ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2 Exhibit)

June 2001

BUDGET ACTIVITY
2 - APPLIED RESEARCH

PE NUMBER AND TITLE
0602624A - Weapons and Munitions Technology

COST (In Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
Total Program Element (PE) Cost		35718	47817	35549	0	0	0	0	0	0	0
H18	ARTY & CBT SPT TECH	14348	12117	11997	0	0	0	0	0	0	0
H19	CLOSE COMBAT WEAPONRY	10910	17854	10344	0	0	0	0	0	0	0
H1A	WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE	0	2972	0	0	0	0	0	0	0	0
H28	MUNITIONS TECHNOLOGY	10460	14874	13208	0	0	0	0	0	0	0

A. Mission Description and Budget Item Justification:

PLEASE NOTE: This administration has not addressed FY2003-2007 requirements. All FY 2003-2007 budget estimates included in this book are notional only and subject to change.

This Program Element (PE) researches improved weapon and munition technologies to enable combat overmatch for the Objective Force. Efforts are focused on meeting requirements of the Future Combat Systems (FCS). This PE funds applied research, which will result in increased system lethality and survivability with the potential of better affordability, lower weight and reduced size. Specific projects within the PE include: the FCS Multi-Role Armament and Ammunition and associated enabling technologies; advanced sensors for smart munitions; agile target effects systems for the battlefield; and the Responsive Accurate Mission Module (RAMM). The FCS Multi-Role Armament is designed to exceed the lethality of the Abrams main battle tank with a 105mm cannon for FCS. It uses advanced materials, novel recoil, and Electrothermal-Chemical (ETC) propulsion to overcome the challenges of creating a smaller, lighter weapon that has lethality equaling or exceeding a 120mm cannon. The corresponding FCS Multi-Role Ammunition will culminate in a three-cartridge suite that provides overwhelming lethality to ranges up to 50 km, with increased weapon delivery accuracy. Specific efforts in explosives, propellants, fuzing, and warhead technology support the ammunition suite. Advanced Sensors for Smart Munitions will enhance current smart sensors for use in the ammunition suite. RAMM provides technologies for an advanced mortar for FCS manned or tele-operated ground vehicles. The PE funds modeling and analytic codes for thermal analysis and high impetus, low flame temperature propellants to reduce wear on gun tubes (which degrades accuracy and increases the system cost); advanced armament fire control, and decision aids and software architecture; advanced laser radar/infrared (LADAR/IR) sensor technology to enhance performance of smart munitions, technology advances in acoustic sensors and anti-armor and anti-personnel area denial systems, advanced wear and erosion resistant barrel coatings to increase service life and provide for environmentally friendly barrel coating process, thermal management of high performance, high rate of fire, large caliber guns, as well as ways to make artillery systems more flexible and deployable through range extension and weight reduction technologies and smart materials to improve accuracy and reduce operational and support (O&S) costs. The work in this PE is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and Project Reliance. The program element contains no duplication with any effort within the Military Departments. The U.S. Army Armament Research, Development and Engineering Center (ARDEC), Picatinny Arsenal, New Jersey primarily manages this program. Work in this PE is related to, and fully coordinated, with efforts in PE 0602618A (Ballistics Technology) and PE 0602623A (Joint Service Small Arms Program (JSSAP)), and its technologies typically

transition to PE 0603004A (Weapons and Munitions Advanced Technology) and PE 0603802A (Weapons and Munitions Advanced Development).

B. Program Change Summary	FY 2000	FY 2001	FY 2002	FY 2003
Previous President's Budget (FY2001 PB)	36521	33761	34654	0
Appropriated Value	36687	48261	0	
Adjustments to Appropriated Value	0	0	0	
a. Congressional General Reductions	0	0	0	
b. SBIR/STTR	-503	0	0	
c. Omnibus or Other Above Threshold Reductions	-78	0	0	
d. Below Threshold Reprogramming	-300	0	0	
e. Rescissions	-88	-444	0	
Adjustments to Budget Years Since FY2001 PB	0	0	895	
Current Budget Submit (FY 2002/2003 PB)	35718	47817	35549	0

Change Summary Explanation: Funding - FY2001: Congressional adds were received for Multi-Role FCS Armaments (+4000), Single Crystal Tungsten Alloy Penetrators (+4500), Low Cost Correction Technology for Conventional Ammunition and Rockets (+3000) and Weapons and Munitions Technology Program Initiative (+3000). Note: The Congressional add for Weapons and Munitions Technology Program Initiatives was originally in Project H28. It was moved to Project H1A for

the President's Budget submit.

FY 2003: Funds realigned to support higher priority activities in 0603004A.

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)

June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
2 - APPLIED RESEARCH	**0602624A - Weapons and Munitions Technology**	**H18**

COST (In Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
H18	ARTY & CBT SPT TECH	14348	12117	11997	0	0	0	0	0	0	0

A. Mission Description and Budget Item Justification: This project focuses on applied research of technology for multi-role cannon, mortar weapon, smart cargo projectile, and fire control and combat support systems in support of FCS and the Objective Force. Specific efforts include FCS Multi-Role Armament and Ammunition; RAMM; Distributed Interactive Fire Mission (DIFM); QuickLook; Advanced Sensors for Smart Munitions; Advanced Acoustic/Seismic Systems; and Extended Range Mortar Cartridge. Recoil management and lightweight materials technologies are being investigated to create a more lethal, lightweight FCS Multi-Role Armament, utilizing ETC propulsion. The objective of the system is to provide multi-mission lethality suitable for a FCS that is air transportable in a C-130 aircraft. Also being pursued is the corresponding FCS Multi-Role Ammunition suite, which includes technologies for achieving both revolutionary fire support lethality and precision point target defeat at extended ranges in lighter and smaller configurations. The RAMM lightweight mortar concept will be matured suitable for insertion into FCS. Development of the DIFM software supports the FCS multi-mission fire control systems. This software will enable groups of fighting vehicles and attack helicopters to fight in unison by coordinating their fires against targets, substantially improving battlefield survivability and operations tempo. Targets will be automatically assigned to individual shooters based on the most effective pattern to ensure rapid first-shot execution and progression to the next target assignment. QuickLook provides the brigade commander with real time target imagery, coordinates, and battle damage assessment (BDA). This system will utilize an artillery launched loitering munition that flies out to a maximum range of 50 km. and acquires and transmits targeting information (i.e., video, Global Positioning System (GPS)) back to the tactical operations center via a wireless link. Advanced acoustic sensors will be investigated which will provide non-line of sight target queuing for a variety of weapons platforms. The application of light-weight, high-strength composites to mortar projectiles is being pursued to significantly extend range while providing increased lethal effectiveness, such as the Extended Range Mortar Cartridge (ERMC) program. This project also supports the development and evaluation of advanced area denial concepts as an FCS countermobility alternative to current anti-vehicle/anti-personnel mining techniques. Technologies for reducing artillery target location error and providing real time targeting and battle damage assessment data to fire direction centers are also being matured to support information dominance strategies for FCS. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2000 Accomplishments

- 4600 Fabricated hardware and conducted preliminary tower flight tests to validate common aperture LADAR/IR sensor performance against low observable targets; fabricated prototype sensor hardware for gun-hardening experiments; conducted field test of prototype area denial hardware; evaluated weapons system and sensor performance; investigated alternative delivery and recovery methods; validated virtual simulations through hardware designs in support of FCS Multi-Role Armament.
- 980 Completed one-year Congressionally directed program in electrorheological (ER) fluid research that included fluid characterization software control methodology, material and structures modeling, and power supply design.
- 4200 Extended the fire mission and movement planning decision aid to a fully Technical Architecture compliant suite of decision aid components to support brigade combat team fires, sustainment, situational awareness and mission rehearsal requirements; established a baseline decision aids application software component reuse library and link with specification data library to support follow-on software component factory technology; performed DIFM domain analysis; initiated development of multi-shooter vs. multi-target algorithms; developed data acquisition methodology and design, and assessed the noise cancellation programs for Striker (High Mobility Multipurpose Wheeled Vehicle (HMMWV) platform); developed acoustic/seismic propagation models and relate performance to potential gains in cost and operational effectiveness of a sensor network.
- 3588 Fabricated QuickLook artillery-fired loitering munition system hardware components and performed sub-system testing, completed 3-D modeling of selected retrofit obturator candidates, and conducted testing of improved obturator band designs.
- 980 Completed one year Congressionally directed program to conduct Extended Range Mortar rocket motor static testing; updated interior and exterior ballistic models; conducted composite motor and fin assembly structural integrity test; conducted live-fire mass simulated flat-fire test.

Total 14348

FY 2001 Planned Program

- 4531 Conduct system trade-off studies, fabricate sensor hardware and perform captive flight tests on alternate sensor designs with a common aperture LADAR/IR transducer for detection of low observable; further identify and investigate critical technologies; update and mature models; validate virtual simulations for stability, precision and accuracy; pursue evaluation of ER recoil management, isogrids and load out of battery technologies in support of FCS Multi-Role Armament; perform a system concept analysis of the RAMM lightweight mortar design for integration into a FCS platform or the Robotic Follower.

FY 2001 Planned Program (Continued)

- 3154 Complete implementation and Depth and Simultaneous Attack Battle Lab concept evaluation of an architecture-based software component factory process for rapid generation of embedded fire mission application software; Complete DIFM multi-shooter algorithms maturation; analyze and optimize the algorithms in a DIFM dedicated Modular Semi-Automated Forces (ModSAF) emulation environment; characterize multi-shooter algorithm performance; collect acoustic signatures of Multiple Launch Rocket System (MLRS), cruise missiles and mortars to expand detection data base capability; evaluate modeling for target location and tracking capabilities using non-real time data and assess improvements in operational effectiveness; pursue investigation of advanced detection, classification and tracking algorithms for advanced acoustic/seismic sensors.
- 4198 Integrate QuickLook system components and perform integrated captive flight test; exhibit improved cannon wear life (Crusader) in wear testing; verification of design improvements for stockpiled ammunition; fabricate prototype hardware and conduct limited short range flight test of the ERMC; conduct review of mission requirements; conduct concept analysis, design trades and preliminary concept design of a smart cargo projectile for FCS Multi-Role cannon.
- 234 Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs.

Total 12117

FY 2002 Planned Program

- 6474 Conclude system tradeoff studies and sensor suite packaging analysis; finalize design and begin fabrication of tactical sensor hardware for smart munitions; complete virtual model, design and fabrication of lightweight cannon system components for verification of key technologies and integration into a turreted armament demonstrator for FCS; finalize the hardware design of the RAMM mortar system and autoloader/magazine.
- 2279 Evaluate integrated acoustic cuers on Strikers for AN/TPQ-36/37 (Fire Finder radar) and transmit detection messages to the fire director center; incorporate advanced detection, classification and tracking algorithms and software into acoustic sensor testbeds and validate the modeling predictions with sensor improvements.
- 3244 Conduct an evaluation of the QuickLook system detecting and locating targets in real-time using battlefield imagery and GPS coordinates; prove concept effectiveness for the smart cargo projectile; perform aeroballistic simulations and in-flight update analyses, and conduct sub-scale wind tunnel test of airframe.

Total 11997

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)

June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
2 - APPLIED RESEARCH	**0602624A - Weapons and Munitions Technology**	**H19**

COST (In Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
H19	CLOSE COMBAT WEAPONRY	10910	17854	10344	0	0	0	0	0	0	0

A. Mission Description and Budget Item Justification: This project focuses on applied research of technology for maneuver and fire support cannon armament systems in support of FCS and the Objective Force. The project funds research in technologies that will result in significantly more lethality with more accurate delivery, significantly reducing logistics footprint while reducing life cycle costs for ground and air combat platforms. This project provides opportunities for longer range, more accurate and more lethal cannon systems for armored vehicles to include enabling technologies to support FCS. Principal efforts support the ammunition suite for the FCS Multi-Role Armament and Ammunition. Also included in this project is the Tank Extended Range Munition (TERM) for rapid extended range defeat of high value targets out to 8km+ expanding the maneuver commander's battle area 7-fold. This project funds modeling and simulation of advanced armament systems leading to application for FCS. Cannon design technologies include: recoil mitigation techniques for use of large caliber cannons on lightweight (less than 20 ton) vehicles and novel chamber configuration leading to overall compact armament system configurations. Advanced barrel coating technology utilizing cylindrical magnetron sputtering (CMS) of refractory alloys is being pursued to provide extended barrel life for tanks, artillery, and FCS cannon systems in addition to providing an environmentally friendly process as a future replacement for chrome plating. This PE will develop advanced multi-mode fuzing technologies to include lower cost self-destruct technologies for submunitions, which will reduce unexploded ordnance on the battlefield and low cost electronic safe and arm devices for single and future multi-mode warheads. The project also develops extended range munitions and alternative defeat mechanisms of advanced armor systems for FCS. The approach will be to develop both the hardware and analytical tools necessary to assess system performance, identify problem areas and to develop solutions. This program supports the Objective Force transition path of the TCP.

FY 2000 Accomplishments

- 1473 Completed CMS process to apply tantalum cannon bore coatings to test coupons.
- 2256 Conducted simulation of existing and conceptual target defeat techniques (i.e., Institute for Advanced Technology (IAT), University of Texas; Armament Research Development and Engineer Center (ARDEC); and Army Research Laboratory (ARL)) for medium caliber applications.
- 2640 Analyzed simulated and selected lethality package of advanced propulsion system for FCS; completed conceptual design of a lightweight, low recoil launcher (both 60% less than 120mm M256); developed a notional concept for improved automation of weapon platforms.
- 2626 Established target set vulnerabilities for three agile target effects systems: dazzler munition using an acoustic/light source to render sensors ineffective for a limited time, a pulsed laser generator for Unmanned Aerial Vehicles (UAV) and sensor suppression and a flat panel multi-mega/gigawatt generator demonstrating neutralization of electronic/communications equipment.

FY 2000 Accomplishments (Continued)

- 737 Matured enhanced target defeat for medium caliber systems exploiting emerging technologies in composite sabots, novel penetrators, propulsion and bursting munitions.
- 1178 Matured lower cost self-destruct fuze technologies for application to Dual Purpose Improved Conventional Munitions, for reduction of unexploded ordnance on the battlefield.

Total 10910

FY 2001 Planned Program

- 1467 Complete first phase of CMS process to apply tantalum cannon bore coatings to full-length medium (25mm) and full length large (120mm) caliber gun barrels; conduct firing tests and complete correlation of results to analytical modeling; transition CMS process to industry (for medium caliber applications) and to on-going Manufacturing Technology Objective (MTO) for large caliber scale-up for application to tank, artillery, Naval Fire Support, and FCS.
- 1894 Complete testing to characterize combined directed energy sources effects on threat targets; complete detailed design of Agile Target Effects weapon system for tactical range FCS secondary armament application against sensors and UAVs.
- 4384 Complete fabrication of lightweight/low impulse launcher for FCS. Complete recoil mitigation technology demonstration of 50% reduction in recoil force; complete detailed design of lightweight/low impulse launcher for FCS Multi-Role Cannon System; determine feasibility of propulsion and launch system to launch a surrogate family of munitions at desired velocities in sub-scale firing; establish best technical approaches for Multi-Role Cannon Munition development.
- 2145 Complete electronic Safe and Arm fuzing design for Multi-Mode Warhead for missiles and smart munitions FCS application; complete concept design for advanced kinetic energy (KE) Munition configuration for defeat of advanced armors to 4km.
- 700 Mature enhanced target defeat mechanism for light armor targets using novel penetrators for increased penetration and behind armor effects.
- 2885 The purpose of this one year Congressional add is to conduct component demonstrations of technologies (sensors, diversion thrusters, etc.) providing significantly lower cost course correction of conventional direct fire ammunition eliminating most system accuracy errors for ground/air platform.
- 3954 The objective of this one year Congressional add is to validate increased armor penetration of co-linear Explosively Formed Penetrators (EFP) warhead concepts.
- 425 Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs.

Total 17854

FY 2002 Planned Program

- 5432 Complete fabrication of lightweight, low impulse Multi-Role Cannon for FCS and conduct non-firing functional demonstration.
- 500 Complete medium caliber novel KE penetrator target effects evaluation and downselect to best technical approach.
- 1740 Fabricate Agile Target Effects Weapon System directed energy sources for FCS secondary armament ground/air vehicle sensor personnel, unmanned air vehicle defeat.
- 2672 Validate FCS KE Munition launch package (novel penetrator with composite sabot) function from FCS ammo configuration; conduct electronic safe and arm fuzing initiation accuracy for multi-point detonations.

Total 10344

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June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
2 - APPLIED RESEARCH	**0602624A - Weapons and Munitions Technology**	**H28**

COST (In Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
H28 MUNITIONS TECHNOLOGY	10460	14874	13208	0	0	0	0	0	0	0

A. Mission Description and Budget Item Justification: This program advances the state of the art of enabling technologies supporting the Future Combat Systems (FCS) and the Objective Force. Specific efforts include warheads (both shaped charge (SC) and explosively formed penetrator (EFP)), high energy explosives, large-caliber gun propellants with barrel wear reducing additives, insensitive munitions (IM), energetics, advanced materials/processes for warheads and techniques/processes to address material corrosion. Advances in warhead design, initiation techniques, and material technology will produce smaller, lighter, more effective, multi-role warheads having advanced warhead liners to efficiently defeat existing and projected targets. Achieving increased lethality is vital as the Army strives for smaller and lighter weapon systems with smaller and lighter armaments. High energy, high-density explosives are needed to increase lethality and optimize design performance. New improved energetic materials have numerous transition opportunities for weapon system upgrades and FCS. Developmental high-impetus propellant formulations optimized for ETC initiation offer increased muzzle kinetic energy, precision ignition and unmatched repeatability. The integrated propellant and explosive insensitive munition (IM) efforts contained in this project will also increase the battlefield survivability of land combat systems and enhance overall safety at manufacturing plants, storage depots, and during air and sea transport. Analysis and development of Multiple-EFP warheads support the Army's Full Spectrum Active Protection (FSAP/APS) System research and development performed by the Tank Automotive and Armaments Command's Tank Automotive Research Development and Engineering Center (TACOM-TARDEC) under Program Element (PE) 0603005A. This program supports the Objective Force transition path of the TCP.

FY 2000 Accomplishments

- 2607 Manufactured laboratory scale quantities of next generation, more powerful explosives and conducted sensitivity tests and evaluations, which showed excellent energy increases.
- 4053 Tested combined anti-armor/anti-bunker warheads, which showed acceptable performance.
- 2000 Formulated, fabricated and tested CL-20 based advanced propellant formulations with impressive energy increases.
- 1800 Designed, fabricated and successfully tested two multiple EFP warhead concepts for evaluation in the Full Spectrum Active Protection (FSAP) System program (PE 0603005A).

Total 10460

FY 2001 Planned Program

- 2389 Fabricate two high-energy and high-blast explosive candidate formulations to optimize FCS multi-purpose warhead.
- 4091 Optimize the Compact SC warhead concept design for a shorter/lighter munition. Optimize the collinear EFP warhead prototype for enhanced performance.
- 1920 Mature ETC Generation II propellant formulations for FCS ETC applications. Initiate charge designs for the FCS Cased-Telescoped cartridge configuration and propulsion performance test and evaluation in scaled (30mm) and large caliber (105mm) test beds.
- 1800 Conduct dynamic testing of modified multiple EFP warhead designs against slow-moving chemical energy (CE) and fast-moving KE threats as the kill mechanism for APS system applications.
- 4326 The purpose of this one year Congressional add is to evaluate the viability and affordability of single crystal tungsten alloy material as a KE penetrator. Validate ballistic performance comparable to depleted uranium (DU) along with a viable manufacturing process.
- 348 Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs.

Total 14874

FY 2002 Planned Program

- 2232 Select, fabricate and deliver high energy and high blast insensitive explosive formulations for FCS multi-purpose warhead concept testing. Continue formulation insensitivity improvements and testing.
- 4696 Conduct laboratory demonstration of the multi-purpose SC warhead and the maturing Collinear EFP warhead concepts.
- 1595 Prove feasibility of Generation II ETC gun propellant for FCS cartridge applications providing a 25% increase in performance.
- 1685 Prove feasibility of an enhanced multiple EFP warhead for APS applications against both CE and KE threats with the goal of producing zero residual penetration (i.e., penetration potential remaining after active protection system intercept penetration on target).
- 3000 Conduct laboratory demonstrations of revolutionary Generation II EFP and Compact SC warhead designs for FCS multi-role ammo suite and common missile; demonstrate greater than 3 times penetration increase in reduced size warhead; demonstrate Compact SC size reduction by 1/2 while maintaining penetration capability.

Total 13208