



TECHNICAL PAPER

STANDARDIZED UXO DEMONSTRATION SITES

NAEVA GEOPHYSICS, INC. – EM61 MK-II/TOWED ARRAY

MINE GRID SCORING RECORD NO. 647



The EM61-MKII in the towed platform is shown being demonstrated by NAEVA Geophysics, Inc.

The EM61 MK-II in the towed array platform was demonstrated by NAEVA Geophysics, Inc. at the Aberdeen Proving Ground Standardized Demonstration Site's Mine Grid 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.

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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

This system will be employed to survey the Calibration Lanes, the Blind Test Grid, the Open Field Site, the Mine Grid and the Active Response Site. During the fall of 2003, NAEVA developed and field tested a new towed-array system for the Geonics EM61 MK-II. Two 1m x 0.5m coils were encased in a durable poly-plastic sled that rests directly on the ground. Coil heights can be adjusted using inflatable air bladders within the sled, but are typically maintained at the standard height of 40 cm above the ground, equivalent to mounting the coils on their standard wheels. The system is towed by an eight-wheeled Argo all-terrain vehicle. A 16-foot tongue attaches the coil assembly to the Argo and maintains sufficient separation so that the vehicle does not influence the geophysical data. A single GPS sensor is mounted over the center of the two coils to provide real-time positional tracking capabilities. System electronics are securely mounted in the vehicle's rear compartment while the data loggers are located in the driver's compartment to allow continuous monitoring of system function.

The system was designed with the goal of quickly collecting the highest quality geophysical data on a modular, reusable platform. The smooth-bottomed sled allows the system to negotiate rough terrain without the jarring and associated mechanical noise usually found in wheel-mounted systems. Light-weight and durable, the poly-plastic shell is composed of several pieces that can

be quickly replaced if field repairs are necessary. In addition, the coils are fully enclosed during operation, allowing the towed-array a degree of weather-proofing not usually found in geophysical equipment.

The EM61 is a time-domain electromagnetic (EM) instrument designed to detect, with high spatial resolution, shallow ferrous and non-ferrous metallic objects. The applicability of the instrument for Ordnance and Explosives (OE) detection has been widely demonstrated at sites across the United States. Each instrument consists of two air-cored coils (1m x 0.5m), batteries, processing electronics, and a digital data recorder. The larger of the two coils functions as the EM source and receiver and is positioned 40 cm below a second receiver coil. Secondary currents induced in both coils are measured in millivolts (mV).

Geonics has recently updated their standard EM61 system to the EM61 MK-II. The primary difference in the MK-II system is the use of multiple time-gates; the time after the electromagnetic pulse is generated that the receiver coil measures the response. Standard EM61's offer a single time-gate in both the bottom and the top coils. While the top coil time-gate is unchanged, the MK-II records early, middle, and late channels from the bottom coil. The late time-gate (third channel) corresponds to the standard EM61 while the earlier time-gates offer enhanced capabilities for the detection of smaller metallic objects.

PERFORMANCE SUMMARY

Results for the Mine Grid 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 P_{fd} 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 MINE GRID RESULTS FOR THE EM61 MK-II

Metric	Overall
RESPONSE STAGE	
P _d	0.40
P _d Low 90% Conf	0.29
P _d Upper 90% Conf	0.55
P _{td}	0.75
P _{td} Low 90% Conf	0.64
P _{td} Upper 90% Conf	0.84
P _{ba}	0.25
DISCRIMINATION STAGE	
P _d	0.25
P _d Low 90% Conf	0.14
P _d Upper 90% Conf	0.37
P _{td}	0.30
P _{td} Low 90% Conf	0.20
P _{td} Upper 90% Conf	0.41
P _{ba}	0.05

Response Stage Noise Level: 1.00

Recommended Discrimination Stage Threshold: 30.50

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.

