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REPORT NO. ATC-8656

STANDARDIZED

UXO TECHNOLOGY DEMONSTRATION SITE

BLIND GRID SCORING RECORD NO. 40

SITE LOCATION:
ABERDEEN PROVING GROUND

DEMONSTRATOR:
GEO-CENTERS, INC.
7 WELLS AVENUE
NEWTON, MA 02459

PREPARED BY:
U.S. ARMY ABERDEEN TEST CENTER
ABERDEEN PROVING GROUND, MD 21005-5059

NOVEMBER 2003

Prepared for:
U.S. ARMY ENVIRONMENTAL CENTER
ABERDEEN PROVING GROUND, MD 21010-5401

U.S. ARMY DEVELOPMENTAL TEST COMMAND
ABERDEEN PROVING GROUND, MD 21005-5055

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The Standardized UXO Technology Demonstration Site Scoring Committee

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14. ABSTRACT
This scoring record documents the efforts of GEO-CENTERS, Inc. to detect and discriminate inert unexploded ordnance (UXO) utilizing the APG Standardized UXO Technology Demonstration Site Blind Grid. The firing record was coordinated by Larry Overbay and by the Standardized UXO Technology Demonstration Site Scoring Committee. Organizations on the committee include the U.S. Army Corps of Engineers, the Environmental Security Technology Certification Program, the Strategic Environmental Research and Development Program, the Institute for Defense Analysis, the U.S. Army Environmental Center, and the U.S. Army Aberdeen Test Center.

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SECTION 1. GENERAL INFORMATION

1.1 BACKGROUND

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 U.S. Army Environmental Center (AEC). 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).

1.2 SCORING OBJECTIVES

The objective in the Standardized UXO Technology Demonstration Site Program is to evaluate the detection and discrimination capabilities of a given technology under various field and soil conditions. Inert munitions and clutter items are positioned in various orientations and depths in the ground.

The evaluation objectives are as follows:

a. Detection and discrimination under realistic scenarios that vary targets, geology, clutter, topography, and vegetation.

b. Cost, time and manpower requirements.

c. Ability to analyze survey data in a timely manner and provide prioritized “Target Lists” with associated confidence levels.

d. Collection of high quality, ground-truth, geo-referenced data for post-demonstration analysis.

1.2.1 Scoring Methodology

a. The scoring of the demonstrator’s performance is conducted in two stages. These two stages are termed the RESPONSE STAGE and DISCRIMINATION STAGE. For both stages, the probability of detection (P_d) and the false alarms are reported as receiver-operating characteristic (ROC) curves. False alarms are divided into those anomalies that correspond to emplaced clutter items, measuring the probability of false positive (P_{fp}), and those that do not correspond to any known item, termed background alarms.

b. The RESPONSE STAGE scoring evaluates the ability of the system to detect emplaced targets without regard to ability to discriminate ordnance from other anomalies. For the blind grid RESPONSE STAGE, the demonstrator provides the scoring committee with a target response from each and every grid square along with a noise level below which target responses are deemed insufficient to warrant further investigation. This list is generated with minimal processing and, since a value is provided for every grid square, will include signals both above and below the system noise level.

c. The DISCRIMINATION STAGE evaluates the demonstrator's ability to correctly identify ordnance as such and to reject clutter. For the blind grid DISCRIMINATION STAGE, the demonstrator provides the scoring committee with the output of the algorithms applied in the discrimination-stage processing for each grid square. The values in this list are prioritized based on the demonstrator's determination that a grid square is likely to contain ordnance. Thus, higher output values are indicative of higher confidence that an ordnance item is present at the specified location. For digital signal processing, priority ranking is based on algorithm output. For other discrimination approaches, priority ranking is based on human (subjective) judgment. The demonstrator also specifies the threshold in the prioritized ranking that provides optimum performance, (i.e. that is expected to retain all detected ordnance and reject the maximum amount of clutter).

d. The demonstrator is also scored on EFFICIENCY and REJECTION RATIO, which measures the effectiveness of the discrimination stage processing. The goal of discrimination is to retain the greatest number of ordnance detections from the anomaly list, while rejecting the maximum number of anomalies arising from non-ordnance items. EFFICIENCY measures the fraction of detected ordnance retained after discrimination, while the REJECTION RATIO measures the fraction of false alarms rejected. Both measures are defined relative to performance at the demonstrator-supplied level below which all responses are considered noise, i.e., the maximum ordnance detectable by the sensor and its accompanying false positive rate or background alarm rate.

e. All scoring factors are generated utilizing the Standardized UXO Probability and Plot Program, version 3.1.1.

1.2.2 Scoring Factors

Factors to be measured and evaluated as part of this demonstration include:

a. Response Stage ROC curves:

(1) Probability of Detection (P_d^{res}).

(2) Probability of False Positive (P_{fp}^{res}).

(3) Background Alarm Rate (BAR^{res}) or Probability of Background Alarm (P_{BA}^{res}).

b. Discrimination Stage ROC curves:

(1) Probability of Detection (P_d^{disc}).

(2) Probability of False Positive (P_{fp}^{disc}).

(3) Background Alarm Rate (BAR^{disc}) or Probability of Background Alarm (P_{BA}^{disc}).

c. Metrics:

(1) Efficiency (E).

(2) False Positive Rejection Rate (R_{fp}).

(3) Background Alarm Rejection Rate (R_{BA}).

d. Other:

(1) Probability of Detection by Size and Depth.

(2) Classification by type (i.e., 20-mm, 40-mm, 105-mm, etc.).

(3) Location accuracy.

(4) Equipment setup, calibration time and corresponding man-hour requirements.

(5) Survey time and corresponding man-hour requirements.

(6) Re-acquisition/resurvey time and man-hour requirements (if any).

(7) Downtime due to system malfunctions and maintenance requirements.

1.3 STANDARD AND NONSTANDARD INERT ORDNANCE TARGETS

The standard and nonstandard ordnance items emplaced in the test areas are listed in Table 1. Standardized targets are members of a set of specific ordnance items that have identical properties to all other items in the set (caliber, configuration, size, weight, aspect ratio, material, filler, magnetic remanence, and nomenclature). Nonstandard targets are ordnance items having properties that differ from those in the set of standardized targets.

TABLE 1. INERT ORDNANCE TARGETS

Standard Type	Nonstandard (NS)
20-mm Projectile M55	20-mm Projectile M55
	20-mm Projectile M97
40-mm Grenades M385	40-mm Grenades M385
40-mm Projectile MKII Bodies	40-mm Projectile M813
BDU-28 Submunition	
BLU-26 Submunition	
M42 Submunition	
57-mm Projectile APC M86	
60-mm Mortar M49A3	60-mm Mortar (JPG)
	60-mm Mortar M49
2.75-inch Rocket M230	2.75-inch Rocket M230
	2.75-inch Rocket XM229
MK 118 ROCKEYE	
81-mm Mortar M374	81-mm Mortar (JPG)
	81-mm Mortar M374
105-mm Heat Rounds M456	
105-mm Projectile M60	105-mm Projectile M60
155-mm Projectile M483A1	155-mm Projectile M483A
	500-lb Bomb

SECTION 2. DEMONSTRATION

2.1 DEMONSTRATOR INFORMATION

Information provided in this section was taken from the Demonstrator's approved test plan. Only minor editorial changes were made in this section.

2.1.1 Demonstrator POC and Address

Address: GEO-CENTERS, Inc.
7 Wells Ave.
Newton, MA 02459
(617) 964-7070
(617) 964-7070 x 262

2.1.2 System Description

The simultaneous electromagnetic (EM) and magnetometry system (multisensor Surface Towed Ordnance Location System (STOLS)) is a towed vehicular array developed by GEO-CENTERS and CEHNC with funding from ESTCP under project UX-0208 (fig. 1). The system simultaneously collects both total field magnometer (Mag) data and EM61 data on a single towed platform. GEO-CENTERS' existing STOLS was used as a host system; the STOLS custom-fabricated aluminum dune buggy with a low magnetic self-signature, Mags, differential Global Positioning System (GPS), sensors, computers, and tractor-trailer for transportation were reused. The new simultaneous electromagnetic (EM) and magnetometry system augments STOLS with interleaved sampling electronics that allow EM61 coils to be physically located on the same platform as the Mags without corrupting the Mag data. The electronics monitor the rising edge of the 75-Hz transmit pulse from the EM61, waits 8 ms for the pulse to die down, samples the Mags for 5 ms, then waits for the next transmit pulse and repeats the cycle. Data acquired at McKinley Test Range (Redstone Arsenal, Huntsville) show that Mag data quality, with the EM system switched on, is commeasurate with Mag data quality when the EM system is switched off. Mag, EM61, and GPS data are acquired in a single file.

Along with new interleaved sampling electronics is a new proof-of-concept non-metallic tow platform to host both the EM61 coils and the Mags in a low-noise environment. Constructed almost entirely from fiberglass, the only metallic components on the platform are the axles, the hub, and a small number of aluminum pop rivets. The wheels are composite. Even the tires have had the metal beads removed. Total metallic mass has been reduced by over 99 percent by weight as compared to the original aluminum STOLS tow platform. Certain key structural locations have been reinforced with marine-grade plywood. The proof-of-concept platform was fielded successfully for a prove-out at McKinley Test Range. However, it should be noted that the platform was designed to fit into the existing budget for the ESTCP project, not for commercial surveys; it has no suspension, is speed-limited, and may not survive a fielding over rugged terrain without sustaining structural damage.

Figure 1. Demonstrator's system.

Five Geometrics 822A Mags updating and outputting at 75 Hz are deployed at 1/2 meter spacing. The Mags are 3 meters behind the tow vehicle. Three 1/2 meter Geonics EM61 coils (upper and lower) internally updating at 75 Hz and outputting at 10 Hz are deployed in a master/slave configuration on the rear of the platform, 2.5 meters behind the Mags, also at 1/2 meter spacing. The center line of the middle three Mags is coincident with the center line of the three EM61 coils. Both the Mags and the lower EM61 coils are mounted on pivots so they can swing up if they encounter an obstacle while moving forward.

2.1.3 <u>Data Processing Description</u>

Custom, Unix-based data processing software is used to process the file containing the Mag, EM61, and GPS data. The GPS updates are first automatically examined, and any jumps that could not occur at a nominal vehicle speed are flagged, allowing the operator to manually correct them. Sensor heading is calculated using smoothed position updates.

Mag and EM61 data are then processed separately, as they require different corrections. For the Mag data, the reference Mag recording the ambient variations of the Earth's magnetic field is time-correlated, then subtracted off. The data are then directionally divided into passes acquired in uniform directions (that is, north-going, south-going, west-going, and east-going, or whatever set of directions were used for the survey site). For each major direction, an independent set of sensor offsets are calculated, and are then applied to that set of data to background-level the sensors and remove streaks in the image. A site-wide offset may also be applied if the reference Mag is over geology with a background different than that of the survey site.

EM61 background is not directionally dependent, but EM61 data is background-leveled individually by file to account for drift that may occur file-to-file.

Once the background-leveling corrections have been determined, data is processed as follows. Adjacent 1-Hz GPS updates are used to position the sensor array at the beginning and at the end of each second. From there, each sensor on the array can be positioned at each of its updates. An array is set up by the data processing software at a 10 cm cell spacing, and each sensor update is positioned into the appropriate cell in the array. A nearest-neighbor-inverse-distance-squared interpolation is used to fill in the intersensor spacing regardless of the direction of travel. The interpolated image is then displayed on the screen for analysis.

Analysis of the Mag is performed using a nonlinear least squares match to a model of a point dipole with adjustable angles. Outputs from the model are object location, depth, magnetic moment, angle of incidence, and angle of orientation. On the basis of magnetic moment, an estimate is made of object size. For objects that do not resemble point dipoles because they are either too weak or too spatially extended, the object's location can be pinpointed using the mouse. An optional comment field may be added to each target.

Simultaneous viewing and analysis of the simultaneously-collected Mag and EM data is obtained by running two linked copies of the data processing software. Once linked, panning, zooming and scrolling in one set of data automatically pans zooms and scrolls in the other set, and drawing a region of interest in one set of data automatically draws the same region in the other set.

Data output is available in a variety of formats, including raw, corrected (navigation corrected and background-leveled), and interpolated.

2.1.4 <u>Data Submission Format</u>

Data was submitted for scoring in accordance with data submission protocols outlined in the Standardized UXO Technology Demonstration Site Handbook (app E, ref 1). This data is not included in this report in order to protect ground truth information.

2.1.5 <u>Demonstrator Quality Assurance and Quality Control</u>

a. The following Quality Control steps are taken:

(1) Coordinates of the control monument over which to set up the base GPS station are obtained before deploying to the survey site. These coordinates are obtained in both latitude and longitude (WGS84) as well as the rectangular coordinate system used for final data submission (preferably UTM WGS84 meters) so verification that coordinates can be correctly converted between these two coordinate systems is obtained.

(2) The system is set up using checklists for the vehicle and platform, GPS, and diurnal variation stations.

(3) GPS data, Mag data, and EM61 data are all numerically displayed in a Windows program on the data acquisition computer. These numbers are all visually inspected prior to survey data acquisition, and at the beginning and end of each survey line.

(4) The six line test required by CEHNC is performed.

b. The following quality assurance steps are taken:

(1) Data are processed and imaged in the field, immediately after survey operations, to ensure that the data are of nominal quality.

(2) Any available control points, such as grid corner coordinates, are overlaid to ensure that the GPS was properly set up and that there are no coordinate offsets.

(3) Reference data are displayed to ensure that there are no unphysical spikes or dropouts.

(4) During processing, GPS data are viewed and corrected if necessary.

(5) Mag data are reference-corrected.

(6) Mag data are background-leveled using a correction specific to the direction of travel.

(7) EM61 data are background-leveled individually for each data file to mitigate the effects of drift.

(8) After data are converted to the desired data output format (e.g., ASCII, comma-delimited .dat files), these files are read back in to the Unix-based data processing software, processed, and viewed.

2.1.6 Additional Records

None.

2.2 ABERDEEN PROVING GROUND SITE INFORMATION

2.2.1 Location

The APG Standardized Test Site is located within a secured range area of the Aberdeen Area of APG. The Aberdeen Area of APG is located approximately 30 miles northeast of Baltimore at the northern end of the Chesapeake Bay. The Standardized Test Site encompasses 17 acres of upland and lowland flats, woods and wetlands.

2.2.2 Soil Type

According to the soils survey conducted for the entire area of Aberdeen Proving Ground in 1998, the test site consists primarily of Elkton Series type soil (ref 2). The Elkton Series consists of very deep, slowly permeable, poorly drained soils. These soils formed in silty aeolin sediments and the underlying loamy alluvial and marine sediments. They are on upland and lowland flats and in depressions of the Mid-Atlantic Coastal Plain. Slopes range from 0 to 2 percent.

ERDC conducted a site-specific analysis in May of 2002 (ref 3). The results basically matched the soil survey mentioned above. Seventy percent of the samples taken were classified as silty loam. The majority (77 percent) of the soil samples had a measured water content between 15- and 30-percent with the water content decreasing slightly with depth.

For more details concerning the soil properties at the APG test site, go to www.uxotestsites.org on the web to view the entire soils description report.

2.2.3 Test Areas

A description of the test site areas at APG is included in Table 2.

TABLE 2. TEST SITE AREAS

Area	Description
Calibration Grid	Contains 14 standard ordnance items buried in six positions at various angles and depths to allow demonstrator to calibrate their equipment.
Blind Test Grid	Contains 400 grid cells in a 0.2-hectare (0.5 acre) site. The center of each grid cell contains ordnance, clutter or nothing.

SECTION 3. FIELD DATA

3.1 DATE OF FIELD ACTIVITIES (8 TO 9 OCTOBER 2002)

3.2 AREAS TESTED/NUMBER OF HOURS

Areas tested and total number of hours spent at each site are summarized in Table 3.

TABLE 3. AREAS TESTED AND NUMBER OF HOURS

Area	Number of Hours
Calibration Lanes	5.17
Blind Test Grid	11.25

3.3 TEST CONDITIONS

3.3.1 Weather Conditions

An ATC weather station located approximately 2 miles west of the test site was used to record average temperature and precipitation on an hourly basis for each day of operation. The temperatures listed in Table 4 represent the average temperature during field operations from 0700 through 1700 hours while the precipitation data represents a daily total amount of rainfall. Hourly weather logs used to generate this summary are provided in Appendix B.

TABLE 4. TEMPERATURE/PRECIPITATION DATA SUMMARY

Date, 02	Average Temperature, ^{o}F	Total Daily Precipitation, in.
8 October	57.6	0.00
9 October	58.9	0.00

3.3.2 Field Conditions

GEO-CENTERS surveyed the blind test grid on 8 and 9 October 2002. The field was dry throughout the survey of the Blind Test Grid.

3.3.3 Soil Moisture

The soil moisture logs are included in Appendix C. Three soil probes were placed at various locations of the site to capture soil moisture data: open field, open field lowland (wet) and open field scenario 1 wooded area. Measurements were collected in percent moisture and were taken twice daily (morning and afternoon) from five different soil layers (0 to 6 in., 6 to 12 in., 12 to 24 in., 24 to 36 in., and 36 to 48 in.) from each probe.

Below is a summary of the soil moisture data collected. The average moisture content was calculated by averaging the morning and afternoon measurements for each layer of each probe for the duration of the field operations in the Blind Test Grid. Data for the wooded area and wet area probes were not included in this summary since no operations were performed in these areas for this report.

TABLE 5. SOIL MOISTURE DATA SUMMARY

Layer, in.	Average Moisture Content, %	Standard Deviation, %
Open Field Probe		
0 to 6	17.37	6.83
6 to 12	10.17	2.03
12 to 24	0.35	0.10
24 to 36	26.52	0.34
36 to 48	9.75	0.17

3.4 FIELD ACTIVITIES

3.4.1 Setup/Mobilization

These activities included initial mobilization and daily equipment preparation and breakdown. A crew of two people took 1 hour and 50 minutes (1.83 hrs) to perform the initial set-up and mobilization on 7 October 2002 and 15 minutes were spent breaking down equipment at the end of that day. On 8 October 2002, 55 minutes were spent preparing the equipment before beginning the survey and 20 minutes were spent breaking down equipment at the end of that day. On 9 October 2002, 53 minutes was spent preparing the equipment and 15 minutes was spent breaking down the equipment at the end of the day.

3.4.2 Calibration

GEO-CENTERS spent 5 hours and 10 minutes in the calibration lanes. No calibration activities were conducted while operating in the Blind Test Grid.

3.4.3 Downtime Occasions

Occasions of downtime were grouped into five categories: equipment/data checks or equipment maintenance, equipment failure and repair, weather, Demonstration Site issues, or breaks/lunch. All downtime is included for the purposes of calculating labor costs (section 5) except for downtime due to Demonstration Site issues. Demonstration Site issues, while noted in the Daily Log, are considered non-chargeable downtime for the purposes of calculating labor costs and are not discussed. Breaks and lunches are not discussed either.

3.4.3.1 <u>Equipment/data checks, maintenance</u>

Data checks amounted to a total 100 minutes and 170 minutes was used for equipment checks while surveying the blind test grid.

3.4.3.2 <u>Equipment failure or repair</u>

The EM61 electrical system failed on 8 October 2002. After this failure occurred, GEO-CENTERS returned to the calibration lanes and surveyed with the Mag sensor only. A replacement part was ordered the same day. Three hours and 47 minutes elapsed on the morning of 9 October 2002 while waiting on delivery of replacement part. After the part was received, it took 45 minutes to replace.

3.4.3.3 <u>Weather</u>

No delays occurred due to weather.

3.4.4 <u>Data Collection</u>

The demonstrator spent 1 hour and 10 minutes collecting data in the blind grid. This time excludes break/lunches, and downtimes as described in section 3.4.3.

3.4.5 <u>Demobilization</u>

It took a crew of two people 2 hours to breakdown and pack up equipment for demobilization. Demobilization actually occurred at the end of the Open Field demonstration on October 11 2002.

3.5 PROCESSING TIME

The raw data was submitted the last day of testing. GEO-CENTERS processed their data for scoring within the 30-day time period.

3.6 DEMONSTRATOR'S FIELD PERSONNEL

Deleted for public release

3.7 DEMONSTRATOR'S FIELD SURVEYING METHOD

GEO-CENTERS began surveying in the northeast corner of the field continuing in a north/south direction. GEO-CENTERS placed two straight lines of flags on the ground separated approximately 5 meters apart in width and approximately 75 meters in length. The tow vehicle was driven between these flags in an effort not to miss any part of the surveying areas.

3.8 SUMMARY OF DAILY LOGS

A few issues occurred while operating in the blind grid:

a. The tow vehicle had to be pulled out of the site on three separate occasions due to slippery conditions.

b. The EM61 electrical system failed. Replacement parts had to be ordered and installed before survey could continue.

SECTION 4. TECHNICAL PERFORMANCE RESULTS

4.1 ROC CURVES USING ALL ORDNANCE COMBINED

It must be noted that ESTCP project UX-0208 did not include any algorithm development work for discriminating UXO from non-UXO. The project did not fund development of discrimination capability and GEO-CENTERS does not claim to currently have such capability at this time. As such, discrimination stage results usually included in the standardized scoring records will not be included in this record.

The data submitted by GEO-CENTERS consisted of three response stages, one from the pulsed EM sensor, one from a Mag sensor, and one for combined EM/MAG. The combined EM/MAG response stage data resulted from the Mag and EM data being visually fused and using human judgement to determine whether or not there was an object in the grid square. Due to the subjective nature of visually selecting targets, true signal responses do not exist. Therefore, ROC curves cannot be presented for the combined EM/MAG data set.

Figure 2a shows the probability of detection for the EM response stage (P_d^{res}) versus the respective probability of false positive. Figure 2b shows the probability of detection for the Mag response stage (P_d^{res}) versus the respective probability of false positive. Figure 3a shows the probability of detection for the EM response stage (P_d^{res}) versus the respective probability of background alarm. Figure 3b shows the probability of detection for the Mag response stage (P_d^{res}) versus the respective probability of background alarm. All figures use a horizontal line to illustrate the demonstrator selected system noise level for the response stages, representing the point below which targets are not considered detectable. Note that all points have been rounded to protect the ground truth.

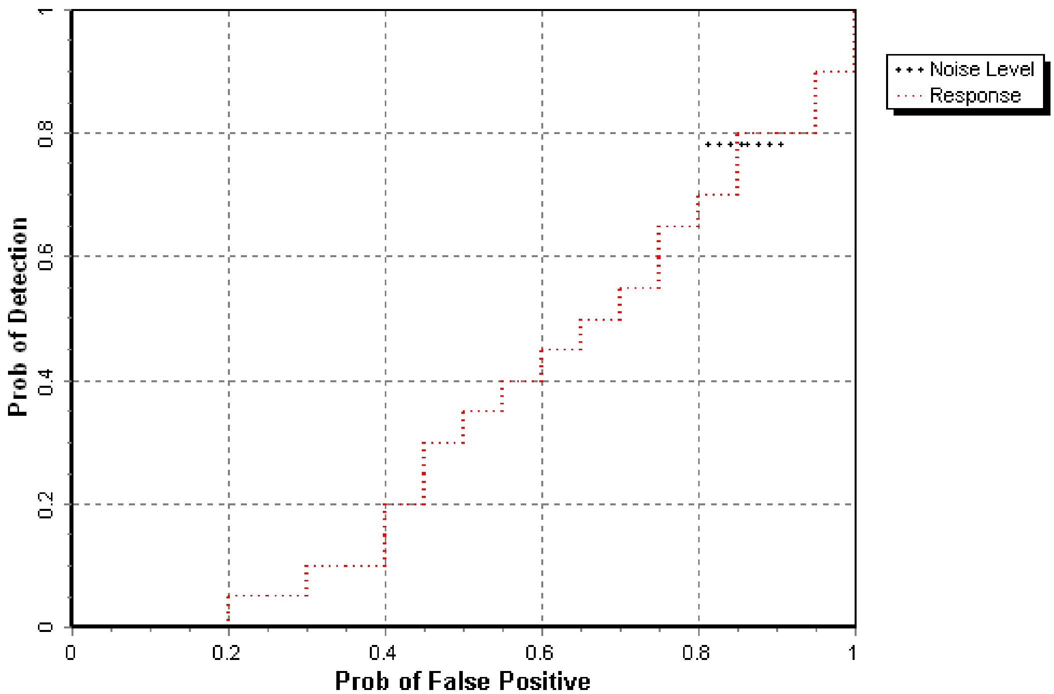

Figure 2a. Blind grid probability of detection for the EM response stage (P_d^{res}) versus the respective probability of false positive.

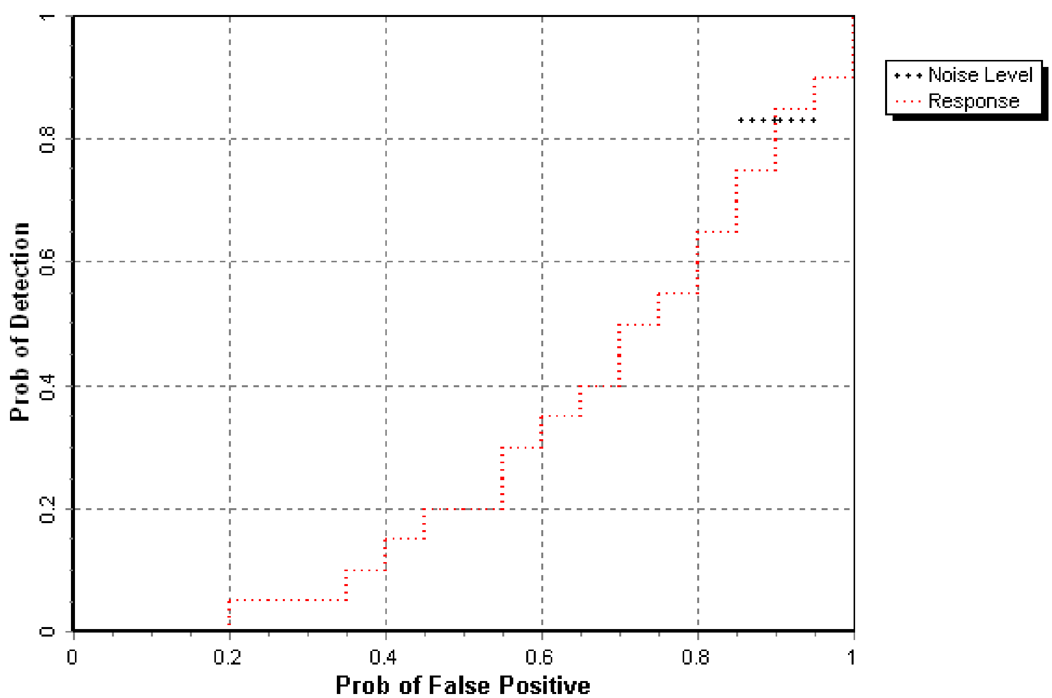

Figure 2b. Blind grid probability of detection for the Mag response stage (P_d^{res}) versus the respective probability of false positive.

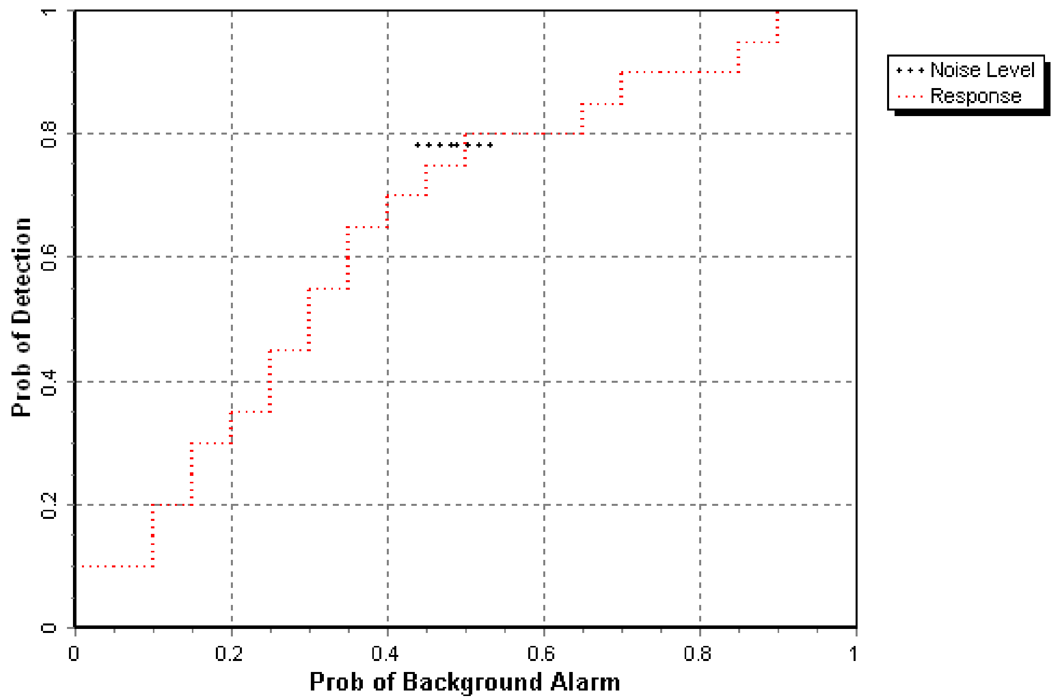

Figure 3a. Blind grid probability of detection for the EM response stage (P_d^{res}) versus the respective probability of background alarm.

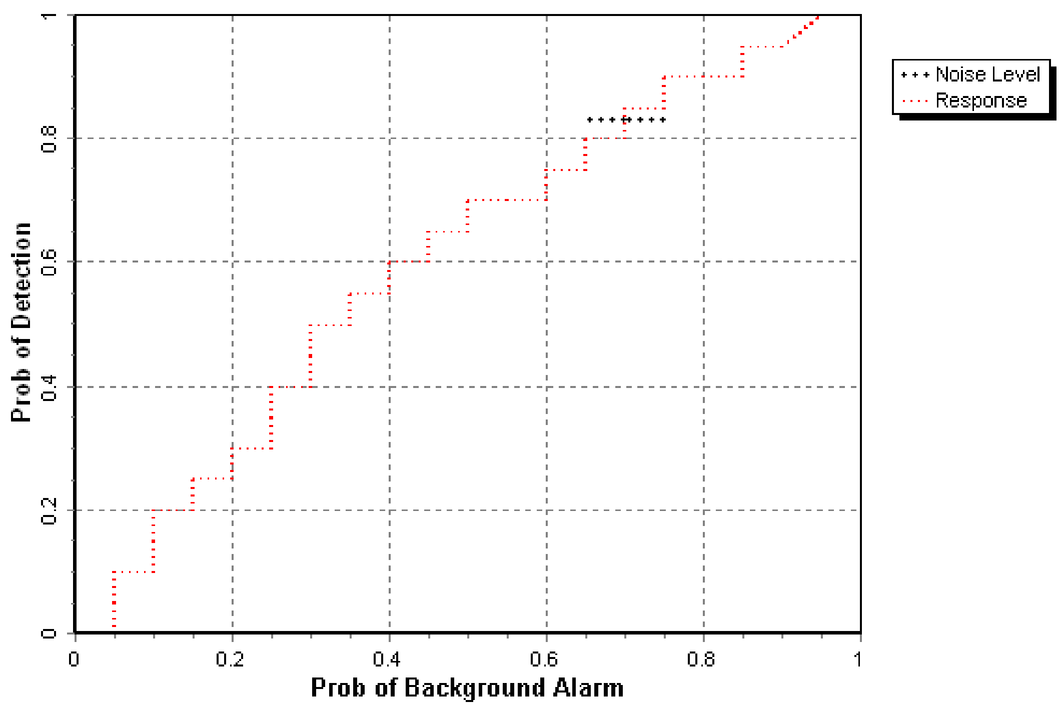

Figure 3b. Blind grid probability of detection for the Mag response stage (P_d^{res}) versus the respective probability of background alarm.

4.2 ROC CURVES USING ORDNANCE LARGER THAN 20 MM

Figure 4a shows the probability of detection for the EM response stage (P_d^{res}) versus the respective probability of false positive when only targets larger than 20 mm are scored. Figure 4b shows the probability of detection for the Mag response stage (P_d^{res}) versus the respective probability of false positive when only targets larger than 20 mm are scored. Figure 5a shows both probabilities probability of detection for the EM response stage (P_d^{res}) versus the respective probability of background alarm. Figure 5b shows both probabilities probability of detection for the Mag response stage (P_d^{res}) versus the respective probability of background alarm. Both figures use a horizontal line to illustrate the demonstrator selected system noise level for the response stages, representing the point below which targets are not considered detectable. Note that all points have been rounded to protect the ground truth.

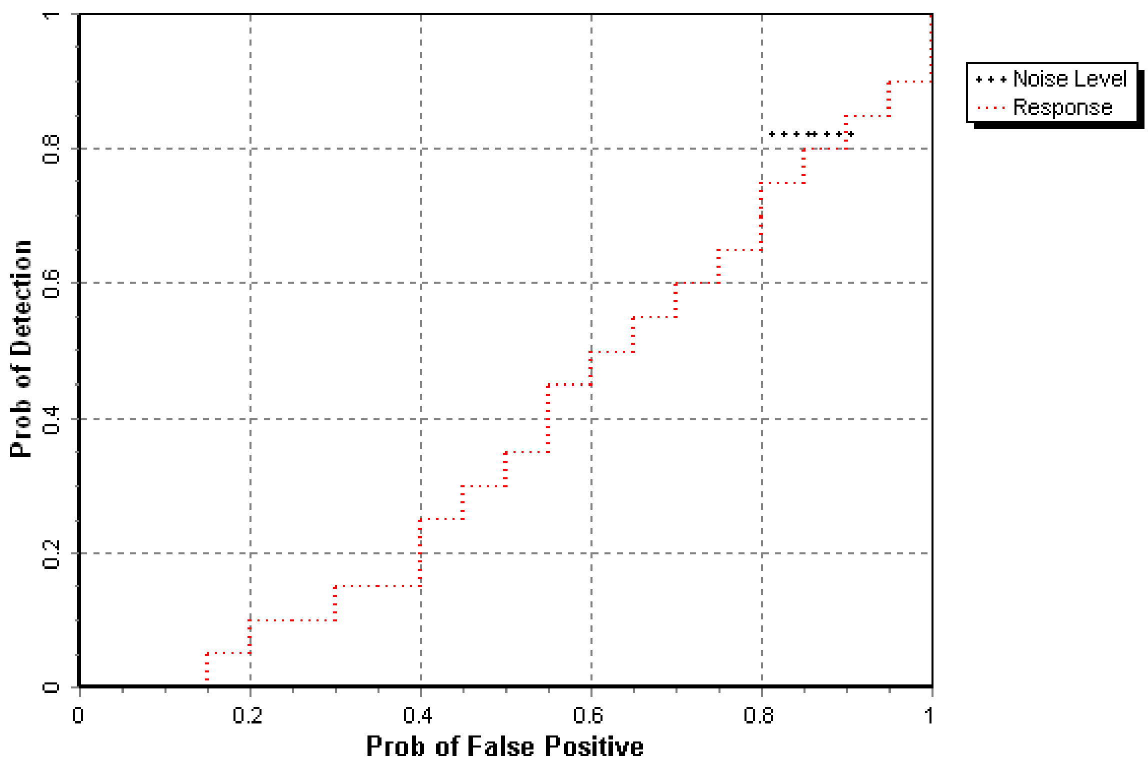

Figure 4a. Blind grid probability of detection for the EM response stage (P_d^{res}) versus the respective probability of false positive for all ordnance larger than 20 mm.

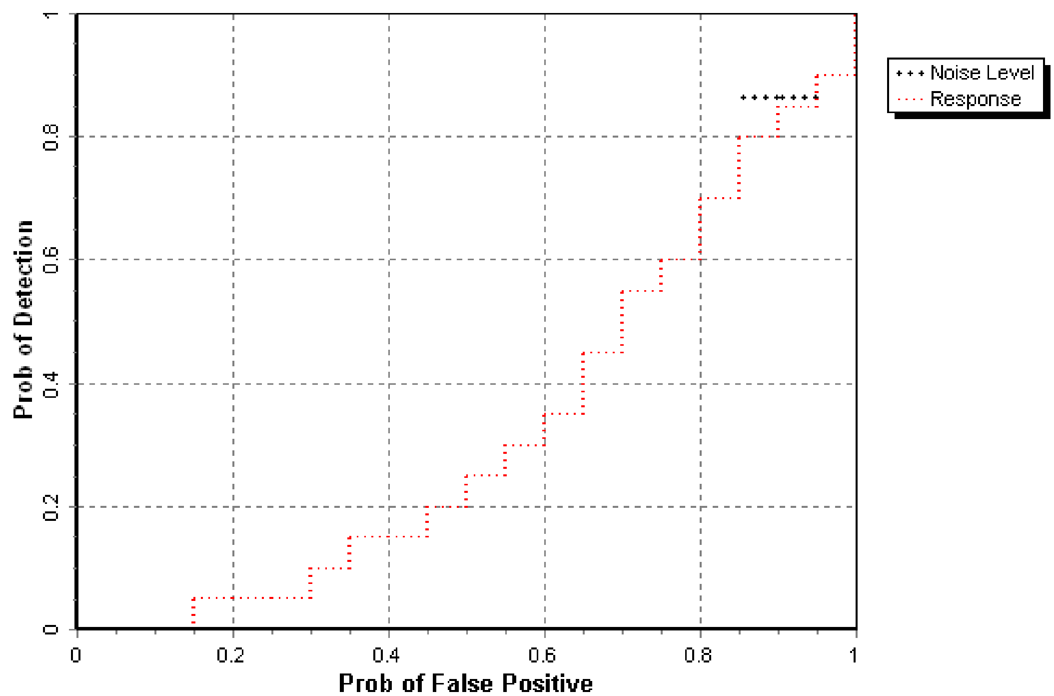

Figure 4b. Blind grid probability of detection for the Mag response stage (P_d^{res}) versus the respective probability of false positive for all ordnance larger than 20 mm.

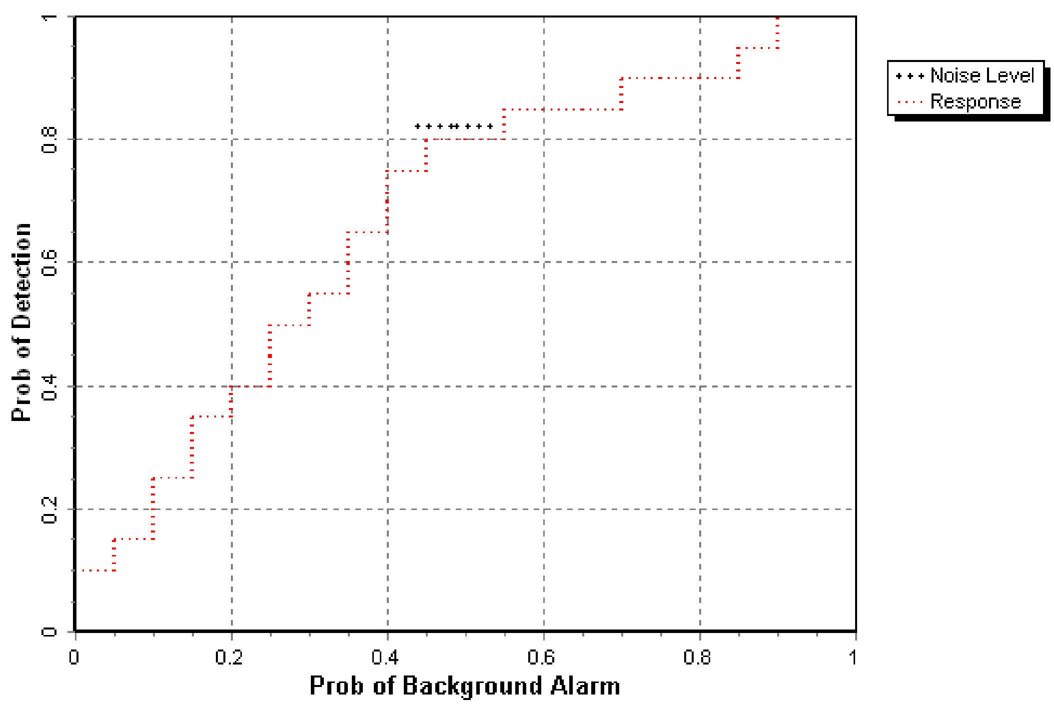

Figure 5a. Blind grid probability of detection for the EM response stage (P_d^{res}) versus the respective probability of background alarm for all ordnance larger than 20 mm.

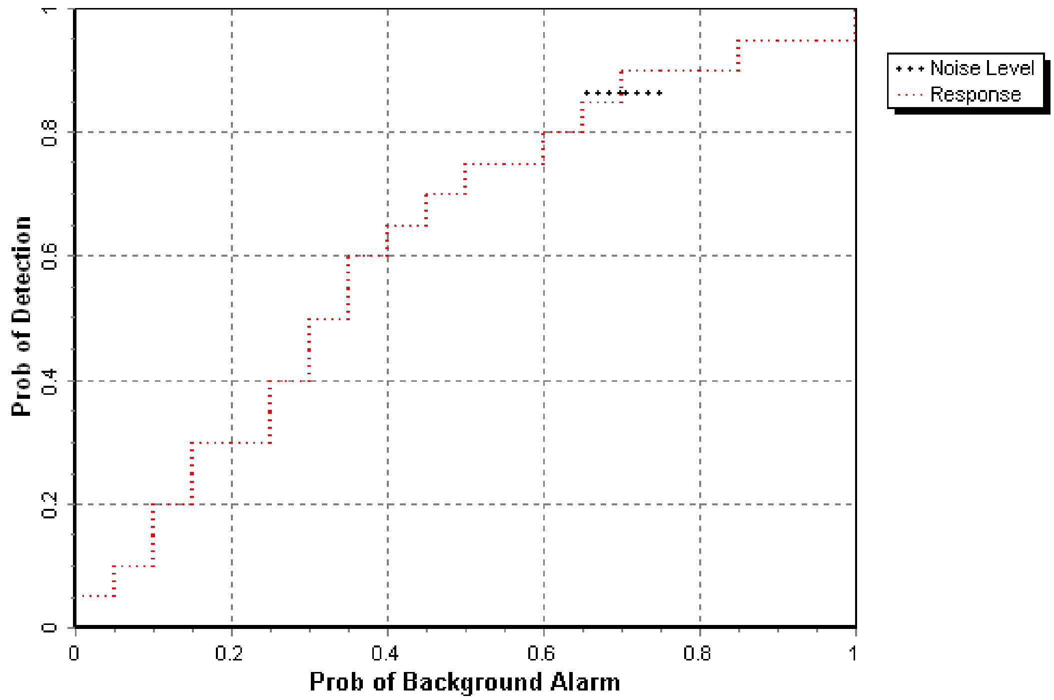

Figure 5b. Blind grid probability of detection for the Mag response stage (P_d^{res}) versus the respective probability of background alarm for all ordnance larger than 20 mm.

4.3 PERFORMANCE SUMMARIES

The data submitted by GEO-CENTERS consisted of three response stages, one from the pulsed EM sensor, one from a Mag sensor, and one for combined EM/MAG. The combined EM/MAG response stage data resulted from the Mag and EM data being visually fused and using human judgment to determine whether or not there was an object in the grid square. Due to the subjective nature of visually selecting targets, true signal responses do not exist.

Results for the blind grid test broken out by size, depth and nonstandard ordnance are presented in Table 6. (For cost results, see section 5.) 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. (See Appendix A for size definitions.) The results are relative to the number of ordnances emplaced. Depth is measured from the closest point of anomaly to the ground surface.

The individual EM and Mag RESPONSE STAGE results were derived from the list of anomalies above the demonstrator-provided noise level. The combined EM/MAG RESPONSE STAGE results were derived by utilizing the demonstrator's provided classification (e.g. blank grid or ordnance in grid) that was visually selected based on human judgement. Due to combined EM/MAG data set not meeting the requirements to utilize the standard scoring software, the data was hand scored utilizing the same scoring rules specified in Appendix A. The lower 90-percent confidence limit on probability of detection and probability of false positive was calculated assuming that the number of detections and false positives are binomially distributed random variables. All results in Table 6 have been rounded to protect the ground truth. However, lower confidence limits were calculated using actual results.

TABLE 6. SUMMARY OF BLIND GRID RESULTS

				By Size			By Depth, m		
Metric	**Overall**	**Standard**	**Non-Standard**	**Small**	**Medium**	**Large**	**< 0.3**	**0.3 to <1**	**>= 1**
EM RESPONSE STAGE									
P_d	0.80	0.80	0.75	0.80	0.75	0.80	0.90	0.70	0.50
P_d Low 90% Conf	0.71	0.72	0.62	0.71	0.61	0.55	0.82	0.58	0.27
P_{fp}	0.85	-	-	-	-	-	0.85	0.90	1.00
P_{fp} Low 90% Conf	0.80	-	-	-	-	-	0.74	0.79	0.63
P_{ba}	0.50	-	-	-	-	-	-	-	-
MAG RESPONSE STAGE									
P_d	0.85	0.90	0.70	0.75	0.85	1.00	0.80	0.85	0.90
P_d Low 90% Conf	0.77	0.84	0.59	0.66	0.76	0.79	0.71	0.72	0.66
P_{fp}	0.90	-	-	-	-	-	0.90	0.90	1.00
P_{fp} Low 90% Conf	0.85	-	-	-	-	-	0.81	0.82	0.63
P_{ba}	0.70	-	-	-	-	-	-	-	-
COMBINED EM/MAG RESPONSE STAGE									
P_d	0.65	0.75	0.45	0.50	0.70	0.90	0.65	0.70	0.20
P_d Low 90% Conf	-	-	-	-	-	-	-	-	-
P_{fp}	0.75	-	-	-	-	-	0.70	0.75	1.00
P_{fp} Low 90% Conf	-	-	-	-	-	-	-	-	-
P_{ba}	0.10	-	-	-	-	-	-	-	-

Response Stage Noise Level: 2.00
Note: The response stage noise level was provided by the demonstrator.

4.4 EFFICIENCY, REJECTION RATES, AND TYPE CLASSIFICATION

Discrimination data was not required for this particular demonstration. Therefore, no results will be presented for this section.

4.5 LOCATION ACCURACY

Discrimination data was not required for this particular demonstration. Therefore, no results will be presented for this section.

TABLE 9. MEAN LOCATION ERROR AND STANDARD DEVIATION (M)

No data available.

SECTION 5.   ON-SITE LABOR COSTS

A standardized estimate for labor costs associated with this effort was calculated as follows: the first person at the test site was designated "supervisor", the second person was designated "data analyst", and the third and following personnel were considered "field support". Standardized hourly labor rates were charged by title: supervisor at $95.00/hour, data analyst at $57.00/hour, and field support at $28.50/hour.

Government representatives monitored on-site activity. All on site activities were grouped into one of ten categories: initial set-up/mobilization, daily set-up/stop, calibration, collecting data, downtime due to break/lunch, downtime due to equipment failure, downtime due to equipment/data checks or maintenance, downtime due to weather, downtime due to demonstration site issue, or demobilization. See Appendix D for the daily activity log. See section 3.4 for a summary of field activities.

The standardized cost estimate associated with the labor needed to perform the field activities is presented in Table 10. Note that calibration time includes time spent in the Calibration Lanes as well as field calibrations. "Site survey time" includes daily set-up/stop time, collecting data, breaks/lunch, downtime due to equipment/data checks or maintenance, downtime due to failure, and downtime due to weather.

TABLE 10. ON-SITE LABOR COSTS

	No. People	Hourly Wage	Hours	Cost
INITIAL SETUP				
Supervisor	1	$95.00	1.83	$173.85
Data Analyst	1	57.00	1.83	$104.31
Field Support	0	28.50	0.00	0.00
SubTotal				**$278.16**
CALIBRATION				
Supervisor	1	$95.00	5.17	$419.15
Data Analyst	1	57.00	5.17	$294.69
Field Support	0	28.50	0.00	0.00
SubTotal				**$713.84**
SITE SURVEY				
Supervisor	1	$95.00	11.25	$1068.75
Data Analyst	1	57.00	11.25	$641.25
Field Support	0	28.50	0.00	0.00
SubTotal				**$1710.00**

See notes at end of table.

TABLE 10 (CONT'D)

	No. People	Hourly Wage	Hours	Cost
DEMOBILIZATION				
Supervisor	1	$95.00	2.00	$190.00
Data Analyst	1	57.00	2.00	$114.00
Field Support	0	28.50	0.00	0.00
SubTotal				**$304.00**
TOTAL				**$3006.00**

Notes: Calibration time includes time spent in the Calibration Lanes as well as calibration before each data run.
Site Survey time includes daily set-up/stop time, collecting data, breaks/lunch, downtime due to system maintenance, failure, and weather.

SECTION 6. COMPARISON OF RESULTS TO DATE

No comparisons to date.

SECTION 7. APPENDIXES

APPENDIX A. TERMS AND DEFINITIONS

GENERAL DEFINITIONS

Anomaly: Location of a system response deemed to warrant further investigation by the demonstrator for consideration as an emplaced ordnance item.

Detection: An anomaly location that is within R_{halo} of an emplaced ordnance item.

Emplaced Ordnance: An ordnance item buried by the government at a specified location in the test site.

Emplaced Clutter: A clutter item (i.e. non-ordnance item) buried by the government at a specified location in the test site.

R_{halo}: A pre-determined radius about the periphery of an emplaced item (clutter or ordnance) within which a location identified by the demonstrator as being of interest is considered to be a response from that item. If multiple declarations lie within R_{halo} of any item (clutter or ordnance), the declaration with the highest signal output within the R_{halo} will be utilized. For the purpose of this program, a circular halo 0.5 meters in radius will be placed around the center of the object for all clutter and ordnance items less than 0.6 meters in length. When ordnance items are longer than 0.6 meters, the halo becomes an ellipse where the minor axis remains 1 meter and the major axis is equal to the length of the ordnance plus 1 meter.

Small Ordnance: Caliber of ordnance less than or equal to 40 mm (includes 20-mm projectile, 40-mm projectile, submunitions BLU-26, BLU-63, and M42).

Medium Ordnance: Caliber of ordnance greater than 40-mm and less than or equal to 81-mm (includes 57-mm projectile, 60-mm mortar, 2.75 in. Rocket, MK118 Rockeye, 81-mm mortar).

Large Ordnance: Caliber of ordnance greater than 81-mm (includes 105-mm HEAT, 105-mm projectile, 155-mm projectile, 500 pound bomb).

Shallow: Items buried less than 0.3 meters below ground surface.

Medium: Items buried greater than or equal to 0.3 meters and less than 1 meter below ground surface.

Deep: Items buried greater than or equal to 1 meter below ground surface.

Response Stage Noise Level: The level that represents the point below which anomalies are not considered detectable. Demonstrators are required to provide the recommended noise level for the Blind Test Grid area.

Discrimination Stage Threshold: The demonstrator selected threshold level that they believe provides optimum performance of the system by retaining all detectable ordnance and rejecting the maximum amount of clutter. This level defines the subset of anomalies the demonstrator would recommend digging based on discrimination.

Binomially Distributed Random Variable: A random variable of the type which has only two possible outcomes, say success and failure, is repeated for n independent trials with the probability p of success and the probability 1-p of failure being the same for each trial. The number of successes x observed in the n trials is an estimate of p and is considered to be a binomially distributed random variable.

RESPONSE AND DISCRIMINATION STAGE DATA

The scoring of the demonstrator's performance is conducted in two stages. These two stages are termed the RESPONSE STAGE and DISCRIMINATION STAGE. For both stages, the probability of detection (P_d) and the false alarms are reported as receiver operating characteristic (ROC) curves. False alarms are divided into those anomalies that correspond to emplaced clutter items, measuring the probability of false positive (P_{fp}) and those that do not correspond to any known item, termed background alarms.

The RESPONSE STAGE scoring evaluates the ability of the system to detect emplaced targets without regard to ability to discriminate ordnance from other anomalies. For the RESPONSE STAGE, the demonstrator provides the scoring committee with the location and signal strength of all anomalies that the demonstrator has deemed sufficient to warrant further investigation and/or processing as potential emplaced ordnance items. This list is generated with minimal processing (e.g., this list will include all signals above the system noise threshold). As such, it represents the most inclusive list of anomalies.

The DISCRIMINATION STAGE evaluates the demonstrator's ability to correctly identify ordnance as such, and to reject clutter. For the same locations as in the RESPONSE STAGE anomaly list, the DISCRIMINATION STAGE list contains the output of the algorithms applied in the discrimination-stage processing. This list is prioritized based on the demonstrator's determination that an anomaly location is likely to contain ordnance. Thus, higher output values are indicative of higher confidence that an ordnance item is present at the specified location. For electronic signal processing, priority ranking is based on algorithm output. For other systems, priority ranking is based on human judgment. The demonstrator also selects the threshold that the demonstrator believes will provide "optimum" system performance, (i.e., that retains all the detected ordnance and rejects the maximum amount of clutter).

Note: The two lists provided by the demonstrator contain identical numbers of potential target locations. They differ only in the priority ranking of the declarations.

RESPONSE STAGE DEFINITIONS

Response Stage Probability of Detection (P_d^{res}): P_d^{res} = (No. of response-stage detections)/(No.of emplaced ordnance in the test site).

Response Stage False Positive (fp^{res}): An anomaly location that is within R_{halo} of an emplaced clutter item.

Response Stage Probability of False Positive (P_{fp}^{res}): P_{fp}^{res} = (No. of response-stage false positives)/(No. of emplaced clutter items).

Response Stage Background Alarm (ba^{res}): An anomaly in a blind grid cell that contains neither emplaced ordnance nor an emplaced clutter item. An anomaly location in the open field or scenarios that is outside R_{halo} of any emplaced ordnance or emplaced clutter item.

Response Stage Probability of Background Alarm (P_{ba}^{res}): Blind Grid only: P_{ba}^{res} = (No. of response-stage background alarms)/(No. of empty grid locations).

Response Stage Background Alarm Rate (BAR^{res}): Open Field only: BAR^{res} = (No. of response-stage background alarms)/(arbitrary constant).

Note that the quantities P_d^{res}, P_{fp}^{res}, P_{ba}^{res}, and BAR^{res} are functions of t^{res}, the threshold applied to the response-stage signal strength. These quantities can therefore be written as $P_d^{res}(t^{res})$, $P_{fp}^{res}(t^{res})$, $P_{ba}^{res}(t^{res})$, and $BAR^{res}(t^{res})$.

DISCRIMINATION STAGE DEFINITIONS

Discrimination: The application of a signal processing algorithm or human judgment to response-stage data that discriminates ordnance from clutter. Discrimination should identify anomalies that the demonstrator has high confidence correspond to ordnance, as well as those that the demonstrator has high confidence correspond to nonordnance or background returns. The former should be ranked with highest priority and the latter with lowest.

Discrimination Stage Probability of Detection (P_d^{disc}): P_d^{disc} = (No. of discrimination-stage detections)/(No. of emplaced ordnance in the test site).

Discrimination Stage False Positive (fp^{disc}): An anomaly location that is within R_{halo} of an emplaced clutter item.

Discrimination Stage Probability of False Positive (P_{fp}^{disc}): P_{fp}^{disc} = (No. of discrimination stage false positives)/(No. of emplaced clutter items).

Discrimination Stage Background Alarm (ba^{disc}): An anomaly in a blind grid cell that contains neither emplaced ordnance nor an emplaced clutter item. An anomaly location in the open field or scenarios that is outside R_{halo} of any emplaced ordnance or emplaced clutter item.

Discrimination Stage Probability of Background Alarm (P_{ba}^{disc}): P_{ba}^{disc} = (No. of discrimination-stage background alarms)/(No. of empty grid locations).

Discrimination Stage Background Alarm Rate (BAR^{disc}): BAR^{disc} = (No. of discrimination-stage background alarms)/(arbitrary constant).

Note that the quantities P_d^{disc}, P_{fp}^{disc}, P_{ba}^{disc}, and BAR^{disc} are functions of t^{disc}, the threshold applied to the discrimination-stage signal strength. These quantities can therefore be written as $P_d^{disc}(t^{disc})$, $P_{fp}^{disc}(t^{disc})$, $P_{ba}^{disc}(t^{disc})$, and $BAR^{disc}(t^{disc})$.

RECEIVER-OPERATING CHARACERISTIC (ROC) CURVES

ROC curves at both the response and discrimination stages can be constructed based on the above definitions. The ROC curves plot the relationship between P_d vs. P_{fp} and P_d vs. BAR or P_{ba} as the threshold applied to the signal strength is varied from its minimum (t_{min}) to its maximum (t_{max}) value.[1] Figure 1 shows how P_d vs. P_{fp} and P_d vs. BAR are combined into ROC curves. Note that the "res" and "disc" superscripts have been suppressed from all the variables for clarity.

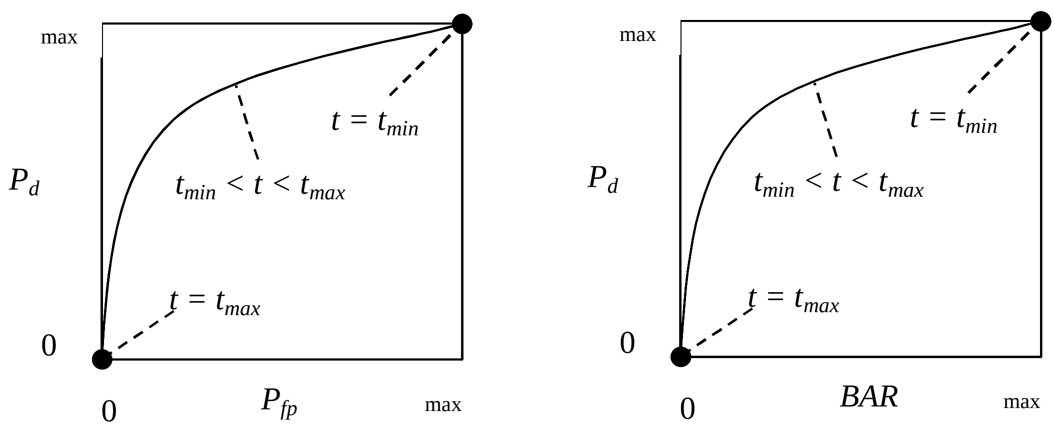

Figure A-1. ROC curves for open-field testing. Each curve applies to both the response and discrimination stages.

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[1]Strictly speaking, ROC curves plot the P_d vs. P_{ba} over a pre-determined and fixed number of detection opportunities (some of the opportunities are located over ordnance and others are located over clutter or blank spots). In an open field scenario, each system suppresses its signal strength reports until some bare-minimum signal response is received by the system. Consequently, the open field ROC curves do not have information from low signal-output locations, and, furthermore, different contractors report their signals over a different set of locations on the ground. These ROC curves are thus not true to the strict definition of ROC curves as defined in textbooks on detection theory. Note, however, that the ROC curves obtained in the Blind Test Grid sites are true ROC curves.

METRICS TO CHARACTERIZE THE DISCRIMINATION STAGE

The demonstrator is also scored on efficiency and rejection ratio, which measure the effectiveness of the discrimination stage processing. The goal of discrimination is to retain the greatest number of ordnance detections from the anomaly list, while rejecting the maximum number of anomalies arising from nonordnance items. The efficiency measures the amount of detected ordnance retained by the discrimination, while the rejection ratio measures the fraction of false alarms rejected. Both measures are defined relative to the entire response list, i.e., the maximum ordnance detectable by the sensor and its accompanying false positive rate or background alarm rate.

Efficiency (E): $E = P_d^{disc}(t^{disc})/P_d^{res}(t_{min}^{res})$; Measures (at a threshold of interest), the degree to which the maximum theoretical detection performance of the sensor system (as determined by the response stage tmin) is preserved after application of discrimination techniques. Efficiency is a number between 0 and 1. An efficiency of 1 implies that all of the ordnance initially detected in the response stage was retained at the specified threshold in the discrimination stage, t^{disc}.

False Positive Rejection Rate (R_{fp}): $R_{fp} = 1 - [P_{fp}^{disc}(t^{disc})/P_{fp}^{res}(t_{min}^{res})]$; Measures (at a threshold of interest), the degree to which the sensor system's false positive performance is improved over the maximum false positive performance (as determined by the response stage tmin). The rejection rate is a number between 0 and 1. A rejection rate of 1 implies that all emplaced clutter initially detected in the response stage were correctly rejected at the specified threshold in the discrimination stage.

Background Alarm Rejection Rate (R_{ba}):

BLIND GRID: $R_{ba} = 1 - [P_{ba}^{disc}(t^{disc})/P_{ba}^{res}(t_{min}^{res})]$
OPEN FIELD: $R_{ba} = 1 - [BAR^{disc}(t^{disc})/BAR^{res}(t_{min}^{res})])$

Measures the degree to which the discrimination stage correctly rejects background alarms initially detected in the response stage. The rejection rate is a number between 0 and 1. A rejection rate of 1 implies that all background alarms initially detected in the response stage were rejected at the specified threshold in the discrimination stage.

APPENDIX B. DAILY WEATHER LOGS

TABLE B-1. WEATHER LOG

DCP 7 Data from Phillips Airfield							
Date	Time, EDST	Average Temperature, °F	Maximum Temperature, °F	Minimum Temperature, °F	RH, %	Station Pressure, in. Hg	Precipitation, in.
7-Oct-2002	2:00	66.3	66.7	65.8	83	30.00	0.00
7-Oct-2002	3:00	66.4	66.7	66.0	84	29.99	0.00
7-Oct-2002	4:00	66.1	66.5	65.7	86	29.96	0.00
7-Oct-2002	5:00	66.1	66.6	65.6	88	29.94	0.00
7-Oct-2002	6:00	66.6	67.1	66.1	89	29.93	0.00
7-Oct-2002	7:00	66.8	67.2	66.0	91	29.93	0.00
7-Oct-2002	8:00	67.1	69.3	65.9	92	29.92	0.00
7-Oct-2002	9:00	69.8	70.4	68.9	83	29.92	0.00
7-Oct-2002	10:00	71.3	72.6	70.0	79	29.92	0.00
7-Oct-2002	11:00	73.6	75.1	72.1	72	29.92	0.00
7-Oct-2002	12:00	74.6	76.4	72.9	63	29.92	0.00
7-Oct-2002	13:00	77.0	78.0	75.3	50	29.91	0.00
7-Oct-2002	14:00	77.4	78.3	76.1	46	29.90	0.00
7-Oct-2002	15:00	75.5	76.7	74.0	47	29.90	0.00
7-Oct-2002	16:00	73.4	74.4	72.4	48	29.91	0.00
7-Oct-2002	17:00	73.0	73.9	72.3	50	29.92	0.00
7-Oct-2002	18:00	71.5	72.8	70.2	48	29.94	0.00
7-Oct-2002	19:00	68.3	70.5	66.0	48	29.97	0.00
7-Oct-2002	20:00	64.1	66.0	62.2	49	30.00	0.00
7-Oct-2002	21:00	61.1	62.7	59.5	51	30.02	0.00
7-Oct-2002	22:00	56.7	59.8	54.9	63	30.04	0.00
7-Oct-2002	23:00	55.9	56.8	54.0	64	30.05	0.00
7-Oct-2002	23:59	56.2	57.7	53.2	61	30.05	0.00
8-Oct-2002	1:00	56.9	57.8	56.3	58	30.07	0.00
8-Oct-2002	2:00	55.8	56.6	54.8	59	30.09	0.00
8-Oct-2002	3:00	54.4	55.0	53.8	61	30.11	0.00
8-Oct-2002	4:00	52.7	54.0	51.7	64	30.12	0.00
8-Oct-2002	5:00	51.4	52.7	49.3	63	30.13	0.00
8-Oct-2002	6:00	48.9	50.2	48.1	69	30.15	0.00
8-Oct-2002	7:00	48.3	49.7	47.4	70	30.17	0.00
8-Oct-2002	8:00	49.9	50.8	49.2	64	30.20	0.00
8-Oct-2002	9:00	52.3	53.9	50.3	60	30.22	0.00
8-Oct-2002	10:00	55.1	56.4	53.5	56	30.25	0.00
8-Oct-2002	11:00	56.9	57.8	56.2	55	30.25	0.00
8-Oct-2002	12:00	58.8	60.7	57.2	48	30.25	0.00
8-Oct-2002	13:00	60.7	62.0	58.6	41	30.24	0.00
8-Oct-2002	14:00	61.7	62.9	60.8	40	30.22	0.00
8-Oct-2002	15:00	62.3	63.6	61.2	40	30.21	0.00

TABLE B-1 (CONT'D)

DCP 7 Data from Phillips Airfield							
Date	Time, EDST	Average Temperature, °F	Maximum Temperature, °F	Minimum Temperature, °F	RH, %	Station Pressure, in. Hg	Precipitation, in.
8-Oct-2002	16:00	63.4	63.9	62.7	38	30.19	0.00
8-Oct-2002	17:00	63.9	64.6	63.1	39	30.19	0.00
8-Oct-2002	18:00	62.6	64.1	60.3	44	30.18	0.00
8-Oct-2002	19:00	58.4	60.9	54.3	54	30.18	0.00
8-Oct-2002	20:00	54.4	55.5	51.5	66	30.20	0.00
8-Oct-2002	21:00	50.7	51.7	50.0	80	30.21	0.00
8-Oct-2002	22:00	48.9	50.4	48.0	85	30.22	0.00
8-Oct-2002	23:00	47.3	48.1	46.2	89	30.22	0.00
8-Oct-2002	23:59	47.5	48.9	46.4	88	30.22	0.00
9-Oct-2002	1:00	48.7	49.2	47.9	86	30.22	0.00
9-Oct-2002	2:00	48.3	48.9	47.6	89	30.22	0.00
9-Oct-2002	3:00	48.1	49.4	47.4	90	30.22	0.00
9-Oct-2002	4:00	49.5	50.3	48.3	89	30.21	0.00
9-Oct-2002	5:00	47.9	49.8	46.0	94	30.21	0.00
9-Oct-2002	6:00	46.1	46.8	45.6	97	30.21	0.00
9-Oct-2002	7:00	47.4	49.8	46.2	97	30.23	0.00
9-Oct-2002	8:00	51.8	53.2	49.6	90	30.24	0.00
9-Oct-2002	9:00	54.5	55.9	52.7	88	30.25	0.00
9-Oct-2002	10:00	56.1	57.3	55.1	83	30.25	0.00
9-Oct-2002	11:00	58.6	60.2	57.1	77	30.25	0.00
9-Oct-2002	12:00	60.5	61.0	59.8	74	30.24	0.00
9-Oct-2002	13:00	62.1	63.4	60.9	73	30.23	0.00
9-Oct-2002	14:00	63.5	64.4	62.8	73	30.22	0.00
9-Oct-2002	15:00	64.4	65.0	63.9	74	30.20	0.00
9-Oct-2002	16:00	64.4	64.7	64.0	77	30.20	0.00
9-Oct-2002	17:00	64.7	65.1	64.3	78	30.19	0.00
9-Oct-2002	18:00	63.5	64.5	63.1	84	30.19	0.00
9-Oct-2002	19:00	63.2	63.9	62.4	89	30.19	0.00
9-Oct-2002	20:00	62.0	62.7	61.4	95	30.19	0.00
9-Oct-2002	21:00	61.5	61.9	61.3	95	30.19	0.00
9-Oct-2002	22:00	61.7	62.1	61.3	96	30.20	0.00
9-Oct-2002	23:00	62.0	62.3	61.5	97	30.20	0.00
9-Oct-2002	23:59	62.2	62.6	61.6	97	30.19	0.00
10-Oct-2002	1:00	61.8	62.2	61.5	97	30.19	0.00
10-Oct-2002	2:00	61.6	62.2	61.0	97	30.20	0.00
10-Oct-2002	3:00	61.0	61.4	60.7	98	30.19	0.00
10-Oct-2002	4:00	60.9	61.4	60.5	99	30.17	0.00
10-Oct-2002	5:00	61.0	61.6	60.5	98	30.17	0.00
10-Oct-2002	6:00	61.4	61.8	61.0	98	30.19	0.00
10-Oct-2002	7:00	61.5	62.1	60.9	98	30.19	0.00
10-Oct-2002	8:00	62.0	62.3	61.6	99	30.20	0.00

TABLE B-1 (CONT'D)

DCP 7 Data from Phillips Airfield							
Date	Time, EDST	Average Temperature, °F	Maximum Temperature, °F	Minimum Temperature, °F	RH, %	Station Pressure, in. Hg	Precipitation, in.
10-Oct-2002	9:00	62.2	62.6	61.7	99	30.21	0.00
10-Oct-2002	10:00	62.5	62.9	62.1	100	30.22	0.00
10-Oct-2002	11:00	63.0	63.4	62.3	100	30.22	0.00
10-Oct-2002	12:00	63.3	63.9	62.9	100	30.22	0.00
10-Oct-2002	13:00	64.0	64.6	63.4	100	30.21	0.11
10-Oct-2002	14:00	64.7	65.3	64.1	99	30.19	0.06
10-Oct-2002	15:00	64.8	65.3	64.5	98	30.18	0.07
10-Oct-2002	16:00	65.0	65.6	64.6	98	30.17	0.03
10-Oct-2002	17:00	65.2	65.7	64.7	97	30.16	0.01
10-Oct-2002	18:00	65.1	65.4	64.8	97	30.17	0.00
10-Oct-2002	19:00	65.1	65.4	64.7	97	30.17	0.02
10-Oct-2002	20:00	64.7	65.2	64.3	98	30.17	0.05
10-Oct-2002	21:00	64.4	64.9	63.9	98	30.17	0.02
10-Oct-2002	22:00	64.1	64.4	63.9	99	30.16	0.02
10-Oct-2002	23:00	64.0	64.4	63.8	99	30.16	0.12
10-Oct-2002	23:59	63.8	64.1	63.4	99	30.15	0.10
11-Oct-2002	1:00	63.6	64.0	63.3	99	30.14	0.13
11-Oct-2002	2:00	63.7	64.1	63.4	99	30.13	0.17
11-Oct-2002	3:00	63.7	64.0	63.4	99	30.11	0.11
11-Oct-2002	4:00	63.8	64.1	63.4	99	30.10	0.23
11-Oct-2002	5:00	64.0	64.5	63.6	100	30.09	0.13
11-Oct-2002	6:00	64.4	65.1	64.0	100	30.09	0.07
11-Oct-2002	7:00	64.8	65.7	63.9	100	30.09	0.31
11-Oct-2002	8:00	64.0	64.5	63.8	100	30.09	0.25
11-Oct-2002	9:00	64.3	65.2	63.9	100	30.10	0.31
11-Oct-2002	10:00	63.6	65.1	62.8	100	30.10	0.41
11-Oct-2002	11:00	63.3	63.6	63.0	100	30.10	0.16
11-Oct-2002	12:00	63.8	64.1	63.3	100	30.10	0.09
11-Oct-2002	13:00	64.1	64.5	63.6	100	30.09	0.04
11-Oct-2002	14:00	64.9	65.8	64.1	100	30.07	0.05
11-Oct-2002	15:00	66.2	67.2	65.2	100	30.05	0.01
11-Oct-2002	16:00	67.2	67.9	66.6	100	30.03	0.00
11-Oct-2002	17:00	67.2	67.7	66.7	100	30.03	0.00
11-Oct-2002	18:00	67.0	67.7	66.6	100	30.03	0.00
11-Oct-2002	19:00	66.9	67.3	66.5	100	30.03	0.00
11-Oct-2002	20:00	67.8	68.4	67.0	100	30.03	0.01
11-Oct-2002	21:00	68.2	68.5	67.7	100	30.04	0.01
11-Oct-2002	22:00	67.9	68.2	67.6	100	30.04	0.00
11-Oct-2002	23:00	67.5	68.2	66.6	99	30.04	0.09
11-Oct-2002	23:59	66.7	67.1	66.3	98	30.03	0.01
							3.20

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APPENDIX C. SOIL MOISTURE

UXO SOIL MOISTURE PROBES DATA
10/23/2002

Rec#: 36

1. Item ID (Vender) GEO CENTER   2. Date: 10/08/2002

3. Start Time: 758   4. Stop Time 815

5. Data Collectors Name

-------------------- REPEAT SECTION --------------------

	Morning % Moisture	Afternoon % Moisture
Wet Area	Time: 815	Time: 0
1	17.3	0.0
2	20.3	0.0
3	19.6	0.0
4	34.8	0.0
5	52.4	0.0
Tree Area	Time: 807	Time: 0
1	11.1	0.0
2	12.3	0.0
3	14.8	0.0
4	4.7	0.0
5	0.4	0.0
Other Area	Time: 758	Time: 0
1	14.5	0.0
2	8.8	0.0
3	0.3	0.0
4	26.8	0.0
5	9.9	0.0

UXO SOIL MOISTURE PROBES DATA

Rec#: 39

1. Item ID (Vender) GEO CENTER   2. Date: 10/09/2002

3. Start Time: 749   4. Stop Time 1357

5. Data Collectors Name

-------------------- REPEAT SECTION --------------------

	Morning % Moisture		Afternoon % Moisture	
Wet Area	Time:	804	Time:	1357
1		16.8		16.5
2		20.5		20.0
3		18.6		18.4
4		4.5		4.5
5		4.6		4.6
Tree Area	Time:	757	Time:	1348
1		11.4		10.8
2		11.1		11.1
3		14.8		14.8
4		4.5		4.8
5		0.4		0.5
Other Area	Time:	749	Time:	1339
1		13.7		13.7
2		8.8		10.0
3		0.3		0.5
4		26.8		26.4
5		9.6		9.9

UXO SOIL MOISTURE PROBES DATA

Rec#: 40

1. Item ID (Vender) GEO CENTER   2. Date: 10/10/2002

3. Start Time: 733   4. Stop Time 1415

5. Data Collectors Name

-------------------- REPEAT SECTION --------------------

	Morning % Moisture		Afternoon % Moisture	
Wet Area	Time:	800	Time:	1415
1		17.6		25.9
2		20.3		19.1
3		18.6		18.9
4		33.2		33.2
5		48.9		48.1

Tree Area	Time: 733	Time: 1408
1	10.8	36.1
2	10.8	64.8
3	14.2	25.4
4	4.8	5.9
5	0.5	4.6

Other Area	Time: 745	Time: 1400
1	15.4	27.6
2	9.4	13.1
3	0.3	0.3
4	26.2	26.1
5	9.9	9.6

APPENDIX D. DAILY ACTIVITY LOGS

Date	No. of People	Area-Tested	Status Start Time	Status Stop Time	Duration min.	Operational Status Code	Operational Status	Operational Status Comments	Track Method	Track Method=Other Explain	Pattern	Field Conditions	
20021007	2	NA	1400	1425	25	1	INITIAL SET-UP	EQUIPMENT SET UP/ START OF TEST OPERATIONS	OTHER	NA	NA	NA	NA
20021007	2	NA	1425	1500	35	1	INITIAL SET-UP	GPS BASE STATION SET UP	OTHER	NA	NA	NA	NA
20021007	2	NA	1500	1520	20	1	INITIAL SET-UP	SET UP MAGNETOMETER TO THE GPS	OTHER	NA	NA	NA	NA
20021007	2	CALIBRATION LANES	1520	1550	30	1	INITIAL SET UP	PREPARE FOR THE FIRST RUN	PIN FLAGS	FLAGS	NA	NA	NA
20021007	2	CALIBRATION LANES	1550	1625	35	2	COLLECTING DATA		PIN FLAGS	FLAGS	LINEAR	CLEAR/UNLIMITED	DRY
20021007	2	CALIBRATION LANES	1625	1630	5	5	DOWNTIME DUE TO EQUIP MAINT/CHECK	EQUIPMENT CHECK	OTHER	NA	NA	NA	NA
20021007	2	CALIBRATION LANES	1630	1642	12	2	CALIBRATION	MAPPING 4 CORNERS OF CALIBRATION GRID USING GPS	OTHER	NA	NA	NA	NA
20021007	2	CALIBRATION LANES	1642	1655	13	2	CALIBRATION	COIL MAPPING FROM THE TOW VEHICLE USING GPS	OTHER	NA	NA	NA	NA
20021007	2	CALIBRATION LANES	1655	1700	5	4	COLLECTING DATA		PIN FLAGS	FLAGS	LINEAR	CLEAR/UNLIMITED	DRY
20021007	2	CALIBRATION LANES	1700	1715	15	3	DAILY START, STOP	END OF DAILY OPERATIONS / EQUIPMENT BREAKDOWN	OTHER	NA	NA	NA	NA
20021008	2	CALIBRATION LANES	700	755	55	3	DAILY START, STOP	START OF DAILY OPERATIONS / EQUIPMENT PRERPARATIONS	OTHER	NA	NA	NA	NA
20021008	2	CALIBRATION LANES	755	810	15	7	DOWNTIME DUE TO EQUIP MAINT/CHECK	ADDED 4 GALLONS OF REGULAR UNLEADED GASOLINE TO TOW VEHICLE	OTHER	NA	NA	NA	NA

Date	No. of People	Area-Tested	Status Start Time	Status Stop Time	Duration min.	Operational Status Code	Operational Status	Operational Status Comments	Track Method	Track Method=Other Explain	Pattern	Field Conditions	
20021008	2	CALIBRATION LANES	810	840	30	7	DOWNTIME DUE TO EQUIP MAINT/CHECK		PIN FLAGS	NA	NA	NA	NA
20021008	2	BLIND TEST GRID	840	910	30	4	COLLECTING DATA		PIN FLAGS	FLAGS	LINEAR	CLEAR/UNLIMITED	DRY
20021008	2	BLIND TEST GRID	910	920	10	4	Collecting Data	MAPPING 4 CORNERS OF THE BLIND GRID USING GPS	GPS	NA	NA	NA	NA
20021008	2	BLIND TEST GRID	920	935	15	7	DOWNTIME DUE TO EQUIP MAINT/CHECK		OTHER	NA	NA	NA	NA
20021008	2	BLIND TEST GRID	935	1110	95	7	DOWNTIME DUE TO EQUIP MAINT/CHECK	CHECKING DATA FROM THE DATA DUMP / EQUIPMENT CHECK	OTHER	NA	NA	NA	NA
20021008	2	BLIND TEST GRID	1110	1120	10	7	DOWNTIME DUE TO EQUIP MAINT/CHECK	CHECKING EM61 ELECTRONICS SYSTEM / EQUIPMENT CHECK	OTHER	NA	NA	NA	NA
20021008	2	BLIND TEST GRID	1120	1300	100	7	DOWNTIME DUE TO EQUIP MAINT/CHECK	REPLACED LAP-TOP IN THE TOW VEHICLE / EQUIPMENT CHECK	OTHER	NA	NA	NA	NA
20021008	2	BLIND TEST GRID	1300	1310	10	5	BREAK/LUNCH	LUNCH BREAK	OTHER	NA	NA	NA	NA
20021008	2	BLIND TEST GRID	1310	1315	5	7	DOWNTIME DUE TO EQUIP MAINT/CHECK		PIN FLAGS	NA	NA	NA	NA
20021008	2	CALIBRATION LANES	1315	1341	26	4	COLLECTING DATA	COLLECTING DATA USING MAGNETOMETER ONLY / NO EM61 ELEC SYSTEM	OTHER	NA	NA	CLEAR/UNLIMITED	DRY
20021008	2	CALIBRATION LANES	1341	1415	34	7	DOWNTIME DUE TO EQUIP MAINT/CHECK	DATA CHECK	OTHER	NA	NA	NA	NA

Date	No. of People	Area-Tested	Status Start Time	Status Stop Time	Duration min.	Operational Status Code	Operational Status	Operational Status Comments	Track Method	Track Method=Other Explain	Pattern	Field Conditions	
20021008	2	CALIBRATION LANES	1415	1430	15	7	DOWNTIME DUE TO EQUIP MAINT/CHECK		OTHER	NA	NA	NA	NA
20021008	2	CALIBRATION LANES	1430	1450	20	3	DAILY START, STOP	END OF DAILY OPERATIONS / EQUIPMENT BREAKDOWN	OTHER	NA	NA	NA	NA
20021009	2	BLIND TEST GRID	700	1047	227	6	DOWNTIME DUE TO EQUIPMENT FAILURE	WAITING FOR REPLACEMENT PARST TO ARRIVE FROM AIRBORNE	OTHER	NA	NA	NA	NA
20021009	2	BLIND TEST GRID	1047	1132	45	6	DOWNTIME DUE TO EQUIPMENT FAILURE	REPLACING EM61 ELECTRONICS SYSTEM	OTHER	NA	NA	NA	NA
20021009	2	BLIND TEST GRID	1132	1140	8	7	DOWNTIME DUE TO EQUIP MAINT/CHECK	PREPARING FOR THE FIRST RUN OF THE DAY WITH REPLACEMENT PART	OTHER	NA	NA	NA	NA
20021009	2	BLIND TEST GRID	1140	1220	40	4	COLLECTING DATA		PIN FLAGS	FLAGS	LINEAR	CLEAR/UNLIMITED	DRY
20021009	2	BLIND TEST GRID	1220	1225	5	7	DOWNTIME DUE TO EQUIP MAINT/CHECK	DATA CHECK	OTHER	NA	NA	NA	NA
20021009	2	BLIND TEST GRID	1225	1240	15	7	DOWNTIME DUE TO EQUIP MAINT/CHECK		OTHER	NA	NA	NA	NA
20021009	2	BLIND TEST GRID	1240	1340	60	7	DOWNTIME DUE TO EQUIP MAINT/CHECK	EQUIPMENT CHECK	OTHER	NA	NA	NA	NA
20021009	2	OPEN FIELD	1340	1350	10	7	DOWNTIME DUE TO EQUIP MAINT/CHECK		PIN FLAGS	FLAGS	NA	NA	NA
20021009	2	OPEN FIELD	1350	1515	85	4	COLLECTING DATA		PIN FLAGS	FLAGS	LINEAR	CLEAR/UNLIMITED	DRY
20021009	2	OPEN FIELD	1515	1525	10	7	DOWNTIME DUE TO EQUIP MAINT/CHECK	TOW VEHICLE STUCK IN DITCH / NEEDED TO BE TOWED OUT	OTHER	NA	NA	NA	NA

Date	No. of People	Area-Tested	Status Start Time	Status Stop Time	Duration min.	Operational Status Code	Operational Status	Operational Status Comments	Track Method	Track Method=Other Explain	Pattern	Field Conditions	
20021009	2	OPEN FIELD	1525	1540	15	7	DOWNTIME DUE TO EQUIP MAINT/CHECK		OTHER	NA	NA	NOT APPLICABLE	NA
20021009	2	OPEN FIELD	1540	1620	40	4	COLLECTING DATA		PIN FLAGS	FLAGS	LINEAR	CLEAR/UNLIMITED	DRY
20021009	2	OPEN FIELD	1620	1635	15	3	DAILY START, STOP	END OF DAILY OPERATIONS / EQUIPMENT BREAKDOWN	OTHER	NA	NA	NA	NA
20021010	1	OPEN FIELD	700	810	70	3	DAILY START, STOP	START OF DAILY OPERATIONS / EQUIPMENT SET UP	OTHER	NA	NA	NA	NA
20021010	1	OPEN FIELD	810	820	10	7	DOWNTIME DUE TO EQUIP MAINT/CHECK	PREPARE FOR FIRST RUN OF THE DAILY OPERATIONS	OTHER	NA	NA	NA	NA
20021010	1	OPEN FIELD	820	1051	151	4	COLLECTING DATA		PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	MINE GRID	1051	1051	0	4	COLLECTING DATA	PASSED THRU MINE GRID WHILE IN THE OPEN FIELD	PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	OPEN FIELD	1051	1100	9	4	COLLECTING DATA		PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	MINE GRID	1100	1100	0	4	COLLECTING DATA	PASSED THRU MINE GRID WHILE IN THE OPEN FIELD	PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	OPEN FIELD	1100	1101	1	4	COLLECTING DATA		PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	MINE GRID	1101	1101	0	4	COLLECTING DATA	PASSED THRU MINE GRID WHILE IN OPEN FIELD	PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	OPEN FIELD	1101	1110	9	4	COLLECTING DATA		PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	MINE GRID	1110	1110	0	4	COLLECTING DATA	PASSED THRU MINE GRID WHILE IN OPEN FIELD	PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET

Date	No. of People	Area-Tested	Status Start Time	Status Stop Time	Duration min.	Operational Status Code	Operational Status	Operational Status Comments	Track Method	Track Method=Other Explain	Pattern	Field Conditions	
20021010	1	OPEN FIELD	1110	1110	0	4	COLLECTING DATA		PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	OPEN FIELD	1110	1116	6	7	DOWNTIME DUE TO EQUIP MAINT/CHECK	DATA CHECK / NO ACTION	OTHER	NA	NA	NA	NA
20021010	1	OPEN FIELD	1116	1116	0	4	COLLECTING DATA		PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	MINE GRID	1116	1117	1	4	COLLECTING DATA	PASSED THRU MINE GRID WHILE IN THE OPEN FIELD	PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	OPEN FIELD	1117	1121	4	4	COLLECTING DATA		PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	MINE GRID	1121	1121	0	4	COLLECTING DATA	PASSED THRU MINE GRID WHILE IN THE OPEN FIELD	PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	OPEN FIELD	1121	1122	1	4	COLLECTING DATA		PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	MINE GRID	1122	1123	1	4	COLLECTING DATA	PASSED THRU MINE GRID WHILE IN THE OPEN FIELD	PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	OPEN FIELD	1123	1139	16	4	COLLECTING DATA	FENCE CHALLENGE AREA INCLUDED IN DATA RUN	PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	MINE GRID	1139	1139	0	4	COLLECTING DATA	PASSED THRU MINE GRID WHILE IN THE OPEN FIELD	PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	OPEN FIELD	1139	1140	1	4	COLLECTING DATA		PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	MINE GRID	1140	1140	0	4	COLLECTING DATA	PASSED THRU MINE GRID WHILE IN THE OPEN FIELD	PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	OPEN FIELD	1140	1141	1	4	COLLECTING DATA	FENCE CHALLENGE AREA INCLUDED IN THE DATA RUN	PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET

Date	No. of People	Area-Tested	Status Start Time	Status Stop Time	Duration min.	Operational Status Code	Operational Status	Operational Status Comments	Track Method	Track Method=Other Explain	Pattern	Field Conditions	
20021010	1	OPEN FIELD	1141	1150	9	7	DOWNTIME DUE TO EQUIP MAINT/CHECK	TOW VEHICLE STUCK IN A DITCH / NEEDED TO BE TOWED OUT	OTHER	NA	NA	NA	NA
20021010	1	OPEN FIELD	1150	1155	5	4	COLLECTING DATA		PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	MINE GRID	1155	1155	0	4	COLLECTING DATA	PASSED THRU MINE GRID WHILE IN THE OPEN FIELD	PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	OPEN FIELD	1155	1156	1	4	COLLECTING DATA		PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	MINE GRID	1156	1156	0	4	COLLECTING DATA	PASSED THRU MINE GRID WHILE IN THE OPEN FIELD	PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	OPEN FIELD	1156	1203	7	4	COLLECTING DATA		PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	MINE GRID	1203	1203	0	4	COLLECTING DATA	PASSED THRU MINE GRID WHILE IN THE OPEN FIELD	PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	OPEN FIELD	1203	1204	1	4	COLLECTING DATA		PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	MINE GRID	1204	1204	0	4	COLLECTING DATA	PASSED THRU MINE GRID WHILE IN THE OPEN FIELD	PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	OPEN FIELD	1204	1212	8	4	COLLECTING DATA		PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	OPEN FIELD	1212	1215	3	7	DOWNTIME DUE TO EQUIP MAINT/CHECK	NOT GETTING A GOOD SATILITE CONNECTION / NO ACTION	OTHER	NA	NA	NA	NA
20021010	1	OPEN FIELD	1215	1236	21	5	BREAK/LUNCH	LUNCH BREAK	OTHER	NA	NA	NA	NA
20021010	1	OPEN FIELD	1236	1308	32	7	DOWNTIME DUE TO EQUIP MAINT/CHECK	NOT GETTING A GOOD SATILITE CONNECTION / NO ACTION	OTHER	NA	NA	NA	NA

Date	No. of People	Area-Tested	Status Start Time	Status Stop Time	Duration min.	Operational Status Code	Operational Status	Operational Status Comments	Track Method	Track Method=Other Explain	Pattern	Field Conditions	
20021010	1	OPEN FIELD	1308	1312	4	4	COLLECTING DATA		PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	MINE GRID	1312	1313	1	4	COLLECTING DATA	PASSED THRU MINE GRID WHILE IN THE OPEN FIELD	PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	OPEN FIELD	1313	1313	0	4	COLLECTING DATA		PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	MINE GRID	1313	1314	1	4	COLLECTING DATA	PASSED THRU MINE GRID WHILE IN THE OPEN FIELD	PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	OPEN FIELD	1314	1320	6	4	COLLECTING DATA		PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	MINE GRID	1320	1320	0	4	COLLECTING DATA	PASSED THRU MINE GRID WHILE IN THE OPEN FIELD	PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	OPEN FIELD	1320	1320	0	4	COLLECTING DATA		PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	MINE GRID	1320	1321	1	4	COLLECTING DATA	PASSED THRU MINE GRID WHILE IN OPEN FIELD	PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	OPEN FIELD	1321	1326	5	4	COLLECTING DATA		PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	MINE GRID	1326	1326	0	4	COLLECTING DATA	PASSED THRU MINE GRID WHILE IN OPEN FIELD	PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	OPEN FIELD	1326	1326	0	4	COLLECTING DATA		PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	MINE GRID	1326	1326	0	4	COLLECTING DATA	PASSED THRU MINE GRID WHILE IN OPEN FIELD	PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	OPEN FIELD	1326	1352	26	4	COLLECTING DATA		PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	OPEN FIELD	1352	1400	8	7	DOWNTIME DUE TO EQUIP MAINT/CHECK	VEHICLE STUCK IN A DITCH / NEEDED TO BE TOWED OUT	OTHER	NA	NA	NA	NA

Date	No. of People	Area-Tested	Status Start Time	Status Stop Time	Duration min.	Operational Status Code	Operational Status	Operational Status Comments	Track Method	Track Method=Other Explain	Pattern	Field Conditions	
20021010	1	OPEN FIELD	1400	1432	32	4	COLLECTING DATA		PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	OPEN FIELD	1432	1450	18	7	DOWNTIME DUE TO EQUIP MAINT/CHECK	EQUIPMENT CHECK	OTHER	NA	NA	NA	NA
20021010	1	OPEN FIELD	1450	1602	72	7	DOWNTIME DUE TO EQUIP MAINT/CHECK	CHARGING THE BATTERY	OTHER	NA	AN	NA	NA
20021010	1	OPEN FIELD	1602	1605	3	7	DOWNTIME DUE TO EQUIP MAINT/CHECK	DATA CHECK	OTHER	NA	NA	NA	NA
20021010	1	OPEN FIELD	1605	1615	10	7	DOWNTIME DUE TO EQUIP MAINT/CHECK		OTHER	NA	NA	NA	NA
20021010	1	OPEN FIELD	1615	1715	60	4	COLLECTING DATA		PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	OPEN FIELD	1715	1750	35	4	COLLECTING DATA	PHONE LINE CHALLENGE AREA INCLUDED IN DATA RUN	PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	OPEN FIELD	1750	1830	40	4	COLLECTING DATA	GRAVEL CHALLENGE AREA INCLUDED IN DATA RUN	PIN FLAGS	FLAGS	LINEAR	RAIN/LIMITED	WET
20021010	1	OPEN FIELD	1830	1845	15	3	DAILY START, STOP	END OF DAILY OPERATIONS / EQUIPMENT BREAKDOWN	OTHER	NA	NA	NA	NA
20021011	2	OPEN FIELD	700	945	165	7	DOWNTIME DUE TO EQUIP MAINT/CHECK	DATA AND EQUIPMENT CHECK	OTHER	NA	NA	NA	NA
20021011	2	NA	945	1145	120	10	DEMOBILIZATION	BREAKDOWN OF OPERATIONS	OTHER	NA	NA	NA	NA

APPENDIX E. REFERENCES

1. Standardized UXO Technology Demonstration Site Handbook, DTC Project No. 8-CO-160-000-473, Report No. ATC-8349, March 2002.

2. Aberdeen Proving Ground Soil Survey Report, October 1998.

3. Data Summary, UXO Standardized Test Site: APG Soils Description, May 2002.

APPENDIX F. ABBREVIATIONS

AEC = U.S. Army Environmental Center
APG = Aberdeen Proving Ground
ATC = U.S. Army Aberdeen Test Center
EM = electromagnetic
ERDC = U.S. Army Corp of Engineers Engineering Research and Development Center
ESTCP = Environmental Security Technology Certification Program
EQT = Army Environmental Quality Technology Program
GPS = Global Positioning System
HEAT = high-explosive, antitank
Mag = Magnetometry
NS = nonstandard
POC = point of contact
QC = quality control
ROC = receiver-operating characteristic
SERDP = Strategic Environmental Research and Development Program
STOLS = Surface Towed Ordnance Location System
UTM = universal tranverse mercator
UXO = unexploded ordnance

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