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

February 2002

BUDGET ACTIVITY	PE NUMBER AND TITLE
2 - Applied Research	**0602624A - Weapons and Munitions Technology**

	COST (In Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
	Total Program Element (PE) Cost	46722	65197	38090	37961	42422	41266	44052
H18	ARTY & CBT SPT TECH	11883	16355	12930	13238	16008	15386	16634
H19	CLOSE COMBAT WEAPONRY	17429	10250	10680	10570	12713	12964	13350
H1A	WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE	2884	0	0	0	0	0	0
H28	MUNITIONS TECHNOLOGY	14526	25692	14480	14153	13701	12916	14068
WA2	GREEN ARMAMENTS TECHNOLOGY	0	5200	0	0	0	0	0
WA3	CORROSION MEASUREMENT AND CONTROL	0	4300	0	0	0	0	0
WA4	ARMAMENT SYSTEMS NETWORK IA CENTER	0	3400	0	0	0	0	0

A. Mission Description and Budget Item Justification: This Program Element (PE) researches improved weapon and munitions 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 that will result in increased system lethality and survivability with the potential for better affordability, lower weight and reduced size. Specific projects within the PE include: the FCS Multi-Role Armament and Ammunition System (MRAAS) Advanced Technology Demonstration (ATD) and associated enabling technologies; advanced sensors for smart munitions; Agile Target Effects systems for the battlefield; and the Responsive Accurate Mission Module (RAMM). The MRAAS will be a direct and indirect fire system for FCS designed to exceed the lethality of the Abrams main battle tank with a lighter and more advanced 105mm cannon system. It uses advanced materials, advanced recoil techniques, and Electrothermal-Chemical (ETC) propulsion to overcome the challenges of creating a smaller, lighter armament system with lethality equaling or exceeding that of current systems. The current government baseline for FCS Multi-Role Ammunition is a three-cartridge suite that provides overwhelming lethality at ranges up to 50 km, with increased weapon delivery accuracy. Specific efforts in explosives, propellants, fuzing, and warhead technology are the pacing technologies in support of 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 development of 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, decision aids and software architecture; advanced laser radar/infrared (LADAR/IR) sensor technology to enhance performance of smart munitions; technology advances in acoustic sensors; advanced wear and erosion resistant barrel coatings to increase service life and provide an environmentally friendly barrel coating process; thermal management of high performance, high rate of fire, large caliber guns; 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). This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

B. Program Change Summary	FY 2001	FY 2002	FY 2003
Previous President's Budget (FY2002 PB)	47817	35549	33255
Appropriated Value	48261	65649	0
Adjustments to Appropriated Value	0	0	0
a. Congressional General Reductions	0	-452	0
b. SBIR/STTR	-1095	0	0
c. Omnibus or Other Above Threshold Reductions	0	0	0
d. Below Threshold Reprogramming	0	0	0
e. Rescissions	-444	0	0
Adjustments to Budget Years Since FY2002 PB	0	0	4835
Current Budget Submit (FY 2003 PB)	46722	65197	38090

Change Summary Explanation:

Significant Change: FY02 congressional adds totaling $30.1M (as noted below) were added to this program element.

FY02 - Congressional adds were made for Corrosion Measurement and Control, Project WA3 ($4300); Future Combat System Propellant and Survivability, Project H28 ($2800); Green Armaments Technology, Project WA2 ($5200); Liquidmetal Alloy-Tungston Alloy Penetrator, Project H28 ($3400); Multiple Explosively-Formed Penetrators, Project H28 ($1000); Single Crystal Tungston Alloy Penetrator, Project H28 ($2000); Smart Coatings, Project H18

($1000); Armament Systems Network IA Center, Project WA4 ($3400); Army COE Acoustics, Project H18 ($3500); and Cooperative Energetics Initiative, Project H28 ($3500).

No R-2A required:
- ($4300) Corrosion Measurement and Control, Project WA3: The objective of this one year Congressional add is to develop methods to inhibit corrosion on Army materiel. No additional funding is required to complete this project. COMPLETE 4QFY02
- ($5200) Green Armaments Technology, Project WA2: The objective of this one year Congressional add is to develop "green" (environmentally friendly) ammunition as well as to fund UXO prevention and detection technology. No additional funding is required to complete this project.COMPLETE 4Q02
- ($3400) Armament Systems Network IA Center, Project WA4: The objective of this one year Congressional add is to develop a secure communication system for fire control applications. (This is a cooperative program with CECOM on cyber security.) No additional funding is required to complete this project. COMPLETE 4Q02
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February 2002

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

COST (In Thousands)		FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
H18	ARTY & CBT SPT TECH	11883	16355	12930	13238	16008	15386	16634

A. Mission Description and Budget Item Justification: This project focuses on applied research of technologies 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 MRAAS; RAMM; Combat Decision Aids Software (CDAS); QuickLook; Advanced Sensors for Smart Munitions; Advanced Acoustic/Seismic Systems; and Extended Range Mortar Cartridge (ERMC). 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 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 developed to a maturity level suitable for insertion into FCS. Development of CDAS 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. With the CDAS, targets can be assigned automatically to individual shooters, based on the most effective pattern to ensure rapid first-shot execution and progression to the next target assignment. QuickLook will provide the brigade commander with real time target imagery, target 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, acquires the target and transmits targeting information, such as video and/or Global Positioning System (GPS)coordinates, back to the tactical operations center via a wireless link. Advanced acoustic sensors will be investigated for providing non-line of sight target cueing for a variety of weapons platforms. The application of light-weight, high-strength composites to mortar projectiles is being pursued to extend range significantly while providing increased lethal effectiveness, such as the ERMC program. Technologies for reducing artillery target location error and for providing to fire direction centers real time targeting and battle damage assessment data are being matured to support information dominance strategies for FCS. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2001 Accomplishments:

- 4531 - Conducted system trade-off studies, fabricated sensor hardware for captive flight tests and performed tower tests on alternate sensor designs with a common aperture LADAR/IR transducer for detection of low observable; further identified and investigated critical technologies; updated and matured models; validated virtual simulations for stability, precision and accuracy; pursued evaluation of ER recoil management, isogrids and load out of battery technologies in support of FCS Multi-Role Armament; performed a system concept analysis of the RAMM lightweight mortar design for integration into a FCS platform or the Robotic Follower.

FY 2001 Accomplishments: (Continued)

- 3154 - Completed concept evaluation of an architecture-based software component factory process for rapid generation of embedded fire mission application software at the Depth and Simultaneous Attack Battle Lab; completed CDAS multi-shooter algorithms maturation; analyzed and optimized the algorithms in a CDAS dedicated Modular Semi-Automated Forces (ModSAF) emu lation environment; characterized multi-shooter algorithm performance; collected acoustic signatures of Multiple Launch Rocket System (MLRS), cruise missiles and mortars to expand detection data base capability; evaluated modeling for target location and tracking capabilities using non-real time data and assess improvements in operational effectiveness; investigated advanced detection, classification and tracking algorithms for advanced acoustic/seismic sensors.
- 4198 - Integrated QuickLook system comp onents and performed integrated captive flight test; exhibited improved cannon wear life (Crusader) in wear testing; verified design improvements for stockpiled ammunition; fabricated prototype hardware and conducted limited short range flight test of the ERMC; conducted review of mission requirements; conducted concept analysis, design trades and preliminary concept design of a smart cargo projectile for FCS Multi-Role cannon.

Total 11883

FY 2002 Planned Program

- 6426 - Conclude system trade-off 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.
- 2232 - 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/ software into acoustic sensor testbeds, then validate the modeling predictions with sensor improvements.
- 3197 - Conduct an evaluation demonstration 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.
- 1000 - This one year Congressional add (Smart Coatings) will develop (and complete development of) coatings for Army materiel that are self-healing and have advanced attributes such as providing camouflage. No additional funding is required to complete this project.
- 3500 - This one year Congressional add (Army COE Acoustics) will develop (and complete development of) acoustic sensor systems for FCS applications. No additional funding is required to complete this project.

Total 16355

FY 2003 Planned Program

- 6245 - Fabricate smart sensor component hardware and perform high-Gee test; complete generation of system simulation models; establish a virtual battlefield model and conduct a performance analysis of the RAMM mortar system.
- 2298 - Integrate acoustic and seismic modeling capabilities; provide critical acoustic sensor components for artillery delivery; implement advanced acoustic sensor networks.
- 4387 - Fabricate smart cargo projectile test hardware for high-Gee testing and full-scale wind tunnel testing; conduct maneuverability analysis and preliminary guidance and control design for laboratory testing; complete fabrication of hardware and conduct breadboard demonstration of a Multi-Purpose Extended Range Munition (MP-ERM) air frame projectile; fabricate hardware for maneuver mechanism and guidance and control airgun tests.

Total 12930

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February 2002

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

COST (In Thousands)		FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
H19	CLOSE COMBAT WEAPONRY	17429	10250	10680	10570	12713	12964	13350

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 greater 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 MRAAS and MP-ERM 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, with potential to provide an environmentally friendly process as a future replacement for chrome plating. This PE will develop advanced multi-mode fuzing technologies including some lower cost, self-destruct technologies for submunitions that could reduce unexploded ordnance on the battlefield and provide low cost electronic safe and arm devices for single and future multi-mode warheads. The project also develops extended range munitions and alternative mechanisms to defeat advanced armor systems. Both hardware and analytical tools will be developed and used to assess system performance, identify problem areas and develop solutions. This program supports the Objective Force transition path of the TCP.

FY 2001 Accomplishments:

- 1467 - Completed first phase of CMS process to apply tantalum cannon bore coatings to full-length medium (25mm) and full length large (120mm) caliber gun barrels; conducted firing tests and completed correlation of results to analytical modeling; transitioned 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 - Completed testing to characterize effects of combined directed energy sources on threat targets; completed detailed design of Agile Target Effects weapon system for tactical range FCS secondary armament application against sensors and UAVs.

FY 2001 Accomplishments: (Continued)

- 4384 - Completed fabrication of lightweight/low impulse launcher for FCS; completed a proof-of-principle demonstration of recoil mitigation technology of 50% reduction in recoil force; completed detailed design of lightweight/low impulse launcher for FCS Multi-Role Cannon System; determined feasibility of propulsion and launch system to launch a surrogate family of munitions at desired velocities in sub-scale firing; established best technical approaches for Multi-Role Cannon Munition development.
- 2145 - Completed electronic safe and arm fuzing design for multi-mode warhead for missiles and smart munitions FCS application; completed concept design for advanced kinetic energy (KE) munitions configuration for defeat of advanced armors to 4km.
- 700 - Matured enhanced target defeat mechanism for light armor targets using novel penetrators for increased penetration and behind armor effects.
- 2885 - This one year Congressional add conducted 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. No additional funding is required to complete this effort.
- 3954 - This one year Congressional add demonstrated, through experimental testing, increased armor penetration of co-linear Explosively Formed Penetrators (EFP) warheads. No additional funding is required to complete this effort.

Total 17429

FY 2002 Planned Program

- 5400 - 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.
- 1709 - Fabricate Agile Target Effects Weapon System directed energy sources for FCS secondary armament ground/air vehicle sensor personnel, unmanned air vehicle defeat.
- 2641 - 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 10250

FY 2003 Planned Program

- 3985 - Complete fabrication of Agile Target Effects Weapon System directed energy sources; complete brassboard integration with surrogate power supply
- 6695 - Complete FCS KE Munition function and armor tests at extended ranges; complete integrated function tests of electronic safe and arm fuzing on inert warhead.

Total 10680

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February 2002

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

COST (In Thousands)		FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
H28	MUNITIONS TECHNOLOGY	14526	25692	14480	14153	13701	12916	14068

A. Mission Description and Budget Item Justification: This program advances the state of the art for enabling technologies supporting the FCS and the Objective Force. The project focuses on achieving increased lethality using smaller and lighter weapon systems with smaller and lighter armaments. The project funds development of: warheads, both shaped charge (SC) and 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. Advanced warhead design, novel initiation techniques and advanced material technologies are being applied to produce smaller, lighter, more effective, multi-role warheads having advanced warhead liners to defeat existing and projected targets more efficiently. High-energy, high-density explosives are being developed to increase lethality and optimize design performance. New improved energetic materials developed provide 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 munitions (IM) developed will 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 System (APS) 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 2001 Accomplishments:

- 2389 - Fabricated two high-energy and high-blast explosive candidate formulations to optimize FCS multi-purpose warhead.
- 4091 - Optimized the compact SC warhead concept design for a shorter/lighter munition. Optimized the collinear EFP warhead prototype for enhanced performance.
- 1920 - Matured ETC Generation II propellant formulations for FCS ETC applications. Initiated 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 - Conducted 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 was to evaluate the viability and affordability of single crystal tungsten alloy material as a KE penetrator. Validated ballistic performance comparable to depleted uranium (DU) along with a viable manufacturing process.

Total 14526

FY 2002 Planned Program

- 2178 - 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.
- 4642 - Conduct laboratory demonstration of the multi-purpose SC warhead and the maturing Collinear EFP warhead concepts.
- 1541 - Prove feasibility of Generation II ETC gun propellant for FCS cartridge applications providing a 25% increase in performance.
- 1631 - 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; show greater than 3 times penetration increase in reduced size warhead; show compact SC size reduction by 1/2 while maintaining penetration capability.
- 2800 - This one year Congressional add (Future Combat System Propellant and Survivability) develops (and completes development of) advanced propellants to meet the propulsion and survivability requirements of the MRAAS. No additional funding is required to complete this project.
- 3400 - This one year Congressional add (Liquidmetal Alloy-Tungsten Alloy Penetrator) demonstrates (and completes demonstration of) an alternative material to replace depleted uranium (DU) for use in medium caliber KE penetrator munitions for the Army, Navy and Air Force. No additional funding is required to complete this effort.
- 1000 - This one year Congressional add (Multiple Explosively-Formed Penetrators) develops (and completes development of) a unique EFP warhead capable of breaching obstacles, concrete walls and other targets from a man-portable system. No additional funding is required to complete this project.
- 2000 - This one year Congressional add (Single Crystal Tungsten Alloy Penetrator) evaluates (and completes evaluation of) the viability and affordability of single crystal tungsten alloy material as a KE penetrator and validates ballistic performance compared to that of DU; explores viability of a manufacturing process. No additional funding is required to complete this project.
- 3500 - This one year Congressional add (Cooperative Energetics Initiative) allows the Army to leverage applicable ARDEC technologies with mining, construction and drilling industries research and development for Dual-Use Science and Technology applications. No additional funding is required to complete this project.

Total 25692

FY 2003 Planned Program

- 3435 - Prove feasibility of an environmentally friendly, pilot-scale process for selected explosive formulation. Deliver 200 pounds of the candidate high-energy and high blast insensitive explosive formulations for testing in FCS warheads.
- 4789 - Tailor selected multi-purpose SC and EFP warhead designs for fabrication in the optimum FCS munition configuration.
- 1593 - Fabricate, characterize and assemble developmental FCS propellant charges for full-up firing demo of ETC propulsion capability in FY04.
- 1663 - Conduct dynamic tests of APS warhead design to validate warhead effectiveness against both CE and the more challenging KE threats.
- 3000 - Research smaller, more lethal EFPs. Conduct form, fit and function of potential EFP warheads tailored for FCS Mid-Range Munition for FCS; fabricate hardware, perform analyses and proof-of-principle demonstration on small scale EFP samples.

Total 14480