Synopsis of Objectives and Results of Jefferson Proving Ground Technology Demonstration Program, Phases I through IV

Phase I, 1994
Objective: Evaluate existing and promising technologies for detecting and remediating UXO.
Results: Limited detection and localization capabilities and inability to discriminate between ordnance and nonordnance. Average false alarm rate was 149 per hectare. Airborne platforms and ground penetrating radar sensors performed poorly; combination electromagnetic induction and magnetometry sensors were the best performers, but also had modest probabilities of detection and very high false alarm rates.

Phase II, 1995
Objective: Evaluate technologies effective for detecting, identifying, and remediating UXO, and measuring these results against the Phase I baseline.
Results: Significant improvement in detection capabilities with commensurate increases in false alarms among better performing technologies. Continued inability to distinguish ordnance from nonordnance. Again, airborne platforms and ground penetrating radar sensors performed poorly; combination electromagnetic induction and magnetometry sensors were the better performers, but continued to have very high false alarm rates.

Phase III, 1996
Objective: Develop relevant performance data of technologies used in site-specific situations to search, detect, characterize, and excavate UXO. Four different range scenarios were used, which had typical groups of UXO.
Results: Improvement in detection, but continued inability to distinguish ordnance from nonordnance. Localization performance for ground-based systems improved. Probability of detection is partially dependent on target size. False alarm rates ranged from 2 to 241 per hectare.

Phase IV, 1998
Objectives: Demonstrate the capabilities of technology to discriminate between UXO and non-UXO; establish discrimination performance baselines for sensors and systems; make raw sensor data available to the public; establish state of the art for predicting ordnance “type”; direct future R&D efforts.
Results: Capability to distinguish between ordnance and nonordnance is developing. Five demonstrators showed a better than chance probability of successful discrimination.

4.5.2 Former Fort Ord Ordnance Detection and Discrimination Study (ODDS)

A phased geophysical study of ordnance detection and discrimination specific to the former Fort Ord, California, environment has been in existence since 1994. In November 1998, the U.S. Army evaluated OE at Fort Ord in an Ordnance and Explosives Remedial Investigation/Feasibility Study (OE RI/FS) concurrently with removal actions. The RI/FS evaluated long-term response alternatives for cleanup and risk management at Fort Ord. The technologies considered for use during the Fort Ord study were demonstrated during the Jefferson Proving Ground study. The text box below describes the four phases of the Fort Ord study.

Synopsis of Objectives and Results of the Former Fort Ord Ordnance Detection and Discrimination Study, Phases I through IV

Phase I
Objective: Evaluate detection technologies "Static" measurements in free air (i.e., in the air above and away from ground influences/effects) given variable OE items, depths, and orientations.
Results: Signal drop-off in the electromagnetic (EM) response is proportional to the depth of the object to the 6^{th} power. For horizontally oriented OE items, the EM signal response was predicted fairly well.

Phase II
Objective: Evaluate the effectiveness of geophysical instruments' ability to detect and locate "seeded" or planted OE items.
Result: Noise levels increased 3 to 35 times from the static to seeded tests. There was a significant degradation of profile signatures between static and field trial tests.

Phase III
Objective: Evaluate geophysical instruments and survey processes at actual uninvestigated OE sites.
Results: The effects of rough terrain and vegetation on detection and discrimination capabilities can be significant. Removal of range residue before the OE investigation began would have reduced time and effort spent on unnecessary excavations.

Phase IV
Objective: Evaluate discrimination capabilities of OE detection systems.
Results: The instruments with the highest detection rate required the most intrusive investigation. Conversely, instruments with lower detection rates required less intrusive investigations. **The ODDS determined that no one instrument provides the single solution to meet the OE detection needs at Fort Ord.**

The first phase of the ODDS found the electromagnetic and magnetometer systems to be effective in the detection and location of buried OE items. Phase II was conducted in a controlled testing environment. The controlled area consisted of five "seeded" plots. Two of the plots consisted of items with known depths and orientations, while the other three areas consisted of "unknown" plots where target information was withheld. The plots were designed to be representative of the terrain of Fort Ord. The seeded tests concluded that the noise levels of the EMI systems increased 3 to 35 times from the static to seeded tests. In Phase III it was concluded that the effects of terrain, vegetation, and range residues can significantly alter detection and discrimination capabilities of the detectors. Phase IV of the study determined that discrimination capability of the instruments tested was minimal. The Phase IV study also determined that both EMI and magnetometer systems performed well in finding the larger and deeper items, whereas only the EMI systems consistently found smaller and shallower items. The results indicated that different systems are required for different types of sites, depending on OE expected and the site-specific environmental/geological conditions.

4.5.3 UXO Technology Standardized Demonstration Sites

The U.S. Army Environmental Center (USAEC) is conducting an ESTCP-funded program to provide UXO technology developers with test sites for the evaluation of UXO detection and discrimination technologies using standardized protocols. The USAEC is developing standardized test methodologies, procedures, and facilities to help ensure accuracy and replicability in measurements of detection capability, false alarms, discrimination, target reacquisition, and system efficiency. Data generated from these standardized sites will be compiled into a technology-screening matrix to assist UXO project managers in selecting the appropriate detection systems for their application.

Standardized test sites will be made up of three areas – the calibration lane, the blind grid, and the open field. The calibration area will contain targets from a standardized target list at six primary orientations and at three depths. The target depth, orientation, type, and location will be provided to demonstrators. The calibration area will allow demonstrators to test their equipment, build a site library, document signal strength, and deal with site-specific variables. In the blind grid area, demonstrators will know possible locations of targets and will be required to report whether or not a UXO target clutter or nothing actually exists. If a UXO target is found, they must report the type of target, classification of target, and target depth and a confidence level. The blind grid allows testing of sensors without ambiguities introduced by the system, site coverage, or other operational concerns. The open field will be a 10 or more acre area with clutter and geolocation targets about which demonstrators will be given no information and will be required to perform as if they were performing at an actual DoD range. Testers will report the location of all anomalies, classify them as clutter or UXO, and provide type, classification, and depth information. The open field conditions will document the performance of the system in an actual range operation mode.

In addition to the construction of test sites available to the UXO community, the primary products of this program will be the creation of a series of protocols to establish procedures necessary for constructing and operating a standardized UXO test site. A standardized target repository will be amassed that can be used by installations, technology developers, and demonstrators.

4.6 Fact Sheets and Case Studies on Detection Technologies and Systems

Three fact sheets on UXO sensors and three case studies describing detection systems are found at the end of this chapter as Attachments 1 through 6. Information on the nature of the technology and its benefits and limitations is provided. Since the performance of the instruments is not solely based upon the sensors deployed, the case studies provide more insights on the operation of the systems. The performance of detection systems is dependent upon platform characteristics, survey methodology and quality, data processing, personnel operation/performance, and appropriate quality control measures that should be taken throughout the investigation.

4.7 Conclusion

The performance of many existing and emerging technologies for UXO detection and discrimination is limited by specific site characteristics such as soil type and composition, topography, terrain, and type and extent of contamination. What works at one site may not work at another. Our ability to find UXO in subsurface locations has improved dramatically. The JPGTD studies have shown that we have gotten much smarter about how to deploy these technologies and how to locate a high percentage of UXO. However, the results of a controlled study such as the JPGTD should not give us unrealistic expectations about the capabilities of these technologies when used in range investigation. Studies at true UXO areas, such as at Fort Ord, provide additional information about the challenges and issues that have to be considered in selecting UXO detection systems. For example, the nature of the targets (e.g., composition, size, and mass), the depth of UXO penetration (a function of the soil and the ordnance item), and expected spatial and depth distribution should be considered along with the geology, terrain, and vegetation. Other factors affecting the results include operator performance and postprocessing techniques. Given the sizes of the ranges and the cost of investigating anomalies, the greatest challenge to improving UXO detection is being able to discriminate UXO from other subsurface anomalies. Although there have been improvements in this area, much developmental work remains.