



TECHNICAL PAPER

STANDARDIZED UXO DEMONSTRATION SITES

USACE ENGINEERING RESEARCH AND DEVELOPMENT CENTER - GEM-3/PUSHCART - MOGULS SCORING RECORD NO. 136



The GEM-3 in the pushcart platform is shown being demonstrated by the U.S. Army Corps of Engineers Engineering Research and Development Center at Yuma Proving Ground, Arizona.

The GEM-3 in the Pushcart Platform was demonstrated by the U.S. Army Corps of Engineers (USACE) Engineering Research and Development Center at the Yuma Proving Ground Standardized Demonstration Site's Moguls Area. This technical paper contains the results of that demonstration. This is a reference document only and does not serve as an endorsement of the demonstrator's product by the US Army or the Standardized UXO Technology Sites Program.

For more information

US Army Environmental Center
Public Affairs Office
410-436-2556, fax 410-436-1693
e-mail: usaecpao@aec.apgea.army.mil
<http://aec.army.mil>
<http://www.uxotestsites.org>

Technologies under development for the detection and discrimination of unexploded ordnance (UXO) require testing so that their performance can be characterized. To that end, Standardized Test Sites have been developed at Aberdeen Proving Ground (APG), Maryland and Yuma Proving Ground (YPG), Arizona. These test sites provide a diversity of geology, climate, terrain, and weather as well as diversity in ordnance and clutter. Testing at these sites is independently administered and analyzed by the government for the purposes of characterizing technologies, tracking performance with system development, comparing performance of different systems, and comparing performance in different environments.

The Standardized UXO Technology Demonstration Site Program is a multi-agency program spearheaded by the U.S. Army Environmental Center (USAEC). The U.S. Army Aberdeen Test Center (ATC) and the U.S. Army Corps of Engineers Engineering Research and Development Center (ERDC) provide programmatic support. The program is being funded and supported by the Environmental Security Technology Certification Program (ESTCP), the Strategic Environmental Research and Development Program (SERDP) and the Army Environmental Quality Technology Program (EQT).

DEMONSTRATOR'S SYSTEM AND DATA PROCESSING DESCRIPTION

The GEM-3 system is able to collect multiple channels of complex frequency domain electromagnetic interference (EMI) data over a wide range of audio frequencies (30 Hz to 48 kHz). The system is a wheeled pushcart with a 96-cm sensor head, a mounted electronics console, a user interface, and a real-time kinematic (RTK) Global Positioning System (GPS). The sensor head consists of three coils. The primary transmitter coil is the outer coil in the sensor head. The receiver coil is the inner coil in the sensor head. The bucking transmitter coil is the middle coil in the sensor head. The current in the bucking coil flows in the opposite direction of the current in the primary transmitter coil. This suppresses the dipole moment on the receiver coil that is directly from the primary transmitter coil. The electronics console contains the multi-frequency current waveform generator, the analog-to-digital converter receiver electronics, the digital signal processor, and the power management module. The user interface utilizes a personal digital assistant (PDA). The PDA is used for data logging and allows for real-time control of the system. The PDA also allows for real-time display of the data collected. The RTK GPS will require a base station to be set up at a suitable reference point for radio communication with the mobile unit on the GEM-3 system. The GEM-3 system's acquisition of multi-frequency data allows for performing what Geophex Ltd., the developer of the system, calls electromagnetic induction

spectroscopy (EMIS) on buried objects. EMIS provides a method to discriminate UXO targets from natural and man-made clutter objects by means of their unique, complex (in-phase and quadrature) frequency responses.

PERFORMANCE SUMMARY

Results for the Moguls test broken out by size, depth and nonstandard ordnance are presented in table below. Results by size and depth include both standard and nonstandard ordnance. The results by size show how well the demonstrator did at detecting/discriminating ordnance of a certain caliber range. The results are relative to the number of ordnance items emplaced. Depth is measured from the geometric center of anomalies.

The Response Stage results are derived from the list of anomalies above the demonstrator-provided noise level. The results for the Discrimination Stage are derived from the demonstrator's recommended threshold for optimizing UXO field cleanup by minimizing false digs and maximizing ordnance recovery. The lower 90 percent confidence limit on probability of detection and Pfp was calculated assuming that the number of detections and false positives are binomially distributed random variables. All results have been rounded to protect the ground truth. However, lower confidence limits were calculated using actual results.

SUMMARY OF MOGUL RESULTS FOR ERDC's GEM-3/PUSHCART

Metric	Overall	Standard	Nonstandard	By Size			By Depth, m		
				Small	Medium	Large	< 0.3	0.3 to <1	>= 1
RESPONSE STAGE									
P _d	0.30	0.30	0.35	0.20	0.35	0.65	0.35	0.35	0.15
P _d Low 90% Conf	0.27	0.23	0.26	0.15	0.25	0.48	0.26	0.23	0.01
P _d Upper 90% Conf	0.38	0.38	0.45	0.30	0.47	0.80	0.41	0.45	0.45
P _{fa}	0.35	-	-	-	-	-	0.35	0.25	0.00
P _{fa} Low 90% Conf	0.29	-	-	-	-	-	0.31	0.17	0.00
P _{fa} Upper 90% Conf	0.38	-	-	-	-	-	0.41	0.38	0.68
BAR	0.05	-	-	-	-	-	-	-	-
DISCRIMINATION STAGE									
P _d	0.30	0.25	0.35	0.15	0.35	0.55	0.30	0.30	0.15
P _d Low 90% Conf	0.23	0.18	0.24	0.11	0.25	0.35	0.22	0.18	0.01
P _d Upper 90% Conf	0.34	0.32	0.44	0.25	0.47	0.70	0.37	0.40	0.45
P _{fa}	0.35	-	-	-	-	-	0.35	0.25	0.00
P _{fa} Low 90% Conf	0.28	-	-	-	-	-	0.30	0.15	0.00
P _{fa} Upper 90% Conf	0.37	-	-	-	-	-	0.41	0.35	0.68
BAR	0.05	-	-	-	-	-	-	-	-

Response Stage Noise Level: 50.00
 Recommended Discrimination Stage Threshold: 70.00

Note: The recommended discrimination stage threshold values are provided by the demonstrator.

To view the full Scoring Record for this demonstration and for all other demonstrations conducted at the Aberdeen and Yuma Proving Grounds in support of the Standardized UXO Technology Demonstration Sites Program please visit our Web site at: www.uxotestsites.org.

