# Report Documentation Page

*Form Approved*
*OMB No. 0704-0188*



| 1. REPORT DATE | 2. REPORT TYPE | 3. DATES COVERED |
|---|---|---|
| **2008** | | **00-00-2008 to 00-00-2008** |

| 4. TITLE AND SUBTITLE | 5a. CONTRACT NUMBER |
|---|---|
| **CREW Modeling of Effectiveness and Compatibility for Operational Test and Evaluation** | 5b. GRANT NUMBER |
| | 5c. PROGRAM ELEMENT NUMBER |
| 6. AUTHOR(S) | 5d. PROJECT NUMBER |
| | 5e. TASK NUMBER |
| | 5f. WORK UNIT NUMBER |
| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Naval Research Laboratory,4555 Overlook Avenue SW,Washington,DC,20375** | 8. PERFORMING ORGANIZATION REPORT NUMBER |
| 9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) | 10. SPONSOR/MONITOR'S ACRONYM(S) |
| | 11. SPONSOR/MONITOR'S REPORT NUMBER(S) |

12. DISTRIBUTION/AVAILABILITY STATEMENT
**Approved for public release; distribution unlimited**

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

| 16. SECURITY CLASSIFICATION OF: | | | 17. LIMITATION OF ABSTRACT | 18. NUMBER OF PAGES | 19a. NAME OF RESPONSIBLE PERSON |
|---|---|---|---|---|---|
| a. REPORT | b. ABSTRACT | c. THIS PAGE | | | |
| **unclassified** | **unclassified** | **unclassified** | **Same as Report (SAR)** | **3** | |

## CREW Modeling of Effectiveness and Compatibility for Operational Test and Evaluation

B. Sjoberg,[1] A. Szymanski,[1] J. Walters,[1] J. Durbin,[1] D. Malloy,[1] I. Will,[1] E. Phillippi,[2] C. Mamaril,[2] K. Lilley,[3] H. Dettmar,[3] A. Bowen,[3] Z. Mistry,[4] and V. Ortiz[5]
[1]*Tactical Electronic Warfare Division*
[2]*SFA, Inc.*
[3]*ITT Corporation*
[4]*Vangent, Inc.*
[5]*AVW Technologies, Inc.*

**Background and Problem Area:** There is an ongoing threat of radio-controlled improvised explosive devices (RCIED) being used against coalition troops in Iraq and Afghanistan, and countering these devices is a top priority for the Department of Defense. The Joint Improvised Explosive Device Defeat Organization (JIEDDO) initiated the Counter RCIED Electronic Warfare (CREW) program for this purpose. Builder CREW Modeling and Simulation Tool (CMAST), a modification of the Interactive Scenario Builder software program developed by the Advanced Tactical Environmental Simulation Team (ATEST), has been designated as the primary modeling and simulation tool for the CREW effort. Builder CMAST provides a user-friendly graphical interface to simulate the radio frequency (RF) capabilities of a number of different CREW systems. The software uses physics-based models to accurately compute signal levels in the presence of varying terrain, objects, soil conditions, atmospheric conditions, and other situations. The results of simulations are used to determine a CREW system's effectiveness at suppressing the operation of various enemy communication links.

**Overview of Builder Capability:** Interactive Scenario Builder (commonly referred to as Builder) is a computer simulation tool that provides insight into and visualization of the RF capabilities of various transmitters and receivers interacting in communications links. In addition, it provides geospatial and temporal situation awareness. Builder models communication and radar systems by calculating one-way and two-way RF propagation loss. It incorporates complex antenna pattern data as well as the effects of meteorology, terrain, environmental factors, and electronic countermeasures when predicting performance of these systems. It visualizes many National Geospatial-Intelligence Agency (NGA) map products, including CADRG and CIB. Builder can be used for pre-mission planning, real-time situational awareness, and after-action debriefing.

**CMAST Enhancements for CREW Effectiveness Analysis:** CMAST accurately models various CREW effectiveness scenarios. A CREW system mounted on a convoy vehicle can be modeled as a transceiver connected to an antenna mounted on the vehicle. An accurate antenna model is used to show the overall antenna pattern created by the antenna and the conducting surface of the vehicle itself. An example of a representative antenna pattern is shown in Fig. 1. RF propagation is calculated at regular points along the vehicle's path of motion. For active operation of a CREW system, this process consists of modeling the transmission to the threat receiver attached to the explosive device. In the case of a reactive CREW system, this additionally includes modeling the transmission of the signal from the threat transmitter (triggerman) to the CREW system's receiver, which initiates the countermeasure signal to the threat receiver. CMAST compares the signals from the threat transmitter and the CREW device transmitter at the threat receiver to calculate the effectiveness of the countermeasure. The CMAST graphical representation is shown in Fig. 2. CMAST can analyze scenarios involving multiple threats at various specific and variable positions along the vehicle route. Enhancements have been made to the propagation engine to accommodate various near-Earth phenomena such as urban environments and soil dielectric variability. A Threat Receiver and Countermeasure (TRAC) Database has been created to store defeat parameter data that have been obtained by laboratory analysis of different CREW systems interacting with threat devices using various techniques for signal generation and transmission.

**CMAST Enhancements for CREW Compatibility Analysis:** Because the CREW systems emit RF radiation over a wide range of frequencies in order to suppress the RCIED threats, it is necessary to evaluate their compatibility with other communications and navigational RF devices in the geographical area of operation. This includes friendly force communications, other CREW systems, both U.S. and coalition, and civil communications systems. In particular, CMAST has been used by the Federal Aviation Administration (FAA) to analyze interference with commercial aviation communication and navigation transmissions while CREW systems are under test on U.S. test ranges.

**Validation Testing:** The CREW systems are configured to emit a set of frequencies and power levels suited to specific collections of threat devices. These configurations are tested on an open-air test range to judge effectiveness of the systems. CMAST has been programmed with parameters obtained from such tests and has been shown to produce good correlation with

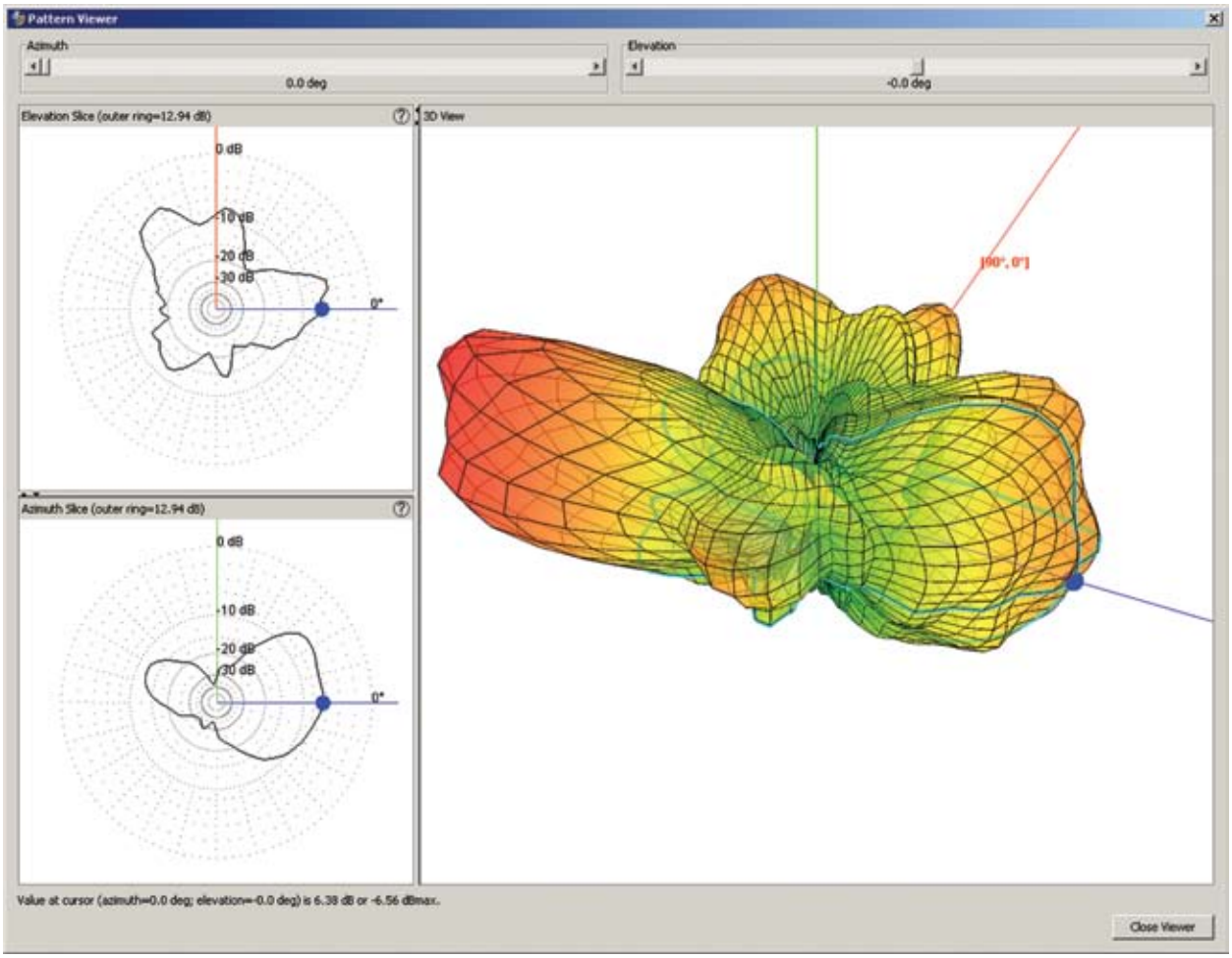


**FIGURE 1**
Representative display of a CMAST antenna pattern that includes the effect of the surrounding platform.

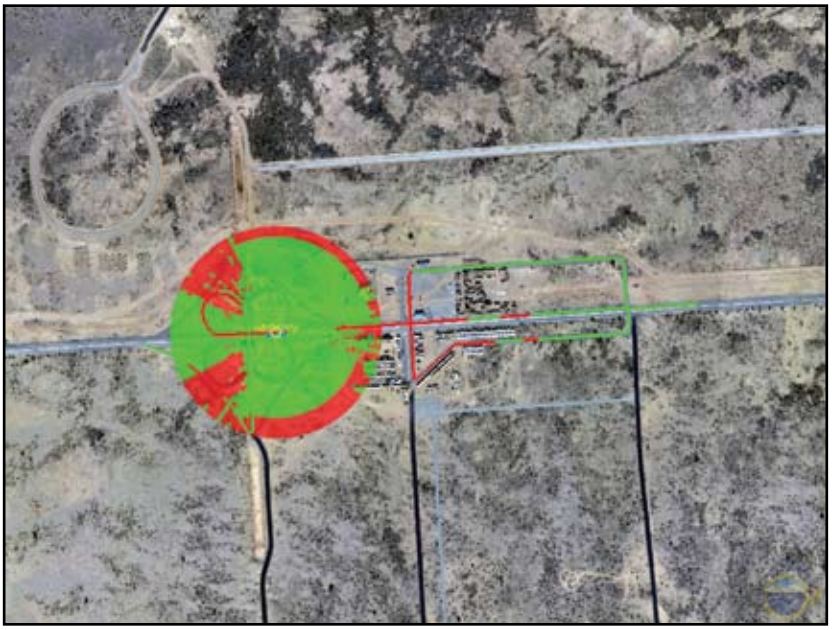

**FIGURE 2**
CMAST display of the effectiveness of a CREW device mounted on a military vehicle traveling a convoy route through an urban area against a threat at an unknown location. A circular region around the vehicle at any point on the route shows where a threat device would be defeated (green) or not defeated (red). Additionally, each point of the path is colored green or red according to the effectiveness criterion for the ratio of green to red in the circle centered at that point.

the measured test results. CMAST provides modeling and simulation capability as a substitute for certain aspects of open air testing, such as allowing tests for many permutations of parameter sets in a short period of time and under identical conditions. This will permit new and reconfigured CREW systems to be fielded in less time and with greater confidence. It also allows new threats discovered in theater to be analyzed more quickly than by use of field testing alone. CMAST is being enhanced to model not only the propagation of the signals between antennas, but also to model actual waveforms so that it can drive a coaxial test network in order to predict the effectiveness of new systems in development, decreasing the need for costly range time.

**Summary:** The IED threat has a worldwide presence, and exists in a multitude of environmental, social, and geographical settings. Therefore, Builder CMAST is continually undergoing modifications and improvements to handle as many of these scenarios as possible. NRL works closely with other organizations to develop modeling and simulation programs to faithfully model antenna patterns, threat protocols, and various geographical and environmental configurations. The Builder CMAST program will be transitioned to JIEDDO and all branches of the military for use in modeling and simulation of CREW systems. The tool will be utilized to refine operating parameters of the CREW devices and to provide the operational community with a tool for mission rehearsal and route planning.

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