# ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2 Exhibit)

**February 2005**

| BUDGET ACTIVITY | PE NUMBER AND TITLE |
|---|---|
| **3 - Advanced technology development** | **0603606A - Landmine Warfare and Barrier Advanced Technology** |

| | COST (In Thousands) | FY 2004 Actual | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | FY 2008 Estimate | FY 2009 Estimate | FY 2010 Estimate | FY 2011 Estimate |
|---|---|---|---|---|---|---|---|---|---|
| | Total Program Element (PE) Cost | 28995 | 33621 | 25327 | 29534 | 33095 | 36623 | 36682 | 37401 |
| 608 | COUNTERMINE & BAR DEV | 20754 | 21790 | 22042 | 25590 | 28675 | 31823 | 31787 | 32409 |
| 64C | COUNTERMINE DEMONSTRATIONS (CA) | 5351 | 9012 | 0 | 0 | 0 | 0 | 0 | 0 |
| 683 | ANTI-PERSONNEL LANDMINE (APL) ALTERNATIVES | 2890 | 2819 | 3285 | 3944 | 4420 | 4800 | 4895 | 4992 |

**A. Mission Description and Budget Item Justification:** This program element (PE) matures and demonstrates the sensor technologies required to detect mines, minefields, improvised explosive devices (IEDs) and obstacles to enable assured mobility for the high operational tempo (OPTEMPO) of Future Combat Systems (FCS), Future Force, and where feasible, exploit opportunities to enhance Current Force capabilities. Project 608 focuses on concepts and technologies that will enable in-stride detection and breaching, close-in detection, area clearance, and neutralization of landmines. This project demonstrates the remote detection of minefields as well as individual landmine detection from handheld, ground, and aerial sensor systems; evaluates detection of both conventional and command detonated types of landmines (including IEDs), metallic and low/non-metallic; and emphasizes the use of wide-area multi-sensor fusion detection systems, coupled with small-area confirmation sensors. This multi-sensor approach has the potential to yield a high probability of landmine detection at very low false alarm rates. Efforts within this project assess airborne mine detectors for contingency applications and mature lightweight plug-and-play detectors for use in mission specific applications. Project 64C funds Congressional special interest items. Project 683 explores alternative systems for anti-personnel landmines and innovative concepts for minefield clearance. This PE will conduct modeling and simulation activities to assess the effectiveness of system concepts.

Work in this PE is related to and is fully coordinated with PE 0602712A (Countermine Systems), PE 0603710 (Night Vision Advanced Technology), and the Marine Corps. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the Defense Technology Area Plan (DTAP). The program adheres to Tri-Service/Project Reliance Agreements on conventional air/surface weapons and ground vehicles. The PE contains no duplication with any effort within the military departments. Work in this PE is performed by the Army Research, Development and Engineering Command/Communications-Electronics Research, Development and Engineering Center/Night Vision & Electronic Sensors Directorate (NVESD), Fort Belvoir, VA.

| B. Program Change Summary | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|
| Previous President's Budget (FY 2005) | 25577 | 26696 | 27731 |
| Current Budget (FY 2006/2007 PB) | 33621 | 25327 | 29534 |
| Total Adjustments | 8044 | -1369 | 1803 |
| Net of Program/Database Changes | | | |
| Congressional Program Reductions | -549 | | |
| Congressional Rescissions | | | |
| Congressional Increases | 9400 | | |
| Reprogrammings | | | |
| SBIR/STTR Transfer | -807 | | |
| Adjustments to Budget Years | | -1369 | 1803 |

Change Summary Explanation:

Five FY05 Congressional adds totaling $9400 were added to this PE.

($1342) EDIT Advanced Landmine Detection, Project 64C: The purpose of this one year Congressional add is to mature a handheld time-domain electro-magnetic sensor and imaging detector based on a Resonant Microstrip Patch Antenna technology. No additional funding is required to complete this project.

($2877) Forward Looking Synthetic Aperture Stepped-Frequency Ground Penetrating RADAR (FLGPSAR), Project 64C: The purpose of this one year Congressional add is to demonstrate a prototype vehicle mounted forward looking ground penetrating radar for the detection of mines in roads and investigate use of same technology for detection on explosive devices along road sides. No additional funding is required to complete this project.

($1439) Landmine Detection System using Terahertz Radiation, Project 64C: The purpose of this one year Congressional add is to mature the THz database for landmine detection, and mature detectors/recorders for operator evaluation. No additional funding is required to complete this project.

($2398) Lightweight Rapidly Deployable Hardened Shelters, Project 64C: The purpose of this one year Congressional add is to develop lightweight, rapidly deployable hardened shelters. No additional funding is required to complete this project.

($959) SCANJACK Mine Clearing System, Project 64C: The purpose of this one year Congressional add is to demonstrate a mine clearing vehicle equipped with a double flail system designed to destroy landmines to a depth of 30cm in a variety of terrain conditions. No additional funding is required to complete this project.

# ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

**February 2005**

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| **3 - Advanced technology development** | **0603606A - Landmine Warfare and Barrier Advanced Technology** | **608** |

| COST (In Thousands) | | FY 2004 Actual | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | FY 2008 Estimate | FY 2009 Estimate | FY 2010 Estimate | FY 2011 Estimate |
|---|---|---|---|---|---|---|---|---|---|
| 608 | COUNTERMINE & BAR DEV | 20754 | 21790 | 22042 | 25590 | 28675 | 31823 | 31787 | 32409 |

**A. Mission Description and Budget Item Justification:** This project matures countermine technologies for integration into future Army systems to enable assured mobility of Future Combat Systems (FCS), Future Force, and where feasible, exploit opportunities to enhance Current Force capabilities. Specific activities include remote detection of minefields by aerial sensor systems and individual landmine detection by handheld and vehicle-based sensor systems and neutralization of individual mines and minefields. The landmines being addressed include conventional and command detonated, including improvised explosive devices (IEDs), metallic and low/non-metallic construction anti-tank and anti-personnel mines. This project will evaluate the potential for wide-area multi-sensor fusion detection systems, coupled with slower small-area confirmation sensors, to yield a high probability of mine detection (Pd) at very low false alarm rates (FAR). This project will evaluate airborne multispectral mine detection sensors and mature them for lightweight plug-and-play use on unmanned aerial vehicles (UAVs) in mission specific applications. The goal is for robust approaches to finding surface-laid and buried mines in temporally and spatially varying vegetation, soil, weather, and diurnal conditions. This project has the potential to provide advanced countermine capabilities to the mounted and dismounted soldier by adapting commercial or emerging technologies for standoff mine detection and neutralization. Detection technologies include, but are not limited to, wide band radar, acoustic, laser, explosive detection sensors, infrared and visual imagery, and radio frequency. Neutralization technologies include chemical reactants, electromagnetic energy, and kinetic energy. The intent is to provide increased operational tempo and survivability for U.S. Forces prior to their entry into harm's way. Efforts are supported by modeling and simulation assessments and defines potential system effectiveness. The FCS Standoff Mine Detection System effort will provide standoff mine/IED detection capability for faster rate of advance (ROA) in high threat areas, using sensors on both a ground vehicle and a UAV. The Autonomous Mine Detection Sensors effort will provide the ability to detect anti-personnel mines at faster ROA while removing the soldier from danger. The Ground Penetrating Radar Countermine On The Move effort will provide faster ROA for on-route detection and provide off-route detection capability with high Pd and low FAR. The Mine Neutralization for Assured Mobility effort will provide the warfighter with standoff area mine neutralization capability to enable in-stride breach for Unit of Action maneuver. The Joint Area Clearance ACTD transitioned several novel mine clearance technologies to PM-CCS and the Marine Corps. The Airborne IED/Mine Detection effort will demonstrate automated processes and algorithms that improve upon the change detection process that detects mines and IEDs. The Aerial Buried Minefield Detection effort will develop sensors and algorithms for detection of mines that have been buried for a long time. The False Alarm Reduction for Improved Optempo effort developed the Ground Penetrating Radar for robust detection of buried on-route mines.

The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the Defense Technology Area Plan (DTAP). Minefield neutralization efforts are closely coordinated with Navy/USMC. Work in this PE is performed by the Army Research, Development and Engineering Command/Communications-Electronics Research, Development and Engineering Center/Night Vision & Electronic Sensors Directorate (NVESD), Fort Belvoir, VA.

| Accomplishments/Planned Program | FY 2004 | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|---|
| FCS Standoff Mine Detection System. In FY04, completed objective sensor design and demonstrated in a temperate environment. In FY05, demonstrate in an arid environment and transition organic aerial vehicle (OAV) component to Program Manager Close Combat Systems (PM CCS); establish baseline performance of bolt-on forward looking ground vehicle sensor and fusion aided target recognition (AiTR); improve fusion AiTRs; and link airborne sensors with ground vehicle suite to demonstrate performance of the combined mine detection approach. In FY06, will complete integration and fusion of forward looking sensors on a single platform; test and demo integrated ground vehicle sensor package and ATR. In FY07, will integrate OAV sensor link with vehicle mounted forward looking sensors; demonstrate integrated concept of OAV multiband IR sensors coupled with forward looking vehicle mounted sensor suite on host vehicle. | 5700 | 5493 | 4990 | 4943 |
| Autonomous Mine Detection Sensors (AMDS). In FY04, delivered surrogate small unmanned ground vehicle (SUGV) platform to hardware developers; completed initial phenomenology study for breadboard sensor design for use against anti-personnel mines; baselined sensor performance in field environment. In FY05, complete sensor and Automated Target Recognition (ATR)/signal processing studies; demonstrate brassboard sensors and initial ATR/signal processing approach on surrogate platform. In FY06, will commence integrating sensor prototypes and signal processing/ATR on SUGV platform; test sensor package on blind test lanes. In FY07, will complete prototype sensor build and ATR/signal processing implementation on SUGV platform and conduct tests in relative environments; prepare for transition to PM-CCS. | 4704 | 4966 | 4954 | 2917 |
| Ground Penetrating Radar (GPR) Countermine On The Move. In FY05, continue maturation of a faster wideband GPR integrated on a surrogate UGV for use against anti-tank mines; increase antenna scan and data acquisition rates for on-route detection, and improve the advanced Automated Target Recognition (ATR) algorithms for improved clutter rejection and tracking of rough terrain; begin mobility evaluation via a series of data collections with the improved GPR on rough terrain and analysis to determine potential capability for off-route detection. In FY06, will refine GPR hardware and ATR improvements and continue on and off route mobility evaluation. In FY07, will complete ATR development and GPR integration; will conduct a series of on and off route demonstrations in a variety of operational scenarios and under representative environmental conditions; will complete mobility evaluation. | 0 | 4057 | 4413 | 5000 |

| **Accomplishments/Planned Program (continued)** | FY 2004 | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|---|
| Mine Neutralization for Assured Mobility. In FY05, conduct industry trade studies of neutralizer darts compatible with Army's guided multiple launch rocket system that will breach minefields from 5-30 km standoff; downselect to one approach and test against mines in Army soil environments and develop a comprehensive model; leverage Navy efforts in modeling and neutralizer dart testing. In FY06, will conduct inert dart flight tests of selected approach to verify feasibility; will conduct Army program review for approval to continue. In FY07, will conduct live dart flight test in anticipation of FY08 final demo; perform test analysis to define trades between cleared lane performance, mission parameters, and area effects. | 0 | 2292 | 2627 | 5493 |
| Joint Area Clearance (JAC) ACTD. In FY04, transitioned mine clearance technologies found to have military utility to Program Manager Close Combat Systems and Marine Corps Systems Command. | 500 | 0 | 0 | 0 |
| Airborne IED/Mine Detection. In FY05, develop automation algorithms for the change detection workstation (CDWS), developed under the Joint Area Clearance (JAC) ACTD, and evaluate multiple platform and emerging sensors options. In FY06, will continue algorithm development and integrate into the CDWS, and procure/integrate emerging sensors and aircraft imagery for an improved IED/mine detection capability. In FY07, will complete algorithm development and sensor integration, conduct flight tests, system demonstrations, and transition to Project Manager, Close Combat Systems (PM-CCS). | 0 | 4982 | 5058 | 3924 |
| Aerial Buried Minefield Detection. In FY07, will begin development of prototype(s) for detection of longer-term buried (greater than 3 days) anti-tank minefields from airborne platforms; use results from 6.2 phenomenology studies, sensor evaluations, and algorithm development to guide selection of prototype configurations and platform options. Sensor technology options include ultra-wideband ground penetrating radar and hyperspectral electro-optical or infrared imaging. | 0 | 0 | 0 | 3313 |
| Mine Detection False Alarm Reduction for Improved OPTEMPO. In FY04, matured and evaluated sensor mine detection technologies, ATRs, and signal processing techniques associated with each technology to improve robustness; integrated the most promising combination scanning/confirmation capabilities on a surrogate reconnaissance vehicle to demonstrate overpass capability and false alarm reduction performance. | 9850 | 0 | 0 | 0 |
| Totals | 20754 | 21790 | 22042 | 25590 |

# ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

**February 2005**

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| **3 - Advanced technology development** | **0603606A - Landmine Warfare and Barrier Advanced Technology** | **683** |

| COST (In Thousands) | | FY 2004 Actual | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | FY 2008 Estimate | FY 2009 Estimate | FY 2010 Estimate | FY 2011 Estimate |
|---|---|---|---|---|---|---|---|---|---|
| 683 | ANTI-PERSONNEL LANDMINE (APL) ALTERNATIVES | 2890 | 2819 | 3285 | 3944 | 4420 | 4800 | 4895 | 4992 |

**A. Mission Description and Budget Item Justification:** This project provides demonstrations of surveillance, command, and control technology components for alternative systems that minimize the risk of injury or loss to non-combatants from exposure to anti-personnel landmines (APLs). The technology components will include distributed anti-personnel surveillance systems (autonomous seismic, acoustic, and day/night imaging sensor systems), command and control systems (ad hoc networked, wireless, sensor communications, and information management tools) to be used with man-in-the-loop overwatch fires. This project will use simulation to evaluate new concepts and modify doctrine. This project will also construct and evaluate components and system architectures at the system level in field tests.

The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the Defense Technology Area Plan (DTAP). The PE contains no duplication with any effort within the military departments. Work in this PE is performed by the Army Research, Development and Engineering Command/Communications-Electronics Research, Development and Engineering Center/Night Vision & Electronic Sensors Directorate (NVESD), Fort Belvoir, VA.

# ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

**February 2005**

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| **3 - Advanced technology development** | **0603606A - Landmine Warfare and Barrier Advanced Technology** | **683** |

| **Accomplishments/Planned Program** | FY 2004 | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|---|
| Anti-Personnel Landmine Alternatives. In FY04, began a study for the concept on networked personnel detection nodes, and completed modeling and simulation capabilities relevant to area denial. In FY05, collect imager data, begin radio and network capacity studies, begin modeling study of standoff detection, complete the concept study, and begin fabrication of a personnel detection and discrimination (combatant vs. noncombatant) networked testbed for demonstration in a relevant environment. In FY06, will complete standoff detection study, complete testbed and demonstrate initial personnel detection and discrimination capability. In FY07, will complete radio and network capacity studies, and continue algorithm enhancements to the personnel discrimination system and improve employment options for the system. | 2890 | 2819 | 3285 | 3944 |
| Totals | 2890 | 2819 | 3285 | 3944 |