



TECHNICAL PAPER

# STANDARDIZED UXO DEMONSTRATION SITES

## NAVAL RESEARCH LABORATORIES (NRL) – MTADS GEM-3 TOWED ARRAY

OPEN FIELD SCORING RECORD NO. 675



The MTADS GEM-3 towed array is shown being demonstrated by Naval Research Laboratories.

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 System (MTADS) GEM array is comprised of three 96-cm diameter GEM-3 frequency-domain electromagnetic interference (EMI) sensors mounted in a triangular array. The array is mounted on a 3.5-meter long platform that is pulled by the MTADS tow vehicle. The sensor transmit electronics and signal analog to digital (A/D) are located on the tow platform just in front of the sensor coils, the remaining sensor electronics are rack mounted in the tow vehicle. Also mounted on the tow platform are three Global Positioning System (GPS) antennae and an International Measurement Unit (IMU).

Each of the three sensors in the array sequentially transmits a composite waveform made up of ten frequencies logarithmically spaced from 30 Hz to just over 20 kHz for one base period (1/30 s). Thus, only one complete cycle of the 30 Hz frequency is transmitted while many thousands of cycles of the highest frequency are transmitted. The transmit current drives both a transmit coil and a counterwound bucking coil. This serves to set up a

The MTAD  
GEM-3 towed array  
was demonstrated by Naval Research  
Laboratories 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.

### For more information

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“magnetic cavity” inside the bucking coil in which is placed a receive coil. The current induced in this receive coil by the induced fields in buried metal targets is detected, digitized, and frequency resolved during the two subsequent base periods while the other array sensors are transmitting. The detected signal is compared to the transmitted current and reported relative to the transmit current (parts per million (ppm)) as both an in-phase and quadrature component.

These twenty measured responses (in-phase and quadrature at ten frequencies) make up the “EMI Spectrum” of the buried targets. These spectra can be analyzed by fitting to empirical functions, comparing against known library spectra, or fitting to target response coefficients. All three of these analysis methodologies will be applied to the data collected in this demonstration and their results compared.

## PERFORMANCE SUMMARY

Results for the Open Field 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<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 FOR THE MTADS (GEM-3)

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	0.75	0.65	0.73	0.70	0.80	0.80	0.65	0.50
P <sub>d</sub> Low 90% Conf	0.68	0.71	0.60	0.65	0.62	0.71	0.77	0.61	0.44
P <sub>d</sub> Upper 90% Conf	0.74	0.79	0.71	0.75	0.74	0.84	0.85	0.73	0.61
P <sub>fa</sub>	0.50	-	-	-	-	-	0.45	0.55	0.70
P <sub>fa</sub> Low 90% Conf	0.48	-	-	-	-	-	0.41	0.52	0.50
P <sub>fa</sub> Upper 90% Conf	0.52	-	-	-	-	-	0.47	0.58	0.84
BAR	0.20	-	-	-	-	-	-	-	-
<b>DISCRIMINATION STAGE</b>									
P <sub>d</sub>	0.55	0.55	0.55	0.55	0.55	0.60	0.60	0.55	0.45
P <sub>d</sub> Low 90% Conf	0.52	0.51	0.49	0.51	0.47	0.49	0.54	0.51	0.34
P <sub>d</sub> Upper 90% Conf	0.59	0.61	0.61	0.62	0.59	0.65	0.65	0.63	0.52
P <sub>fa</sub>	0.35	-	-	-	-	-	0.20	0.35	0.45
P <sub>fa</sub> Low 90% Conf	0.31	-	-	-	-	-	0.28	0.33	0.28
P <sub>fa</sub> Upper 90% Conf	0.35	-	-	-	-	-	0.34	0.38	0.62
BAR	0.20	-	-	-	-	-	-	-	-

Response Stage Noise Level: 7.00  
 Recommended Discrimination Stage Threshold: 125.00

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).

