



TECHNICAL PAPER

STANDARDIZED UXO DEMONSTRATION SITES

US ARMY CORPS OF ENGINEERS (USAEC) EM63/PUSHCART

BLIND GRID SCORING RECORD NO. 216



The EM63/Pushcart as demonstrated by the US Army Corps of Engineers, Engineering Research and Development Center.

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, Maryland, and Yuma Proving Ground, 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 US Army Environmental Center. The US Army Aberdeen Test Center and the US Army Corps of Engineers Engineering Research and Development Center provide programmatic support. The program is being funded and supported by the Environmental Security Technology Certification Program, the Strategic Environmental Research and Development Program, and the Army Environmental Quality Technology Program.

DEMONSTRATOR'S SYSTEM AND DATA PROCESSING DESCRIPTION

The EM63/Pushcart is a commercially available sensor (produced by Geonics, Ltd., of Mississauga, Ontario, Canada, who also produces the EM61). It is a high power, high sensitivity, wide bandwidth full Time Domain UXO Detector. The EM63 consists of a powerful transmitter that generates a pulsed primary magnetic field, which induces eddy currents in nearby metallic objects. The time decay of the currents is accurately measured over a wide dynamic range of time. The second receiver coil axially mounted with the main coil, is used for target depth determination. The acquisition is controlled either by wheel odometer, manual fiducial, or free running. The EM63 system consists of three major hardware sub-systems:

- (1) EM63 Control Console Sub-system
- (2) Antenna Cart Sub-system
- (3) Global Positioning System (GPS) and Navigation Sub-system.

The EM63 Control Console Sub-system consists of receiver and transmitter unit, controlled by an integrated field computer. The control console also houses the system battery. The Antenna Cart Sub-system consists of the transmitter antenna (the 1 meter by 1 meter bottom coil), and receiver coils. The GPS Navigation Sub-system - Local positioning

The EM63/Pushcart

was demonstrated by USACE at the Aberdeen Proving Ground Blind Grid Area.

This technical paper contains the results of that demonstration. This technical paper is a reference document only and does not serve as an endorsement of the demonstrator's product by the US Army of the Standardized UXO Technology Sites Program.



and geo-referencing of the Geonics EM63 system is accomplished using a Trimble 5700 Real Time Kinematic (RTK) GPS system.

The navigational Trimble GPS consists of two receivers that are in radio communication with each other, the rover, and base station. A roving GPS antenna is mounted in the center of the EM63 coils two meters above the bottom coil. The operator or his assistant carries the controller for the roving antenna. The antenna is positioned so that it minimizes any influence on the EM63. The roving GPS is constantly receiving coordinate corrections from the base station.

EM63 and GPS data are merged in real time in the control console. The EM63 output files will be processed with Geonics' proprietary DAT63W software to convert the files from binary to American Standard Code for Information Interchange (ASCII). The ASCII data files will be imported into Geosoft's Oasis Montaj. There are no corrections required for positioning since the GPS antenna is centered with respect to the coils. The EM63 files will be combined in Oasis to create one file per area. The resulting area files exported by Oasis meet the requirements as the Raw Sensor Data that must be delivered at the end of the demonstration. Background removal or leveling, map generation, and target picking are performed in Oasis.

PERFORMANCE SUMMARY

Results for the Blind Grid test, broken out by size, depth, and nonstandard ordnance, are presented in the 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 ordnances emplaced. Depth is measured from the closest point of anomaly to the ground surface.

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 probability of false positives 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.

BLIND GRID SCORING SUMMARY

Metric	Overall	Standard	Nonstandard	By Size			By Depth, m		
				Small	Medium	Large	< 0.3	< 1	>= 1
RESPONSE STAGE									
P_d	0.80	0.80	0.80	0.80	0.75	0.95	0.90	0.80	0.30
P_d Low 90% Conf	0.74	0.73	0.67	0.70	0.59	0.75	0.82	0.65	0.08
P_{fp}	0.95	-	-	-	-	-	0.95	0.95	0.00
P_{fp} Low 90% Conf	0.90	-	-	-	-	-	0.89	0.82	-
P_{ba}	0.00	-	-	-	-	-	-	-	-
DISCRIMINATION STAGE									
P_d	0.80	0.80	0.80	0.80	0.75	0.95	0.90	0.80	0.30
P_d Low 90% Conf	0.74	0.73	0.67	0.70	0.59	0.75	0.82	0.65	0.08
P_{fp}	0.95	-	-	-	-	-	0.95	0.95	0.00
P_{fp} Low 90% Conf	0.90	-	-	-	-	-	0.89	0.82	-
P_{ba}	0.00	-	-	-	-	-	-	-	-

Response Stage Noise Level: 1.1

Recommended Discrimination Stage Threshold: 0.90

Note: The Response Stage noise level and recommended Discrimination Stage threshold values are provided by the demonstrator.

