

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2 Exhibit)	February 2006
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BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602618A - BALLISTICS TECHNOLOGY
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COST (In Thousands)	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	55305	52010	52221	51092	52188	52062	52220
H03 ROBOTICS TECHNOLOGY	16264	14882	16418	16303	16527	16083	15964
H75 ELECTRIC GUN TECHNOLOGY	4944	4733	5237	5349	5442	5488	5530
H80 BALLISTICS TECHNOLOGY	27827	28847	30566	29440	30219	30491	30726
HB1 SURVIVABILITY AND LETHALITY TECHNOLOGIES (CA)	6270	3548	0	0	0	0	0

A. Mission Description and Budget Item Justification: This program element (PE) provides ballistic technologies required for armaments and armor to support the Future Combat Systems (FCS) and the Future Force and, where feasible, exploits opportunities to enhance Current Force capabilities to allow US dominance in future conflicts across a full spectrum of threats in a global context. Project H03 focuses on applied research for advanced autonomous mobility technology for future land combat systems of the Future Force. Project H75 focuses on technologies for electric armaments which offer the potential to achieve leap-ahead lethality capability by providing hypervelocity and hyperenergy launch well above the ability of the conventional cannon. It also includes work in hypervelocity penetrator effectiveness that will greatly increase anti-armor capabilities. Project H80 is focused on applied research in ballistics technology to enhance the lethality and survivability of the Future Force. Focus areas include advanced solid propellants, launch and flight dynamics, weapons concepts for light forces, warheads and projectiles, armor and munition/target interactions. Projects H03 and H80 will enable lethality and survivability technologies for the Future Combat Systems (FCS). Work in this PE is related to and fully coordinated with efforts in PE 0602105A (Materials Technology), PE 0602120A (Sensors and Electronic Survivability), PE 0602601A (Combat Vehicle and Automotive Technology), PE 0602624A (Weapons and Munitions Technology), PE 0602705A (Electronics and Electronic Devices), PE 0602716A (Human Factors Engineering), PE 0602782A (Command, Control, Communications Technology), PE 0603004A (Weapons and Munitions Advanced Technology), and PE 0603005A (Combat Vehicle Advanced Technology). 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). Work in this project is performed by the Army Research Laboratory (ARL).

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BUDGET ACTIVITY
2 - Applied Research

PE NUMBER AND TITLE
0602618A - BALLISTICS TECHNOLOGY

	FY 2005	FY 2006	FY 2007
<u>B. Program Change Summary</u>			
Previous President's Budget (FY 2006)	54889	49163	52168
Current BES/President's Budget (FY 2007)	55305	52010	52221
Total Adjustments	416	2847	53
Congressional Program Reductions		-228	
Congressional Rescissions		-525	
Congressional Increases		3600	
Reprogrammings	416		
SBIR/STTR Transfer			
Adjustments to Budget Years			53

Two FY06 Congressional adds totaling \$3600 were added to this PE.

FY06 Congressional adds with no R-2A (appropriated amount shown):
(\$2600) Advanced Tungsten Penetrators and Ballistic Materials
(\$1000) Gun Barrel Coatings

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BUDGET ACTIVITY 2 - Applied Research			PE NUMBER AND TITLE 0602618A - BALLISTICS TECHNOLOGY			PROJECT H03	
COST (In Thousands)	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
H03 ROBOTICS TECHNOLOGY	16264	14882	16418	16303	16527	16083	15964
<p>A. Mission Description and Budget Item Justification: This project advances autonomous mobility technology for the Future Combat Systems (FCS) and the Future Force. It will investigate robotics technology critical to the maturation of future Army systems, including unmanned elements of the FCS, Future Force Warrior (FFW) and crew aids for future manned systems. It provides the basis for the Collaborative Technology Alliance (CTA) in robotics, which is a tri-service research consortium joining researchers from DOD, other Government agencies, industry, and academia in a concerted, collaborative effort to advance key enabling technologies. Achieving these goals will provide future land combat forces with significant new operational capabilities permitting paradigm shifts in the conduct of ground warfare, providing significantly greater survivability and deployability. Technical efforts are focused on advancing perception for autonomous ground mobility, intelligent vehicle control and behaviors, and human supervision of unmanned ground systems. Research products will enable rapid implementation of near-term robotic follower technology in support of PE/Project: 0603005A/515, and subsequent development of both semi-autonomous and near autonomous unmanned ground vehicles (UGVs). Research is conducted at the Army Research laboratory, other DOD laboratories and research centers, National Institute of Standards and Technology, National Aeronautics and Space Administration and Department of Energy research laboratories, as well as industry and academic institutions. The applied research conducted in this program will be transitioned to technology development, demonstration and materiel acquisition programs being conducted by the Office of the Secretary of Defense Joint Robotics Program and each of the Services. Research supports collaborative efforts with Defense Advanced Research Projects Agency (DARPA). 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). Work in this project is performed by the Army Research Laboratory (ARL).</p>							
Accomplishments/Planned Program					<u>FY 2005</u>	<u>FY 2006</u>	<u>FY 2007</u>
- Execute CTA for advanced perception, control/behavior and man-machine interface technology required for high-speed mobility (including robotic-follower operations) and basic tactical behaviors common to multiple military missions. Research focuses upon new sensor and sensor processing algorithms for rapid detection and classification of objects in the environment enabling high-speed mobility and intelligent tactical behavior by future unmanned systems; implementing adaptive control strategies that will enable unmanned systems to display intelligent tactical behavior, and development of human-robot interaction (HRI) scalable, intuitive, multi-modal control interfaces that will minimize the additional cognitive workload for Soldiers controlling unmanned assets. In FY05, inserted mature perception, control, and HRI technologies onto testbed platforms to promote rapid transition of semi-autonomous capability to Future Force systems, including transfer of LADAR sensor technology to FCS program. In FY06, will conduct research enabling safe operation of semi-autonomous vehicles in populated environments, including movement in dynamic environments, e.g., oncoming traffic and pedestrians, a key barrier to the utilization of unmanned systems in future urban military operations. Research supports collaborative efforts with DARPA focused upon both near-term implementation of technologies, and incorporation of DARPA sponsored research in adaptive perception and control technology. In FY07, will conduct research to permit meaningful collaboration by autonomous vehicles (including mixed air and ground assets) utilizing the scout reconnaissance mission as the focus for technology development.					6859	7197	7477
- Enhance modeling and simulation infrastructure to enable maturation of semi-autonomous UGV's; devise and implement tools to enable rapid maturation of tactical behaviors. In FY05, integrated mechanisms for behavioral adaptability into test bed vehicles and evaluated approach through field exercises during which a minimum of two vehicles collaboratively conducted maneuver required for a zone reconnaissance mission while adapting their behavior to reflect environmental changes.					809	0	0

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BUDGET ACTIVITY	PE NUMBER AND TITLE		PROJECT
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- Mature perception, intelligent control, and man-machine interface technology required for a single Soldier to manage the operation of multiple unmanned ground vehicles maneuvering with high levels of autonomy through the battlefield. In FY05, matured the perception and control technology required to show baseline tactical behaviors by unmanned ground vehicles adapting to dynamic changes in the environment while maneuvering through rolling, vegetated terrain. This transitioned into Tank and Automotive Research, Development and Engineering Center's Armed Robotic Vehicle Program.	4623	0	0
- Mature perception and intelligent control technologies required to meet objective capabilities for the Armed Robotic Vehicle program and transition this technology to advanced development programs being conducted under PE 0603005A (Combat Vehicle Advanced Technology) Project D515 for integration into test bed systems. Leverage DARPA sponsored research, e.g., Software for Distributed Robotics, for control of collaborating agents to enable mixed teams (manned/unmanned) to conduct military missions. In FY06 will conduct research in perception and control technologies for autonomous mobility that will permit realistic operational speed for FCS with spirals to Current Force. In FY07, will mature perception and control technology to permit implementation of behaviors to enhance the operational effectiveness of robotic vehicles.	0	4799	3463
Integrate technology on unmanned ground vehicle testbeds and conduct extensive field exercises for experimentation, technology characterization, and to show capability maturation for near autonomous UGVs. Leverage algorithms being conducted under DARPA sponsored research, e.g., Learning Applied to Ground Robotics (LAGR). Conduct regular, periodic experimentation at Ft. Indiantown Gap, PA and other military facilities to stress technology in complex environments to further focus CTA sponsored research, assess performance and provide the opportunity for US Army Training and Doctrine Command to initiate early development of the Tactics, Techniques, and Procedures required for successful utilization of unmanned systems in future conflicts. In FY05, proved baseline adaptive tactical behaviors through field experimentation designed to demonstrate the ability of unmanned systems to autonomously alter behavior in response to changes in the local environment. In FY06, will incorporate advanced perception and control technology and transition to FCS Autonomous Navigation System prototypes for evaluation in relevant environments. In FY07, will evaluate technologies for collaborative operation of networked air & ground unmanned vehicles managed by a single Soldier.	3973	2886	5478
Total	16264	14882	16418

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BUDGET ACTIVITY 2 - Applied Research			PE NUMBER AND TITLE 0602618A - BALLISTICS TECHNOLOGY				PROJECT H75		
COST (In Thousands)			FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
H75	ELECTRIC GUN TECHNOLOGY		4944	4733	5237	5349	5442	5488	5530
<p><u>A. Mission Description and Budget Item Justification:</u> This project funds applied research for the Army Electromagnetic (EM) armaments technology program. To achieve the objectives of the Army Vision, future armored combat vehicles, including the Future Combat Systems (FCS), requires more lethal, yet compact main armament systems capable of defeating protection levels significantly greater than current values. The goal of this project is to evaluate the potential of EM Armaments to field a leap-ahead capability by providing adjustable velocities, including hypervelocity that far exceeds the ability of the conventional cannon. EM armaments potentially can be fully integrated with electric propulsion and electromagnetic armor systems to provide the efficient, highly mobile, and deployable armored force required by the nation. This project focuses on addressing technical barriers associated with an EM armament, in particular with advanced materials for pulsed power and launchers; experimentally validating full-scale hypervelocity utility of novel kinetic energy penetrators (NKEPs) against the range of threat armors; and devising and experimentally validating high energy launch packages. In the area of pulse power, it will mature and prove critical materials for compact pulsed power for EM guns. For the launcher, it will establish and mature technologies for efficient, lightweight EM guns and projectile launch packages to enable revolutionary lethality for Future Force platforms. In the area of launch package (projectiles), it will establish technologies for full-scale hypervelocity novel kinetic energy penetrators. This research is conducted at the Army Research Laboratory (ARL), Aberdeen Proving Ground, MD. The applied research program receives the output of basic research conducted under Program Element 0601104A, Project H62 by the Institute for Advanced Technology, UT-Austin, and transitions it to the Army environment. In turn, the applied research is moved directly into the Armament Research, Development and Engineering Center advanced technology demonstration program where it is incorporated by industry into an EM gun system. 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). Work in this project is performed by ARL.</p>									
<u>Accomplishments/Planned Program</u>						<u>FY 2005</u>	<u>FY 2006</u>	<u>FY 2007</u>	
Pulsed Power - In FY05, proved through laboratory testing the strength of new, thick composite rotor bandings and validated thermal management components. In FY06, will prove advanced low density, high strength, low resistivity field coil conductors and efficient switch packaging. In FY07, will experimentally validate active cooling of high speed rotor for pulsed power generation.						1875	1871	1991	
Launch - In FY05, validated integrity of advanced composite EM launchers by subjecting to 950 kA across the rails; launched a payload intact at 1.9 MJ of energy and a velocity of 2.3 km/s. In FY06, will validate robustness and rail life of composite launcher; and will electromagnetically launch an 8 MJ projectile with monolithic rod. In FY07, will electromagnetically launch an 8 MJ projectile with functioning novel penetrator.						1193	1423	1518	
Full-Scale Hypervelocity Lethality - In FY05, evaluated flexible geometry NKEP and down-selected to most promising hypervelocity penetrator approach. In FY06, will mature mechanisms to deploy NKEP in flight. In FY07, will validate performance of functional NKEP against realistic targets in full-scale EM gun.						1876	1439	1728	
Total						4944	4733	5237	

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BUDGET ACTIVITY 2 - Applied Research			PE NUMBER AND TITLE 0602618A - BALLISTICS TECHNOLOGY			PROJECT H80	
COST (In Thousands)	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
H80 BALLISTICS TECHNOLOGY	27827	28847	30566	29440	30219	30491	30726
<p>A. Mission Description and Budget Item Justification: The goal of this project is to provide key technologies required for armor and armaments that will enable U.S dominance in future conflicts across a full spectrum of threats. The program supports the Army vision by focusing on more lethal and more deployable weapons and on survivability technologies to lighten and protect Future Combat Systems (FCS) and the Future Force and, where feasible, exploits opportunities to enhance Current Force capabilities. The challenge is to ensure combat overmatch and the survivability of the FCS while achieving rapid deployability in a lighter weight platform (less than 20 tons). Specific technology thrusts include: lightweight armors and structures to defeat existing and emerging ballistic threats; Kinetic Energy (KE) Active Protection (AP) to defeat/degrade threats before they reach the combat platform; crew and component protection from ballistic shock, mine-blast, and fuel or ammunition fires; insensitive high energy propellants/munitions to increase lethality of compact weapon systems and to reduce propellant/munition vulnerability to attack; novel KE penetrator concepts to maintain/improve lethality while reducing the size/mass of the penetrator; novel multi-function warhead concepts to enable defeat of full-spectrum of targets (anti-armor, bunker, helicopter, troops); smart projectile technologies for launch, flight, and precision strike; physics-based techniques, methodologies, and models to analyze combat effectiveness of future technologies for improved ballistic lethality and survivability. The work is conducted at the Army Research Laboratory (ARL), Aberdeen Proving Ground, MD and provides required technologies for advanced development programs at the Armaments Research, Development and Engineering Center (ARDEC), Picatinny Arsenal, NJ; the Tank and Automotive Research, Development and Engineering Center (TARDEC), Warren, MI; and the Aviation and Missile Research, Development and Engineering Center (AMRDEC), Huntsville, AL. 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). Work in this project is performed by ARL.</p>							
Accomplishments/Planned Program				<u>FY 2005</u>	<u>FY 2006</u>	<u>FY 2007</u>	
- Optimize advanced lightweight structural, ceramic, and electromagnetic armor technologies for transition to FCS vehicle designers, Current and Future Force Platforms, and Ground Tactical Vehicles. In FY05, optimized armor packaging and transitioned improved hybrid armor technologies to FCS and current vehicle designers; and validated advanced pulse power componentry necessary to enhance FCS survivability. In FY06, will validate the advanced technology for shaped charge defeat and apply the design tools to tactical vehicles to increase their survivability against small arms and improvised explosive devices. In FY07, will experimentally validate integrated and add-on ballistic protection technologies that make tactical combat vehicles more survivable.				5371	6306	7391	
- Mature mine blast, ballistic shock mitigation, and crew protection technologies to enable survivability of Current and Future Force Platforms, Ground Tactical Vehicles, and the individual Soldier. In FY05, validated Anti-Tank (AT) mine blast appliqué kit and crew restraint system for FCS; and showed capability of ballistic shock mitigation technologies. In FY06, will advance models and mature first-generation designs for integrated AT mine blast protection structure/crew system. In FY07, will provide design guidance and proven AT mine blast protection structure/crew system to vehicle designers for FCS Spirals and Ground Tactical Vehicles; and will validate technologies to improve flexibility of protection equipment (torso, extremities, neck) for individual Soldier.				1950	2961	3738	
- Mature advanced ammunition and lethality technologies. Couple physics-based models describing interior ballistics, launch dynamics, and flight mechanics with system effectiveness models and emerging high G guidance, navigation, and control (GN&C) technologies to enable dynamic retargeting of precision munitions for revolutionary Future Force lethality. In FY05, transitioned fully coupled suite of				4128	4003	4041	

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models and validated first generation dynamic retargeting technology to munitions development community. In FY06, will experimentally validate new engineering analysis capability which couples interior, exterior, and projectile structures for analysis of smart munitions; and will validate computational fluid dynamics model of advanced actuator divert for medium caliber munitions. In FY07, will experimentally prove dynamic retargeting technologies (in-flight position update) applicable to FCS and Future Force munitions; and will validate closed loop actuator control system technologies required for divert of medium caliber munitions.			
- Mature propulsion and energetics technologies. Evaluate, select, and prove novel/nanostructural insensitive high-energy materials (IHEM) concepts, which exploit managed energy release, and are required for improving the lethality and reducing the vulnerability of FCS/Future Force gun/missile systems and warheads. In FY05, extended and validated modeling tools used for design of managed energy systems; experimentally assessed promising insensitive high-energy materials in notional energy managed configuration; and provided matrix of novel IHEM propellant and explosives candidates for specific Future Force Insensitive Munitions (IM) applications. In FY06, will down-select a weapons system application for validation of novel insensitive energetic material (gun/rocket/ propellant/multi-purpose warhead); and will mature numerical tools for insensitive munitions design. In FY07, will validate selected system using advanced energetic material with tuned energy release (gun/rocket propulsion/ multi-purpose warhead) with increased performance while meeting FCS insensitive munition requirements and will apply emerging numerical tools to novel insensitive munitions.	4505	4073	3889
- Mature Active Protection counter-munition and sensor technologies to effectively defeat all anti-armor munitions including kinetic energy (KE) projectiles, which is critical to enable survivability of FCS and Future Force platforms. In FY05, proved blast-deflect universal countermeasure design against a variety of KE and CE threats, and transitioned to TARDEC Integrated Survivability Advanced Technology Demonstration (IS ATD) program. In FY06, will optimize universal counter-munition performance through improved modeling, materials and experimentation. In FY07, will transition optimized universal counter-munition to the IS ATD program.	2000	1972	2029
- Mature advanced ammunition and lethality technologies. Identify and model preferred options to reduce energy/mass required to defeat emerging armor threats and to provide multi-purpose capabilities for revolutionary Future Force lethality. In FY05, matured and integrated emerging materials and novel lethal mechanism technologies & conducted full-scale experimental validation of integrated solution for transition to Future Force munitions developers. In FY06, will integrate lethal mechanisms and prove out broad, multi-functional target defeat capabilities. In FY07, will transition Multi-Threat Objective Projectile Technology to ARDEC and AMRDEC and investigate warhead concepts for tailorable and scaleable lethal effects for Military Operations in Urban Terrain.	3456	3201	3088
- Devise state-of-the-art survivability/lethality/vulnerability (SLV) methodologies to dynamically model the interaction of conventional ballistic threats versus FCS and Future Force System of Systems. In FY05, incorporated models for various damage mechanisms such as fuel fire, blast and shock, and penetration into complex armors, into production SLV codes; modeled lethality of structural secondary fragments; developed code architecture and capabilities based metrics to assess survivability in a Systems of Systems context. In FY06, will update SLV modeling framework , as well as methodology for emerging technologies. In FY07, will mature newly emerging technologies; will incorporate models for weapons effects in urban environments, including structural response and structural damage mechanisms; experimentally validate models.	6417	6331	6390
Total	27827	28847	30566