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

**June 2001**

BUDGET ACTIVITY
**2 - APPLIED RESEARCH**

PE NUMBER AND TITLE
**0602105A - Materials Technology**

| COST (In Thousands) | | FY 2000 Actual | FY 2001 Estimate | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Program Element (PE) Cost | | 15077 | 27326 | 13794 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| H7B | ADVANCED MATERIALS PROCESSING | 0 | 6951 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| H7C | AMORPHOUS METAL KINETIC ENERGY PENETRATOR | 0 | 2979 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| H84 | MATERIALS | 12691 | 11451 | 13794 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HM1 | HARDENED MATERIALS | 2386 | 5945 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**A. Mission Description and Budget Item Justification:**

**PLEASE NOTE: This administration has not addressed FY2003-2007 requirements. All FY 2003-2007 budget estimates included in this book are notional only and subject to change.**

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.

| B. Program Change Summary | FY 2000 | FY 2001 | FY 2002 | FY 2003 |
|---|---|---|---|---|
| President's Previous Budget (FY 2001 PB) | 16266 | 11557 | 14385 | 0 |
| Appropriated Value | 16349 | 27557 | 0 | |
| Adjustments to Appropriated Value | 0 | 0 | 0 | |
| a. Congressional General Reductions | 0 | 0 | 0 | |
| b. SBIR / STTR | -189 | 0 | 0 | |
| c. Omnibus or Other Above Threshold Reductions | -29 | 0 | 0 | |
| d. Below Threshold Reprogramming | -1000 | 0 | 0 | |
| e. Rescissions | -54 | -253 | 0 | |
| Adjustments to Budget Years Since FY2001 PB | 0 | 0 | -591 | |
| Current Budget Submit (FY 2002/2003 PB ) | 15077 | 27304 | 13794 | 0 |

Change Summary Explanation: Funding - FY 2001: Congressional adds were received for HM1, Composite Materials Technology (+6000); Amorphous Kinetic Energy Penetrator Materials Technology (+3000); and Advanced Materials Processing Technology (+7000).

-(+6000) Composite Materials Technology to focus 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.

-(+3000) Amorphous Kinetic Energy Penetrator Materials Technology focuses on discovery and synthesis of a high-density, low cost, bulk amorphous

metal alloy for use in developing composite materials as alternatives to depleted uranium for kinetic energy penetrators.

- (+7000) Advanced Materials Processing Technology focuses on the development of a unique multi-axis friction stir capability/technology to achieve stronger welds in lightweight materials for application to Objective Force combat platforms.

FY 2003: Funds realigned (-2103) to higher priority programs.

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

**June 2001**

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| **2 - APPLIED RESEARCH** | **0602105A - Materials Technology** | **H84** |

| COST (In Thousands) | FY 2000 Actual | FY 2001 Estimate | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| H84 MATERIALS | 12691 | 11451 | 13794 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**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. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

**FY 2000 Accomplishments**

- 8099 - Devised life prediction models for Army materiel based on accelerated weathering, cyclic corrosion testing, and real-world exposure studies that will significantly reduce logistical costs for Army systems.

  - Quantified and optimized sensor arrays to assess ballistic damage, environmental degradation and potential chemical/biological agent threats.

  - Devised and evaluated new mass-efficient means to improve the ballistic resistance of ceramics by integrating them with organic-matrix composites to enable improved lightweight combat vehicles.

  - Determined the microstructural influences of metallic-intermetallic-ceramic components on the performance of current composite armor designs.

**FY 2000 Accomplishments (Continued)**

- Determined high strain-rate behavior and failure criteria of layered and functionally graded ceramics, metals and anisotropic composites to develop constitutive models for the rational design of materials for high-performance, integrated, multifunctional armors.

• 2800 - Devised atomic scale, physics-based models of propellant gas interactions with the gun bore surface to predict the durability of the bore surface for a variety of coatings systems and propellants.

- Determined dielectric materials for antenna sections that will enable extended range and improved accuracy for both direct and indirect fire weaponry.

- Devised refractory metal explosively formed projectile liners and determined their processibility.

• 1085 - Determined critical materials technologies essential for the successful testing of pulsed power machines for the Objective Force.

• 707 - Conducted microwave Non-Destructive Evaluation (NDE) measurement and analyses for large composite structures; devised more portable and field usable laser ultrasonic inspection technique; and evaluated an advanced off-road, high-speed wheeled testbed, for structural dynamics research.

Total 12691

**FY 2001 Planned Program**

• 7069 - Evaluate reduced-cost, appropriate quality processing technology for lightweight combat vehicles that feature integrated armor structure technologies.

- Devise structure/property relationships, processing methodologies, and advanced characterization techniques for emerging nanomaterials and multi-functional protective coatings to enable a survivable and sustainable Objective Force.

- Model and engineer emerging lightweight armor materials and structures to improve penetration resistance and minimize collateral damage in future lightweight combat vehicles.

- Devise physics-based models and perform ballistic evaluation to characterize the failure mechanisms of personnel protective armor materials to ballistic impact of emerging threats.

• 3590 Optimize physics-based models of propellant interactions with gun bore surface and transition thermo-chemical erosion modeling package to armament developers for design of improved wear-resistant gun tubes

- Evaluate thin film phase shifter materials with properties comparable to bulk materials to significantly reduce the cost and weight of future antenna systems

**FY 2001 Planned Program (Continued)**

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

• 741 - Evaluate active control technologies for advanced high-speed, off-road, ground vehicles; devise advanced laser ultrasonics, microwave, and thermal NDE technologies for thick multi-layered structures in support of FCS; investigate sensor technologies to assess fatigue behavior in metallic and composite structures; and experimentally characterize high-speed, ground vehicle tire and TACOM 5-ton truck tire to provide modeling and simulation input parameters.

• 51 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs.

Total 11451

**FY 2002 Planned Program**

• 7483 - 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.

• 3490 - Devise improved models, characterization techniques, and processing technologies to enable the design and synthesis of improved penetrator/warhead materials for future munitions.

- 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.

**FY 2002 Planned Program (Continued)**

- 821 - 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.
- 2000 - 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 13794