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

February 2003

BUDGET ACTIVITY
2 - Applied Research

PE NUMBER AND TITLE
0602105A - MATERIALS TECHNOLOGY

COST (In Thousands)		FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
Total Program Element (PE) Cost		20206	33621	15186	14881	15148	15918	16044	16421
H7B	ADVANCED MATERIALS PROCESSING	6955	7434	0	0	0	0	0	0
H7D	ELECTRONICS COMPONENTS RELIABILITY	0	2382	0	0	0	0	0	0
H7E	MATERIALS JOINING FOR ARMY WEAPONS	0	2859	0	0	0	0	0	0
H7F	PRECISION MAGNETORHEOLOGICAL FLUIDS	0	3241	0	0	0	0	0	0
H84	MATERIALS	13251	17705	15186	14881	15148	15918	16044	16421

A. Mission Description and Budget Item Justification: This program element (PE) provides materials technology for armor and armaments to enable US dominance in future conflicts across a full spectrum of threats in a global context, by increasing the survivability and lethality of Future Combat System (FCS)and Objective Force systems. Project H84 is directed toward devising materials technology that will make our heavy forces lighter and more deployable, and our light forces more lethal and survivable. It provides the technology base, including a new thrust in nanomaterials, required for solving materials-related problems in individual soldier support equipment, armor, armaments, aircraft, ground and combat vehicles and combat support. Work in this PE is related to and fully coordinated with efforts in PE 0602618 (Ballistics Technology), PE 0602601 (Combat Vehicle and Automotive Technology), PE 602782 (Command, Control, Communications Technology), PE 0602786 (Warfighter Technology), PE 0603001 (Warfighter Advanced Technology), PE 0603004 (Weapons and Munitions Advanced Technology), PE 0603005 (Combat Vehicle Advanced Technology), and PE 0603008 (Command, Control, Communications Advanced Technology). The cited work 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. Work is performed by the Army Research Laboratory (ARL). This program supports the Objective Force transition path of the Transformation Campaign Plan.

No Defense Emergency Response Funds (DERF) have been provided to this program.

B. Program Change Summary	FY 2002	FY 2003	FY 2004	FY 2005
Previous President's Budget (FY 2003)	20617	18659	14215	15602
Current Budget (FY 2004/2005 PB)	20206	33621	15186	14881
Total Adjustments	-411	14962	971	-721
Congressional program reductions				
Congressional rescissions		-1903		
Congressional increases		17700		
Reprogrammings	-147	-194		
SBIR/STTR Transfer	-264	-641		
Adjustments to Budget Years			971	-721

Change Summary Explanation:
Significant Changes:
FY04: Funds increased to support nanomaterials research at the Institute for Soldier Nanotechnologies University Affiliated Research Center (UARC).

FY03 Congressional Adds:
Precision magnetorheological fluids to polish large optics, Project H7F ($3400); Advanced Coatings Research to Extend the Service Life of Vehicles and Equipment, Project H84 ($1000); Advanced materials processing, Project H7B ($2800); Electronic components reliability, Project H7D ($2500); FCS Composite Research, Project H7B ($1500); Future affordable Multi-Utility Materials for FCS, Project H7B ($1400); Low Cost Enabling Technologies, Project H7B ($2100); Materials Joining for Army Weapons ($3000)

Projects with no R-2A:
($3348) Precision magnetoheological fluids to polish large optics, Project H7F: The objective of this one-year Congressional Add is to develop new approaches to affordably polishing large-scale optics three meters or greater in diameter. No additional funding is required to complete this project.
($2761) Advanced Materials Processing, Project H7B: This one-year Congressional add focuses on applied research in advanced material characterization and processing technologies for composite and metallic materials. No additional funding is required to complete this project.

($2465) Electronic Components Reliability, Project H7D: The objective of this one-year Congressional Add is to optimize munitions design by simulating the physics of electronic component reliability under realistic loading conditions found in vehicles and munitions. No additional funding is required to complete this project.
($1480) FCS Composite Research, Project H7B: This one-year congressional add focuses on advanced resins and fibers, thick-section mechanics, damage tolerance, processing sciences, validated design models, and predictive models for the optimal application of composite materials for FCS requirements. No additional funding is required to complete this project.
($1381) Future Affordable Multi-Utility Materials for FCS, Project H7B: This one-year congressional add focuses on maturing advanced lightweight materials processing technologies that will enable a cost effective, survivable, durable, and deployable FCS force. No additional funding is required to complete this project.
($2071) Low Cost Enabling Technologies, Project H7B: The objective of this one-year Congressional Add is to mature affordable processing of advanced multi-functional materials for wide range of Army applications. No additional funding required to complete this project.
($2958) Materials for Joining Army Weapons, Project H7E: The objective of this one-year Congressional Add is to mature affordable joining technologies (friction stir welding, laser hybrid welding) to provide capability to join complex shapes, dissimilar materials, and out of tolerance parts (wide gaps) to ensure full range of reliable and sustainable Objective Force platforms. No additional funding required to complete this project.

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

February 2003

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
2 - Applied Research	**0602105A - MATERIALS TECHNOLOGY**	**H84**

COST (In Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
H84 MATERIALS	13251	17705	15186	14881	15148	15918	16044	16421

A. Mission Description and Budget Item Justification: The goal of this project is to provide the technical foundation for materials technology in metals, ceramics, polymers, and composites that are essential for lethal and survivable Future Combat Systems (FCS), Objective Force Warrior (OFW) and other Objective Force platforms. In order to meet the challenge of the Army Vision, new systems must be significantly lighter, more deployable, and more sustainable. A barrier to this challenge is the requirement for new materials and structures solutions that offer significant weight reduction with improved performance, durability and cost reduction for application to individual soldier support equipment, armor, armaments, aircraft, ground combat vehicles, and combat support equipment. This project will address these needs through: nanomaterials research, improved physics-based material, mechanics, and structural models; high strain rate material characterization techniques; non-destructive inspection/evaluation technologies; new high strength/temperature materials and coatings; and advanced fabrication/processing methodologies. Applied research efforts are focused in armor/armament materials, as well as lightweight structural materials and materials affording protection against chemical, biological, or directed energy threats. The work is conducted at the Army Research Laboratory (ARL), Aberdeen Proving Ground, MD and Hampton, VA 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; the Aviation and Missile Research, Development and Engineering Center (AMRDEC), Huntsville, AL; the Natick Soldier Center, Natick, MA; the Edgewood Chemical and Biological Center, Edgewood, MD; and the Communications and Electronics Research Development and Engineering Center (CECOM), Ft. Monmouth, NJ. This project also funds a collaborative research effort in nanomaterials technology between the ARL and the Institute for Soldier Nanotechnologies (ISN) at the Massachusetts Institute for Technology, MA. The cited work 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. Work is performed by the Army Research Laboratory (ARL). This program supports the Objective Force transition path of the Transformation Campaign Plan.

No Defense Emergency Response Funds have been provided to this project.

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
- Optimize lightweight armor materials/structures, processing methodology, and modeling and simulation tools to enable development of lightweight frontal and structural armors that will revolutionize FCS and Objective Force platform survivability. In FY02, validated penetration and structural simulations and integrated emerging materials technology (lightweight metals, ceramics, ceramic laminates, composites, and energetic materials) with novel defeat mechanisms; validated improved, cost-effective manufacturing process for multifunctional composite structures and transitioned technology to FCS. In FY03, optimize lightweight armor materials, structures, and modeling and simulation tools for transition to FCS vehicle designers. In FY04, provide and evaluate improved materials and processes to include functionally graded materials (FGMs) and transparent ceramics that increase performance of FCS armor systems and create computational methodologies for design of blast and impact-resistant multifunctional (e.g., power, communications, propulsion, sensory) composite structures for FCS enhancement. In FY05, prove low cost processing of enhanced structural armor, metallics, and ceramics to enable advanced armor technology development and validate computational methodologies for design of blast and impact-resistant multifunctional (e.g., power, communications, propulsion, sensory) composite structures critical for full-spectrum survivability of FCS/Objective Force platforms.	3812	3129	3104	3147

Accomplishments/Planned Program (continued)	FY 2002	FY 2003	FY 2004	FY 2005
- Optimize lightweight armor materials and defeat mechanisms against emerging threats and provide advanced processing techniques to enable affordable design of future multifunctional ballistic protective systems for the OFW. In FY02, investigated novel lightweight armor materials (boron carbide, silicon carbide) and processing techniques, refined physics-based models, and showed improved performance of lightweight ballistic protection for the future warrior; and designed and synthesized novel nano-structured materials (dendrimers, nanocomposites, self-assembled polymers) and multi-functional coatings (water dispersible, chemical agent resistant, nanoreactor fabric). In FY03, provide novel lightweight materials and physics-based design tools to development community for integration into OFW protective systems; and employ advanced models and processing techniques to optimize performance of promising nano-structured materials and multi-functional coatings to provide improved protection and sustainability for the Objective Force. In FY04, optimize lightweight armor materials and defeat mechanisms against emerging threats and provide prototype armors that incorporate advanced processing techniques to enable affordable design of future multifunctional ballistic protective systems for the OFW. In FY05, validate computational models and investigate armor materials and processing techniques that will enable the fabrication of a uniform with integrated warrior electronic devices and multi-functional ballistic protection.	3735	3128	1668	2049

Accomplishments/Planned Program (continued)	FY 2002	FY 2003	FY 2004	FY 2005
- Investigate ceramic, composite and other advanced materials to enable FCS and Objective Force lethality. Design, validate, and optimize advanced and electroceramic materials and processing techniques for smaller more lethal penetrators and affordable, lightweight high performance armaments for revolutionary Objective Force lethality. In FY02, devised improved models, employed novel characterization techniques, and proved sheathed penetrator processing technologies that will enable the design and synthesis of improved penetrator/warhead materials for future munitions; showed the utility (e.g., strength, erosion resistance, thermal properties, manufacturability) of several commercially available ceramics for application to gun barrels; and optimized mechanical characterization techniques and devised non-linear analysis capability for continuous fiber metal matrix and completed design for an FCS cargo shell. In FY03, synthesize candidate penetrator/warhead alloys, evaluate ballistic performance against threat armors, and initiate transition of promising concepts to ammunition designers; characterize candidate ceramics in non-ballistic environment and design gun barrel concept/sheathing technologies; and design, produce, and characterize prototype metal matrix composite projectile shell and transition design tools and prototype to ammunition designers for application to FCS to enable lightweight, lethal FCS/Objective Force munitions. In FY04, characterize failure mechanisms in emerging anti-armor materials and investigate effects of processing variables and constituents for improved design of penetrators/warheads; and prove thermally robust sheathing techniques capable of inducing a multi-axial compressive stress to insure structural integrity of sheathed ceramics subjected to internal pressure loading to enable improved armaments for the Objective Force. In FY05, transition improved anti-armor materials and ceramic gun barrel technology to ARDEC/AMRDEC.	3221	5154	5028	4159
Design and optimize electro-ceramic materials and processing techniques for integration by CECOM into advanced antennas that will enable affordable, reliable Command, Control, Communications (C3) Information for FCS and Objective Force platforms. In FY02, evaluated electro-ceramic materials (functionally doped BSTO thin films and bulk ceramic composites) properties for discrete and integrated microwave applications including fire control radar, smart munitions, and point-to-point communications. In FY03, design and fabricate new electro-ceramic materials. In FY04, validate affordable processing methods to improve performance and integration into communication systems for FCS. In FY05, transition technology to CECOM.	500	480	450	446

Accomplishments/Planned Program (continued)	FY 2002	FY 2003	FY 2004	FY 2005
- Devise and validate improved physics-based materials property models and concepts for multifunctional lightweight and responsive hierarchical material technologies and exploit breakthroughs in nanomaterials and multifunctional fiber processing technologies (e.g., scale-up of processes and fabrication into woven materials) to enable revolutionary Objective Force Warrior survivability. Research conducted by ARL in collaboration with ISN Industry Partners. In FY02, devised unique high strain rate nanomaterials characterization capability and proved novel nanomaterials technologies for reversible adhesive bonding, stimuli-responsive actuation and biological agent detection techniques. In FY03, exploit nanocomposite material breakthroughs to design and fabricate ultra-lightweight structural and ballistic protection concepts, and scale-up processing and fabrication of novel lightweight energy absorbing nanomaterials for experimental evaluation. In FY04, design and develop scalable processing/synthesis methods and demonstrate improved physics-based materials property models. In FY05, validate multiple protective materials designs that incorporate at least three functions (e.g., ballistic, blast and fire/flame protection) with reduced weight within single integrated system and exploit selected processing methodology to fabricate prototype nanomaterials-based, functionally integrated specimens for testing and evaluation.	1983	4847	4936	5080
Advanced Coatings Research to Extend the Service Life of Vehicles and equipment: This one year congressional add focuses on providing novel coatings to improve the reliability/durability, and significantly reduce life-cycle costs, of Army Materiel. No additional funding is required to complete this project.	0	967	0	0
Totals	13251	17705	15186	14881