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

**February 2002**

| BUDGET ACTIVITY | PE NUMBER AND TITLE |
|---|---|
| **2 - Applied Research** | **0602105A - MATERIALS 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 | 30625 | 20617 | 18659 | 14215 | 15602 | 15750 | 17591 |
| H7B | ADVANCED MATERIALS PROCESSING | 6729 | 6946 | 0 | 0 | 0 | 0 | 0 |
| H7C | AMORPHOUS METAL KINETIC ENERGY PENETRATOR | 2884 | 0 | 0 | 0 | 0 | 0 | 0 |
| H84 | MATERIALS | 11400 | 13671 | 18659 | 14215 | 15602 | 15750 | 17591 |
| HM1 | HARDENED MATERIALS | 9612 | 0 | 0 | 0 | 0 | 0 | 0 |

**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. It provides the technologies essential for Army Transformation. Project AH84 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 required for solving materials-related problems in individual soldier support equipment, armor, armaments, aircraft, ground and combat vehicles and combat support. Technology for advanced materials will enable the Future Combat Systems' (FCS) and Objective Force survivability and lethality. 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. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

| **B. Program Change Summary** | FY 2001 | FY 2002 | FY 2003 |
|---|---|---|---|
| President's Previous Budget (FY 2002 PB) | 27304 | 13794 | 12762 |
| Appropriated Value | 27557 | 20794 | 0 |
| Adjustments to Appropriated Value | 0 | 0 | 0 |
| a. Congressional General Reductions | 0 | -177 | 0 |
| b. SBIR / STTR | -523 | 0 | 0 |
| c. Omnibus or Other Above Threshold Reductions | 0 | 0 | 0 |
| d. Below Threshold Reprogramming | 3844 | 0 | 0 |
| e. Rescissions | -253 | 0 | 0 |
| Adjustments to Budget Years Since FY2002 PB | 0 | 0 | 5897 |
| Current Budget Submit (FY 2003 PB ) | 30625 | 20617 | 18659 |

Change Summary Explanation:

FY03 (+5897) - Project H84 increased to accelerate development of affordable technologies for multifunctional, polymer-inorganic. hybrid nanocomposite materials to revolutionize survivability and lethality of the Objective Force Warrior and other objective force platforms; and to accelerate the testing of a prototype laser ultrasound NDE system.

FY02: Congressional adds were made for Advanced Materials Processing Center, Project H7B ($3000); Future Combat Systems Composites Research, Project H7B ($2500); and AAN Multifunctional Materials, Project H7B ($2500).

Projects with no R2-A:

Project H7B:
FY02 funding = $2500 FCS Composites Research : 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.

Project H7B:
FY02 funding = $1500 Army after Next Multifunctional Materials : This one year congressional focuses on the development of rigid rod polyphenylene structural materials with potential military applications.

Project H7B:
FY02 funding = $3000 Advanced Materials Processing Program. : This one year Congressional add focuses on applied research in advanced material discovery, characterization and processing technologies for composite and metallic materials.

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

**February 2002**

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

| COST (In Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate |
|---|---|---|---|---|---|---|---|
| H84 MATERIALS | 11400 | 13671 | 18659 | 14215 | 15602 | 15750 | 17591 |

**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) 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. The 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: 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, Aberdeen Proving Ground, MD and Hampton, VA and provides required technologies for advanced development programs at the Armaments Research, Development and Engineering Center, Picatinny Arsenal, NJ; the Tank and Automotive Research, Development and Engineering Center, Warren, MI; the Aviation and Missile Research, Development and Engineering Center, 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, Ft. Monmouth, NJ. 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 Materiel Command. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

**FY 2001 Accomplishments:**

- 7069 - Proved reduced-cost (30%), appropriate quality composite processing technology for lightweight combat vehicles that feature integrated armor structure technologies.

  - Devised structure/property relationships (enhanced barrier properties of perm-selective clothing membranes), processing methodologies (nanocomposites for ballistic protection), and advanced characterization techniques for emerging nanomaterials and multi-functional protective coatings to enable a survivable and sustainable Objective Force.

  - Modeled and engineered emerging lightweight armor materials including improved titanium and advanced silicon carbide ceramics and encapsulated ceramic armor structures to improve penetration resistance and minimize collateral damage in future lightweight combat vehicles.

**FY 2001 Accomplishments: (Continued)**

- Devised physics-based models to predict back face deformation and blunt trauma and performed ballistic evaluation experiments to characterize the failure mechanisms of personnel protective armor materials to ballistic impact of emerging threats.

• 3590 - Optimized physics-based models of propellant interactions with gun bore surface and transitioned thermo-chemical erosion modeling package to the Armaments Research, Development and Engineering Center for design of improved wear-resistant gun tubes for Advanced Technology Demonstration Program.

- Provided thin film phase shifter materials with high tunability and temperature stability properties comparable to bulk materials that will significantly reduce the cost and weight of future antenna systems under development at the US Army Communications and Electronics Command.

- Validated mechanical/thermal models and characterized mechanical/thermal fatigue properties of continuous fiber metal matrix composites (MMC) for application to future lightweight munitions and gun tubes.

• 741 - Devised and proved out advanced laser ultrasonics, microwave, and thermal Non Destructive Evaluation technologies for thick multi-layered structures in support of FCS; investigated and applied sensor technologies to assess fatigue behavior in metallic and composite structures for life extension; and experimentally characterized high-speed, ground vehicle tire and TACOM 5-ton truck tire to provide modeling and simulation input parameters for improved tire designs (technology transferred to TACOM).

Total 11400

**FY 2002 Planned Program**

• 7415 - Provide improved process for affordably and reliably infusing composite and multi-functional materials to produce low cost, large-scale sections for FCS and Objective Force platforms.

- Design and synthesize novel nano-structured materials and multi-functional coatings to provide improved protection and sustainability for the Objective Force.

- Validate penetration and structural simulations and integrate emerging materials technology (lightweight metals, ceramics, ceramic laminates, composites, and energetic materials) with novel defeat mechanisms for FCS armors and survivability concepts.

- Investigate novel lightweight armor materials and processing techniques and refine physics-based models to improve the performance of ballistic protection for the future lightweight warrior.

• 3459 - Devise improved models, characterization techniques, and processing technologies to enable the design and synthesis of improved penetrator/warhead materials for future munitions.

**FY 2002 Planned Program (Continued)**

- Evaluate electro-ceramic materials for discrete and integrated microwave applications including fire control radar, smart munitions, and point-to-point communications.

- Optimize mechanical characterization techniques, modeling and simulation design tools, and processing capability for continuous fiber MMCs for FCS armament/ammunition applications.

• 814 - Evaluate a prototype laser ultrasonic NDE concept that uses low energy, low cost pulsed laser diodes for improved detection; establish database of microwave measurements to improve damage assessment in Army composite structures; extend fatigue sensor to enhance measurement of fatigue life expended in ground vehicle dynamic components; and investigate alternative control algorithms for a Fuzzy Logic Controller for an active vehicle suspension to enhance performance and response.

• 1983 - Explore novel methodologies for the integration of nanomaterials technologies, and emerging concepts from the Institute for Soldier Nanotechnologies University Affiliated Research Center, to enable the design and development of future ultralightweight, multifunctional personnel protective system(s) for the Objective Force Warrior.

Total 13671

**FY 2003 Planned Program**

• 8525 - Optimize lightweight armor materials, structures, and modeling and simulation tools for transition to FCS vehicle designers.

- 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.

- Provide novel lightweight materials and physics-based design tools to development community for integration into future lightweight warrior protective systems.

• 3826 - Synthesize candidate penetrator/warhead alloys, evaluate ballistic performance against threat armors, and transition promising concepts to ammunition designers and Army Manufacturing Technology (MANTECH) Program.

- Optimize and transition electro-ceramic materials and processing techniques to CECOM for integration into advanced antennas for FCS.

- Design, produce, and characterize prototype gun tube or projectile shell and transition design tools/prototype to armament/ammunition designers for application to FCS.

• 899 - Conduct field experiments on a prototype laser ultrasonic NDE system; prototype microwave measurement instrument for NDE assessment of large area composite structures; conduct validation experiments of fatigue sensors on selected rotorcraft and ground vehicle dynamic components; and test advanced algorithms for the fuzzy logic controller of an active vehicle suspension.

**FY 2003 Planned Program (Continued)**

- 5409 - Optimize physical-mechanical properties, improve predictive models, and develop affordable synthesis/processing technologies to facilitate development of multifunctional, polymer-inorganic hybrid nanocomposite materials to revolutionize survivability and lethality of the Objective Force Warrior and other Objective Force platforms.

  - Explore and discover nano intelligent materials, which incorporate emerging nano and bio technologies, to enable protection of Objective Force Warrior and Objective Force Platforms from non-traditional threats posed during asymmetric confrontations.

Total 18659