VSWR

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U.S. ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

*Test Operations Procedure 02-2-731 — 11 July 2022
DTIC AD No.

ELECTROMAGNETIC ENVIRONMENT / ELECTROMAGNETIC COMPATIBILITY TESTING IN A MOVING TARGET SIMULATOR ON FIRE CONTROL SYSTEMS

1. SCOPE.

This Test Operations Procedure (TOP) provides procedures to determine Intra-system electromagnetic compatibility (EMC) and compatibility with external radio frequency (RF) electromagnetic environment (EME) of a test item's Fire Control System, as stated in Military Standard (MIL-STD)-464D[**1] "Electromagnetic Environmental Effects Requirement for Systems". This procedure will utilize a target simulation using a moving target simulator (MTS) facility.

2. FACILITIES AND INSTRUMENTATION.

2.1 Facility.

Item	Requirement
Test Area	Simulated firing laboratory per International Test Operations Procedure (ITOP) 03-2-836 (2.5.1.1)[2] is the recommended facility. As a minimum, a clear area around the building shell with all unnecessary equipment removed to minimize vulnerabilities to the high level RF and also minimize RF reflections.
Building shell	RF reflectivity of the screen material and surrounding structure should be kept to a minimum.
Exhaust system	Adequate exhaust system to evacuate any fumes made by the equipment under test.
Anechoic Material	MIL-STD-461G[3] compliant anechoic material placed on any metallic item in the test area that could interfere with the test results.

2.2 Instrumentation.

System Name	Description
Target projection system	Provide a horizontal and vertical field-of-view (FOV) of approximately 180 degrees horizontal by 90 degrees vertical.

** Superscript numbers correspond to Appendix C, References.

System Name	Description
Data collection	Data collection device to record on-board system instrumentation values to determine the gun pointing direction, gunner aim error, and boresight error. All communications utilize fiber optics to minimize vulnerability to RF.
Camera(s)	Video camera with at least 1080 pixel resolution at 30-Hertz (Hz) to be mounted coaxially to the gun. If the system under test (SUT) has an optical based sighting system, another video camera should be placed in front of the eyepiece or sighting extension, not to impede the operator’s view. The camera should be configured to reduce the visibility of the vehicle's reticle. With camera based sighting systems, video pickoff without symbology is desired. All cameras fiber optically controlled; EMC hardened up to 1000-Volts per meter (V/m) pulsed up to 18-Gigahertz (GHz). All cabling utilizing fiber optics to minimize vulnerability to RF.
Cable and antenna tester (CAT)	Able to measure in the frequency range of interest and display it in the frequency domain. Example is the Keysight FieldFox RF Analyzer.
Directional coupler	Able to operate in the frequency range and power level of interest with less than 0.5dB of insertion loss.
Spectrum analyzer	Able to measure the frequency and power level of interest.
RF field meter system	Able to measure the frequency, modulation and field strength of the frequency of interest.

2.3 Measurement Tolerances.

Measurement	Tolerance
Frequency	2 percent
Amplitude	2 decibels (dB)
Field strength	0.1 V/m
Dimensions of target	0.25 milliradian (mrad), or as small as permissible
Angular deviation of sight line-of-sight (LOS) to target	Refer to ITOP 03-2-836 (2.3.4)[4] for specific requirements
Target speed minimum	1 milliradian per second (mrad/sec)
Cant, relative to line of sight	3 mrad
Pitch, roll, yaw, angular rate of turret if necessary (e.g., for diagnostic purposes)	1 mrad/sec
Time	1 millisecond (ms) (The permissible error of time measurement is independent of data rate(s). Data rates depend on parameter accuracy requirements.)

3. REQUIRED TEST CONDITIONS.

3.1 Inspection and Servicing.

a. Ensure that all required SUT maintenance is performed in accordance with applicable technical manuals, lubrication orders, or other guidance documents.

b. Ensure that all operating systems are working properly at normal operating temperatures (electro-optical and mechanical).

3.2 Safety.

a Inspect all test operating systems and area for safety hazards before testing, and continually monitor the systems for hazards during testing.

b. Ensure that adequate protective clothing and equipment is worn, e.g., safety shoes, eye, and ear protection.

c. Use experienced SUT operators who have received formal training on the systems they are operating.

3.3 Personnel Radio Frequency Exposure.

Operating equipment under test (EUT) transmitters can potentially exceed the Exposure Reference Level (ERL) outlined in the Department of Defense Instruction (DODI) 6055.11[5], and the Institute of Electrical and Electronics Engineers (IEEE) Standard C95.1-2345-2014[6]. Therefore, precautions need to be taken for personnel to maintain a safe distance from the transmitting antenna. A safe separation distance and any restrictions for SUT occupational or egress areas must be determined to prevent overexposure of personnel to radio frequency energy. When performing External RF EME testing per MIL-STD-464C/D, the transmitters used may require time averaging for personnel operating the EUT during test.

3.3.1 Known Safe Separation and Any SUT Restrictions.

Obtain the safe separation distance and restrict occupational use of the SUT or operational use of the EUT transmitters as determined from the SUT system literature or evaluations from previously prepared surveys or reports.

3.3.2 Unknown Safe Separation or SUT Restrictions.

A safe separation distance may be found by taking measurements or conducting a worst-case analysis through EUT system modeling and using procedures and techniques recommended in IEEE Standards C95.3[7] and C95.7[8] for basic guidance Measurements from the transmitting antenna are recommended to determine any operational or occupational restrictions required in and around the SUT. During these measurements, all personnel besides the SUT communication operator and the individual taking the measurements should be removed from the chamber. The SUT communication operator should be as far away as possible from the main beam of any EUT emitters to avoid exceeding the ERL. If the direction of the beam is unknown, the following measurements should be made at the SUT communication system operator’s location first.

a. Measurements with an RF field meter must be taken to determine whether RF exposure levels within SUT occupational or egress areas are in compliance with DODI 6055.11.

(1) Determine the operating frequency bands of the transmitting system. Spectrum analyzer measurements will be taken in the proximity of each transmitting antenna with the transmitter outputting maximum power. Record each frequency band with the highest peak amplitudes.

(2) Determine the corresponding maximum safe ERL, in terms of power density (watts per square meter (W/m^2), volts per meter (V/m), or amperes per meter (A/m)) for each applicable transmit frequency band. The DODI 6055.11 specifies ERLs for three distinct exposure environments: unrestricted exposure environment (uncontrolled access), restricted exposure environment (REE) (informed personnel with regard to RF exposure), and restricted

expert only. For REE ERLs, refer to IEEE Standard C95.1-2345-2014, Table 9-Zone 1 ERLs for frequencies between 100 kilohertz (kHz) and 300 GHz. For frequencies below 300 megahertz (MHz), both the electric and magnetic field component must be evaluated; however, either component is sufficient if the point in question is in the far field of the source.

(3) When calculating the standoff distance in relation to the maximum power density levels, use the most restrictive REE ERL for the applicable frequency band (assuming that the effective isotropic radiated power is relatively the same throughout the band). For frequencies above 100 MHz, the lowest frequency level will have the greatest restriction, ensuring an increased safety margin for any operators who may be required to operate the EUT.

b. Measurements with RF Field Meter and associated E-Field (electric field) Probe, measure power density levels at each antenna and each SUT area of review.

(1) Starting at the furthest possible measurement point from the front of each antenna and with the E-field probe at chest level slowly move towards the antenna face until the corresponding maximum safe power density measurement is displayed on the RF Field Meter.

(2) When the maximum safe power density level is measured on the RF Field Meter, record the distance from the front face of the antenna to determine the safe standoff distance. Measurements should be made at a distance no closer than three probe-diameters between the center of the probe and any object, or 20 cm, whichever is greater.

(3) Set the RF Field Meter to MAX HOLD or SPATIAL AVERAGE (as applicable) to measure each occupational and egress area in and around the SUT to deconflict any personnel (occupational areas) or EUT (operational use) to define any SUT restrictions.

4. TEST PROCEDURES.

4.1 Facility Calibration.

a. Full Calibration. Ensure instrumentation tools are calibrated prior to the baseline testing. The calibration process starts with taking center of rotation (COR) and trunnion height measurements of the SUT. The data are fed into the target generation system to account for the inaccuracies of SUT placement. This is necessary to align the targeting environment with respect to the SUT. Afterwards, the gun tube and thru-sight video channels are to be calibrated to convert the target position in raw pixel space to an angular measurement, in both horizontal and vertical direction. With the operator centering the reticle on target, a zero reference can be applied for both video channels, to act as the reference origin for measurements taken. Calibration will need to be performed before conducting both Intra-system EMC and EME.

b. Partial Calibration. Since this TOP relies on baseline testing a reduced facility calibration can occur. For a partial calibration, the SUT is to be positioned as close as possible to the center of the MTS facility to minimize parallax errors between the weapon and sighting system. This will allow you to get very close in the alignment of the targeting environment. If any testing abnormalities occur from the baseline testing, a decision to perform a full calibration will need to be made if it is determined it could of caused the issue.

4.2 Electromagnetic Compatibility (EMC) Victim / Source Matrix Development.

a. Develop a list of all the subsystems that are on the SUT, noting any systems that are not operational.

b. Using the developed list of subsystems, create a testing matrix for all the victims against the sources. See an example of a matrix in Figure 1.

P = PASS F = FAIL = NOT APPLICABLE

	CULPRITS	VICTIMS																						
		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	24.
1.	Master Power / Ign ON / Engine On	X																						
2.	Headlights (including high beams)		X																					
3.	Four-way flashers			X																				
4.	Trilliant Lights				X																			
5.	Troop Heater					X																		
6.	A/C system						X																	
7.	Gauge Cluster Unit (GCU)							X																
8.	Driver's instrument panel (DIP)								X															
9.	Radiation Detection, Indication, and Computation (RADIAC)									X														
10.	Dome lights										X													
11.	CTIS											X												
12.	Exhaust Vents (Driver & Crew)												X											
13.	Rear Door Open/Close													X										
14.	DVE / Rear View Sensor System (RVSS)														X									
15.	NBC system / Gas Particulate Filter Unit (GFCU)															X								
16.	Squad Leader Display (VDT-Video Display Terminal)																X							
17.	Vehicle Intercommunication System (VIS) Master Control Station (MCS)																	X						
18.	FBCB2, DAGR, PED and BFT2																		X					
19.	AC Inverter																			X				
20.	Duke Jammer																				X			
21.	SINCGARS A (rear R/S AS-3916 Antenna) - 40 MHz																					X		
22.	SINCGARS B (rear C/S AS-3916 Antenna) - 60 MHz																						X	
23.	Fire Control System (MITAS, THRU SIGHT, CAMERA, GUNNER CONTROL)																							X
24.	All Systems On and Operating																							
25.	All Systems On and Operating (PRC-152)																							

Figure 1. Sample EMC matrix.

c. Mark the matrix blocks that are not applicable due to the following:

(1) Victim is also the source block.

(2) Block is not in the fire control testing scope.

(3) Items that are not functioning and approved to move forward with testing by the test officer and the customer.

4.3 System Under Test (SUT) Communication Equipment Verification.

Verifying the SUT communications equipment are functioning properly is important for both intra-system EMC testing as well as EME.

a. Acquire the datasheet/DD1494 for all the antennas/transmitters on the SUT.

b. Take a Voltage Standing Wave Ratio (VSWR) measurement of the EUT antennas to verify the antenna(s) and associated cabling are not damaged and are in good working order (if applicable).

(1) CAT VSWR method.

(a) Disconnect the RF cable of the antenna closest to the antenna's transmitter.

(b) Connect the disconnected RF cable to the CAT.

(c) Using the CAT's user manual as a guide, record the VSWR measurement in the useful frequency range of the antenna per the antenna datasheet.

(d) Compare the recorded measurement with the maximum VSWR from the antenna datasheet and correct any issues if discrepancies are determined.

(2) Manual VSWR method.

(a) Setup the manual VSWR measurement using Figure 2 as a guide.

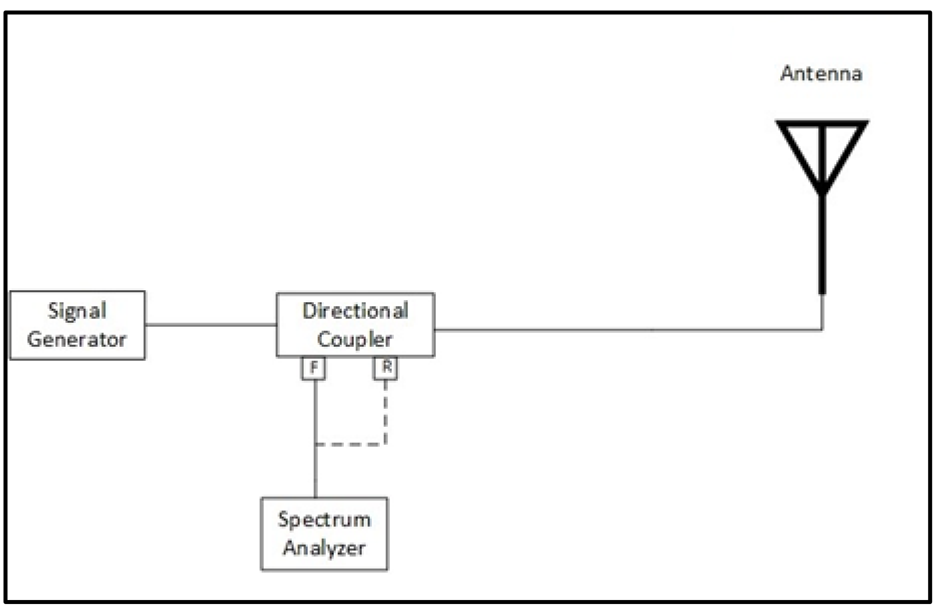

Figure 2. VSWR manual method measurement setup.

(b) Determine all the frequencies that you will be measuring the VSWR at. At a minimum for broadband antennas, a low, middle, and high frequency should be used.

(c) Output a frequency of interest using the signal generator usually at 0 decibel milliwatts (dBm) (verify that you have frequency allocation).

(d) Measure the forward power from the spectrum analyzer and record the value with the unit dBm.

(e) Measure the reverse power from the spectrum analyzer and record the value with the unit dBm.

(f) Calculate the VSWR using Equation 1.

$$VSWR = \frac{1+\sqrt{\frac{1}{10^{\left(\frac{FWR-RVS}{10}\right)}}}}{1-\sqrt{\frac{1}{10^{\left(\frac{FWR-RVS}{10}\right)}}}} \qquad \textit{(Equation 1)}$$

where:

FWR = Forward power, typically in watts or dBm.

RVS = Reverse power, typically in watts or dBm.

NOTE: Both FWR and RVS need to be in a common unit.

4.4 EMC Test Execution.

For all Target Engagements times, ITOP 03-2-836 (2.3.4)[4] and for all Target Tracking, ITOP 03-2-836 (2.3.5)[10] will be used for EMC test execution. This procedure would be applicable for day and/or night sight testing.

a. Select the projection target.

b. Baseline the SUT's fire control system using all the testing scenarios (see paragraph 4.4.d(1). Document the SUT's time to acquire and deviation from a tracked target.

c. Select one of block from the EMC matrix.

d. Perform the Source/Victim procedure outline in TOP 01-2-511A[9] for SUT testing to determine EMC using the following clarification procedures for the fire control system.

NOTE: The background scene that is used for this test is not known to impact the testing and any one can be used as long as it is documented.

(1) EMC Projection system scenarios are shown in Table 1.

TABLE 1. EMC PROJECTION SYSTEM CONFIGURATIONS

<table>
<tr><th>SCENARIO</th><th>TARGET SPEED</th><th colspan="2">TARGET MOVEMENT</th></tr>
<tr><td>1</td><td>5 mrad/sec unless reversing direction</td><td colspan="2">Left and right at a constant elevation from 0-180 degrees.</td></tr>
<tr><td>2</td><td>15 mrad/sec unless reversing direction</td><td colspan="2">Left and right at a constant elevation from 0-180 degrees.</td></tr>
<tr><td>3</td><td>5 mrad/sec unless reversing direction</td><td colspan="2">up and down at a constant azimuth from 0 to 90 degrees</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">5 mrad/sec unless reversing direction</td><td>Target 1</td><td>Up and down at a constant azimuth from 0 to 90 degrees.</td></tr>
<tr><td>Target 2</td><td>Left and right at a constant elevation from 0 to 270 degrees.</td></tr>
</table>

(2) SUT target tracking for all scenarios.

(a) Acquire target and record the time it took.

(b) After target is acquired, maintain the track and document any deviation from target.

(3) For EMC Scenario No. 4 – Commander hand-over targeting.

(a) Commander will hand-over target one to the gunner.

(b) Repeat scenario 4 but the commander will hand-over target two to track.

(4) Repeat paragraphs 4.4.c-d until all the blocks from the EMC matrix are complete.

(5) All system on testing.

(a) When communication equipment are on the SUT, use the low, middle, and high frequency from each band of the radio if multiple frequencies are possible.

(b) Only EMC scenario 4 should be utilized during this testing. If EMC scenario 4 is not able to be performed, EMC scenario 1 can be used in its place.

4.5 Electromagnetic Environment (EME) Test Execution.

The EME requirements are described in MIL-STD-464D and further clarified for ground vehicles in Army-Tank Purchase Description (ATPD)-2407A[11]. Both of these documents are good resources to understand the requirements, but in this procedure the ATPD-2407A requirements will be the focus since its intent is for ground vehicles. The following procedure describes the testing method to meet this requirement for the fire control system with the help of the MTS. This procedure would be applicable for day and/or night sight testing.

4.5.1 External EME Recorded Method RF Field Calibration.

Perform an RF field calibration before commencing with EME testing. The maximum external EME field strengths and frequency requirements are defined in Table II and Table IV respectively in ATPD-2407. Calibration may be done with an RF probe or by formula with calibrated equipment. The RF probe method is preferred.

a. Calibration by RF probe with the SUT removed from the facility.

(1) Setup the recorded method instrumentation using Figure 3 as a guide.

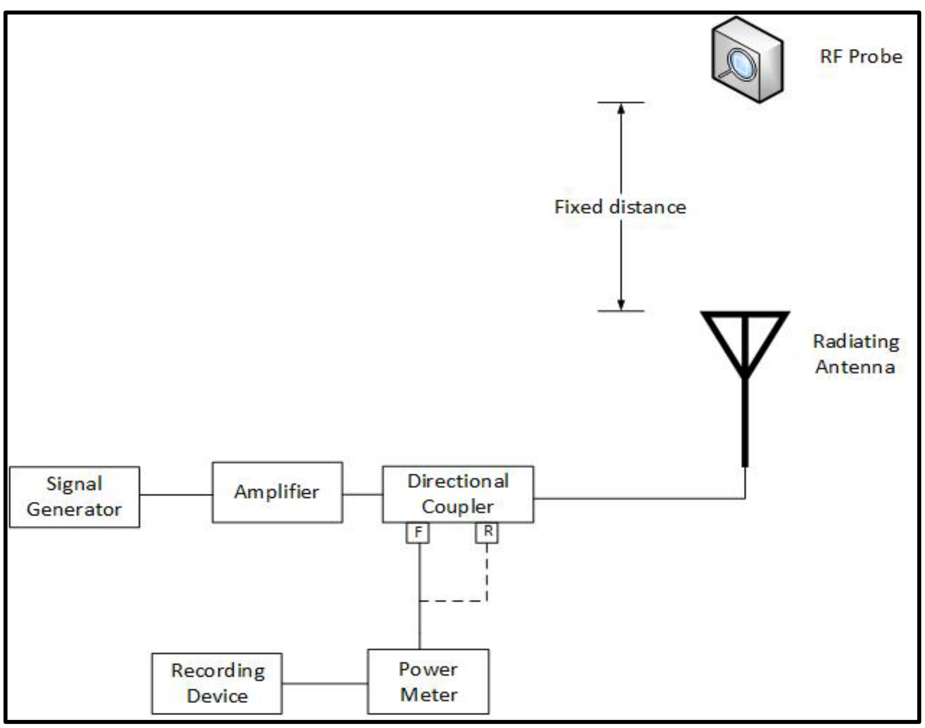

Figure 3. Recorded method calibration setup.

(2) Setup a RF probe in the test location in the facility at one of the testing heights, verifying the probe covers the frequency range is calibrated

(3) Determine and implement the fixed distance from the radiating antenna to the field probe (no less than 2 meter).

(4) Using the signal path from the signal generator to the radiating antenna, radiate a test frequency to the specified test limit as monitored by the field probe with the calibration factors applied.

(5) With the inline directional coupler to the radiating antenna, measure and record the forward power, the antenna distance from the field probe, antenna polarity, modulation and the antenna height at the test frequency.

(6) Repeat the steps in paragraphs 4.5.1.a(1) through (5) for each test frequency including both horizontal and vertical polarity at all the heights that will be used during test.

b. Calibration by formula.

(1) Use the general setup as Figure 3 without a RF probe.

(2) Acquire the following information:

(a) Numerical gain of the transmit antenna at the frequency of interest.

(b) Coupling factor for the directional couple.

(c) Losses from the directional coupler to the antenna.

(3) Using the following equations, calculate the amount of power to meet the requirement as measured at the forward power port of the directional coupler:

(a) Power required at the antenna.

$$Power_{antenna} = \frac{\left(\frac{Field \times Distance}{3.28}\right)^2}{(30 \times Gain)} \qquad \textit{(Equation 2)}$$

where:

Power= is measured in watts at the antenna
Field = field strength requirement at a particular frequency in (V/m)
Gain = numerical gain of the antenna

(b) Taking into account losses from the directional coupler to the antenna to meet the requirement:

$$Power_{Directional\_Coupler} = Power_{antenna} \times 10^{\frac{loss(db)}{10}} \quad \textit{(Equation 3)}$$

where:

Power = is measured in watts at the directional coupler
Loss = cable loss from directional couple to the antenna in (dB)

(c) Power in watts seen at the forward power port of the directional coupler to meet the requirement:

$$Power_{Forward\_power} = Power_{Directional\_Coupler} \times 10^{\frac{Coupling\_Factor}{10}} \quad \textit{(Equation 4)}$$

where:

Coupling Factor = measured in (dB) to represent the actual forward power

(d) Fill out a spreadsheet with amount of power needed at the forward power port for all the test frequencies using the same procedure as in Equations 2 through 4.

NOTE: Ground bounce can significantly affect the field at the point of intended testing, especially when low gain antennas are used.

4.5.2 Test Setup.

For all Target Engagements times, ITOP 03-2-836 (2.3.4)[4] and for all Target Tracking, ITOP 03-2-836 (2.3.5)[10] will be used for EME test execution.

a. Select the projection target.

b. Baseline the fire control system using the following EME scenarios, documenting the SUT time to acquire and deviation from a tracked target.

(1) EME Scenario 1 (see Table 2) – Commander hand-over targeting.

TABLE 2. EME PROJECTION SYSTEM CONFIGURATION

SCENARIO	TARGET SPEED	TARGET MOVEMENT	
1	5 mrad/sec unless reversing direction	**Target 1**	Up and down at a constant azimuth from 0 to 90 degrees.
		Target 2	Left and right at a constant elevation from 0 to 270 degrees.

Note: If you are unable to perform EME scenario 1, you can perform EMC scenario 1 instead.

(2) SUT target tracking.

(a) Commander will hand-over target one to the gunner.

(b) Acquire target and record the time it took.

(c) After target is acquired, keep tracking and document any deviation from target.

(3) Repeat EME scenario 1 now with commander hand-over of the opposite target to the gunner until an adequate baseline can be achieved (consistent time for both acquiring the target and deviation from during the tracking).

Note: The background scene that is used for this test is not known to impact the testing and any one can be used as long as it is documented.

4.5.3 External EME Recorded Method RF Field Playback.

a. Setup the instrumentation as depicted in Figure 4.

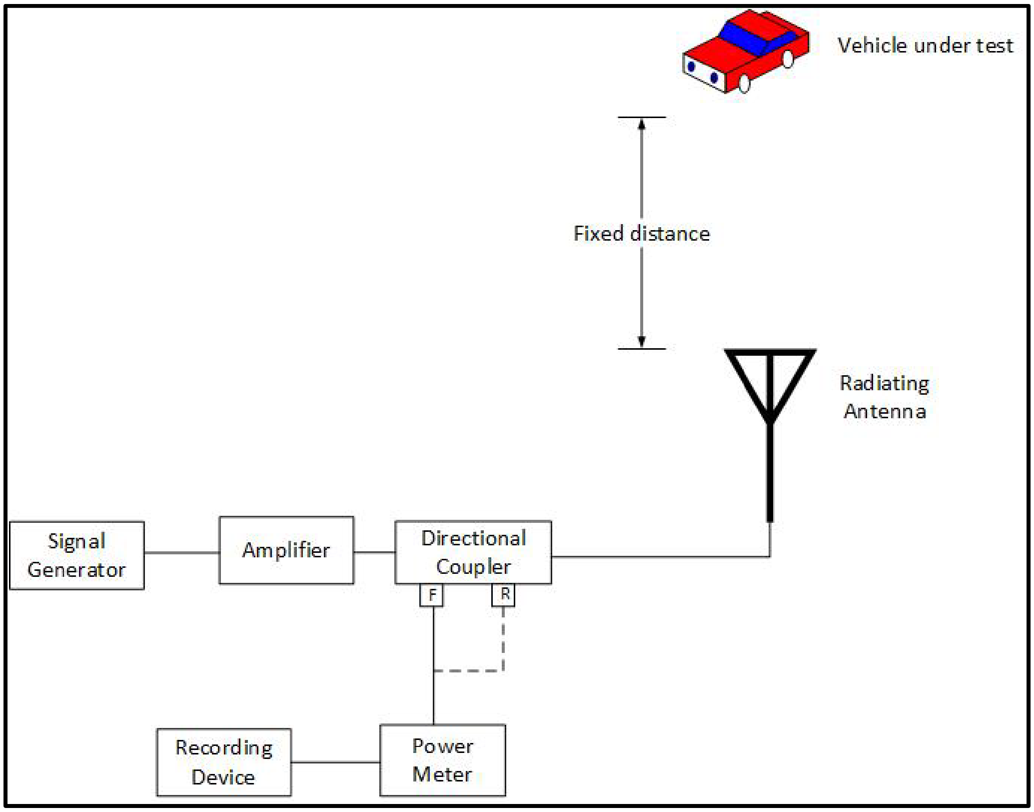

Figure 4. Recorded method testing setup.

b. Using the recorded information for each frequency determined in paragraph 4.5.1, radiate each frequency and polarity at the equipment under test while monitoring the fire control system at the testing locations.

(1) Select the first location to test on the SUT and use the appropriate calibration data based on the height determined in paragraph 4.5.2.

(2) Increase the signal generator amplitude until the power meter displays the calibrated value.

(3) While the calibrated RF field is applied to the SUT, perform the paragraph 4.5.2.b(1) EME Scenario No. 1 - Commander hand-over targeting scenario.

(4) During the testing scenario note any variation from the baseline testing and determine if it is repeatable.

(5) Repeat paragraph 4.5.3b for all locations.

5. DATA REQUIRED.

a. For all testing:

(1) Configuration of the vehicle serial number, etc.

(2) Moving target simulation facility calibration information.

(3) Baseline SUT fire control timing for acquisition of target and also deviation of target.

(4) All anomaly or vulnerability information of fire control system (data may be classified and you should refer to the EUT's security classification guide).

(5) Any deviations from this TOP.

(6) Baseline fire control timing for acquisition of target and also deviation from target.

(a) T_0 - T_6 where applicable from ITOP 03-2-836 (2.3.4).

(b) Target Acquisition, Time to Reacquisition, and Percentage of Time on Target where applicable from ITOP 03-2-836 (2.3.5).

(7) Calibration data for the test instrumentation.

b. For Intra-System EMC testing:

(1) EMC Matrix.

(2) VSWR information.

(3) Forward power on all communications gear.

c. For EME testing:

(1) Log of all the frequencies, modulations and powered levels that were successfully subjected to the SUT.

(2) Forward power logs for each test frequency.

(3) Equipment log of all the testing equipment used to conduct the test.

6. PRESENTATION OF DATA.

Examples of how data can be presented are shown in Figures 5 through 8.

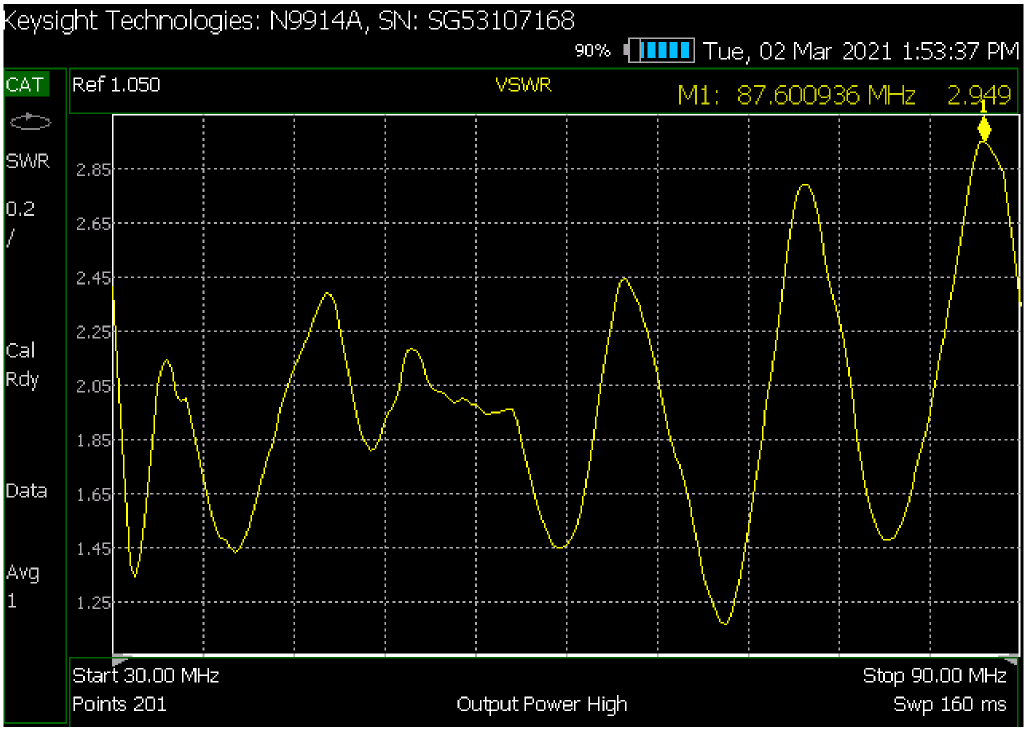

Figure 5. VSWR plot.

P = PASS F = FAIL = NOT APPLICABLE

	CULPRITS	VICTIMS																						
		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	24.
1.	Master Power / Ign ON / Engine On	x																						
2.	Headlights (including high beams)		X																					
3.	Four-way flashers			X																				
4.	Trilliant Lights				X																			
5.	Troop Heater					X																		
6.	A/C system						X																	
7.	Gauge Cluster Unit (GCU)							X																
8.	Driver's instrument panel (DIP)								X															
9.	Radiation Detection, Indication, and Computation (RADIAC)									X														
10.	Dome lights										X													
11.	CTIS											X												
12.	Exhaust Vents (Driver & Crew)												X											
13.	Rear Door Open/Close													X										
14.	DVE / Rear View Sensor System (RVSS)														X									
15.	NBC system / Gas Particulate Filter Unit (GFCU)															X								
16.	Squad Leader Display (VDT-Video Display Terminal)																X							
17.	Vehicle Intercommunication System (VIS) Master Control Station (MCS)																	X						
18.	FBCB2, DAGR, PED and BFT2																		X					
19.	AC Inverter																			X				
20.	Duke Jammer																				X			
21.	SINCGARS A (rear R/S AS-3916 Antenna) - 40 MHz																					X		
22.	SINCGARS B (rear C/S AS-3916 Antenna) - 60 MHz																						X	
23.	Fire Control System (MITAS, THRU SIGHT, CAMERA, GUNNER CONTROL)																							X
24.	All Systems On and Operating																							
25.	All Systems On and Operating (PRC-152)																							

Figure 6. Example EMC Source/Victim matrix.

EMC TEST RESULTS

REPORT NO:______________________ DATE:______________________________

TEST ITEM:______________________ TESTER:_______________________

CULPRIT	VICTIM	REMARKS

Figure 7. EMC Source/Victim Test results.

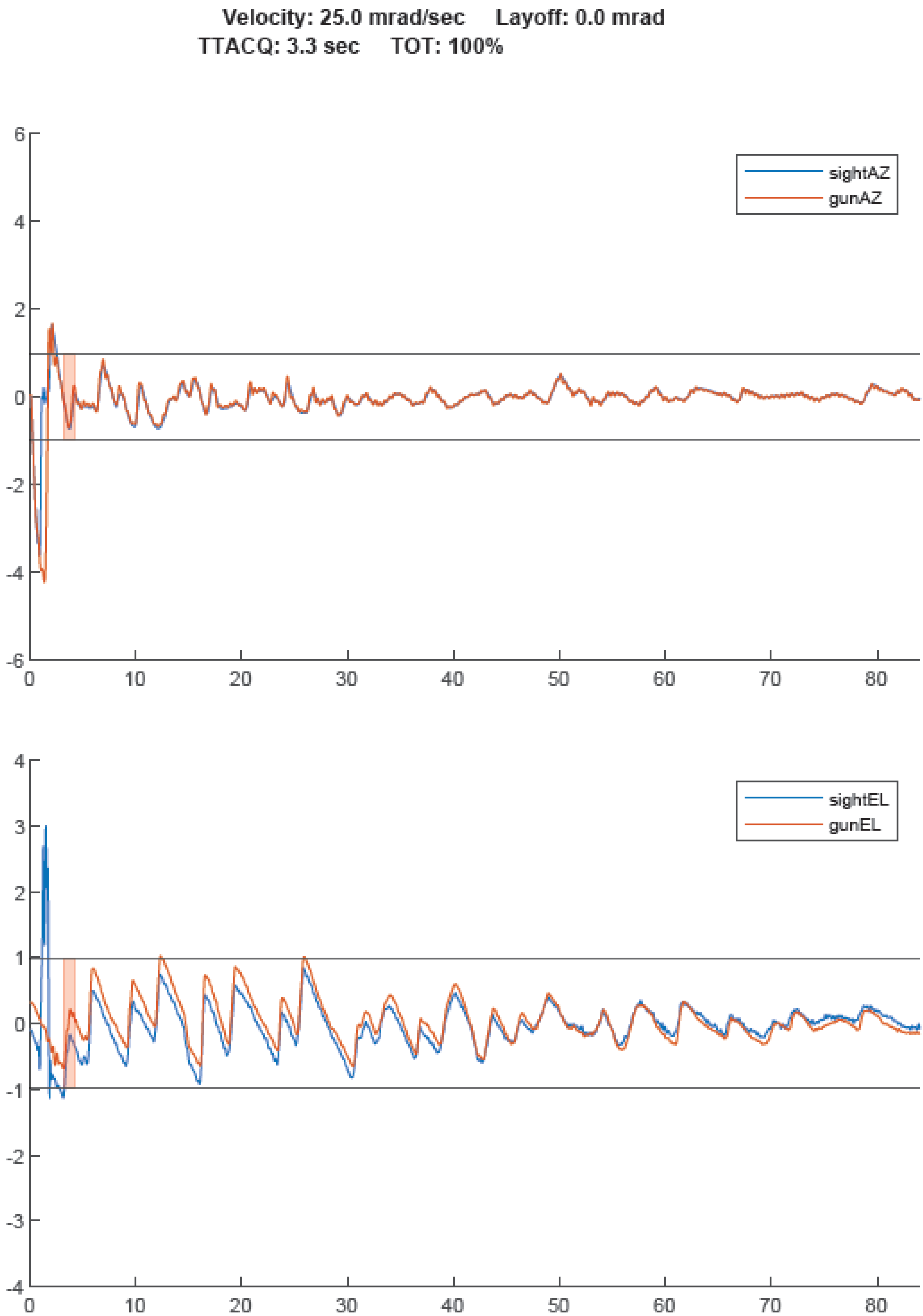

Figure 8. Target tracking plot.

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APPENDIX A. GLOSSARY.

Term	Definition
Anechoic	free from echoes and reverberations
Directional Coupler	a 4-port device that is used to sample a small amount of input signal power for measurement purposes
Trunnion	a pin or pivot on which something can be rotated or tilted
VSWR	A measurement of how efficiently radio-frequency power is transmitted from a power source, through a transmission line, into a load

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APPENDIX B. ABBREVIATIONS.

ATPD	Army Tank Purchase Description
COR	center of rotation
CAT	cable and antenna tester
dB	decibel
DODI	Department of Defense Instruction
E3	Electromagnetic Environmental Effects
E-FIELD	electric field
EMC	electromagnetic compatibility
EME	electromagnetic environment
ERL	exposure reference level
EUT	equipment under test
FOV	field-of-view
GHz	Gigahertz
Hz	Hertz
IEEE	Institute of Electrical and Electronic Engineers
ITOP	International Test Operations Procedure
kHz	kilohertz
LOS	line-of-sight
MIL-STD	Military Standard
mrad	milliradian
ms	millisecond
mW/cm^2	milliwatts per square centimeter
REE	restricted exposure environment
RF	radio frequency
sec	second
SUT	system under test
TOP	Test Operations Procedure
V/m	volts per meter
VSWR	voltage standing wave ratio

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APPENDIX C. REFERENCES.

1. MIL-STD-464D, Electromagnetic Environmental Effect Requirements for Systems, 24 December 2020.

2. ITOP 03-2-836 (2.5.1.1), Combat Vehicle Fire Control Systems Simulated Firing, Laboratory, 13 October 1997.

3. MIL-STD-461G, Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment, 11 December 2015.

4. ITOP 03-2-836 (2.3.4), Combat Vehicle Fire Control Systems Target Engagement Times, 26 October 1999.

5. DODI 6055.11, Protecting Personnel from Electromagnetic Fields, 12 May 2021.

6. IEEE C95.1-2345-2014, IEEE Standard for Military Workplaces - Force Health Protection Regarding Personnel Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz, 16 May 2014.

7. IEEE Std C95.3-2021, IEEE Recommended Practice for Measurements and Computations of Electric, Magnetic, and Electromagnetic Fields with Respect to Human Exposure to Such Fields, 0 Hz to 300 GHz, 25 March 2021.

8. IEEE Std C95.7-2014 IEEE Recommended Practice for Radio Frequency Safety Programs, 3 kHz to 300 GHz, 12 June 2014.

9. TOP 1-2-511A, Electromagnetic Environmental Effects System Testing, 20 November 2013.

10. ITOP 03-2-836 (2.3.5), Combat Vehicle Fire Control Systems Target Tracking, 10 April 2000.

11. ATPD 2407A, Electromagnetic Environmental Effects (E3) for U.S. Army Tank and Automotive Vehicle Systems Tailored from MIL-STD-464C, 11 November 2018.

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APPENDIX D. APPROVAL AUTHORITY.

CSTE-CI 11 July 2022

MEMORANDUM FOR

Commander, U.S. Army White Sands Missile Range
Executive Director, U.S. Army Evaluation Center
Commander, U.S. Army Operational Test Command
Commander, U.S. Army Yuma Proving Ground
Commander, U.S. Army Dugway Proving Ground
Commanders, U.S. ATEC Test Centers
Director, U.S. ATEC Tropic Regions Test Center
Director, U.S. ATEC West Desert Test Center

SUBJECT: Test Operations Procedure 02-2-731 Electromagnetic Environment / Electromagnetic Compatibility Testing In A Moving Target Simulator On Fire Control Systems

1. Test Operations Procedure (TOP) 02-2-731 Electromagnetic Environment / Electromagnetic Compatibility Testing In A Moving Target Simulator On Fire Control Systems, has been reviewed by the U.S. Army Test and Evaluation Command (ATEC) Test Centers, the U.S. Army Operational Test Command, and the U.S. Army Evaluation Center. All comments received during the formal coordination period have been adjudicated by the preparing agency.

2. Scope of the document. This TOP provides the foundation to run electromagnetic environmental effects testing with a moving target simulator (MTS) on fire control systems. The focus of this TOP is on Military Standard 464 Intra-System Compatibility Victim/Source testing as well as external radio frequency electromagnetic environment testing of ground vehicle fire control systems while in the MTS.

3. 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/.

4. Comments, suggestions, or questions on this document should be addressed to U.S. Army Test and Evaluation Command (CSTE-CI), 6617 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: Policy and Standardization Division (CSTE-CI-P), U.S. Army Test and Evaluation Command, 6617 Aberdeen Boulevard, Aberdeen Proving Ground, Maryland 21005-5001. Technical information may be obtained from the preparing activity: Automotive Directorate (TEDT-AT-AD), U.S. Army Aberdeen Test Center, 6943 Colleran Road, Aberdeen Proving Ground, MD 21005. Additional copies can be requested through the following website: https://www.atec.army.mil/publications/documents.html, 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.