



TECHNICAL PAPER

# STANDARDIZED UXO DEMONSTRATION SITES

## NAVAL RESEARCH LABORATORIES (NRL) – MAGNETOMETER MTADS/TOWED – OPEN FIELD SCORING RECORD NO. 673



The Magnetometer MTADS in the towed platform is shown being demonstrated by Naval Research Laboratories (NRL).

The Magnetometer MTADS in the towed platform was demonstrated Naval Research Laboratories (NRL) at the Aberdeen Proving Ground Standardized Demonstration Site's Open Field 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

The Multi-Sensor Towed Array Detection Systems (MTADS) hardware consists of a low-magnetic signature vehicle that is used to tow linear arrays of magnetometer and pulsed-induction sensors to conduct surveys of large areas to detect buried UXO. The MTADS tow vehicle, manufactured by Chenoweth Racing Vehicles, is a custom-built off-road vehicle, specifically modified to have an extremely low magnetic signature. Most ferrous components have been removed from the body, drive train, and engine and replaced with nonferrous alloys.

The MTADS magnetometers are Cs-vapor full-field magnetometers (Geometrics Model 822ROV). Eight 1.75 meter long sensors are deployed as a linear magnetometer array.

The pulsed-induction sensors (specially modified Geonics EM61s for the baseline system and EM61 MKII's for this demonstration) are deployed as an overlapping array of three sensors. The sensors employed by MTADS have been modified to make them more compatible with vehicular speeds and to increase their sensitivity to small objects. The MTADS baseline EM61s have the sample gate at the earliest possible time. This enhances signal levels, and thus detection performance, but at the cost of classification ability. The EM61 MKIIs that will be evaluated were equipped with four sample gates.

This is intended to enhance our ability to discriminate large objects from a collection of smaller fragments.

The sensor positions are measured in real-time (5 Hz) using the latest real time kinematic (RTK) Global Positioning System (GPS) technology. All navigation and sensor data are time-stamped and recorded by the data acquisition computer in the tow vehicle. The Data Analysis System (DAS) employs routines to convert these sensor and position data streams into anomaly maps for analysis.

## PERFORMANCE SUMMARY

Results for the Open Field 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 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<sub>fd</sub> 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 OPEN FIELD RESULTS (FERROUS ONLY)

Metric	Overall	Standard	Nonstandard	By Size			By Depth, m		
				Small	Medium	Large	< 0.3	0.3 to <1	>= 1
<b>RESPONSE STAGE</b>									
P <sub>d</sub>	0.70	0.70	0.60	0.60	0.65	0.85	0.75	0.65	0.55
P <sub>d</sub> Low 90% Conf	0.64	0.67	0.55	0.52	0.60	0.77	0.88	0.60	0.48
P <sub>d</sub> Upper 90% Conf	0.71	0.77	0.67	0.65	0.72	0.89	0.79	0.72	0.66
P <sub>fa</sub>	0.55	-	-	-	-	-	-	0.50	0.75
P <sub>fa</sub> Low 90% Conf	0.52	-	-	-	-	-	-	0.45	0.55
P <sub>fa</sub> Upper 90% Conf	0.56	-	-	-	-	-	-	0.51	0.69
BAR	0.70	-	-	-	-	-	-	-	-
<b>DISCRIMINATION STAGE</b>									
P <sub>d</sub>	0.65	0.70	0.55	0.50	0.65	0.80	0.70	0.65	0.55
P <sub>d</sub> Low 90% Conf	0.59	0.63	0.49	0.45	0.56	0.72	0.62	0.56	0.45
P <sub>d</sub> Upper 90% Conf	0.67	0.73	0.61	0.59	0.68	0.86	0.73	0.69	0.63
P <sub>fa</sub>	0.35	-	-	-	-	-	-	0.35	0.40
P <sub>fa</sub> Low 90% Conf	0.31	-	-	-	-	-	-	0.32	0.28
P <sub>fa</sub> Upper 90% Conf	0.35	-	-	-	-	-	-	0.38	0.34
BAR	0.65	-	-	-	-	-	-	-	-

Response Stage Noise Level: 19.00  
Recommended Discrimination Stage Threshold: 490.50

## SUMMARY OF OPEN FIELD RESULTS (FULL GROUND TRUTH)

Metric	Overall	Standard	Nonstandard	By Size			By Depth, m		
				Small	Medium	Large	< 0.3	0.3 to <1	>= 1
<b>RESPONSE STAGE</b>									
P <sub>d</sub>	0.60	0.65	0.55	0.45	0.65	0.85	0.80	0.60	0.55
P <sub>d</sub> Low 90% Conf	0.56	0.58	0.49	0.38	0.60	0.77	0.55	0.55	0.47
P <sub>d</sub> Upper 90% Conf	0.63	0.67	0.61	0.49	0.72	0.89	0.65	0.67	0.64
P <sub>fa</sub>	0.50	-	-	-	-	-	-	0.45	0.55
P <sub>fa</sub> Low 90% Conf	0.50	-	-	-	-	-	-	0.44	0.54
P <sub>fa</sub> Upper 90% Conf	0.54	-	-	-	-	-	-	0.50	0.60
BAR	0.70	-	-	-	-	-	-	-	-
<b>DISCRIMINATION STAGE</b>									
P <sub>d</sub>	0.55	0.60	0.50	0.40	0.65	0.80	0.55	0.60	0.50
P <sub>d</sub> Low 90% Conf	0.52	0.55	0.44	0.33	0.56	0.72	0.50	0.52	0.44
P <sub>d</sub> Upper 90% Conf	0.59	0.64	0.56	0.44	0.68	0.86	0.61	0.64	0.61
P <sub>fa</sub>	0.30	-	-	-	-	-	-	0.35	0.30
P <sub>fa</sub> Low 90% Conf	0.30	-	-	-	-	-	-	0.31	0.27
P <sub>fa</sub> Upper 90% Conf	0.34	-	-	-	-	-	-	0.37	0.33
BAR	0.65	-	-	-	-	-	-	-	-

Response Stage Noise Level: 19.00  
Recommended Discrimination Stage Threshold: 490.50

*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](http://www.uxotestsites.org).

