AD NO. ____________________
DTC PROJECT NO. 8-CO-160-UXO-021
REPORT NO. ATC-8856

# STANDARDIZED

# UXO TECHNOLOGY DEMONSTRATION SITE

# BLIND GRID SCORING RECORD NO. 168

SITE LOCATION:
U.S. ARMY YUMA PROVING GROUND

DEMONSTRATOR:
TETRA TECH FOSTER WHEELER, INC.
143 UNION BLVD, SUITE 1010
LAKEWOOD, CO 80212

TECHNOLOGY TYPE/PLATFORM:
EM61 MKII/PUSHCART

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

SEPTEMBER 2004

Prepared for:
U.S. ARMY ENVIRONMENTAL CENTER
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**14. ABSTRACT**
This scoring record documents the efforts of Tetra Tech Foster Wheeler (TtFW) to detect and discriminate inert unexploded ordnance (UXO) utilizing the YPG Standardized UXO Technology Demonstration Site Blind Grid. The scoring record was coordinated by Larry Overbay and by the Standardized UXO Technology Demonstration Site Scoring Committee. Organizations on the committee included 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 (APG), Maryland and U.S. Army 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 (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. To determine detection and discrimination effectiveness under realistic scenarios that vary targets, geology, clutter, topography, and vegetation.

b. To determine cost, time, and manpower requirements to operate the technology.

c. To determine demonstrator's ability to analyze survey data in a timely manner and provide prioritized "Target Lists" with associated confidence levels.

d. To provide independent site management to enable the 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 rejects 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) Reacquisition/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 inert 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 |
| | M75 Submunition |

JPG = Jefferson Proving Ground.

## SECTION 2. DEMONSTRATION

### 2.1 DEMONSTRATOR INFORMATION

#### 2.1.1 Demonstrator Point of Contact (POC) and Address

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#### 2.1.2 System Description (provided by demonstrator)

The Geonics EM61 MKII TDEM geophysical sensor, CST, and Leica Series 1100 Robotic Total Station (RTS) laser positioning systems are proposed for APG. The EM61 MKII pushcart uses time domain technology to facilitate the detection and discrimination of metallic objects. Two coils, 100 by 100 cm, are oriented in a horizontal coplanar fashion and separated by a vertical distance of 40 cm. The system is utilized either on nonmagnetic wheels or as a man-portable unit (terrain-dependent) with the lower coil 40 cm above the ground surface. In general, a transmit pulse of uni-polar rectangular current (25 percent duty) of very short duration is applied to the lower coil. This primary current creates a primary magnetic field that induces eddy currents in nearby metal objects. The current flowing in the metal object creates a secondary magnetic field that is detected by both the lower and upper coils. The transmitter pulse frequency is 75 hertz (Hz), the pulse duration is 3.3 milliseconds, the peak power output is 50 watts, and the average power is 25 watts. Both coils possess zero decibels of gain.

The secondary magnetic field created by metal objects is sampled by the EM61 MKII electronics, which reside in the backpack, at times of 216 microseconds ($\mu$s), 366 $\mu$s, 660 $\mu$s on the bottom coil and 660 $\mu$s on the top coil after the turn-off of the transmit pulse. Digital data for these four individual time gates are integrated and recorded to a Juniper Allegro field computer at a rate of 12 Hz. The individual time gate data are converted into units of millivolts (mV), normalized, and gain is applied to each time gate by the EM61 MK2A software v1.22 on the Juniper Allegro field computer. Normalization and gain parameters are available in the EM61 MKII manual, Appendix B.

Safety hazards for the EM61 MKII equipment include electromagnetic radiation. The electromagnetic field of the system could potentially detonate some types of specialized ordnance. The Hazards of Electromagnetic Radiation to Ordnance (HERO) distance for the EM61 MKII pushcart is 20 cm. The ACE recommends a ground clearance of at least 40 cm when electrically fused ordnance is present.

The CST consists of four laser transmitters and a field computer for logging the position data via wireless modem. Four Trimble Spectra Precision LS920 Laser Transmitters are positioned in a diamond or square geometry over 1/2 to 1 acre depending upon the tree density. The transmitters are leveled, and an automatic routine calculates the relative x-y-z- plane between the transmitters to a tolerance of 1 inch or less. A laser detector "wand" (i.e., receiver) is centered over the EM61 MKII coils on a Tetra Tech Foster Wheeler (TtFW) designed fiberglass doghouse. The detector wand receives the laser pulses from the four transmitters simultaneously, and computes a position based on the known position of the laser transmitters. Only two of the laser transmitters are necessary to compute a reliable position to a relative accuracy of approximately 1 inch. The position data are updated at 2 to 3 Hz and sent via wireless modem to the field computer for storage. The Leica Series 1100 RTS consists of a laser-based total station survey instrument (transmitter), prism (receiver), and RCS 100 remote control. The transmitter is positioned over a ground position point of known location, and an x-y-z Cartesian coordinate system is defined by occupying an additional known ground position with the receiver prism. The receiver prism is mounted on a TtFW doghouse centered over the EM61 MKII coils, and the RTS automatically tracks the prism at distances of several thousand feet to an accuracy of approximately 1 inch. Position data for the receiver prism are updated at a rate of 3 to 4 Hz and stored on a Personal Computer Memory Card International Association (PCMCIA) card located on the robotic total station.

**EM61 MKII Pushcart and RTS Positioning System**

The EM61 MKII pushcart configured as a one man push-pull with wheels for repeatability testing at Fort McClellan, Alabama and in open areas with flat, smooth surfaces at APG (fig. 1).

Figure 1. Demonstrator's system, the EM61 MKII pushcart.

The positioning sensors mounted on the doghouse are differential Global Positioning System (DGPS) antenna (not to be used), USRADS crystal (not to be used), and RTS prism. This setup was used to directly compare the accuracy and repeatability of all three of the stated positioning systems for the ACE-Huntsville Division.

### 2.1.3 Data Processing Description (provided by demonstrator)

In the densely wooded area, the CST laser-based positioning system was integrated with the EM61 MKII geophysical sensor, and used as a two man tethered system, or in areas where the surface terrain was judged to be smooth, as a one-man pushcart. The four transmitters were organized in a diamond or square geometry over an area of 1/2 to 1 acre in size depending upon the area-specific vegetation density. At least two of the laser transmitter locations were surveyed with the RTS instrument (located at a known control point) in order to position the data in the requested coordinate system.

The RTS laser based system was used in conjunction with the EM61 MKII in the areas outside of the dense woods. The survey area was divided into two-acre plots (grids), and a wood survey lathe was positioned at predefined grid corners using the RTS.

For this demonstration, a transect spacing of no more than 2 to 2.5 feet was required when using the proposed geophysical sensor to detect and discriminate objects as small as 20-mm projectiles.

Several fiberglass tape measures were laid out perpendicular to the direction of the data acquisition transects at intervals of approximately 50 to 100 feet. Specially modified traffic cones were positioned along the intended transect at the measuring tape locations; the data acquisition crew used these cones as waypoints. When the crew reached a waypoint, the sensor operator moved the cone sideways to the next intended transect (2 to 2.5 ft to the side), and continued navigating to the next waypoint (cone) along the current transect. The acquisition crew proceeded a minimum of 10 feet outside of the intended survey area, reversed direction, and proceeded along the next intended transect. When an obstacle was encountered, the sensor operator paused for 1 second, stepped around the obstacle, and paused for an additional second. In this manner, the highest quality spatial data was obtained around obstacles. In areas where rough terrain was present (moguls, slopes, etc.) pin flags were employed rather than traffic cones, at intervals of 25 feet.

A Juniper Allegro ruggedized data collector recorded the EM61 MKII data at 12 Hz. At a normal acquisition speed of 3 feet per second, samples along each acquisition transect were produced at intervals of approximately 3 to 4 inches. Geonics software DAT61MK2 v1.30 was used to convert the EM61 MKII data to units of mV with a corresponding time stamp for each record.

The CST positioning information was recorded via wireless modem to a binary file at 2 to 3 Hz to a field computer along with a corresponding time stamp for each recorded position. The positioning and EM61 MKII signal data were merged with the software Vulcproc v1.5 developed by TtFW.

Position data were collected with the RTS at a rate of 3 to 4 Hz and stored, along with a time stamp, on a PCMCIA card in the RTS. The positioning and EM61 MKII signal data were merged with the software RTSproc v2.2 developed by TtFW.

The data were leveled (background subtraction as determined by mode of data) during processing and are output as an American Standard Code for Information Interchange (ASCII) file (x, y, z1, z2, z3, z4, z5) that contained the state planar coordinates of each measurement location in feet, EM61 MKII signal intensity for each time gate in millivolts, and a quality identifier for each recorded position (number 1-6, based on standard deviation).

The raw data for all three instruments (EM61, CTS, RTS) was uploaded to a PCMCIA card, transferred to the in-field processing computer, and backed up on compact disk, read-only memory (CD-ROM).

### 2.1.4 Data Submission Format

Data were submitted for scoring in accordance with data submission protocols outlined in the Standardized UXO Technology Demonstration Site Handbook. These submitted data are not included in this report in order to protect ground truth information.

### 2.1.5 Demonstrator Quality Assurance (QA) and Quality Control (QC) (provided by demonstrator)

Overview of QC. Field personnel, data processors, and data interpreters implement our QC program in a consistent fashion. In general, our geophysics QC program consists of a battery of pre-project tests, and once the project has started, a test regimen is applied for each acquisition session (usually 2 to 3 times per day, not just at the beginning of the day, or each week). The test regimen includes functional checks to ensure the position and geophysical sensor instrumentation is functioning properly prior to and at the end of each data acquisition session; processing checks to ensure the data collected are of sufficient quality and quantity to meet the project objectives, and interpretation checks to ensure the processed data are representative of the site conditions.

Pre-project tests included functional checks to ensure the position and geophysical sensor instrumentation was operating within their defined parameters. For all of our projects we perform a geophysical prove-out (GPO) or verification of detection system (VDS); during this project these tasks were replaced by the calibration lane data. Specific pre-project tests included the following:

- 15-minute Static tests for each EM61 MKII system.
- Cable integrity tests for each EM61 MKII system.
- Manufacturer suggested functional checks for CST and RTS positioning systems.

- Time-stamp relative accuracy tests for position and EM61 MKII systems.

- PCMCIA card integrity checks.

Specific functional checks during the data acquisition program were slightly different depending upon the positioning system used; however, generic functional checks included the following:

- Acquisition personnel metal check (ensure no metal on acquisition personnel).

- Static position system check (accuracy and repeatability of position).

- Static geophysical sensor check (repeatability of measurements, influence of ambient noise).

- Static geophysical sensor check with test item (repeatability and comparability of measurements with metal present).

- Kinematics geophysical sensor check with test item (repeatability and comparability of measurements with sensor in motion).

- Repeatability of overall data (re-survey of portion of the survey area during each data acquisition session).

- Occupation of survey monuments to ensure comparability, accuracy, and repeatability of RTS and CST positioning systems.

Overview of QA. The QA program designed by TtFW geophysicists was applied to ensure the QC system functioned properly. The QA procedures applied during the processing phase of the project were performed each day in the field to ensure the integrity of the data. Data that were not of sufficient quality and quantity to meet the project objectives were documented and recollected. Procedural checks during the processing of the data include the following:

- Evaluation of the static position and EM61 MKII data. EM61 MKII static noise above a predefined threshold was documented and a root cause analysis was performed prior to collecting additional data.

- Evaluation of the kinematics geophysical sensor check. These data allowed the processor to qualitatively and quantitatively monitor the noise level and repeatability of the data over a standard item, as well as ensure the data were merged correctly using the time-stamp information (i.e., the data contain no time or position shift; also known as lag).

- Visual examination of the repeatability and track path. Data were mathematically interpolated so that gaps present in the data showed up as a white color in the color-coded image of the data. These areas were documented and provided to the field crew for additional data collection, when necessary.

- Repeat data for each acquisition session were assessed in terms of the adequacy of the background removal operation.

- Corner stake locations for the survey grid were compared to known survey data and verified.

- Sample density along transects was verified through statistics.

- EM61 MKII measurement values outside of the range -5000 to +5000 mV were documented and compared to the site cultural features map.

TtFW geophysicists developed internal software to meet some of the needs during merging, processing, and interpretation of the data. QA measures applied during the interpretation of the data were the following:

- Targets selected interactively by the user were compared to those selected automatically by EM61int v6.7 (TtFW) and/or UX Detect (Oasis Montaj). This process ensured anomalies that met a certain criteria for selection were not missed by the interpreter and thus included on the dig sheet.

- Depths were calculated using two independent methods. These depths were compared and the most accurate solution obtained. Depths greater than 3.5 feet were documented and the characteristics of these anomalies (shape, number of transects detected on, signal intensity) were interactively assessed by the interpreter using the color-coded image and 1D profile data.

- Several aboveground metal features (e.g., fence posts, monitoring wells, etc.) were selected from each acquisition session for reacquisition by field personnel to verify accuracy of the interpreted position coordinates.

- The position and EM61 MKII data were compared to the site features map (e.g., above ground cultural features are documented-should be variance in track path).

- Interpreted data characteristics were compared to the known responses acquired during the initial test program (e.g., calibration lane).

### 2.1.6 Additional Records

The following record(s) by this vendor can be accessed via the Internet as PDF files at www.uxotestsites.org.

## 2.2 YPG SITE INFORMATION

### 2.2.1 Location

YPG is located adjacent to the Colorado River in the Sonoran Desert. The UXO Standardized Test Site is located south of Pole Line Road and east of the Countermine Testing and Training Range. The Open Field range, Calibration Grid, Blind Grid, Mogul area, and Desert Extreme area comprise the 350- by 500-meter general test site area. The open field site is the largest of the test sites and measures approximately 200 by 350 meters. To the east of the open field range are the calibration and blind test grids that measure 30 by 40 meters and 40 by 40 meters, respectively. South of the Open Field is the 135- by 80-meter Mogul area consisting of a sequence of man-made depressions. The Desert Extreme area is located southeast of the open field site and has dimensions of 50 by 100 meters. The Desert Extreme area, covered with desert-type vegetation, is used to test the performance of different sensor platforms in a more severe desert conditions/environment.

### 2.2.2 Soil Type

Soil samples were collected at the YPG UXO Standardized Test Site by ERDC to characterize the shallow subsurface (<3 m). Both surface grab samples and continuous soil borings were acquired. The soils were subjected to several laboratory analyses, including sieve/hydrometer, water content, magnetic susceptibility, dielectric permittivity, X-ray diffraction, and visual description.

There are two soil complexes present within the site, Riverbend-Carrizo and Cristobal-Gunsight. The Riverbend-Carrizo complex is comprised of mixed stream alluvium, whereas the Cristobal-Gunsight complex is derived from fan alluvium. The Cristobal-Gunsight complex covers the majority of the site. Most of the soil samples were classified as either a sandy loam or loamy sand, with most samples containing gravel-size particles. All samples had a measured water content less than 7 percent, except for two that contained 11-percent moisture. The majority of soil samples had water content between 1 to 2 percent. Samples containing more than 3 percent were generally deeper than 1 meter.

An X-ray diffraction analysis on four soil samples indicated a basic mineralogy of quartz, calcite, mica, feldspar, magnetite, and some clay. The presence of magnetite imparted a moderate magnetic susceptibility, with volume susceptibilities generally greater than 100 by 10-5 SI.

For more details concerning the soil properties at the YPG 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 YPG is included in Table 2.

**TABLE 2. TEST SITE AREAS**

| Area | Description |
|---|---|
| Calibration Grid | Contains the 15 standard ordnance items buried in six positions at various angles and depths to allow demonstrator equipment calibration. |
| Blind Grid | Contains 400 grid cells in a 0.16-hectare (0.39-acre) site. The center of each grid cell contains ordnance, clutter, or nothing. |

## SECTION 3. FIELD DATA

### 3.1 DATE OF FIELD ACTIVITIES: 1 December 2003

### 3.2 AREAS TESTED/NUMBER OF HOURS

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

TABLE 3. AREAS TESTED AND NUMBER OF HOURS

| Area | Number of Hours |
|---|---|
| Calibration Lanes | 2.08 |
| Blind Grid | 1.05 |

### 3.3 TEST CONDITIONS

#### 3.3.1 Weather Conditions

A YPG weather station located approximately one mile west of the test site was used to record average temperature and precipitation on a half hour basis for each day of operation. The temperatures listed in Table 4 represent the average temperature during field operations from 0700 to 1700 hours while 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, 2003 | Average Temperature, $^0$F | Total Daily Precipitation, in. |
|---|---|---|
| 1 December | 59.7 | 0.00 |

#### 3.3.2 Field Conditions

The field conditions remained dry throughout the demonstration.

#### 3.3.3 Soil Moisture

Three soil probes were placed at various locations within the site to capture soil moisture data: Calibration, Mogul, and Desert Extreme areas. Measurements were collected in percent moisture and were taken twice daily (morning and afternoon) from five different soil depths (1 to 6 in., 6 to 12 in., 12 to 24 in., 24 to 36 in., and 36 to 48 in.) from each probe. Soil moisture logs are included in Appendix C.

## 3.4 FIELD ACTIVITIES

### 3.4.1 Setup/Mobilization

These activities included initial mobilization and daily equipment preparation and break down. Initial set up of equipment took 1-hour and 55 minutes on 1 December 2003. Total survey was conducted within one day and TtFW went on to the Open Field for the remainder of the day. Therefore, there was no time accounted for daily set up or breakdown time.

### 3.4.2 Calibration

TtFW spent 2 hours and 5 minutes in the Calibration Lanes prior to surveying the Blind Grid on 1 December 2003.

### 3.4.3 Downtime Occasions

Occasions of downtime are 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 Equipment/data checks, maintenance.** TtFW did not perform any equipment checks or maintenance while surveying the Calibration Lanes. A total of 20 minutes was spent swapping out batteries in the Blind Grid.

**3.4.3.2 Equipment failure or repair.** TtFW did not experience any equipment problems while surveying the Calibration Lanes or Blind Grid.

**3.4.3.3 Weather.** Overall weather conditions did not interfere with the demonstration. Conditions remained dry and pleasant.

### 3.4.4 Data Collection

TtFW spent only 1-hour and 3 minutes collecting data in the Blind Grid. This time excludes break/lunches and downtimes described in section 3.4.3.

### 3.4.5 Demobilization

TtFW went on to conduct a demonstration of the entire site with the EM61 MKII system. Therefore, demobilization did not occur until 1 December 2003. On that day, it took the crew spent 18 minutes to break down and pack up their equipment.

### 3.5 PROCESSING TIME

TtFW submitted the raw data from the demonstration activities on the last day of the demonstration, as required. The scoring submittal data was also provided within the required 30-day time frame.

### 3.6 DEMONSTRATOR'S FIELD PERSONNEL

| | |
|---|---|
| Project Geophysicist: | Tim Deignan |
| Data Acquisition Specialists: | William Lewis |
| | Heesoo Chung |
| | Adam Maier |

### 3.7 DEMONSTRATOR'S FIELD SURVEYING METHOD

TtFW began surveying in the northwest corner of both the calibration and blind grids. Both surveys were conducted in a north/south direction.

### 3.8 SUMMARY OF DAILY LOGS

Daily logs capture all field activities during this demonstration and are located in Appendix D. Activities pertinent to this demonstration are indicated in highlighted text.

## SECTION 4. TECHNICAL PERFORMANCE RESULTS

### 4.1 ROC CURVES USING ALL ORDNANCE CATEGORIES

Figure 2 shows the probability of detection for the response stage ($P_d^{res}$) and the discrimination stage ($P_d^{disc}$) versus their respective probability of false positive. Figure 3 shows both probabilities plotted against their respective probability of background alarm. Both figures use horizontal lines to illustrate the performance of the demonstrator at two demonstrator-specified points: at the system noise level for the response stage, representing the point below which targets are not considered detectable, and at the demonstrator's recommended threshold level for the discrimination stage, defining the subset of targets the demonstrator would recommend digging based on discrimination. Note that all points have been rounded to protect the ground truth.

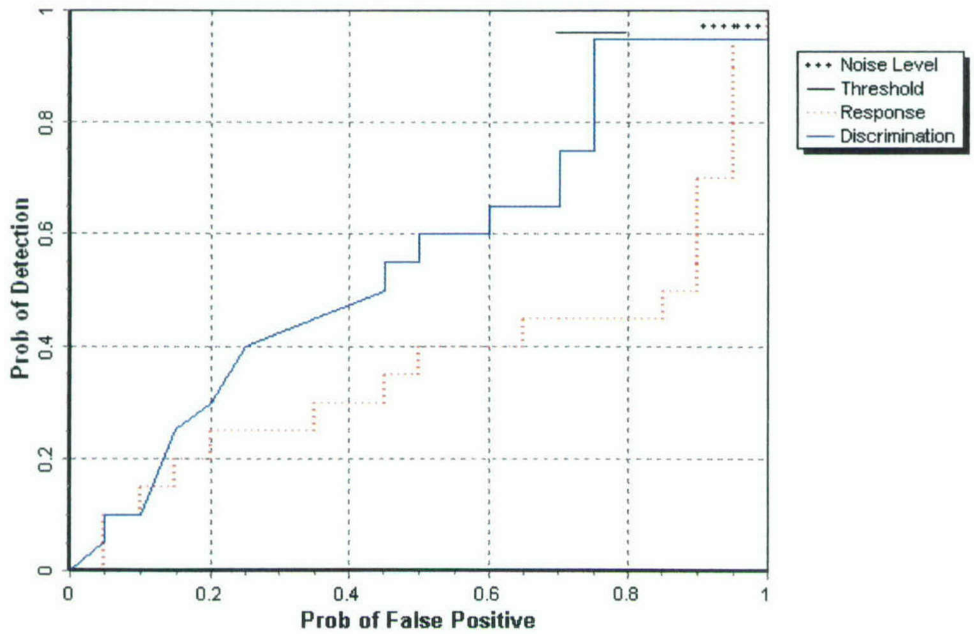


Figure 2. EM61 MKII pushcart blind grid probability of detection for response and discrimination stages versus their respective probability of false positive over all ordnance categories combined.

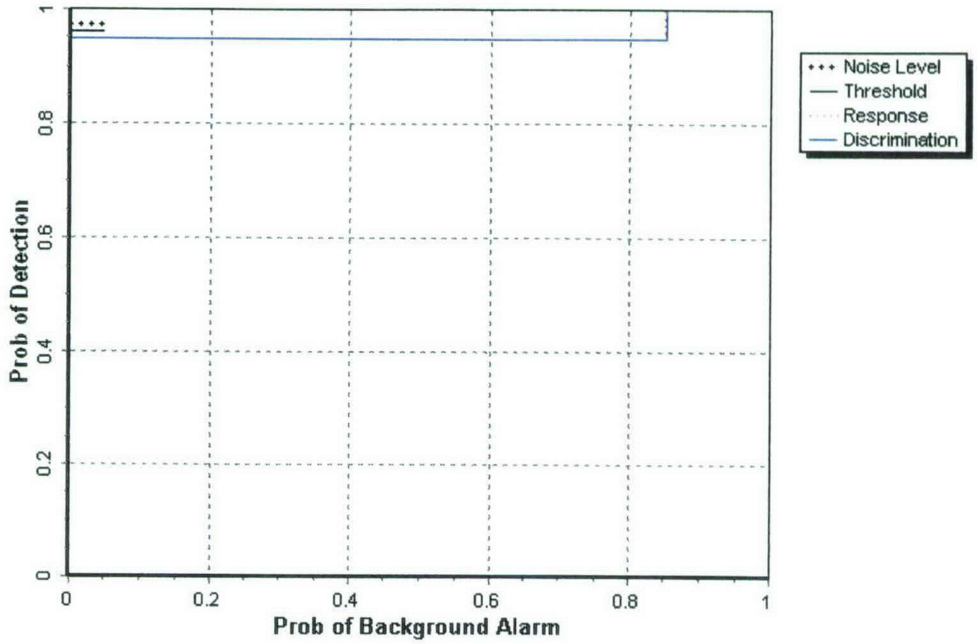


Figure 3. EM61 MKII pushcart blind grid probability of detection for response and discrimination stages versus their respective probability of background alarm over all ordnance categories combined.

## 4.2 ROC CURVES USING ORDNANCE LARGER THAN 20 MM

Figure 4 shows the probability of detection for the response stage ($P_d^{res}$) and the discrimination stage ($P_d^{disc}$) versus their respective probability of false positive when only targets larger than 20 mm are scored. Figure 5 shows both probabilities plotted against their respective probability of background alarm. Both figures use horizontal lines to illustrate the performance of the demonstrator at two demonstrator-specified points: at the system noise level for the response stage, representing the point below which targets are not considered detectable, and at the demonstrator's recommended threshold level for the discrimination stage, defining the subset of targets the demonstrator would recommend digging based on discrimination. Note that all points have been rounded to protect the ground truth.

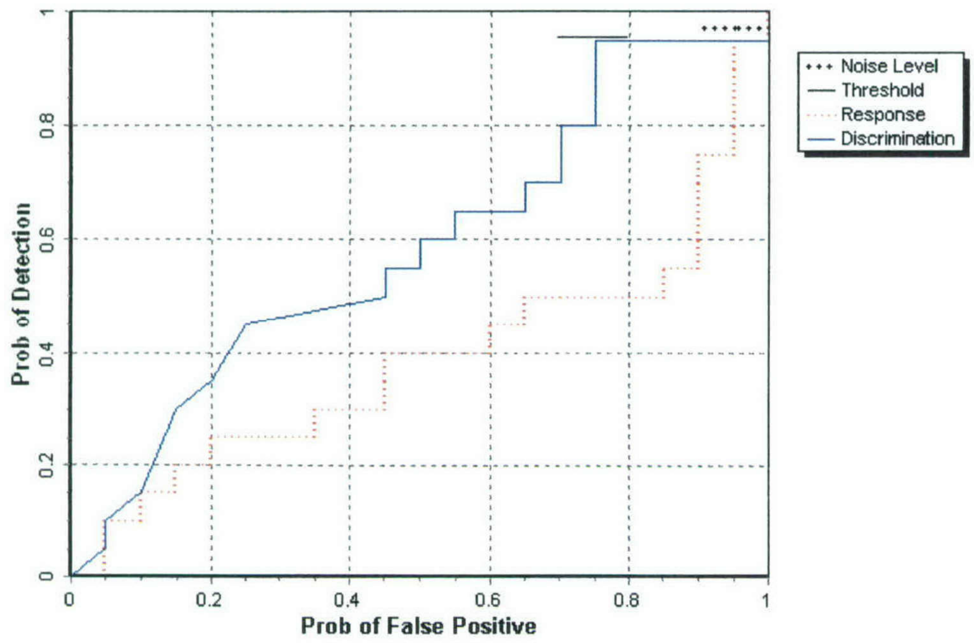


Figure 4. EM61 MKII pushcart blind grid probability of detection for response and discrimination stages versus their respective probability of false positive for all ordnance larger than 20 mm.

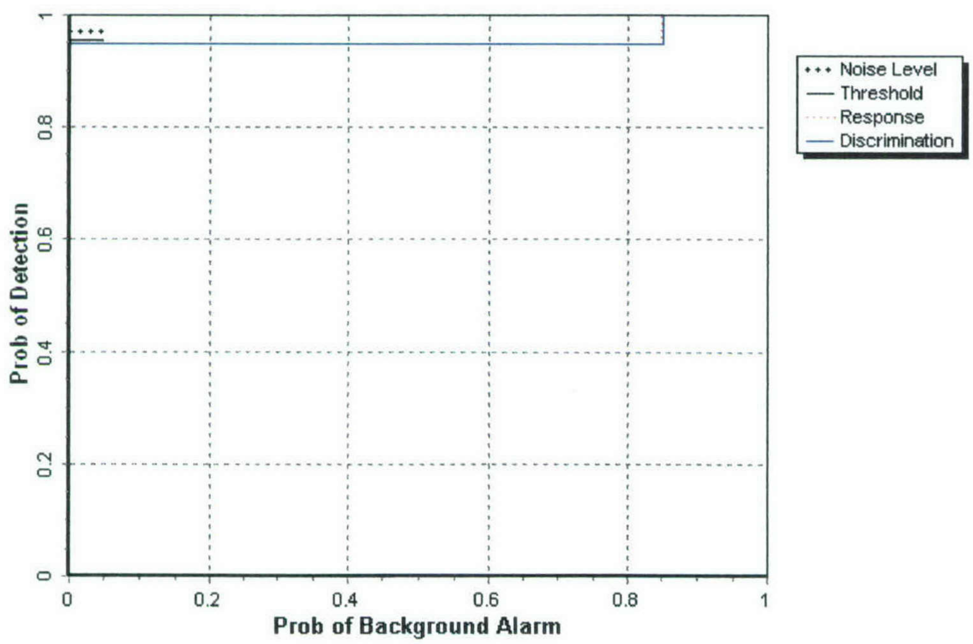


Figure 5. EM61 MKII pushcart blind grid probability of detection for response and discrimination stages versus their respective probabilities of background alarm for all ordnance larger than 20 mm.

### 4.3 PERFORMANCE SUMMARIES

Results for the Blind Grid test, broken out by size, depth and nonstandard ordnance, are presented in Table 5. (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 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 positive was calculated assuming that the number of detections and false positives are binomially distributed random variables. All results in Table 5 have been rounded to protect the ground truth. However, lower confidence limits were calculated using actual results.

**TABLE 5. SUMMARY OF BLIND GRID RESULTS FOR EM61 MKII**

| Metric | Overall | Standard | Nonstandard | By Size | | | By Depth, m | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Small | Medium | Large | < 0.3 | 0.3 to <1 | >= 1 |
| **RESPONSE STAGE** | | | | | | | | | |
| $P_d$ | 0.95 | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 |
| $P_d$ Low 90% Conf | 0.93 | 0.89 | 0.92 | 0.86 | 0.90 | 0.85 | 0.91 | 0.85 | 0.72 |
| $P_{fp}$ | 0.95 | - | - | - | - | - | 0.95 | 1.00 | - |
| $P_{fp}$ Low 90% Conf | 0.92 | - | - | - | - | - | 0.89 | 0.92 | - |
| $P_{ba}$ | 0.00 | - | - | - | - | - | - | - | - |
| **DISCRIMINATION STAGE** | | | | | | | | | |
| $P_d$ | 0.95 | 0.95 | 1.00 | 0.95 | 0.95 | 1.00 | 1.00 | 0.95 | 0.85 |
| $P_d$ Low 90% Conf | 0.91 | 0.86 | 0.92 | 0.86 | 0.84 | 0.85 | 0.91 | 0.85 | 0.55 |
| $P_{fp}$ | 0.75 | - | - | - | - | - | 0.65 | 0.95 | - |
| $P_{fp}$ Low 90% Conf | 0.69 | - | - | - | - | - | 0.60 | 0.87 | - |
| $P_{ba}$ | 0.00 | - | - | - | - | - | - | - | - |

Response Stage Noise Level: 0.00
Recommended Discrimination Stage Threshold: 5.00

Notes: The response stage noise level and recommended discrimination stage threshold values are provided by the demonstrator.

## 4.4 EFFICIENCY, REJECTION RATES, AND TYPE CLASSIFICATION

Efficiency and rejection rates are calculated to quantify the discrimination ability at specific points of interest on the ROC curve: (1) at the point where no decrease in $P_d$ is suffered (i.e., the efficiency is by definition equal to one) and (2) at the operator selected threshold. These values are reported in Table 6.

**TABLE 6. EFFICIENCY AND REJECTION RATES FOR EM61 MKII**

| | Efficiency (E) | False Positive Rejection Rate | Background Alarm Rejection Rate |
|---|---|---|---|
| At Operating Point | 0.99 | 0.22 | undefined |
| With No Loss of $P_d$ | 1.00 | 0.16 | undefined |

Note: Demonstrator did not report any background alarms. Therefore, background alarm rejection rate cannot be calculated.

At the demonstrator's recommended setting, the ordnance items that were detected and correctly discriminated were further scored on whether their correct type could be identified (table 8). Correct type examples include "20-mm projectile, 105-mm HEAT Projectile, and 2.75-inch Rocket". A list of the standard type declaration required for each ordnance item was provided to demonstrators prior to testing. For example, the standard type for the three example items are 20mmP, 105H, and 2.75in, respectively.

**TABLE 7. CORRECT TYPE CLASSIFICATION OF TARGETS CORRECTLY DISCRIMINATED AS UXO**

| Size | % Correct |
|---|---|
| Small | 48.6 |
| Medium | 27.3 |
| Large | 42.9 |
| Overall | 40.8 |

## 4.5 LOCATION ACCURACY

The mean location error and standard deviations appear in Table 8. These calculations are based on average missed depth for ordnance correctly identified in the discrimination stage. Depths are measured from the closest point of the ordnance to the surface. For the Blind Grid, only depth errors are calculated, since (x, y) positions are known to be the centers of each grid square.

**TABLE 8. MEAN LOCATION ERROR AND STANDARD DEVIATION (M)**

| | Mean | Standard Deviation |
|---|---|---|
| Depth | -0.10 | 0.22 |

## 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 setup/mobilization, daily setup/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 9. Note that calibration time includes time spent in the Calibration Lanes as well as field calibrations. "Site survey time" includes daily setup/stop time, collecting data, breaks/lunch, downtime due to equipment/data checks or maintenance, downtime due to failure, and downtime due to weather.

### TABLE 9. ON-SITE LABOR COSTS

| | No. People | Hourly Wage | Hours | Cost |
|---|---|---|---|---|
| **Initial Setup** | | | | |
| Supervisor | 1 | $95.00 | 1.92 | 182.40 |
| Data Analyst | 3 | 57.00 | 1.92 | 328.32 |
| Field Support | 0 | 28.50 | 1.92 | 0.00 |
| SubTotal | | | | **$510.72** |
| **Calibration** | | | | |
| Supervisor | 1 | $95.00 | 2.08 | 197.60 |
| Data Analyst | 3 | 57.00 | 2.08 | 355.68 |
| Field Support | 0 | 28.50 | 2.08 | 0.00 |
| SubTotal | | | | **$553.28** |
| **Site Survey** | | | | |
| Supervisor | 1 | $95.00 | 1.05 | 99.75 |
| Data Analyst | 3 | 57.00 | 1.05 | 179.55 |
| Field Support | 0 | 28.50 | 1.05 | 0.00 |
| SubTotal | | | | **$279.30** |

See notes at end of table.

**TABLE 9 (CONT'D)**

| | No. People | Hourly Wage | Hours | Cost |
|---|---|---|---|---|
| **Demobilization** | | | | |
| Supervisor | 1 | $95.00 | 0.30 | 123.50 |
| Data Analyst | 3 | 57.00 | 0.30 | 222.30 |
| Field Support | 0 | 28.50 | 0.30 | 0.00 |
| Subtotal | | | | **$345.80** |
| Total | | | | **$1689.10** |

Notes: Calibration time includes time spent in the Calibration Lanes as well as calibration before each data run.

Site Survey time includes daily setup/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 meter below ground surface.

Medium: Items buried greater than or equal to 0.3 meter 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 Grid test 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: 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 non-ordnance 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: 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 $P_d$ versus $P_{fp}$ and $P_d$ versus 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 A-1 shows how $P_d$ versus $P_{fp}$ and $P_d$ versus BAR are combined into ROC curves. Note that the "res" and "disc" superscripts have been suppressed from all the variables for clarity.

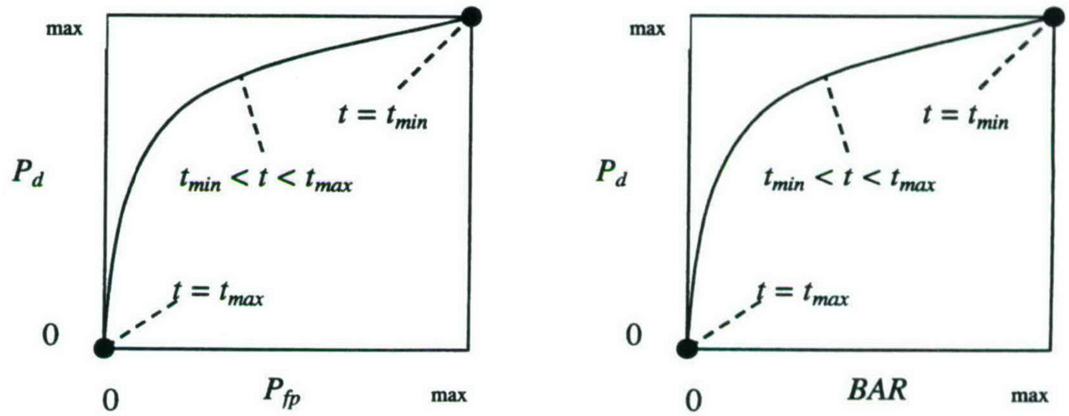


Figure A-1. ROC curves for open field testing. Each curve applies to both the response and discrimination stages.

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[1]Strictly speaking, ROC curves plot the $P_d$ versus $P_{ba}$ 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 Grid test 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 non-ordnance 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.

CHI-SQUARE COMPARISON EXPLANATION:

The Chi-square test for differences in probabilities (or 2 x 2 contingency table) is used to analyze two samples drawn from two different populations to see if both populations have the same or different proportions of elements in a certain category. More specifically, two random samples are drawn, one from each population, to test the null hypothesis that the probability of event A (some specified event) is the same for both populations (ref 4).

A 2 x 2 contingency table is used in the Standardized UXO Technology Demonstration Site Program to determine if there is reason to believe that the proportion of ordnance correctly detected/discriminated by demonstrator X's system is significantly degraded by the more challenging terrain feature introduced. The test statistic of the 2 x 2 contingency table is the

Chi-square distribution with one degree of freedom. Since an association between the more challenging terrain feature and relatively degraded performance is sought, a one-sided test is performed. A significance level of 0.05 is chosen which sets a critical decision limit of 2.71 from the Chi-square distribution with one degree of freedom. It is a critical decision limit because if the test statistic calculated from the data exceeds this value, the two proportions tested will be considered significantly different. If the test statistic calculated from the data is less than this value, the two proportions tested will be considered not significantly different.

An exception must be applied when either a 0 or 100 percent success rate occurs in the sample data. The Chi-square test cannot be used in these instances. Instead, Fischer's test is used and the critical decision limit for one-sided tests is the chosen significance level, which in this case is 0.05. With Fischer's test, if the test statistic is less than the critical value, the proportions are considered to be significantly different.

Standardized UXO Technology Demonstration Site examples, where blind grid results are compared to those from the open field and open field results are compared to those from one of the scenarios, follow. It should be noted that a significant result does not prove a cause and effect relationship exists between the two populations of interest; however, it does serve as a tool to indicate that one data set has experienced a degradation in system performance at a large enough level than can be accounted for merely by chance or random variation. Note also that a result that is not significant indicates that there is not enough evidence to declare that anything more than chance or random variation within the same population is at work between the two data sets being compared.

Demonstrator X achieves the following overall results after surveying each of the three progressively more difficult areas using the same system (results indicate the number of ordnance detected divided by the number of ordnance emplaced):

| | Blind Grid | Open Field | Moguls |
|---|---|---|---|
| $P_d^{res}$ | 100/100 = 1.0 | 8/10 = .80 | 20/33 = .61 |
| $P_d^{disc}$ | 80/100 = 0.80 | 6/10 = .60 | 8/33 = .24 |

$P_d^{res}$: BLIND GRID versus OPEN FIELD. Using the example data above to compare probabilities of detection in the response stage, all 100 ordnance out of 100 emplaced ordnance items were detected in the blind grid while 8 ordnance out of 10 emplaced were detected in the open field. Fischer's test must be used since a 100 percent success rate occurs in the data. Fischer's test uses the four input values to calculate a test statistic of 0.0075 that is compared against the critical value of 0.05. Since the test statistic is less than the critical value, the smaller response stage detection rate (0.80) is considered to be significantly less at the 0.05 level of significance. While a significant result does not prove a cause and effect relationship exists between the change in survey area and degradation in performance, it does indicate that the detection ability of demonstrator X's system seems to have been degraded in the open field relative to results from the blind grid using the same system.

$P_d^{disc}$: BLIND GRID versus OPEN FIELD. Using the example data above to compare probabilities of detection in the discrimination stage, 80 out of 100 emplaced ordnance items were correctly discriminated as ordnance in blind grid testing while 6 ordnance out of 10 emplaced were correctly discriminated as such in open field testing. Those four values are used to calculate a test statistic of 1.12. Since the test statistic is less than the critical value of 2.71, the two discrimination stage detection rates are considered to be not significantly different at the 0.05 level of significance.

$P_d^{res}$: OPEN FIELD versus MOGULS. Using the example data above to compare probabilities of detection in the response stage, 8 out of 10 and 20 out of 33 are used to calculate a test statistic of 0.56. Since the test statistic is less than the critical value of 2.71, the two response stage detection rates are considered to be not significantly different at the 0.05 level of significance.

$P_d^{disc}$: OPEN FIELD versus MOGULS. Using the example data above to compare probabilities of detection in the discrimination stage, 6 out of 10 and 8 out of 33 are used to calculate a test statistic of 2.98. Since the test statistic is greater than the critical value of 2.71, the smaller discrimination stage detection rate is considered to be significantly less at the 0.05 level of significance. While a significant result does not prove a cause and effect relationship exists between the change in survey area and degradation in performance, it does indicate that the ability of demonstrator X to correctly discriminate seems to have been degraded by the mogul terrain relative to results from the flat open field using the same system.

# APPENDIX B. DAILY WEATHER LOGS

## TABLE B-1. WEATHER LOG

| Date | Time, EDST | Temperature, °F | RH, % | Precipitation, in. |
|---|---|---|---|---|
| 1-Dec-04 | 15:00 | 73.9 | 15 | 0.00 |
| 1-Dec-04 | 16:00 | 72.6 | 16 | 0.00 |
| 1-Dec-04 | 17:00 | 71.0 | 14 | 0.00 |
| 1-Dec-04 | 18:00 | 67.4 | 18 | 0.00 |
| 1-Dec-04 | 19:00 | 64.2 | 23 | 0.00 |
| 1-Dec-04 | 20:00 | 60.2 | 24 | 0.00 |
| 1-Dec-04 | 21:00 | 57.3 | 27 | 0.00 |
| 1-Dec-04 | 22:00 | 55.5 | 29 | 0.00 |
| 1-Dec-04 | 23:00 | 55.4 | 29 | 0.00 |
| 1-Dec-04 | 24:00 | 53.6 | 32 | 0.00 |
| 2-Dec-04 | 1:00 | 51.9 | 33 | 0.00 |
| 2-Dec-04 | 2:00 | 51.3 | 36 | 0.00 |
| 2-Dec-04 | 3:00 | 50.0 | 37 | 0.00 |
| 2-Dec-04 | 4:00 | 51.5 | 37 | 0.00 |
| 2-Dec-04 | 5:00 | 52.4 | 38 | 0.00 |
| 2-Dec-04 | 6:00 | 51.6 | 38 | 0.00 |
| 2-Dec-04 | 7:00 | 50.1 | 38 | 0.00 |
| 2-Dec-04 | 8:00 | 49.3 | 40 | 0.00 |
| 2-Dec-04 | 9:00 | 50.1 | 35 | 0.00 |
| 2-Dec-04 | 10:00 | 56.3 | 28 | 0.00 |
| 2-Dec-04 | 11:00 | 60.3 | 20 | 0.00 |
| 2-Dec-04 | 12:00 | 66.4 | 17 | 0.00 |
| 2-Dec-04 | 13:00 | 71.0 | 15 | 0.00 |
| 2-Dec-04 | 14:00 | 74.6 | 14 | 0.00 |
| 2-Dec-04 | 15:00 | 75.3 | 16 | 0.00 |
| 2-Dec-04 | 16:00 | 76.4 | 16 | 0.00 |
| 2-Dec-04 | 17:00 | 77.6 | 15 | 0.00 |
| 2-Dec-04 | 18:00 | 71.2 | 17 | 0.00 |
| 2-Dec-04 | 19:00 | 67.8 | 22 | 0.00 |
| 2-Dec-04 | 20:00 | 65.1 | 25 | 0.00 |
| 2-Dec-04 | 21:00 | 64.0 | 27 | 0.00 |
| 2-Dec-04 | 22:00 | 62.5 | 28 | 0.00 |
| 2-Dec-04 | 23:00 | 57.3 | 28 | 0.00 |
| 2-Dec-04 | 24:00 | 55.1 | 31 | 0.00 |
| 3-Dec-04 | 1:00 | 52.0 | 37 | 0.00 |
| 3-Dec-04 | 2:00 | 51.6 | 37 | 0.00 |
| 3-Dec-04 | 3:00 | 50.4 | 37 | 0.00 |
| 3-Dec-04 | 4:00 | 51.4 | 34 | 0.00 |
| 3-Dec-04 | 5:00 | 52.2 | 33 | 0.00 |
| 3-Dec-04 | 6:00 | 48.4 | 39 | 0.00 |
| 3-Dec-04 | 7:00 | 44.8 | 46 | 0.00 |
| 3-Dec-04 | 8:00 | 43.7 | 50 | 0.00 |

## TABLE B-1 (CONT'D)

| Date | Time, EDST | Temperature, °F | RH, % | Precipitation, in. |
|---|---|---|---|---|
| 3-Dec-04 | 9:00 | 50.7 | 39 | 0.00 |
| 3-Dec-04 | 10:00 | 58.8 | 28 | 0.00 |
| 3-Dec-04 | 11:00 | 63.7 | 23 | 0.00 |
| 3-Dec-04 | 12:00 | 69.0 | 19 | 0.00 |
| 3-Dec-04 | 13:00 | 73.6 | 15 | 0.00 |
| 3-Dec-04 | 14:00 | 76.0 | 14 | 0.00 |
| 3-Dec-04 | 15:00 | 77.2 | 13 | 0.00 |
| 3-Dec-04 | 16:00 | 77.0 | 13 | 0.00 |
| 3-Dec-04 | 17:00 | 75.2 | 14 | 0.00 |
| 3-Dec-04 | 18:00 | 69.6 | 17 | 0.00 |
| 3-Dec-04 | 19:00 | 67.0 | 19 | 0.00 |
| 3-Dec-04 | 20:00 | 65.5 | 19 | 0.00 |
| 3-Dec-04 | 21:00 | 63.0 | 21 | 0.00 |
| 3-Dec-04 | 22:00 | 62.0 | 21 | 0.00 |
| 3-Dec-04 | 23:00 | 58.6 | 24 | 0.00 |
| 3-Dec-04 | 24:00 | 56.1 | 27 | 0.00 |
| 4-Dec-04 | 1:00 | 54.8 | 28 | 0.00 |
| 4-Dec-04 | 2:00 | 50.7 | 31 | 0.00 |
| 4-Dec-04 | 3:00 | 48.6 | 34 | 0.00 |
| 4-Dec-04 | 4:00 | 46.0 | 37 | 0.00 |
| 4-Dec-04 | 5:00 | 45.3 | 38 | 0.00 |
| 4-Dec-04 | 6:00 | 43.8 | 42 | 0.00 |
| 4-Dec-04 | 7:00 | 45.5 | 38 | 0.00 |
| 4-Dec-04 | 8:00 | 45.8 | 40 | 0.00 |
| 4-Dec-04 | 9:00 | 52.0 | 32 | 0.00 |
| 4-Dec-04 | 10:00 | 58.0 | 27 | 0.00 |
| 4-Dec-04 | 11:00 | 64.2 | 21 | 0.00 |
| 4-Dec-04 | 12:00 | 67.8 | 18 | 0.00 |
| 4-Dec-04 | 13:00 | 72.0 | 15 | 0.00 |
| 4-Dec-04 | 14:00 | 73.2 | 14 | 0.00 |
| 4-Dec-04 | 15:00 | 75.4 | 14 | 0.00 |
| 4-Dec-04 | 16:00 | 76.1 | 13 | 0.00 |
| 4-Dec-04 | 17:00 | 74.8 | 13 | 0.00 |
| 4-Dec-04 | 18:00 | 70.0 | 16 | 0.00 |
| 4-Dec-04 | 19:00 | 67.0 | 18 | 0.00 |
| 4-Dec-04 | 20:00 | 64.2 | 20 | 0.00 |
| 4-Dec-04 | 21:00 | 63.3 | 20 | 0.00 |
| 4-Dec-04 | 22:00 | 59.0 | 23 | 0.00 |
| 4-Dec-04 | 23:00 | 56.3 | 25 | 0.00 |
| 4-Dec-04 | 24:00 | 58.1 | 23 | 0.00 |
| 5-Dec-04 | 1:00 | 49.8 | 33 | 0.00 |
| 5-Dec-04 | 2:00 | 49.2 | 33 | 0.00 |
| 5-Dec-04 | 3:00 | 49.2 | 35 | 0.00 |
| 5-Dec-04 | 4:00 | 48.3 | 37 | 0.00 |

**TABLE B-1 (CONT'D)**

| Date | Time, EDST | Temperature, °F | RH, % | Precipitation, in. |
|---|---|---|---|---|
| 5-Dec-04 | 5:00 | 46.7 | 37 | 0.00 |
| 5-Dec-04 | 6:00 | 48.2 | 36 | 0.00 |
| 5-Dec-04 | 7:00 | 46.0 | 40 | 0.00 |
| 5-Dec-04 | 8:00 | 47.6 | 38 | 0.00 |
| 5-Dec-04 | 9:00 | 52.3 | 32 | 0.00 |
| 5-Dec-04 | 10:00 | 58.1 | 26 | 0.00 |
| 5-Dec-04 | 11:00 | 63.3 | 22 | 0.00 |
| 5-Dec-04 | 12:00 | 64.4 | 18 | 0.00 |
| 5-Dec-04 | 13:00 | 71.0 | 15 | 0.00 |
| 5-Dec-04 | 14:00 | 73.4 | 14 | 0.00 |
| 5-Dec-04 | 15:00 | 75.2 | 13 | 0.00 |
| 5-Dec-04 | 16:00 | 76.1 | 13 | 0.00 |
| 5-Dec-04 | 17:00 | 75.3 | 13 | 0.00 |
| 5-Dec-04 | 18:00 | 70.0 | 17 | 0.00 |
| 5-Dec-04 | 19:00 | 63.3 | 23 | 0.00 |
| 5-Dec-04 | 20:00 | 61.0 | 24 | 0.00 |
| 5-Dec-04 | 21:00 | 57.2 | 30 | 0.00 |
| 5-Dec-04 | 22:00 | 56.5 | 30 | 0.00 |
| 5-Dec-04 | 23:00 | 56.8 | 29 | 0.00 |
| 5-Dec-04 | 24:00 | 54.3 | 31 | 0.00 |
| 8-Dec-04 | 1:00 | 60.3 | 63 | 0.00 |
| 8-Dec-04 | 2:00 | 60.4 | 64 | 0.00 |
| 8-Dec-04 | 3:00 | 59.3 | 66 | 0.00 |
| 8-Dec-04 | 4:00 | 58.4 | 70 | 0.00 |
| 8-Dec-04 | 5:00 | 55.6 | 75 | 0.00 |
| 8-Dec-04 | 6:00 | 55.6 | 76 | 0.00 |
| 8-Dec-04 | 7:00 | 54.7 | 78 | 0.00 |
| 8-Dec-04 | 8:00 | 53.4 | 81 | 0.00 |
| 8-Dec-04 | 9:00 | 57.5 | 67 | 0.00 |
| 8-Dec-04 | 10:00 | 61.7 | 36 | 0.00 |
| 8-Dec-04 | 11:00 | 63.8 | 30 | 0.00 |
| 8-Dec-04 | 12:00 | 65.8 | 28 | 0.00 |
| 8-Dec-04 | 13:00 | 67.4 | 26 | 0.00 |
| 8-Dec-04 | 14:00 | 68.5 | 23 | 0.00 |
| 8-Dec-04 | 15:00 | 69.8 | 18 | 0.00 |
| 8-Dec-04 | 16:00 | 70.0 | 14 | 0.00 |
| 8-Dec-04 | 17:00 | 68.1 | 15 | 0.00 |
| 8-Dec-04 | 18:00 | 65.3 | 16 | 0.00 |
| 8-Dec-04 | 19:00 | 62.2 | 18 | 0.00 |
| 8-Dec-04 | 20:00 | 60.3 | 18 | 0.00 |
| 8-Dec-04 | 21:00 | 57.0 | 28 | 0.00 |
| 8-Dec-04 | 22:00 | 52.0 | 25 | 0.00 |
| 8-Dec-04 | 23:00 | 50.9 | 25 | 0.00 |
| 8-Dec-04 | 24:00 | 51.4 | 22 | 0.00 |

## APPENDIX C. SOIL MOISTURE

### Daily Soil Moisture Logs

**Demonstrator:** TETRA TEK (EM61A & EM61B)
**Date:** DECEMBER 1, 2003
**Times:** (0900), (1305)

| Probe Location: | Layer, in. | AM Reading, % | PM Reading, % |
|---|---|---|---|
| Calibration Area | 0 to 6 | 1.8 | 1.8 |
| | 6 to 12 | 2.4 | 2.4 |
| | 12 to 24 | 3.7 | 3.7 |
| | 24 to 36 | 3.6 | 3.6 |
| | 36 to 48 | 4.0 | 4.0 |
| Mogul Area | 0 to 6 | 1.7 | 1.7 |
| | 6 to 12 | 2.2 | 2.2 |
| | 12 to 24 | 3.5 | 3.5 |
| | 24 to 36 | 3.9 | 3.9 |
| | 36 to 48 | 3.9 | 3.9 |
| Desert Extreme Area | 0 to 6 | 1.6 | 1.6 |
| | 6 to 12 | 2.2 | 2.2 |
| | 12 to 24 | 3.4 | 3.4 |
| | 24 to 36 | 3.9 | 3.9 |
| | 36 to 48 | 4.1 | 4.1 |

**Date:** DECEMBER 2, 2003
**Times:** (0710), (1308)

| Probe Location: | Layer, in. | AM Reading, % | PM Reading, % |
|---|---|---|---|
| Calibration Area | 0 to 6 | 1.8 | 1.8 |
| | 6 to 12 | 2.4 | 2.4 |
| | 12 to 24 | 3.7 | 3.7 |
| | 24 to 36 | 3.6 | 3.6 |
| | 36 to 48 | 4.0 | 4.0 |
| Mogul Area | 0 to 6 | 1.7 | 1.7 |
| | 6 to 12 | 2.2 | 2.2 |
| | 12 to 24 | 3.5 | 3.5 |
| | 24 to 36 | 3.9 | 3.9 |
| | 36 to 48 | 3.9 | 3.9 |
| Desert Extreme Area | 0 to 6 | 1.6 | 1.6 |
| | 6 to 12 | 2.2 | 2.2 |
| | 12 to 24 | 3.4 | 3.4 |
| | 24 to 36 | 3.9 | 3.9 |
| | 36 to 48 | 4.1 | 4.1 |

**Date:** DECEMBER 3, 2003
**Times:** (0720), (1302)

| Probe Location: | Layer, in. | AM Reading, % | PM Reading, % |
|---|---|---|---|
| Calibration Area | 0 to 6 | 1.8 | 1.8 |
| | 6 to 12 | 2.4 | 2.4 |
| | 12 to 24 | 3.7 | 3.7 |
| | 24 to 36 | 3.6 | 3.6 |
| | 36 to 48 | 4.0 | 4.0 |
| Mogul Area | 0 to 6 | 1.6 | 1.6 |
| | 6 to 12 | 2.1 | 2.1 |
| | 12 to 24 | 3.5 | 3.5 |
| | 24 to 36 | 3.9 | 3.9 |
| | 36 to 48 | 3.9 | 3.9 |
| Desert Extreme Area | 0 to 6 | 1.6 | 1.6 |
| | 6 to 12 | 2.2 | 2.2 |
| | 12 to 24 | 3.4 | 3.4 |
| | 24 to 36 | 3.9 | 3.9 |
| | 36 to 48 | 4.1 | 4.1 |

**Date:** DECEMBER 4, 2003
**Times:** (0715), (1300)

| Probe Location: | Layer, in. | AM Reading, % | PM Reading, % |
|---|---|---|---|
| Calibration Area | 0 to 6 | 1.8 | 1.8 |
| | 6 to 12 | 2.4 | 2.4 |
| | 12 to 24 | 3.7 | 3.7 |
| | 24 to 36 | 3.6 | 3.6 |
| | 36 to 48 | 3.9 | 3.9 |
| Mogul Area | 0 to 6 | 1.6 | 1.6 |
| | 6 to 12 | 2.2 | 2.2 |
| | 12 to 24 | 3.5 | 3.5 |
| | 24 to 36 | 3.9 | 3.9 |
| | 36 to 48 | 3.9 | 3.9 |
| Desert Extreme Area | 0 to 6 | 1.6 | 1.6 |
| | 6 to 12 | 2.3 | 2.3 |
| | 12 to 24 | 3.3 | 3.3 |
| | 24 to 36 | 3.9 | 3.9 |
| | 36 to 48 | 4.1 | 4.1 |

**Date:** DECEMBER 5, 2003
**Times:** (0704), (1300)

| Probe Location: | Layer, in. | AM Reading, % | PM Reading, % |
|---|---|---|---|
| Calibration Area | 0 to 6 | 1.8 | 1.8 |
| | 6 to 12 | 2.4 | 2.4 |
| | 12 to 24 | 3.7 | 3.7 |
| | 24 to 36 | 3.6 | 3.6 |
| | 36 to 48 | 4.0 | 4.0 |
| Mogul Area | 0 to 6 | 1.7 | 1.7 |
| | 6 to 12 | 2.2 | 2.2 |
| | 12 to 24 | 3.5 | 3.5 |
| | 24 to 36 | 3.9 | 3.9 |
| | 36 to 48 | 3.9 | 3.9 |
| Desert Extreme Area | 0 to 6 | 1.6 | 1.6 |
| | 6 to 12 | 2.2 | 2.2 |
| | 12 to 24 | 3.3 | 3.3 |
| | 24 to 36 | 3.9 | 3.9 |
| | 36 to 48 | 4.1 | 4.1 |

**Date:** DECEMBER 8, 2003
**Times:** (0706), (1040)

| Probe Location: | Layer, in. | AM Reading, % | PM Reading, % |
|---|---|---|---|
| Calibration Area | 0 to 6 | 1.8 | 1.8 |
| | 6 to 12 | 2.4 | 2.4 |
| | 12 to 24 | 3.7 | 3.7 |
| | 24 to 36 | 3.6 | 3.6 |
| | 36 to 48 | 4.0 | 4.0 |
| Mogul Area | 0 to 6 | 1.6 | 1.6 |
| | 6 to 12 | 2.1 | 2.1 |
| | 12 to 24 | 3.6 | 3.6 |
| | 24 to 36 | 3.9 | 3.9 |
| | 36 to 48 | 3.9 | 3.9 |
| Desert Extreme Area | 0 to 6 | 1.6 | 1.6 |
| | 6 to 12 | 2.1 | 2.3 |
| | 12 to 24 | 3.4 | 3.3 |
| | 24 to 36 | 3.9 | 3.9 |
| | 36 to 48 | 3.9 | 4.1 |

# APPENDIX D. DAILY LOG ACTIVITIES

| Date | No. of People | Area Tested | Status Start Time | Status Stop Time | Duration, min | Operational Status | Operational Status Comments | Track Method | Track Method = Other Explain | Pattern | Field Conditions | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TEAM 2 | | | | | | | | | | | | |
| 12/01/2003 | 2 | CALIBRATION LANES | 0815 | 1150 | 115 | INITIAL SETUP | SETUP/MOBILIZATI ON | NA | NA | NA | SUNNY | COOL |
| 12/01/2003 | 2 | CALIBRATION LANES | 1150 | 1230 | 40 | COLLECT DATA | COLLECT DATA BIDIRECTIONAL NORTH TO SOUTH | GPS | NA | LINEAR | SUNNY | COOL |
| 12/01/2003 | 2 | CALIBRATION LANES | 1230 | 1240 | 10 | SETUP/DAILY START/ STOP/CALIBRATION | CALIBRATION | NA | NA | NA | SUNNY | COOL |
| 12/01/2003 | 2 | CALIBRATION LANES | 1240 | 1315 | 35 | SETUP/DAILY START/ STOP/CALIBRATION | SETUP/MOBILIZATI ON | NA | NA | NA | SUNNY | WARM |
| 12/01/2003 | 2 | CALIBRATION LANES | 1315 | 1345 | 30 | COLLECT DATA | COLLECT DATA BIDIRECTIONAL EAST TO WEST | GPS | NA | LINEAR | SUNNY | WARM |
| 12/01/2003 | 2 | CALIBRATION LANES | 1345 | 1355 | 10 | SETUP/DAILY START/ STOP/CALIBRATION | CALIBRATION | NA | NA | NA | SUNNY | WARM |
| 12/01/2003 | 2 | BLIND TEST GRID | 1355 | 1445 | 50 | SETUP/DAILY START/ STOP/CALIBRATION | SETUP/MOBILIZATI ON | NA | NA | NA | SUNNY | WARM |
| 12/01/2003 | 2 | BLIND TEST GRID | 1445 | 1455 | 10 | COLLECT DATA | COLLECT DATA BIDIRECTIONAL NORTH TO SOUTH | GPS | NA | LINEAR | SUNNY | WARM |
| 12/01/2003 | 2 | BLIND TEST GRID | 1455 | 1515 | 20 | DOWNTIME DUE TO EQUIP MAIN/CHECK | CHANGE BATTERY | NA | NA | NA | SUNNY | WARM |
| 12/01/2003 | 2 | BLIND TEST GRID | 1515 | 1608 | 53 | COLLECT DATA | COLLECT DATA BIDIRECTIONAL NORTH TO SOUTH | GPS | NA | LINEAR | SUNNY | WARM |

Note: Activities pertinent to this specific demonstration are indicated in highlighted text.

| Date | No. of People | Area Tested | Status Start Time | Status Stop Time | Duration, min | Operational Status | Operational Status Comments | Track Method | Track Method = Other Explain | Pattern | Field Conditions | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/01/2003 | 2 | BLIND TEST GRID | 1608 | 1612 | 4 | SETUP/DAILY START/ STOP/CALIBRATION | CALIBRATION | NA | NA | NA | SUNNY | WARM |
| 12/01/2003 | 2 | BLIND TEST GRID | 1612 | 1630 | 18 | SETUP/DAILY START/STOP/CALIB RATION | END OF DAILY OPERATIONS/ EQUIPMENT BREAKDOWN | NA | NA | NA | SUNNY | WARM |
| 12/02/2003 | 2 | OPEN FIELD | 0700 | 0840 | 100 | SETUP/DAILY START/STOP/CALIB RATION | SETUP/MOBILIZATION | NA | NA | NA | SUNNY | COOL |
| 12/02/2003 | 2 | OPEN FIELD | 0840 | 1049 | 129 | COLLECT DATA | COLLECT DATA BIDIRECTIONAL NORTH TO SOUTH | GPS | NA | LINEAR | SUNNY | COOL |
| 12/02/2003 | 2 | OPEN FIELD | 1049 | 1054 | 5 | SETUP/DAILY START/STOP/CALIB RATION | CALIBRATION | NA | NA | NA | SUNNY | COOL |
| 12/02/2003 | 2 | OPEN FIELD | 1054 | 1135 | 41 | SETUP/DAILY START/STOP/CALIB RATION ` | SETUP/MOBILIZATION | NA | NA | NA | SUNNY | COOL |
| 12/02/2003 | 2 | OPEN FIELD | 1135 | 1235 | 60 | BREAK/LUNCH | LUNCH | NA | NA | NA | SUNNY | COOL |
| 12/02/2003 | 2 | OPEN FIELD | 1235 | 1240 | 5 | DOWNTIME DUE TO EQUIP MAIN/CHECK | CHANGE BATTERY | NA | NA | NA | SUNNY | COOL |
| 12/02/2003 | 2 | OPEN FIELD | 0700 | 0840 | 100 | SETUP/DAILY START/STOP/CALIB RATION | SETUP/MOBILIZATION | NA | NA | NA | SUNNY | COOL |

Note: Activities pertinent to this specific demonstration are indicated in highlighted text.

| Date | No. of People | Area Tested | Status Start Time | Status Stop Time | Duration, min | Operational Status | Operational Status Comments | Track Method | Track Method = Other Explain | Pattern | Field Conditions | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/02/2003 | 2 | OPEN FIELD | 0840 | 1049 | 129 | COLLECT DATA | COLLECT DATA BIDIRECTIONAL NORTH TO SOUTH | GPS | NA | LINEAR | SUNNY | COOL |
| 12/02/2003 | 2 | OPEN FIELD | 1049 | 1054 | 5 | SETUP/DAILY START/STOP/CALIB RATION | CALIBRATION | NA | NA | NA | SUNNY | COOL |
| 12/02/2003 | 2 | OPEN FIELD | 1054 | 1135 | 41 | SETUP/DAILY START/STOP/CALIB RATION ` | SETUP/MOBILIZATION | NA | NA | NA | SUNNY | COOL |
| 12/02/2003 | 2 | OPEN FIELD | 1135 | 1235 | 60 | BREAK/LUNCH | LUNCH | NA | NA | NA | SUNNY | COOL |
| 12/02/2003 | 2 | OPEN FIELD | 1235 | 1240 | 5 | DOWNTIME DUE TO EQUIP MAIN/CHECK | CHANGE BATTERY | NA | NA | NA | SUNNY | COOL |
| 12/02/2003 | 2 | OPEN FIELD | 1240 | 1246 | 6 | SETUP/DAILY START/STOP/CALIB RATION ` | SETUP/MOBILIZATION | NA | NA | NA | SUNNY | COOL |
| 12/02/2003 | 2 | OPEN FIELD | 1246 | 1400 | 74 | COLLECT DATA | COLLECT DATA BIDIRECTIONAL NORTH TO SOUTH | GPS | NA | LINEAR | SUNNY | COOL |
| 12/02/2003 | 2 | OPEN FIELD | 1400 | 1410 | 10 | BREAK/LUNCH | BREAK | NA | NA | NA | SUNNY | COOL |
| 12/02/2003 | 2 | OPEN FIELD | 1410 | 1450 | 40 | COLLECT DATA | COLLECT DATA BIDIRECTIONAL NORTH TO SOUTH | GPS | NA | LINEAR | SUNNY | COOL |
| 12/02/2003 | 2 | OPEN FIELD | 1450 | 1500 | 10 | SETUP/DAILY START/ STOP/CALIBRATION | CHANGE OPERATOR | NA | NA | NA | SUNNY | COOL |

| Date | No. of People | Area Tested | Status Start Time | Status Stop Time | Duration, min | Operational Status | Operational Status Comments | Track Method | Track Method = Other Explain | Pattern | Field Conditions | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/02/2003 | 2 | OPEN FIELD | 1500 | 1520 | 20 | COLLECT DATA | COLLECT DATA BIDIRECTIONAL NORTH TO SOUTH | GPS | NA | LINEAR | SUNNY | COOL |
| 12/02/2003 | 2 | OPEN FIELD | 1520 | 1525 | 5 | DOWNTIME DUE TO EQUIP MAIN/CHECK | CHANGE BATTERY | NA | NA | NA | SUNNY | COOL |
| 12/02/2003 | 2 | OPEN FIELD | 1525 | 1532 | 7 | COLLECT DATA | COLLECT DATA BIDIRECTIONAL NORTH TO SOUTH | GPS | NA | LINEAR | SUNNY | COOL |
| 12/02/2003 | 2 | OPEN FIELD | 1532 | 1535 | 3 | SETUP/DAILY START/ STOP/CALIBRATION | CALIBRATION | NA | NA | NA | SUNNY | COOL |
| 12/02/2003 | 2 | OPEN FIELD | 1535 | 1550 | 15 | COLLECT DATA | COLLECT DATA BIDIRECTIONAL NORTH TO SOUTH | GPS | NA | LINEAR | SUNNY | COOL |
| 12/02/2003 | 2 | OPEN FIELD | 1550 | 1555 | 5 | SETUP/DAILY START/ STOP/CALIBRATION | CALIBRATION | NA | NA | NA | SUNNY | COOL |
| 12/02/2003 | 2 | OPEN FIELD | 1555 | 1615 | 20 | SETUP/DAILY START/ STOP/CALIBRATION | END OF DAILY OPERATIONS/ EQUIPMENT BREAKDOWN | NA | NA | NA | SUNNY | COOL |
| 12/03/2003 | 2 | OPEN FIELD | 0715 | 0833 | 78 | SETUP/DAILY START/ STOP/CALIBRATION | SETUP/MOBILIZATION | NA | NA | NA | SUNNY | COOL |
| 12/03/2003 | 2 | OPEN FIELD | 0833 | 1100 | 147 | COLLECT DATA | COLLECT DATA BIDIRECTIONAL NORTH TO SOUTH | GPS | NA | LINEAR | SUNNY | COOL |
| 12/03/2003 | 2 | OPEN FIELD | 1100 | 1150 | 50 | BREAK/LUNCH | LUNCH | NA | NA | NA | SUNNY | WARM |
| 12/03/2003 | 2 | OPEN FIELD | 1150 | 1250 | 60 | SETUP/DAILY START/ STOP/CALIBRATION | SETUP/MOBILIZATION | NA | NA | NA | SUNNY | WARM |

| Date | No. of People | Area Tested | Status Start Time | Status Stop Time | Duration, min | Operational Status | Operational Status Comments | Track Method | Track Method = Other Explain | Pattern | Field Conditions | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/03/2003 | 2 | OPEN FIELD | 1250 | 1510 | 140 | COLLECT DATA | COLLECT DATA BIDIRECTIONAL NORTH TO SOUTH | GPS | NA | LINEAR | SUNNY | WARM |
| 12/03/2003 | 2 | OPEN FIELD | 1510 | 1515 | 5 | SETUP/DAILY START/ STOP/CALIBRATION | CALIBRATION | NA | NA | NA | SUNNY | WARM |
| 12/03/2003 | 2 | OPEN FIELD | 1515 | 1600 | 45 | SETUP/DAILY START/ STOP/CALIBRATION | END OF DAILY OPERATIONS/ EQUIPMENT BREAKDOWN | NA | NA | NA | SUNNY | WARM |
| 12/04/2003 | 2 | OPEN FIELD | 0700 | 0811 | 71 | SETUP/DAILY START/ STOP/CALIBRATION | SETUP/MOBILIZATION | NA | NA | NA | SUNNY | COOL |
| 12/04/2003 | 2 | OPEN FIELD | 0811 | 0908 | 57 | COLLECT DATA | COLLECT DATA BIDIRECTIONAL NORTH TO SOUTH | GPS | NA | LINEAR | SUNNY | COOL |
| 12/04/2003 | 2 | CALIBRATION LANES | 0908 | 0911 | 3 | SETUP/DAILY START/ STOP/CALIBRATION | SETUP/MOBILIZATION | NA | NA | NA | SUNNY | COOL |
| 12/04/2003 | 2 | CALIBRATION LANES | 0911 | 0935 | 24 | COLLECT DATA | COLLECT DATA BIDIRECTIONAL NORTH TO SOUTH | GPS | NA | LINEAR | SUNNY | COOL |
| 12/04/2003 | 2 | CALIBRATION LANES | 0935 | 0945 | 10 | BREAK/LUNCH | BREAK | NA | NA | NA | SUNNY | COOL |
| 12/04/2003 | 2 | OPEN FIELD | 0945 | 1025 | 40 | SETUP/DAILY START/ STOP/CALIBRATION | SETUP/MOBILIZATION | NA | NA | NA | SUNNY | COOL |
| 12/04/2003 | 2 | OPEN FIELD | 1025 | 1057 | 32 | BREAK/LUNCH | LUNCH | NA | NA | NA | SUNNY | WARM |
| 12/04/2003 | 2 | OPEN FIELD | 1057 | 1106 | 9 | SETUP/DAILY START/ STOP/CALIBRATION | CALIBRATION | NA | NA | NA | SUNNY | WARM |

| Date | No. of People | Area Tested | Status Start Time | Status Stop Time | Duration, min | Operational Status | Operational Status Comments | Track Method | Track Method = Other Explain | Pattern | Field Conditions | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/04/2003 | 2 | OPEN FIELD | 1106 | 1400 | 174 | COLLECT DATA | COLLECT DATA BIDIRECTIONAL NORTH TO SOUTH | GPS | NA | LINEAR | SUNNY | WARM |
| 12/04/2003 | 2 | OPEN FIELD | 1400 | 1405 | 5 | SETUP/DAILY START/ STOP/CALIBRATION | CALIBRATION | NA | NA | NA | SUNNY | WARM |
| 12/04/2003 | 2 | MOGUL | 1405 | 1440 | 35 | DOWNTIME DUE TO EQUIP MAIN/CHECK | CHECK DATA | NA | NA | NA | SUNNY | WARM |
| 12/04/2003 | 2 | MOGUL | 1440 | 1540 | 60 | SETUP/DAILY START/ STOP/CALIBRATION | SETUP/MOBILIZATION | NA | NA | NA | SUNNY | WARM |
| 12/04/2003 | 2 | MOGUL | 1540 | 1600 | 20 | SETUP/DAILY START/ STOP/CALIBRATION | END OF DAILY OPERATIONS/ EQUIPMENT BREAKDOWN | NA | NA | NA | SUNNY | WARM |
| 12/05/2003 | 2 | MOGUL | 0655 | 0820 | 85 | SETUP/DAILY START/ STOP/CALIBRATION | SETUP/MOBILIZATION | NA | NA | NA | SUNNY | COOL |
| 12/05/2003 | 2 | MOGUL | 0820 | 0930 | 70 | COLLECT DATA | COLLECT DATA BIDIRECTIONAL NORTH TO SOUTH | GPS | NA | LINEAR | SUNNY | COOL |
| 12/05/2003 | 2 | MOGUL | 0930 | 0933 | 3 | BREAK/LUNCH | BREAK | NA | NA | NA | SUNNY | COOL |
| 12/05/2003 | 2 | MOGUL | 0933 | 1036 | 63 | COLLECT DATA | COLLECT DATA BIDIRECTIONAL NORTH TO SOUTH | GPS | NA | LINEAR | SUNNY | WARM |
| 12/05/2003 | 2 | MOGUL | 1036 | 1041 | 5 | BREAK/LUNCH | BREAK | NA | NA | NA | SUNNY | WARM |
| 12/05/2003 | 2 | MOGUL | 1041 | 1112 | 31 | COLLECT DATA | COLLECT DATA BIDIRECTIONAL NORTH TO SOUTH | GPS | NA | LINEAR | SUNNY | WARM |

| Date | No. of People | Area Tested | Status Start Time | Status Stop Time | Duration, min | Operational Status | Operational Status Comments | Track Method | Track Method = Other Explain | Pattern | Field Conditions | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/05/2003 | 2 | MOGUL | 1112 | 1125 | 13 | DOWNTIME DUE TO EQUIP MAIN/CHECK | CHANGE BATTERY | NA | NA | NA | SUNNY | WARM |
| 12/05/2003 | 2 | MOGUL | 1125 | 1132 | 7 | SETUP/DAILY START/ STOP/CALIBRATION | CALIBRATION | NA | NA | NA | SUNNY | WARM |
| 12/05/2003 | 2 | MOGUL | 1132 | 1320 | 108 | COLLECT DATA | COLLECT DATA BIDIRECTIONAL NORTH TO SOUITH | GPS | NA | LINEAR | SUNNY | WARM |
| 12/05/2003 | 2 | MOGUL | 1320 | 1400 | 40 | DOWNTIME DUE TO EQUIP MAIN/CHECK | CHECK DATA | NA | NA | NA | SUNNY | WARM |
| 12/05/2003 | 2 | MOGUL | 1400 | 1410 | 10 | SETUP/DAILY START/ STOP/CALIBRATION | END OF DAILY OPERATIONS/ EQUIPMENT BREAKDOWN | NA | NA | NA | SUNNY | WARM |
| 12/08/2003 | 2 | CALIBRATION PIT | 0655 | 0840 | 105 | SETUP/DAILY START/ STOP/CALIBRATION | SETUP/MOBILIZATION | NA | NA | NA | SUNNY | COOL |
| 12/08/2003 | 2 | CALIBRATION PIT | 0840 | 0850 | 10 | COLLECT DATA | SIGNATURE DATA ON 40 MM | GPS | NA | LINEAR | SUNNY | COOL |
| 12/08/2003 | 2 | CALIBRATION PIT | 0850 | 0858 | 8 | COLLECT DATA | SIGNATURE DATA ON M-42 | GPS | NA | LINEAR | SUNNY | COOL |
| 12/08/2003 | 2 | CALIBRATION PIT | 0858 | 0904 | 6 | COLLECT DATA | SIGNATURE DATA ON 20 MM | GPS | NA | LINEAR | SUNNY | COOL |
| 12/08/2003 | 2 | CALIBRATION PIT | 0904 | 0910 | 6 | COLLECT DATA | SIGNATURE DATA ON BLU 26 | GPS | NA | LINEAR | SUNNY | COOL |
| 12/08/2003 | 2 | CALIBRATION PIT | 0910 | 0938 | 28 | DOWNTIME DUE TO EQUIP MAIN/CHECK | CHECK DATA | NA | NA | NA | SUNNY | COOL |

| Date | No. of People | Area Tested | Status Start Time | Status Stop Time | Duration, min | Operational Status | Operational Status Comments | Track Method | Track Method = Other Explain | Pattern | Field Conditions | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/08/2003 | 2 | CALIBRATION PIT | 0938 | 0949 | 11 | COLLECT DATA | SIGNATURE DATA ON 40 MM MK2 | GPS | NA | LINEAR | SUNNY | COOL |
| 12/08/2003 | 2 | CALIBRATION PIT | 0949 | 0955 | 6 | COLLECT DATA | SIGNATURE DATA ON 57 MM | GPS | NA | LINEAR | SUNNY | COOL |
| 12/08/2003 | 2 | CALIBRATION PIT | 0955 | 1000 | 5 | COLLECT DATA | SIGNATURE DATA ON MK1 18 ROCKEYE | GPS | NA | LINEAR | SUNNY | COOL |
| 12/08/2003 | 2 | CALIBRATION PIT | 1000 | 1006 | 6 | COLLECT DATA | SIGNATURE DATA ON BDU 28 | GPS | NA | NA | SUNNY | COOL |
| 12/08/2003 | 2 | CALIBRATION PIT | 1006 | 1012 | 6 | COLLECT DATA | SIGNATURE DATA ON 60 MM | GPS | NA | LINEAR | SUNNY | COOL |
| 12/08/2003 | 2 | CALIBRATION PIT | 1012 | 1017 | 5 | COLLECT DATA | SIGNATURE DATA ON 2.75 INCH | GPS | NA | LINEAR | SUNNY | COOL |
| 12/08/2003 | 2 | CALIBRATION PIT | 1017 | 1021 | 4 | COLLECT DATA | SIGNATURE DATA ON 90 MM | GPS | NA | LINEAR | SUNNY | COOL |
| 12/08/2003 | 2 | CALIBRATION PIT | 1021 | 1027 | 6 | COLLECT DATA | SIGNATURE DATA ON 105 MM | GPS | NA | LINEAR | SUNNY | COOL |
| 12/08/2003 | 2 | CALIBRATION PIT | 1027 | 1034 | 7 | COLOLECT DATA | SIGNATURE DATA ON 105 MM | GPS | NA | LINEAR | SUNNY | COOL |
| 12/08/2003 | 2 | CALIBRATION PIT | 1034 | 1039 | 5 | COLLECT DATA | SIGNATURE DATA ON 40 MM | GPS | NA | LINEAR | SUNNY | COOL |
| 12/08/2003 | 2 | CALIBRATION PIT | 1039 | 1042 | 3 | COLLECT DATA | SIGNATURE DATA ON BDU 28 | GPS | NA | LINEAR | SUNNY | COOL |

| Date | No. of People | Area Tested | Status Start Time | Status Stop Time | Duration, min | Operational Status | Operational Status Comments | Track Method | Track Method = Other Explain | Pattern | Field Conditions | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/08/2003 | 2 | CALIBRATION PIT | 1042 | 1046 | 4 | COLLECT DATA | SIGNATURE DATA ON 57 MM | GPS | NA | LINEAR | SUNNY | COOL |
| 12/08/2003 | 2 | CALIBRATION PIT | 1046 | 1050 | 4 | COLLECT DATA | SIGNATURE DATA ON 60 MM | GPS | NA | LINEAR | SUNNY | COOL |
| 12/08/2003 | 2 | CALIBRATION PIT | 1050 | 1054 | 4 | COLLECT DATA | SIGNATURE DATA ON MK1 18 ROCKEYE | GPS | NA | LINEAR | SUNNY | COOL |
| 12/08/2003 | 2 | CALIBRATION PIT | 1054 | 1056 | 2 | COLLECT DATA | SIGNATURE DATA ON 81 MM | GPS | NA | LINEAR | SUNNY | COOL |
| 12/08/2003 | 2 | CALIBRATION PIT | 1056 | 1059 | 3 | COLLECT DATA | SIGNATURE DATA ON 2.75 INCH | GPS | NA | LINEAR | SUNNY | COOL |
| 12/08/2003 | 2 | CALIBRATION PIT | 1059 | 1102 | 3 | COLLECT DATA | SIGNATURE DATA ON105 MM | GPS | NA | LINEAR | SUNNY | COOL |
| 12/08/2003 | 2 | CALIBRATION PIT | 1102 | 1107 | 5 | COLLECT DATA | SIGNATURE DATA ON155 MM | GPS | NA | LINEAR | SUNNY | COOL |
| 12/08/2003 | 2 | CALIBRATION PIT | 1107 | 1111 | 4 | COLLECT DATA | SIGNATURE DATA ON105 MM | GPS | NA | LINEAR | SUNNY | COOL |
| 12/08/2003 | 2 | CALIBRATION PIT | 1111 | 1113 | 2 | SETUP/DAILY START/ STOP/CALIBRATION | CALIBRATION | NA | NA | NA | SUNNY | COOL |
| 12/08/2003 | 2 | CALIBRATION PIT | 1113 | 1200 | 47 | DOWNTIME DUE TO EQUIP MAIN/CHECK | CHECK DATA | NA | NA | NA | SUNNY | COOL |
| 12/08/2003 | 2 | CALIBRATION PIT | 1200 | 1240 | 40 | DEMOBILIZATION | END OF TEST TURN-IN DISK | NA | NA | NA | SUNNY | COOL |

| Date | No. of People | Area Tested | Status Start Time | Status Stop Time | Duration, min | Operational Status | Operational Status Comments | Track Method | Track Method = Other Explain | Pattern | Field Conditions | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TEAM 1 | | | | | | | | | | | | |
| 12/01/2003 | 2 | OPEN FIELD | 0815 | 1045 | 150 | SETUP/DAILY START/ STOP/CALIBRATION | SETUP/MOBILIZATION | NA | NA | NA | SUNNY | COOL |
| 12/01/2003 | 2 | OPEN FIELD | 1045 | 1140 | 55 | SETUP/DAILY START/ STOP/CALIBRATION | SETUP/MOBILIZATION | NA | NA | NA | SUNNY | COOL |
| 12/01/2003 | 2 | OPEN FIELD | 1140 | 1335 | 115 | COLLECT DATA | COLLECTED DATA BI-DIRECTIONAL NORTH TO SOUTH | GPS | NA | LINEAR | SUNNY | COOL |
| 12/01/2003 | 2 | OPEN FIELD | 1335 | 1415 | 40 | BREAK/LUNCH | BREAK | NA | NA | NA | SUNNY | WARM |
| 12/01/2003 | 2 | OPEN FIELD | 1415 | 1420 | 5 | DOWNTIME DUE TO EQUIP MAIN/CHECK | CHANGE BATTERY | NA | NA | NA | SUNNY | WARM |
| 12/01/2003 | 2 | OPEN FIELD | 1420 | 1515 | 55 | COLLECT DATA | COLLECTED DATA BI-DIRECTIONAL NORTH TO SOUTH | GPS | NA | LINEAR | SUNNY | WARM |
| 12/01/2003 | 2 | OPEN FIELD | 1515 | 1550 | 35 | SETUP/DAILY START/ STOP/CALIBRATION | END OF DAILY OPERATIONS/ EQUIPMENT BREAKDOWN | NA | NA | NA | SUNNY | WARM |
| 12/02/2003 | 2 | OPEN FIELD | 0700 | 0859 | 119 | SETUP/DAILY START/ STOP/CALIBRATION | SETUP/MOBILIZATION | NA | NA | NA | SUNNY | COOL |
| 12/02/2003 | 2 | OPEN FIELD | 0859 | 1041 | 102 | COLLECT DATA | COLLECTED DATA BI-DIRECTIONAL NORTH TO SOUTH | GPS | NA | LINEAR | SUNNY | COOL |
| 12/02/2003 | 2 | OPEN FIELD | 1041 | 1050 | 9 | DOWNTIME DUE TO EQUIP MAIN/CHECK | CHANGE BATTERY | NA | NA | NA | SUNNY | COOL |

| Date | No. of People | Area Tested | Status Start Time | Status Stop Time | Duration, min | Operational Status | Operational Status Comments | Track Method | Track Method = Other Explain | Pattern | Field Conditions | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/02/2003 | 2 | OPEN FIELD | 1050 | 1135 | 45 | BREAK/LUNCH | BREAK | NA | NA | NA | SUNNY | COOL |
| 12/02/2003 | 2 | OPEN FIELD | 1135 | 1240 | 65 | BREAK/LUNCH | LUNCH | NA | NA | NA | SUNNY | COOL |
| 12/02/2003 | 2 | OPEN FIELD | 1240 | 1245 | 5 | SETUP/DAILY START/ STOP/CALIBRATION | SETUP/MOBILIZATION | NA | NA | NA | SUNNY | COOL |
| 12/02/2003 | 2 | OPEN FIELD | 1245 | 1437 | 112 | COLLECT DATA | COLLECTED DATA BI-DIRECTIONAL NORTH TO SOUTH | NA | NA | NA | SUNNY | COOL |
| 12/02/2003 | 2 | OPEN FIELD | 1437 | 1450 | 13 | BREAK/LUNCH | BREAK | GPS | NA | LINEAR | SUNNY | COOL |
| 12/02/2003 | 2 | OPEN FIELD | 1450 | 1515 | 25 | SETUP/DAILY START/ STOP/CALIBRATION | END OF DAILY OPERATIONS/ EQUIPMENT BREAKDOWN | NA | NA | NA | SUNNY | COOL |
| 12/03/2003 | 2 | OPEN FIELD | 0715 | 0822 | 67 | SETUP/DAILY START/ STOP/CALIBRATION | SET UP/ MOBILIZATION | NA | NA | NA | SUNNY | COOL |
| 12/03/2003 | 2 | OPEN FIELD | 0822 | 1005 | 103 | COLLECT DATA | COLLECTED DATA BI-DIRECTIONAL NORTH TO SOUTH | GPS | NA | LINEAR | SUNNY | COOL |
| 12/03/2003 | 2 | OPEN FIELD | 1005 | 1030 | 25 | BREAK/LUNCH | BREAK | NA | NA | NA | SUNNY | COOL |
| 12/03/2003 | 2 | OPEN FIELD | 1030 | 1100 | 30 | SETUP/DAILY START/ STOP/CALIBRATION | SET UP/ MOBILIZATION | NA | NA | NA | SUNNY | COOL |
| 12/03/2003 | 2 | OPEN FIELD | 1100 | 1150 | 50 | BREAK/LUNCH | LUNCH | NA | NA | NA | SUNNY | WARM |

| Date | No. of People | Area Tested | Status Start Time | Status Stop Time | Duration, min | Operational Status | Operational Status Comments | Track Method | Track Method = Other Explain | Pattern | Field Conditions | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/03/2003 | 2 | OPEN FIELD | 1150 | 1215 | 25 | SETUP/DAILY START/ STOP/CALIBRATION | SET UP/ MOBILIZATION | NA | NA | NA | SUNNY | WARM |
| 12/03/2003 | 2 | OPEN FIELD | 1215 | 1414 | 119 | COLLECT DATA | - | GPS | NA | LINEAR | SUNNY | WARM |
| 12/03/2003 | 2 | OPEN FIELD | 1414 | 1505 | 51 | SETUP/DAILY START/ STOP/CALIBRATION | END OF DAILY OPERATIONS/ EQUIPMENT BREAKDOWN | NA | NA | NA | SUNNY | WARM |
| 12/04/2003 | 2 | OPEN FIELD | 0700 | 0805 | 65 | SETUP/DAILY START/ STOP/CALIBRATION | SETUP/MOBILIZATION | NA | NA | NA | SUNNY | COOL |
| 12/04/2003 | 2 | OPEN FIELD | 0805 | 0917 | 72 | COLLECT DATA | COLLECTED DATA BI-DIRECTIONAL NORTH TO SOUTH | GPS | NA | LINEAR | SUNNY | COOL |
| 12/04/2003 | 2 | OPEN FIELD | 0917 | 0930 | 13 | BREAK/LUNCH | BREAK | NA | NA | NA | SUNNY | COOL |
| 12/04/2003 | 2 | OPEN FIELD | 0930 | 0957 | 27 | SETUP/DAILY START/ STOP/CALIBRATION | SET UP/ MOBILIZATION | NA | NA | NA | SUNNY | COOL |
| 12/04/2003 | 2 | OPEN FIELD | 0957 | 1156 | 119 | COLLECT DATA | COLLECTED DATA BI-DIRECTIONAL NORTH TO SOUTH | GPS | NA | LINEAR | SUNNY | WARM |
| 12/04/2003 | 2 | OPEN FIELD | 1156 | 1322 | 26 | BREAK/LUNCH | BREAK | NA | NA | NA | SUNNY | WARM |
| 12/04/2003 | 2 | YUMA EXTERME | 1322 | 1327 | 5 | DOWNTIME DUE TO EQUIP MAIN/CHECK | CHANGE BATTERY | NA | NA | NA | SUNNY | WARM |
| 12/04/2003 | 2 | YUMA EXTERME | 1327 | 1416 | 49 | SETUP/DAILY START/ STOP/CALIBRATION | SET UP/ MOBILIZATION | NA | NA | NA | SUNNY | WARM |

| Date | No. of People | Area Tested | Status Start Time | Status Stop Time | Duration, min | Operational Status | Operational Status Comments | Track Method | Track Method = Other Explain | Pattern | Field Conditions | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/04/2003 | 2 | YUMA EXTERME | 1416 | 1540 | 84 | COLLECT DATA | COLLECTED DATA BI-DIRECTIONAL EAST TO WEST | GPS | NA | NA | SUNNY | WARM |
| 12/04/2003 | 2 | YUMA EXTERME | 1540 | 1600 | 20 | SETUP/DAILY START/ STOP/CALIBRATION | END OF DAILY OPERATIONS/ EQUIPMENT BREAKDOWN | NA | NA | NA | SUNNY | WARM |
| 12/05/2003 | 2 | YUMA EXTERME | 0655 | 0755 | 60 | SETUP/DAILY START/ STOP/CALIBRATION | SET UP/ MOBILIZATION | NA | NA | NA | SUNNY | COOL |
| 12/05/2003 | 2 | YUMA EXTERME | 0755 | 0938 | 103 | COLLECT DATA | COLLECTED DATA BI-DIRECTIONAL EAST TO WEST | GPS | NA | LINEAR | SUNNY | COOL |
| 12/05/2003 | 2 | YUMA EXTERME | 0938 | 1000 | 22 | DOWNTIME DUE TO EQUIP MAIN/CHECK | CHANGE BATTERY | NA | NA | NA | SUNNY | COOL |
| 12/05/2003 | 2 | YUMA EXTERME | 1000 | 1015 | 15 | BREAK/LUNCH | BREAK | NA | NA | NA | SUNNY | COOL |
| 12/05/2003 | 2 | YUMA EXTERME | 1015 | 1220 | 125 | SETUP/DAILY START/ STOP/CALIBRATION | SET UP/ MOBILIZATION | NA | NA | NA | SUNNY | WARM |
| 12/05/2003 | 2 | YUMA EXTERME | 1220 | 1330 | 70 | BREAK/LUNCH | LUNCH | NA | NA | NA | SUNNY | WARM |
| 12/05/2003 | 2 | YUMA EXTERME | 1330 | 1345 | 15 | SETUP/DAILY START/ STOP/CALIBRATION | END OF DAILY OPERATIONS/ EQUIPMENT BREAKDOWN | NA | NA | NA | SUNNY | WARM |
| 12/08/2003 | 2 | YUMA EXTERME | 0655 | 0740 | 45 | SETUP/DAILY START/ STOP/CALIBRATION | SET UP/MOBILIZATION | NA | NA | NA | SUNNY | COOL |

| Date | No. of People | Area Tested | Status Start Time | Status Stop Time | Duration, min | Operational Status | Operational Status Comments | Track Method | Track Method = Other Explain | Pattern | Field Conditions | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/08/2003 | 2 | YUMA EXTERME | 0740 | 0848 | 68 | COLLECT DATA | COLLECTED DATA BI-DIRECTIONAL EAST TO WEST | GPS | NA | LINEAR | SUNNY | COOL |
| 12/08/2003 | 2 | CALIBRATION LANES | 0848 | 0912 | 24 | SETUP/DAILY START/ STOP/CALIBRATION | SET UP/ MOBILIZATION | NA | NA | NA | SUNNY | COOL |
| 12/08/2003 | 2 | CALIBRATION LANES | 0912 | 0933 | 21 | COLLECT DATA | COLLECTED DATA BI-DIRECTIONAL NORTH TO SOUTH | GPS | NA | LINEAR | SUNNY | COOL |
| 12/08/2003 | 2 | CALIBRATION LANES | 0933 | 1113 | 100 | DEMOBILIZATION | END OF TEST | NA | NA | NA | SUNNY | COOL |

## 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.

4. Data Summary, UXO Standardized Test Site: YPG Soils Description, May 2003.

5. Practical Nonparametric Statistics, W.J. Conover, John Wiley & Sons, 1980, pages 144 through 151.

## APPENDIX F. ABBREVIATIONS

| | | |
|---|---|---|
| AEC | = | U.S. Army Environmental Center |
| APG | = | Aberdeen Proving Ground |
| ASCII | = | American Standard Code for Information Interchange |
| ATC | = | U.S. Army Aberdeen Test Center |
| CAD | = | computer-aided design |
| CD-ROM | = | compact disk, read-only memory |
| DGPS | = | differential Global Positioning System |
| EMIS | = | Electromagnetic Induction Spectroscopy |
| EQT | = | Army Environmental Quality Technology Program |
| ERDC | = | U.S. Army Corps of Engineers Engineering Research and Development Center |
| ESTCP | = | Environmental Security Technology Certification Program |
| GPO | = | geophysical prove-out |
| GPR | = | ground-penetrating radar |
| GPS | = | Global Positioning System |
| GX | = | Geosoft executable |
| HERO | = | Hazards of Electromagnetic Radiation to Ordnance |
| HH | = | handheld |
| JPG | = | Jefferson Proving Ground |
| MS | = | Microsoft |
| mV | = | millivolts |
| PCMCIA | = | Personal Computer Memory Card International Associations |
| PDA | = | personal digital assistant |
| POC | = | point of contact |
| PVC | = | polyvinyl chloride |
| QA | = | quality assurance |
| QC | = | quality control |
| ROC | = | receiver-operating characteristic |
| RTK | = | real time kinematic |
| RTS | = | Robotic Total Station |
| SAR | = | synthetic-aperture radar |
| SERDP | = | Strategic Environmental Research and Development Program |
| TtFW | = | Tetra Tech Foster Wheeler |
| UXO | = | unexploded ordnance |
| VDS | = | verification of detection system |
| YPG | = | U.S. Army Yuma Proving Ground |

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