

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2 Exhibit)

February 2004

BUDGET ACTIVITY

2 - Applied Research

PE NUMBER AND TITLE

0602618A - BALLISTICS TECHNOLOGY

COST (In Thousands)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
Total Program Element (PE) Cost		61372	57197	51301	53700	56100	52348	53354
H03	ROBOTICS TECHNOLOGY	17091	18181	17740	17927	18215	18572	18937
H75	ELECTRIC GUN TECHNOLOGY	4805	5240	5133	4933	5138	5242	5372
H80	BALLISTICS TECHNOLOGY	39476	28355	28428	30840	32747	28534	29045
HB1	SURVIVABILITY AND LETHALITY TECHNOLOGIES (CA)	0	5421	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 and to allow US dominance in future conflicts across a full spectrum of threats in a global context. Project H75 focuses on technologies for electric armaments which offer the potential to field leap-ahead capability in 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 included advanced solid propellants, launch and flight dynamics, weapons concepts for light forces, warheads and projectiles, armor and munition/target interactions. Project H03 focuses on applied research for advanced autonomous mobility technology for future land combat systems of the Future Force. 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 0602105 (Materials Technology), PE 0602120 (Sensors and Electronic Survivability), PE 0602601 (Combat Vehicle and Automotive Technology), PE 0602624 (Weapons and Munitions Technology), PE 0602705 (Electronics and Electronic Devices), PE 0602716 (Human Factors Engineering), PE 602782 (Command, Control, Communications Technology), PE 0603004 (Weapons and Munitions Advanced Technology), and PE 0603005 (Combat Vehicle Advanced Technology). The program element contains no duplication with any effort within the Military Departments. 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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<u>B. Program Change Summary</u>	FY 2003	FY 2004	FY 2005
Previous President's Budget (FY 2004)	62458	53478	52392
Current Budget (FY 2005 PB)	61372	57197	51301
Total Adjustments	-1086	3719	-1091
Congressional program reductions		-503	
Congressional rescissions			
Congressional increases		5600	
Reprogrammings	-1086	-1378	
SBIR/STTR Transfer			
Adjustments to Budget Years			-1091

Significant Change Explanation:

FY04 - Four FY04 Congressional Adds totaling \$5600 were added to this PE.

FY04 Congressional Adds with no R-2As:

(\$939) Advanced LFT Composites for Lightweight Weapons Systems, Project HB1: The purpose of this one year Congressional add is to fund research in long fiber thermoplastic composites. No additional funds are required to complete this project.

(\$1973) Alloy Tungsten Armor Piercing Ammunition, Project HB1: The purpose of this one year Congressional add is to fund research in alloy tungsten armor piercing ammunition. No additional funds are required to complete this project.

(\$939) Structural Reliability of Electronic Components for Munitions, Project HB1: The purpose of this one year Congressional add is to perform research in electronic component structures. No additional funds are required to complete this project.

(\$1409) Structural Reliability of Electronic Components for Munitions and Lightweight Structures, Project HB1: The purpose of this one year Congressional add is to perform research in electronic component structures. No additional funds are required to complete this project.

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)					February 2004				
BUDGET ACTIVITY 2 - Applied Research			PE NUMBER AND TITLE 0602618A - BALLISTICS TECHNOLOGY			PROJECT H03			
COST (In Thousands)			FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
H03 ROBOTICS TECHNOLOGY			17091	18181	17740	17927	18215	18572	18937
<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, Objective Force Warrior (OFW) 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 will be focused towards 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: 63005/515, 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, NIST, NASA and DOE 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 OSD Joint Robotics Program and each of the Services. 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>									

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)		February 2004		
BUDGET ACTIVITY 2 - Applied Research		PE NUMBER AND TITLE 0602618A - BALLISTICS TECHNOLOGY		PROJECT H03
<u>Accomplishments/Planned Program</u>		FY 2003	FY 2004	FY 2005
- Execute industry/academic consortium (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. In FY03, advanced technologies in terrain classification and mid-range perception and proved initial tactical behaviors and an improved understanding of human-machine interaction. In FY04, mature initial algorithmic structure to enable adaptive behaviors. In FY05, insert mature technologies onto testbed platforms to promote rapid transition of semi-autonomous capability to Future Force systems.		5602	7575	7674
- Enhance modeling and simulation infrastructure to enable maturation of semi-autonomous UGVs; devise and implement tools to enable rapid maturation of tactical behaviors. In FY03, matured common set of modeling tools for creation of tactical behaviors and for improving soldier-machine interfaces. In FY04, employ modeling tools to improve the soldier-machine interface. FY05, integrate mechanisms for behavioral adaptability into testbed vehicles and evaluate approach through field exercises during which a minimum of two vehicles collaboratively conduct maneuver required for a zone reconnaissance mission while adapting their behavior to reflect environmental changes.		915	928	843
- Mature and integrate perception and control technology required for an intelligent robotic follower vehicle capable of achieving 35 MPH on-road and 20 MPH off-road mobility (chassis limited) with a time delay between passage of the manned leader vehicle and unmanned follower of up to 12 hours. In FY03, proved technology maturity in Technology Readiness Level (TRL) 6 field exercise and transitioned technology to TARDEC for implementation in Robotic Follower Advanced Technology Demonstration (ATD) and FCS lead systems integrator (LSI) Unmanned Combat Demonstration.		2744	0	0
- Mature perception, intelligent control, and man-machine interface technology required for a single soldier to manage the operation of multiple unmanned ground vehicles maneuvering near-autonomously through the battlefield. In FY03, matured techniques of terrain classification for autonomous mobility and validated through extensive field experiments in three relevant FCS environments (rolling arid, rolling vegetated, near-urban). In FY04, implement fusion of multiple sensor modes for improved terrain reasoning. In FY05 mature technology required to show baseline adaptive tactical behaviors by unmanned ground vehicles.		2643	5018	5083
- 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. In FY03, advanced maturity of autonomous mobility technology required to implement FCS Increment 1 Armed Reconnaissance Vehicle and proved TRL 6 technology maturity for FCS Increment 1 level of capability. In FY04, incorporate improved perception and control technology to enable baseline cooperative behaviors. In FY05, prove baseline adaptive tactical behaviors.		5187	4148	4140

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)		February 2004	
BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602618A - BALLISTICS TECHNOLOGY		
		PROJECT H03	

Accomplishments/Planned Program (continued)	FY 2003	FY 2004	FY 2005
Small Business Innovative Research/Small Business Technology Transfer Programs	0	512	0
Totals	17091	18181	17740

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

February 2004

BUDGET ACTIVITY
2 - Applied Research

PE NUMBER AND TITLE
0602618A - BALLISTICS TECHNOLOGY

PROJECT
H75

COST (In Thousands)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
H75	ELECTRIC GUN TECHNOLOGY	4805	5240	5133	4933	5138	5242	5372

A. Mission Description and Budget Item Justification: 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), require 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 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, Aberdeen Proving Ground, MD and is closely coordinated with an advanced development program ongoing at the Armaments Research, Development and Engineering Center (ARDEC), Picatinny Arsenal, NJ. The program element contains no duplication with any effort within the Military Departments. 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).

Accomplishments/Planned Program	FY 2003	FY 2004	FY 2005
Pulse Power - In FY03, finalized and documented design of candidate EM gun pulsed power system. In FY04, devise advanced composite structures for pulsed power machine rotor and explore advanced thermal management technology. In FY05, prove through laboratory testing the strength of new, thick composite rotor bandings and validate thermal management components.	3865	1955	1948
Launcher - In FY03, identified and solved some of the engineering challenges associated with an EM launcher to enable acceptable service life of an EM weapons system. In FY04, establish processing methodology for fabricating EM launcher; explore lightweight materials for EM launchers; and experimentally validate prototype 8 mega joule (MJ) projectile armatures. In FY05, will validate material and fabrication technologies for EM launcher; experimentally validate reduced-scale EM launchers for integrity; and experimentally validate full-scale projectile slugs.	940	1202	1238

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)**February 2004**BUDGET ACTIVITY
2 - Applied ResearchPE NUMBER AND TITLE
0602618A - BALLISTICS TECHNOLOGYPROJECT
H75**Accomplishments/Planned Program (continued)**

Launch Package (Projectile) - In FY04, establish hypervelocity performance of monolithic depleted uranium kinetic energy penetrator materials; ballistically evaluate two alternative novel kinetic energy penetrator technologies; and evaluate novel kinetic energy penetrator electronics in EM environment. In FY05, will down-select to most promising hypervelocity penetrator and evaluate performance against realistic targets in full-scale EM gun.

FY 2003 FY 2004 FY 2005

0 1956 1947

Small Business Innovative Research/Small Business Technology Transfer Programs

0 127 0

Totals**4805 5240 5133**

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)					February 2004			
BUDGET ACTIVITY 2 - Applied Research		PE NUMBER AND TITLE 0602618A - BALLISTICS TECHNOLOGY				PROJECT H80		
COST (In Thousands)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
H80	BALLISTICS TECHNOLOGY	39476	28355	28428	30840	32747	28534	29045
<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 insure 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 (KEAP) 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, 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 program element contains no duplication with any effort within the Military Departments. 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>								

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)		February 2004		
BUDGET ACTIVITY 2 - Applied Research		PE NUMBER AND TITLE 0602618A - BALLISTICS TECHNOLOGY		PROJECT H80
<u>Accomplishments/Planned Program</u>		FY 2003	FY 2004	FY 2005
<p>- Optimize advanced lightweight structural, ceramic, and electromagnetic armor technologies that meet FCS threshold capability for transition to FCS vehicle designers, and mature ballistic shock and mineblast mitigation technologies to enable revolutionary survivability for FCS and Future Force Platforms. In FY03, experimentally validated frontal, structural, and applique armor technologies and transitioned to TARDEC and FCS Lead System Integrator for application to FCS Increment 1; optimized logic and control system to minimize space and weight for FCS system. In FY04, evaluate improved objective armor technologies to include electromagnetic and enhanced ceramic armor that improve upon the performance of the transitioned threshold armor and evolve ballistic shock and mineblast mitigation technologies. In FY05, optimize armor packaging and transition improved hybrid armor technologies to FCS vehicle designers, prove capability of ballistic shock and mineblast mitigation technologies, and prove advanced pulse power componentry necessary to enhance FCS survivability. Program executed by ARL in coordination with TARDEC.</p>		18190	9094	8098
<p>- 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 FY03, experimentally validated multi-disciplinary design tools on gun-launched maneuvering munition employing novel control mechanisms and fully characterized high-g GN&C components under realistic launch conditions. In FY04, prove validated multidisciplinary models for precision gun-fired munitions, couple with system effectiveness models, and prove gun launch as well as deployment of gun launched dynamic retargeting assets. In FY05, transition fully coupled suite of models and validated first generation dynamic retargeting technology to munitions development community.</p>		4139	4568	4765

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Accomplishments/Planned Program (continued)		FY 2003	FY 2004	FY 2005
- 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 FY03, performed critical evaluation of IHEM concepts including quantification of late-time impulse energy delivery (enhanced blast) from thermobaric explosive and characterization of combustion and erosion properties of propellant formulations containing Hi-nitrogen molecules which show promise of reducing gun wear and erosion by 40%. In FY04, characterize candidate novel insensitive high-energy materials and assess concepts for exploiting managed energy release for FCS/Future Force gun/missile systems and warheads. In FY05, extend and validate modeling tools used for design of managed energy systems; experimentally assess promising insensitive high-energy materials in notional energy managed configuration; and provide matrix of novel IHEM propellant and explosives for specific Future Force applications.		3000	2850	3150
- Mature counter-munition and sensor technologies effective for active protection defeat of kinetic energy (KE) munitions, which is critical to enable revolutionary survivability of FCS and Future Force platforms. In FY03, combined blast deflect KE counter-munition and sensor suite in breadboard KE active protection experiment which proved limited-range tracking radar and blast counter-munition capable of diverting KE rod to completely miss vehicle crew compartment; showed feasibility of using this counter-munition to defeat selected chemical energy (CE) threats. In FY04, prove effectiveness of blast-deflect KEAP system consistent with Tank Automotive and Armaments Command Full Spectrum Active Protection (FSAP) system requirements. In FY05, optimize blast-deflect countermeasure design against both KE and CE threats, and transition to TARDEC full spectrum active protection (FSAP) development program.		4450	1900	2050

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February 2004

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2 - Applied Research

PE NUMBER AND TITLE
0602618A - BALLISTICS TECHNOLOGY

PROJECT
H80

Accomplishments/Planned Program (continued)

- 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 FY03, experimentally validated improved KE missile lethal mechanism and transitioned design technology to AMRDEC for compact kinetic energy missile (CKEM) and to ARDEC; Performed 1/3 scale experimental validation proving feasibility of dual mode penetrator/warhead concept capable of providing single round to defeat armor, bunkers, personnel, and UAVs. In FY04, identify preferred options to reduce energy/mass required to defeat emerging threats and to provide multi-purpose capabilities for revolutionary Future Force lethality. In FY05, mature and integrate emerging materials and novel lethal mechanism technologies & conduct full-scale experimental validation of integrated solution for transition to Future Force munitions developers.

FY 2003	FY 2004	FY 2005
3290	3440	3671

- Devise state-of-the-art survivability/lethality/vulnerability methodologies to dynamically model the interaction of conventional ballistic threats versus FCS and Future Force System of Systems. In FY03, the first generation advanced armor penetration algorithms were implemented into survivability/lethality analysis codes for sophisticated multi-layering protection schemes employed for multi-hit protection of U.S. Army ground systems and the Future Force. Advanced Finite Element Analysis simulation code was exercised to predict the dynamic responses of novel glass-fiber composite panels under blast wave pressure loadings. Coding is being performed to provide the survivability/lethality analysis framework to dynamically model the interaction of an incoming conventional ballistic threat versus a ground combat vehicle equipped with an active protection system. In FY04, devise models for various damage mechanisms such as fuel fire and ammunition reaction as well as penetration and blast damage to new/novel materials. In FY05, experimentally validate models.

6407	6231	6694
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Small Business Innovative Research/Small Business Technology Transfer Programs

0	272	0
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Totals	39476	28355	28428
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