



National Defense Center for Environmental Excellence

Unexploded Ordnance (UXO) (Task N. 0407 AA) - FY04



USACE Engineer Research and Development Center
Cold Regions Research and Engineering Laboratory

A few of the organizations that are represented in the UXO Stakeholder Teams. There are over 100 stakeholder participants on the UXO Stakeholder Teams, representing over 60 organizations.

Objectives:

- Build upon the prior 2 years of Congressionally directed effort to meet DoD-wide needs and improve responsiveness / tool availability.
- Address DoD UXO priority needs through a UXO community stakeholder vetting process.

Justification:

- Military readiness and homeland security depend on the ability to properly train military personnel and test military equipment. A direct by-product of these activities is MEC (munitions and explosives of concern) and more specifically UXO.
- Management of MEC is a complex issue that encompasses a wide range of technical areas including, but not limited to, geophysics, corrosion, fate and transport mechanisms, geographic information systems, and process and manufacturing systems.
- Mitigation of these issues is further compounded by the fact that the total amount of UXO and DMM (discarded military munitions) and the corresponding total contaminated land area are not known.

Schedule:

Tasks/Milestones	FY04	FY05	FY06
1 Program Mgmt			
2 Evaluate Bullet Traps			
3 Testing of EMI on Live Fuzes			
4 UXO Removal from Sediment			
5 Shallow Water Technologies			
6 UXO Recovery Database:T2			
7 Develop MCs Database			
8 BulkSoil UXO Removal Sys			
9 UXO Migration Field Studies			
10 Develop a UXO Web Portal			
11 EMI Influences on Fuzes			
12 Expand the EDCT			
13 Enhanced Ordnance Detectability			
14 Recycling of Range Scrap			
15 Magnetic Recovery of UXO			
16 Ammo Eng Data Archival Database			
17 Dud Rates Vs Env Factors: II			

Approach

- In executing each of the technical subtasks, the NDCEE UXO Team will continue to coordinate and work with the Stakeholder Teams that were established under Tasks N.307 and 318. The teams are composed of representatives from the DoD user community including federal and state government agencies, industry, and academia.
- In addition, the NDCEE will continue to identify other relevant stakeholders for each of the subtasks to minimize duplication of effort, leverage past work, ensure communication on project status and accomplishments and facilitate transfer of technologies within the UXO community.



Evaluate Bullet Traps – Subtask 2

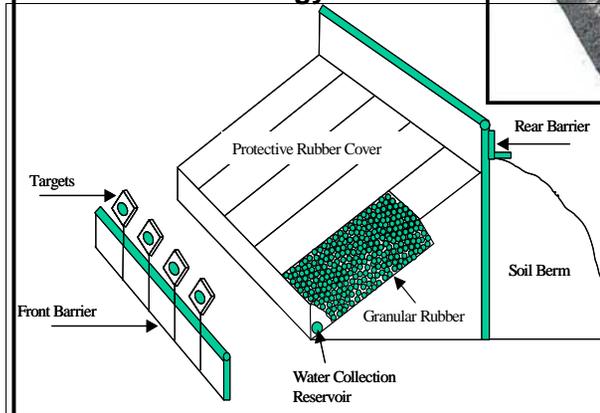
Objectives:

- To identify and analyze alternative bullet trap technologies.
- To develop and coordinate execution of a demonstration/validation plan that will evaluate the performance of the selected technology and validate its ability to reduce the amount of lead that is introduced to the environment.

Justification:

- The Army has an Environmental Requirement (ID Number: A (2.5e), titled Sustainable Army Live-Fire Range Design and Maintenance) to maintain compliance with local, state, federal, or Army regulations and to continue to pursue prevention or minimization of environmental impacts from military training activities.
- The use of a bullet trap with the warranted characteristics would help meet that requirement by reducing clean-up needs, effective collection of range scrap, and aid in erosion control.

Orange County Sheriff's Dept. tactical shooting range utilizing the Super Trap® technology.



Conceptual diagram of STAPP bullet catcher system.

Schedule:

Tasks/Milestones	FY04	FY05	FY06
Conduct Literature Search			
Conduct Site Visits			
Develop Dem/Val & H/S Plans			
Perform Dem/Val			
Develop Final Report			

Approach

- Conduct a literature search and field investigation to generate a report on the state-of-the-art for small arms range bullet traps.
- Assure that the report provides: Capabilities, limitations, cost, and environmental impacts
- Conclude the report with an analysis of which traps are in need of further evaluations due to recent innovations.
- Conduct a Demonstration / Validation (Dem/Val) of at least one bullet trap system for outdoor small arms firing ranges, which will be conducted after the evaluation of available systems has been completed.



Testing of Electromagnetic Induction (EMI) on Live Fuzes – Subtask 3

Objectives:

- Test/verify the theoretical results from FY03 NDCEE Task 307, Subtask 7, on selected live fuzes.
- The M732 and M734 fuzes were selected and suspected to be susceptible to EMI due to low initiation energy for the detonators.
- Initial testing (307 Subtask 7) focused on identifying if the phenomenon of EMI was a potential safety hazard of increasing power to EM-based detectors.

Justification:

- EM-based technologies are increasingly being used to locate buried ordnance items, with instruments being used in the field becoming more powerful so as to improve buried object resolution, depth of detection and underground mapping capability.
- The potential impact of the increasing field strength (energy levels) from the instrument on buried Electronic/VT fuzes needs to be more fully assessed to prevent possible detonation of buried ordnance by EM-type instruments during UXO cleanup efforts.
- The results of the FY03 research indicate that it may be possible to induct energy into an inert detonator at sufficient levels to cause the Maximum No Fire Current (MNFC) of the bridge wire to be exceeded, resulting in potential detonation.

Schedule:

Tasks/Milestones	FY04	FY05	FY06
Develop Test & Safety Plan			
Conduct Testing			
Develop Final Report			



Top: M732 Proximity Fuze and 105mm Inert Projectile
Bottom: M734 Multi-Option Fuze and 120mm Inert Mortar

Approach

- Re-engage stakeholder team that was established under Task 307 Subtask 7.
- Procure the select group of live fuzes for testing.
- Develop test and safety plans.
- Test live fuzes in selected configurations to determine if induction of EM energy will cause detonation.
- Capture data for reporting purposes.



UXO Removal from Sediment – Subtask 4

Objectives:

- Review existing technologies such as dredges, salvage vacuums and water jets, and remotely operated systems.
- Determine what are the most effective state-of-the-art of technologies for UXO removal from sediment.
- Develop a demonstration/validation plan in order to focus upon technology(ies) that offer the most interest to the stakeholders.
- Upon completion of the Dem/Val plan, work will UXO community to identify funding to execute a demo.
- Technology transfer to reduce costs and safety risks for UXO removal from sediment, including dredging operators and material deposition personnel.

Justification:

- The shallow water / sediment interface with UXO is an emerging DoD need area
- Removal of UXO from sediment has not been performed to the same extent as ground UXO cleanup.
- As a result, there are not as many technologies available and their capabilities and limitations are not well known and/or documented throughout the UXO community.

Schedule:

Tasks/Milestones	FY04	FY05	FY06
Conduct Technology Search			
Develop Dem/Val Plan			
Develop Final Report			



Cutter dredge (photograph from Ellicott’s website)

Approach

- Establish stakeholders group – document requirements.
- Review work performed as part of the ESTCP project “Dredging Equipment Modifications for Ordnance Detection and Removal”.
- Complete technology review, if needed.
- Prepare technology vs. requirements matrix.
- Select technology with highest level of interest.
- Prepare a demonstration/validation plan for this technology.
- Capture data for reporting purposes.



Survey Shallow Water Detection/Discrimination Technologies – Subtask 5

Objectives:

- Document the state-of-the-art for shallow water detection and discrimination technologies (with their advantages and disadvantages).
- Format the data/information so that it can be used by UXO project managers as a ready reference.

Justification:

- There is an unknown amount of UXO-contaminated water bodies in the CONUS. These water bodies may include ponds, lakes, streams and rivers as well as estuaries and surf zones.
- This effort will further support UXO project managers by identifying potential UXO detection and discrimination technologies and their respective applicability for use on sites with UXO present in shallow water.
- With the upcoming FY05 BRAC round, shallow water detection will become a contributing factor for facilitating the transferring of DoD properties.



Moat at Fort Monroe (Tradoc)

Schedule:

Tasks/Milestones	FY04	FY05	FY06
Conduct Literature Search			
Prepare Technology Matrix			
Develop Final Report			

Approach

- Conduct literature and database search, including international sources of information, to report on the state-of-the-art for shallow water and tidal wetlands UXO detection and discrimination technologies currently being used in the field or being developed in the laboratory.
- Develop a technology matrix that will incorporate the capabilities, limitations, manufacturer, available capital costs, available operating costs, applicability for use in differing environments, and past use and/or demonstration information associated with the identified technologies.
- Capture data for reporting purposes.



UXO Recovery Database: Additional Data Entry and Transition Plan – Subtask 6

Objectives:

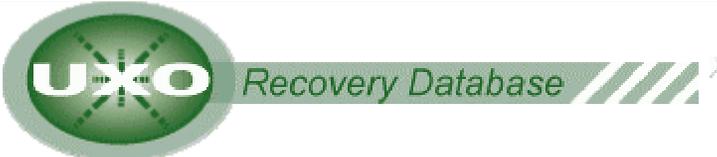
- Implement a transition plan for the UXO Recovery Database.
- Further enhance the functionality of the current database and complete additional data entry.

Justification:

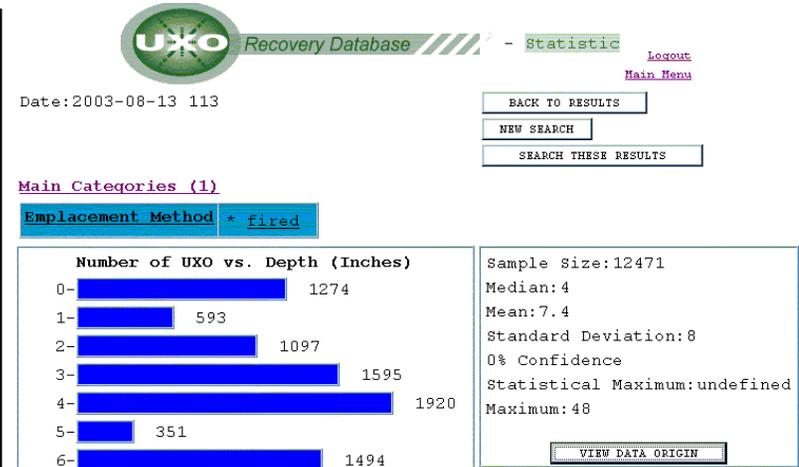
- In FY02 under Task 307, Subtask 4, a web-accessible database of UXO recovery depth data was developed and contains 32,000 readily accessible UXO data records.
- Then in FY03 under Task 318, Subtask 5, the data collection aspect of the database was enhanced through the development of a field-deployable PDA data collection device.
- The database currently resides on an internal NDCEE hosted server. Pending the results of a cost benefit analysis, the database will be transitioned to a permanent location.
- As the FY05 BRAC round will present compliance challenges, the the tool can be used to facilitate regulatory “buy-in” by providing historical recovery depth data.

Schedule:

Tasks/Milestones	FY04	FY05	FY06
Identify Requirements			
Modify Tool & Data Entry			
Develop T2 Plan & Provide Support			
Develop Final Report			



The UXO RDS is currently available through www.ndcee.ctc.com



Screen Shot of the Statistical Analysis Page, which can be generated for any search criteria versus number of UXO located at a particular depth.

Approach

- Determine requirements for additional functionality based on stakeholder input and results from previous field demonstrations.
- Gather additional recovery data reports and input data into the database.
- Develop transition plan including user training.
- Coordinate database transition with receiving government agency.
- Make the database available to user on the NDCEE website.



Munitions Constituents Database – Subtask 7

Objectives:

- Collect and organize military munitions and their chemical constituents into a Microsoft ACCESS database..
- Focus on military munitions in current use (last three years), rather than historical use.
- Look at primary explosives, secondary explosives, propellants, and metals (excepting the shell casing itself).
- Provide a tool for Installation and R&D community to efficiently analyze the amount of a particular military munition constituent the Army uses annually and resulting maximum potential constituent loading for various sites, such as training ranges.

Justification:

- As the Army and the DoD are faced with potentially-increasing environmental regulations and public scrutiny on chemical constituents released into the environment, it is in the interest of the NDCEE Executive Agent to have easy access to data concerning military munition constituents, such as type and amount per item.
- This tool will be available to all DoD components.



4.2 inch High Explosive (HE) Mortar split open with HE exposed to environment (photo courtesy of C. Hospodar, NDCEE UXO team). Database will provide users access to constituent information for certain munition types.

Schedule:

Tasks/Milestones	FY04	FY05	FY06
Identify List of MCs			
Develop Database			
Populate Database			
Conduct Beta Testing			
Develop Final Report			

Approach

- Obtain munitions usage data for the past three years, including type, DODIC, and available manufacturer information, from Joint Munitions Command.
- Cross-reference the munitions types with MIDAS and other databases, as appropriate, to identify the munitions constituent type and amount.
- Identify resulting data gaps.
- Contact manufacturers and procurement agencies from the Services to fill in resulting data gaps.
- Develop database specifications including data configuration and uploading requirements based upon stakeholder input.
- Develop Database – and Beta-test the database.



Bulk Soil UXO Removal System – Subtask 8

Objectives:

- Demonstrate / validate a UXO removal technology that shows significant promise for reducing cost and time for cleanup.
- Support further development of the Range Master based upon previous ESTCP testing results that would enhance its capabilities and progress it towards deployable status.

Justification:

- Timberline’s Range Master is designed to combine remotely controlled mechanical removal of items, screening and identification with manual inspection/handling.
- Impact areas on operational training ranges are typically areas where a high-density of UXO items are present.
- In such situations, the manual removal method is very time-consuming due in large part to the amount of metallic fragments present.
- The use of mechanized removal, albeit combined with some manual work, has been shown to make economic sense in these types of situations.

Schedule:

Tasks/Milestones	FY04	FY05	FY06
Identify Improvements		■	
Document Upgrades		■	
Install Improvements		■	
Develop T/S Plans & Perform Demo		■	
Develop Final Report			■



Range Master unit (photo courtesy of Timberline Environmental Services).

Approach

- Establish stakeholders group.
- Document further development and/or demonstration needs.
- Perform selected improvements and prepare for selected demonstration.
- Perform demonstration to evaluate system’s capabilities.
- Capture data for reporting purposes.



Continue UXO Migration Field Studies – Subtask 9

Objectives:

- Continue monitoring and collecting data from the field studies initiated under Task 307 Subtask 8.
- Document more fully, the migration characteristics of UXO/MEC based upon more climatic cycles and “real-world” site conditions.
- Provide more data input for future development of UXO migration predictability models.

Justification:

- Previously NDCEE worked with CRREL to set up the field test sites to subject inert ordnance to freezing and evaporation conditions to investigate the subsurface movement of UXO.
- Freeze sites include outside CRREL facilities in New Hampshire and Ft. McCoy, Wisconsin. The evaporation / salt heave site is at Yuma Proving Ground, Arizona.
- Conducting testing over a significant period will provide data for future modeling efforts that could support the DoD and other stakeholders, such as the USEPA and others, to predict the longevity of clearance efforts. Such models will increase confidence in the DOD’s program for transferring former ranges and other UXO-contaminated properties.



Setting up the test site at CRREL. Jack Rose (NDCEE), Dr. Karen Henry (CRREL), Mr. Larry Danyluk (CRREL) and Tom Anderson (NDCEE)

Schedule:

Tasks/Milestones	FY04	FY05	FY06
Monitor Sites			
Analyze Data			
Develop Final Report			

Approach

- Continue daily recording of measurements through electronic dataloggers.
- Conduct periodic site visits to inspect and to record visual measurements.
- Fully engaging stakeholder group in decision-making process as well as full visibility of results
- Ensure scientific validity throughout testing schedule.
- Develop Final report that documents all activities and details the experiment controls and limitations and resulting data.
- Capture data for reporting purposes.



Develop a UXO Web Portal – Subtask 10

Objectives:

- Develop, for the UXO cleanup community, a central Web portal for efficiently accessing information/documents required for UXO cleanup operations.
- Tailor the website for improved regulatory community utilization from the specific EPA region, state, agency, and service that are applicable to that manager’s site.

Justification:

- The UXO community is engulfed in reference materials, technology reports, standard operating procedures, policies, and regulations that differ from service to service, agency to agency, state to state, and region to region.
- An accepted and accessible website database portal will improve regulatory “buy-in” and approvals for cleanup, removal, and property transfers.



Screen shot of primary screen for the UXO web portal application.

Schedule:

Tasks/Milestones	FY04	FY05	FY06
Identify Requirements			
Develop Conceptual Model			
Develop Tool			
Gather Document Locations			
Validate Tool			
Develop Final Report			

Approach

- Establish stakeholder team.
- Develop requirements, including search capabilities and functionality and the resulting output, for identifying UXO resource links based on stakeholder input.
- Build a conceptual database.
- Develop a beta-version of the database,
- Conduct beta-testing.
- Populate the database, and validate the final database configuration and capabilities.
- Capture data for reporting purposes.



Active Electromagnetic Induction (EMI) Influences on Electronic Fuzes Subtask 11

Objectives:

- Expand the effort started under Task 307, Subtask 7 to include additional fuze types and new transmitter configurations (i.e., Skip Snyder's high powered transmitter-timed domain EM Detector).

Justification:

- Initial testing focused on identifying if the phenomenon of EMI was a potential safety hazard of increasing power output of current detectors. The testing was focused on only one detonator used in two fuzes and five ordnance shapes.
- The results of this initial research indicate that at certain frequencies, it is possible to induct energy into an inert detonator at sufficient levels to cause the minimum no fire current (MNFC) of the bridgewire to be exceeded, resulting in potential detonation.
- This phase of testing will identify additional ordnance/fuze/detonator combinations that may also pose a risk, as well as test other types of detectors that emit EM energy in different ways.



Susceptibility of the M734 (left) and M732 (right) fuzes to EMI were studied during the first phase of testing.

Schedule:

Tasks/Milestones	FY04	FY05	FY06
Assess Test Materials			
Revise Test & Safety Plans			
Conduct Testing			
Develop Final Report			

Approach

- Re-engage stakeholder team assembled under previous effort (Task 307 Subtask 7).
- Identify additional ordnance/fuze/detonator combinations and new detectors for testing and review with stakeholders.
- Working with Dahlgren and ATC, test identified ordnance combinations against existing test parameters as well as new parameters driven by new/emerging detectors.
- Coordinate and work with ATC and NSWCCD to assess susceptibility of ordnance combinations and detectors.
- Capture data for reporting purposes.



Expand Functionality of Electronic Data Collection Tool – Subtask 12

Objectives:

- Integrate the EDCT, developed under FY03 NDCEE Task 318 Subtask 5, with additional programs used in UXO cleanup efforts in order to expand compatibility, functionality, and usability of the tool.
- Expand the tool to address contractor and Government personnel feedback.

Justification:

- Leverage the FY03 work and improve usefulness and robustness of the EDCT.
- Currently the EDCT provides the ability to enter UXO data during field operations and upload that data to the UXO Recovery Database System (RDS) that was developed under Task 307-5.
- This subtask is the result of user feedback (contractors and Government personnel) gathered during demonstrations conducted under Task 318 Subtask 5.
- Increasing the functionality of the tool with these desired features will facilitate transitioning this technology to a larger user community.

Schedule:

Tasks/Milestones	FY04	FY05	FY06
Identify Requirements			
Develop Functionality			
Develop & Execute Test Plan			
Develop T2 Plan & Perform Demo			
Develop Final Report			

Screen Shots of EDCT Interface:
Opening screen (Left), Data Entry General (center) and Location (right)

Approach

- Evaluate additional programs for integration with the EDCT including:
 - Count Forcing Tool (CFT) and OE Dig developed by USACE – Huntsville
 - Data collection tool used at Fort Ord
 - Data Management Model (DMM) developed by ERDC & USAEC
- Evaluate additional functionality including:
 - Digital photograph uploading
 - Geographic Information System (GIS)
 - GPS
 - Digital Survey Data
 - Wireless uploading to RDS
- Capture data for reporting purposes.



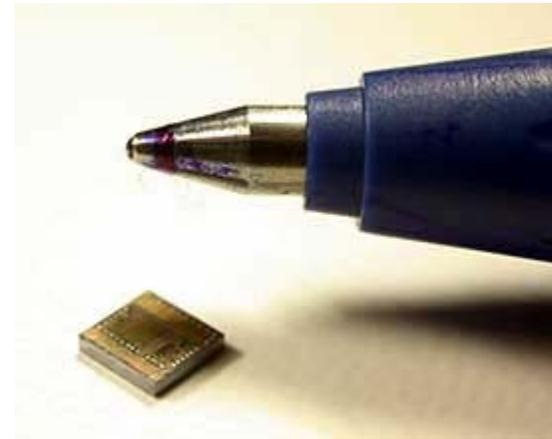
Enhanced Ordnance Detectability Testing – Subtask 13

Objectives:

- Continue work accomplished under Task 318, Subtask 9
- Complete technology down selection and testing
- Develop Prototype Design Document

Justification:

- Reducing the amount of false positive digs in the field by even a small percentage is a significant improvement to the UXO clearance process, which has the potential to reduce costs significantly.
- The objective of this project task is to leverage work accomplished under NDCEE UXO Task 318 Subtask 9 *Enhanced Munitions Detectability* to develop a low cost, simple, lightweight, fully functional device that once inserted into or attached to munitions enhances the ability of existing detection technologies to locate that munition should it become UXO. This device, must survive firing and impact and cannot affect the ballistics or normal operation of the munition. In addition, it cannot create additional “clutter” impeding detection.



Berkeley's Smart Dust single-chip Mote measures approximately 2mm x 2.5mm .

Schedule:

Tasks/Milestones	FY04	FY05	FY06
Perform Technology Down-Selection Analysis			
Develop Test and Safety Plans			
Re-Engineer or Modify Technologies			
Conduct Testing on Potential Alternatives			
Select Prototype Documentation			
Task Management			

Approach

- Re-engage stakeholder team assembled under previous effort (Task 318 Subtask 9), along with other participants
- Conduct a technology down-selection process based on the final report from the FY03 effort, resulting in as many as 3 technologies selected for further consideration.
- Along with teammate Battelle, prepare for any required re-engineering or modification to the technologies.
- Test candidate technologies re. both survivability and detectability.
- Present results of candidate sensor technologies using a rank-ordered matrix based on relative ability to survive firing and impact.
- Capture data for reporting purposes.



Recycling of Range Scrap – Subtask 14

Objectives:

- Investigate and document current approaches, activities, regulations, and practices related to recycling of range scrap.
- Identify successful recycling programs at current range maintenance sites.
- Identify potential issues with regulator/recycler/insurers and disseminate this information to the UXO community.
- Track the life cycle costs of range scrap (collection, decontamination, certification and disposition), document the chain of custody and identify issues associated with recycling range scrap.

Justification:

- Identifying successful range scrap recycling programs will aid with the DoD range sustainability and environmental stewardship programs and assist the UXO community by providing successful options for the management of range scrap.



Examples of various types of range scrap.

Schedule:

Tasks/Milestones	FY04	FY05	FY06
Collect Data		■	
Conduct Site Surveys		■	
Develop Final Report			■

Approach

- Identify current successful DoD range maintenance practices and activities and then document their history and disseminate information to the UXO community.
- Conduct a thorough study of successful methods for addressing range scrap issues, actual costs and long-term ramifications of instituting these types of recycling programs.
- Based on the data collected, prioritize a list of identified sites and conduct 4 site visits with the goal to include at least one range scrap program for each of the services.
- Identify the barriers to implementation of effective range scrap programs.
- Capture the data for reporting purposes.



Magnetic Recovery of UXO – Subtask 15

Objectives:

- Conduct a literature search and report on the state-of-the-art of technologies for magnetic recovery of UXO in both land and water.
- Develop a summary of
 - Current technologies available for use in the field,
 - Description of the technologies / capabilities and limitations,
 - Case studies,
 - Manufacturer, reference service providers,
 - Safety issues / effectiveness,
 - Specific applications.
- Develop a conceptual design for the most promising technology for potential future development efforts.

Justification:

- This effort will support UXO project managers by identifying and characterizing potential magnetic technologies that are available for UXO recovery efforts.



Automated Ordnance Excavator with command and control vehicle.

Schedule:

Tasks/Milestones	FY04	FY05	FY06
Research Technologies			
Develop Design			
ID Test & Safety Requirements			
Develop Final Report			

Approach

- Establish stakeholder team.
- Prepare a matrix on the state-of-the-art for magnetic recovery technologies for use in the field or being developed in the laboratory. The matrix will incorporate the capabilities, limitations, available cost information associated with identified technologies, and past use and/or demonstration.
- Research and document the resulting potential effects of soil magnetization when using magnetic technologies during UXO removal actions.
- Design system combining remotely controlled system and magnetic recovery of UXO/fragments.
- Capture the data for reporting purposes.



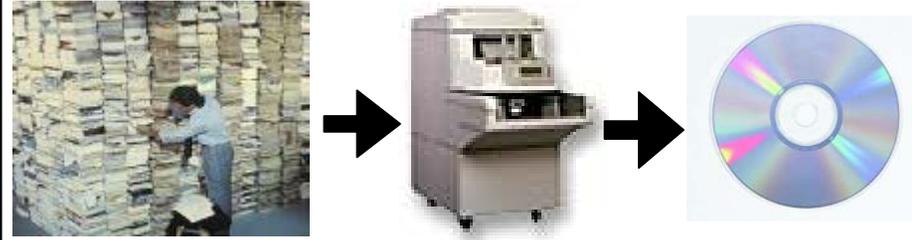
Ammunition Engineering Data Archival Database (Lake City Army Ammunition Plan) – Subtask 16

Objectives:

- To capture in electronic format archived ammunition engineering drawings and data located at Lake City Army Ammunition Plant (AAP).
- Scan, store, and present the electronic data in an accessible format for availability to the archival generating agency (e.g. Lake City AAP).

Justification:

- This ammunition data is in hardcopy format only and this effort is to ensure that important historical data is not lost.
- This task will convert the data to a portable form that can be uploaded to existing government databases.
- The task will document a process to convert documents to electronic form.



Conversion of Paper Engineering Drawings to Digital Media will Promote Document Distribution while Reducing Physical Size and Archive Maintenance.

Schedule:

Tasks/Milestones	FY04	FY05	FY06
Identify Requirements			
Scan Data			
Develop Final Report			

Approach

- The archival data will be scanned, stored, and provided to the appropriate US Army Archival records, i.e., ammunition engineering data will be made available for upload into the MIDAS database housed and maintained at DAC McAlester, and ammunition engineering drawings will be made available for upload into the JEDMICS database warehoused and maintained at Rock Island Arsenal.
- All data will be provided to the appropriate personnel for upload into the existing databases.
- A summary report will be developed, detailing the methodology of archiving the ammunition engineering drawings and data into the electronic databases.



Phase II Dud Rates Vs. Environmental Factors – Subtask 17

Objectives:

- Collect empirical data to validate the PENCRV3D impact analyses conducted as part of Phase I and perform more simulations to predict casing failures.
- Model the condition of a thin-skinned mortar (60 mm or 81 mm) and a thick-skinned projectile (155 mm artillery shell), as fired into an engineered soil bed and improve engineering design for future pads.
- Identify the range of impact area geologic characteristics (e.g., soils, bedrock and topography) and ordnance operational parameters (e.g., propellant charge, launch angle, impact angle, and impact velocity) that would result in casing failures for dud rounds that impact hard or soft soil conditions.
- Develop a matrix that correlates ordnance type, impact area characteristics and ordnance operational parameters so that a tester or trainer can identify the probable net result of using these munitions on his range.

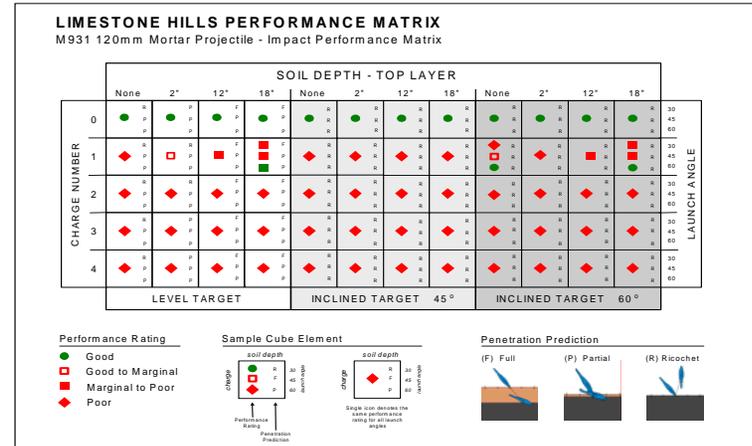
Justification:

- The results of this subtask will assess the probable projectile impact effects (e.g., casing failures), based on various factors, such as ordnance type and mass, impact angle and velocity, and impact area geologic characteristics.
- This information would be used by range managers to assess the potential risk of casing failures, with subsequent explosives releases, from testing or training activities in the event of fuze malfunctions.

NOTE: This design task is theoretical in nature; no live fire testing will be performed.

Schedule:

Tasks/Milestones	FY04	FY05	FY06
Collect Data		█	
Evaluate Data		█	
Conduct Impact Analysis		█	
Develop Final Report		█	



Projectile impact performance matrix (PENCRV3D output) developed under Phase I for Limestone Hills Case Study.

Approach

- Re-engage the stakeholders established under Task 318 Subtask 8.
- Perform PENCRV3D simulations to predict projectile case failure.
- Model the condition of a thin-skinned mortar (60 mm or 81 mm) and a thick-skinned projectile (155 mm artillery shell) as fired into a raised engineered soil bed.
- Assess impact area geologic characteristics as well as ordnance operational parameters that would create distinct differences in the condition of the shell when impacting one of two (hard vs. soft) soil types.
- Develop a table of impact velocities and soil properties to facilitate the design of the soil receiving pads.
- Capture data for reporting purposes.