

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2 Exhibit)

February 2008

BUDGET ACTIVITY		PE NUMBER AND TITLE					
2 - Applied Research		0602786A - Warfighter Technology					
COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
Total Program Element (PE) Cost	43200	36237	21948	22276	22519	23066	23631
283 AIRDROP ADV TECH	2307	2314	2370	2400	2418	2471	2527
C60 AC60	3582						
E01 Warfighter Technology Initiatives (CA)	18496	13311					
H98 CLOTHING & EQUIPM TECH	13878	15419	14262	14496	14680	15054	15437
H99 JOINT SERVICE COMBAT FEEDING TECHNOLOGY	4937	5193	5316	5380	5421	5541	5667

A. Mission Description and Budget Item Justification: This applied research program element (PE) investigates/evaluates technologies to improve Soldier survivability, sustainability, mobility, combat effectiveness, and field quality of life. Efforts focus on technologies for use in the Future Force and, where feasible, exploit opportunities to enhance Current Force capabilities. Work includes the design, development, and improvements of components used for air delivery of personnel and cargo; combat clothing; personal equipment (including protective equipments such as personal armor and eye wear); combat rations and combat feeding equipment. Main focus is on providing the Soldier with the most effective personal clothing, equipment and rations at the least weight and sustainment burden. The Airdrop Advanced Technology project (283) supports all Services' requirements for designing and developing technologies that support air dropping increasingly heavier combat and logistics loads while improving delivery accuracy, minimizing vulnerability of aircraft, and reducing life cycle costs. In addition, this project investigates technologies for safer, more efficient personnel parachutes, addressing a critical capability for rapid deployment and force projection into hostile environments. Project AC60 supports programs that are classified. Project E01 comprises Congressional special interest items. The Clothing and Equipment Technology project (H98) funds cutting edge research and investigation/evaluation of components and materials that have potential to enhance Soldier survivability from combat threats and the field environment (e.g., cold, heat, wet). Efforts focus on incorporating novel materials into component designs that protect Soldiers against flame, blast and ballistic threats, as well as, certain directed energy threats. This effort has the potential to enhance the areas of personnel armor, helmets and protective inserts for shelters. In addition, clothing components and other personal equipment is designed and evaluated to enhance signature management; provide wearable, conducting materials to augment data and power transmission; provide cooling to the Soldier to reduce risk of heat stress; lighten the Soldier's load; and reduce physical stress-induced injuries while conducting operational activities. Human science, anthropometric, and psychophysical methods are used to assess human responses to sensory, cognitive and affective stimuli to enable better prediction of the performance/effectiveness of items. Data is collected and incorporated into modeling and analysis tools that enable technologists and military users to trade-off potential Soldier system capabilities and mature a human-centered Soldier system design. The Joint Services Combat Feeding Technology project (H99) supports all Military Services, the Special Operations Command, and the Defense Logistics Agency with results of research investigations and evaluation conducted on high payoff technologies for preparing, preserving, stabilizing combat rations and ensuring that the rations provide the best combination of nutrients and energy enhancements to sustain the Soldier during missions. In addition, this project investigates novel ration packaging and combat feeding equipment/systems. Investigative focus is on enhancing nutrient composition and consumption to maximize cognitive and physical performance on the battlefield; minimizing physical, chemical and nutritional degradation of combat rations during storage; meeting the needs of individual Soldiers in highly mobile battlefield situations; and providing equipment and energy technologies to reduce the logistics footprint of field feeding while improving the quality of food service. The efforts in this PE adhere to Tri-Service Reliance agreements on clothing, textiles, and operational rations and field food service equipment with oversight and coordination by the Department of Defense (DoD) Combat Feeding Research and Engineering Board.

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Efforts are related to and fully coordinated with those in PE 0603001A (Warfighter Advanced Technology) and are complementary/non-duplicative with armor materials efforts conducted in PE 0602618A and PE 0602105A. The cited work is consistent with the Department of Defense Research and Engineering Strategic Plan, the Army Science and Technology Master Plan, the Army Modernization Strategy, and the Army Posture Statement. Work in this PE is performed by the US Army Natick Soldier Research, Development and Engineering Center, Natick, MA.

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2 - Applied Research	0602786A - Warfighter Technology		
<u>B. Program Change Summary</u>	FY 2007	FY 2008	FY 2009
Previous President's Budget (FY 2008/2009)	44044	23083	21988
Current BES/President's Budget (FY 2009)	43200	36237	21948
Total Adjustments	-844	13154	-40
Congressional Program Reductions		-246	
Congressional Rescissions			
Congressional Increases		13400	
Reprogrammings	105		
SBIR/STTR Transfer	-949		
Adjustments to Budget Years			-40

Nine FY08 congressional adds totaling \$13400 were added to this PE.

- (\$400) Injection Molded Ceramic Body Armor
- (\$800) Protective Textile Fabric
- (\$1000) Active and Smart Packaging for Combat Feeding
- (\$1000) Advanced Fabric Treatment for Flame Resistant Uniforms
- (\$1000) Nano-Enabled Ultra High Storage Non-Volatile Memory for Next Generation Commander's Digital Assistant
- (\$1600) Carbon Nanotube Armor Protection System
- (\$1600) Chemical and Biological-Protective Hangars (CAB-PH)
- (\$2000) Biosecurity Research for Food Safety
- (\$4000) Modular Ballistic System for Force Protection

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BUDGET ACTIVITY 2 - Applied Research		PE NUMBER AND TITLE 0602786A - Warfighter Technology					PROJECT 283	
COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	
283 AIRDROP ADV TECH	2307	2314	2370	2400	2418	2471	2527	

A. Mission Description and Budget Item Justification: This project researches, investigates and evaluates component technologies to enhance cargo and personnel airdrop capabilities. These enabling technologies support the goals of Army Transformation for global precision delivery, rapid deployment, and insertion capabilities for force projection, particularly into hostile regions. Areas of emphasis include parachute technologies, parachutist injury reduction, precision offset aerial delivery, soft landing technologies, and airdrop simulation. Efforts result in increased personnel safety; more survivable and more accurate cargo delivery; and reduced aircraft, crew, and cargo vulnerability. The goal for personnel parachute technology is to reduce injuries and to improve performance and combat effectiveness of the Advanced Tactical Parachute System (ATPS). The cited work is consistent with the Department of Defense Research and Engineering Strategic Plan, the Army Science and Technology Master Plan, the Army Modernization Strategy, and the Army Posture Statement. Work in this project is performed and managed by the US Army Natick Soldier Research, Development and Engineering Center, Natick, MA.

Accomplishments/Planned Program:	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
Precision Airdrop Enhancements: In FY07, developed new means of measuring air flow around parachutes, cargo payloads, and paratroopers; and investigated and evaluated state-of-the-art autonomous Guidance, Navigation and Control (GN&C) of precision airdrop systems to improve aerodynamic performance and landings. In FY08, experiment with favorable GN&C technologies to mature sensing, guidance, navigation, and control algorithms for precision airdrop. In FY09, will downselect and implement the most mature and favorable GN&C technologies into prototypical precision airdrop systems and transition technology to be matured and demonstrated in PE 0603001A.	1255	1230	1280
Modeling and Simulation for Tactical Parachute System Performance Enhancement: In FY07, refined and evaluated computer tools developed to model parachute inflation and to calculate opening shock. Used High Performance Computing modeling and simulation to investigate fully open parachutist control and rate of descent aspects of ATPS. In FY08, utilize experimental methodologies to develop detailed knowledge of baseline parachute physics; complete investigation of fully open parachutist control and rate of descent issues; and investigate parachute opening phenomena. In FY09, will complete investigation of ATPS parachuting opening and validate full fidelity model against baseline physics from experiments; will provide detailed ATPS performance enhancement assessment to PM-Clothing and Individual Equipment (CIE); and will transition results to PM-CIE ATPS product improvement program.	1052	1076	1090
Small Business Innovative Research/Small Business Technology Transfer Programs		8	
Total	2307	2314	2370

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BUDGET ACTIVITY 2 - Applied Research		PE NUMBER AND TITLE 0602786A - Warfighter Technology					PROJECT H98	
COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	
H98 CLOTHING & EQUIPM TECH	13878	15419	14262	14496	14680	15054	15437	

A. Mission Description and Budget Item Justification: This project researches, investigates and evaluates component technologies to improve Soldier survivability, sustainability, mobility, combat effectiveness, and field quality of life. The project funds cutting edge research and investigation/evaluation of components and materials that have potential to enhance Soldier survivability from combat threats and the field environment (e.g., cold, heat, wet). Included are personnel armor, helmets, and protective inserts for shelters - efforts that focus on incorporating novel materials into designs that protect Soldiers against flame, blast and ballistic threats, as well as, certain directed energy threats. In addition clothing and other personal equipment is designed and evaluated to enhance signature management; provide wearable, conducting materials to augment data and power transmission; provide cooling to the Soldier to reduce risk of heat stress; lighten the Soldier's load; and reduce physical stress-induced injuries while conducting operational activities. Work includes exploration of nanomaterials and novel fibers for potential use in personnel armor plate laminates. This project leverages work performed by the Institute for Soldier Nanotechnologies supported by PE 0601104A (University and Industry Research Centers) and PE 602105A (Materials Technology). The goal of the Ballistic and Blast Protection for the Individual Warrior effort is to research and apply advances in materials and materials-processing technology to improve the protection and performance of next generation personal armor and helmet systems against conventional and emerging ballistic threats while continually striving to reduce the weight and bulkiness of protective wear. In addition, this effort characterizes blast profiles, determines the hazard, and demonstrates improved personal protection concepts that provide protection against effects of blast and ballistic threats combined at minimum weight. The Soldier Integrated Tunable (Frequency Agile) Laser/Ballistic Eye Protection effort addresses the emerging threat of frequency agile lasers on the battlefield and provides increased ballistic fragmentation protection for the eyes, face and neck, and scratch resistance for the lenses. Lightweight transparent materials and advanced coatings (using novel coating methods) are fabricated and evaluated against laser, ballistic, and environmental threats (especially abrasives like sand) for use in Soldier protective glasses and goggles. The effort is performed in collaboration with the Army Research Laboratory in PE 0602120A (Sensors and Electronic Devices). The goal of Infantry Warrior Simulation (IWARS) is to continue to improve and mature accuracy and capability of essential analytic tools needed to assess the combat effectiveness of next generation Soldier systems, with a focus on network centric warfare technologies. The IWARS toolset is used extensively throughout the Army and with our national and international partners. Maintaining and increasing the capabilities of the models to correctly simulate advanced Soldier materiel and equipment in more relevant operational environments is essential to achieving cost-effective solutions to existing and emerging individual Soldier and small unit capability gaps. The Biomechanical Tools for Individual Soldier Extremity Protection and Performance Enhancement effort identifies promising candidate component configurations of extremity armor to provide individual Soldiers with extremity ballistic protection affording flexibility, agility and mobility, while minimizing the energy expended during dismounted operations. This effort also explores the effects of combined physical stresses (including physical load and load distribution, environment (heat/cold) and mission type) on a Soldier's ability to perform tasks without sustaining physical injury, perform with less fatigue, and process, act on and make decisions. This work is collaborative with and fully coordinated with the US Army Research Institute of Environmental Medicine (USARIEM). The data and results feed the component design efforts for Soldier as a System personal clothing and protective equipment. Electrotiles - Self Powered, Conductive, and Smart Materials focuses on designing and evaluating conducting, flexible, wearable materials for lightweight power generating and storage devices that can be used to augment power sources for Soldier-worn computers and equipment. This effort makes extensive use of nanomaterials and photovoltaic technologies to achieve lightweight, multifunctional textiles and fabrics with novel electrical properties. The purpose of the Soldier Borne Microclimate Cooling effort is to design a capability to mitigate the effects of heat stress encountered by dismounted infantry exposed to hot environments and encumbered in protective clothing. The cited work is consistent with the Department of Defense Research and Engineering Strategic Plan, the Army Science and Technology Master Plan, the Army Modernization Strategy, and the Army Posture Statement. Work in this project is performed by the US Army Natick Soldier Research, Development and Engineering Center, Natick, MA.

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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT		
2 - Applied Research	0602786A - Warfighter Technology	H98		
<u>Accomplishments/Planned Program:</u>		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
Ballistic and Blast Protection for the Individual Warrior: In FY07, validated, through laboratory testing, composite technology to enable a 20 to 30 percent reduction over current weight (FY03 fielded helmet weight of 2.0lb/ft ²) with equivalent fragmentation protection; transitioned composite technologies for small arms protection to reduce weight and/or increase multiple-hit capability to PE 0603001A Warfighter Advanced Technology; developed and validated performance of an add-on concept for body blast protection. In FY08, continue development of advanced fiber technology (e.g., carbon nanotube-based) for lightweight armor applications, investigate conformable material configurations to reduce weight, minimize performance vulnerability associated with complex shapes in personnel armor applications, and explore performance thresholds for increased protection levels for personal armor technology; define and develop material system concepts for integrated ballistic/blast protection for use in improved body armor. In FY09, will validate performance of selected materials configurations for enhanced helmet performance; will downselect materials and begin integration of technological elements and components into a breadboard system for next generation armor systems and evaluate in various environments; will refine and validate material system concepts for integrated ballistic/blast protection for use in improved body armor.		3130	4035	5200
Soldier Integrated Tunable (Frequency Agile) Laser/Ballistic Eye Protection: In FY07, matured lighter weight ballistic materials while maintaining the improved level of performance; identified and evaluated abrasion resistant coatings and coating application procedures; and researched optical limiting concepts that meet system design response time requirements. In FY08, validate potential of new ballistic materials achieved through leveraged efforts; prepare and analyze hybrid lighter weight ballistic materials while maintaining the improved level of performance; integrate multi-layered laminates to provide multifunctional transparent armor materials with scratch resistance, and validate optical limiting concepts that do not require a lens system and that meet response time requirements over the visual spectrum. In FY09, will combine laser eye protection concepts, compatible ballistic materials, and abrasion resistance coatings into a new composite material; will assemble components on breadboard and perform system evaluation in a simulated environment.		3130	3408	1500
Infantry Warrior Simulation (IWARS): In FY07, developed initial small unit battle command module to support small unit information transfer impacts, and released the High Level Architecture compliant third version of IWARS. In FY08, include Advanced Soldier representations within IWARS, to include effects of sensor systems and the User Defined Operating Picture on the ability to provide actionable information to small units. In FY09, will enhance IWARS to include effects of Netted Communications and Collaborative Situational Awareness; will release the fourth version of IWARS.		2162	2293	2339
Biomechanical Tools for Individual Soldier Extremity Protection and Performance Enhancement: In FY07, completed a biomechanical model that predicts Soldier performance when encumbered with body armor; defined performance thresholds for the biomechanical variables; and developed empirically based fatigue model for integration with the biomechanical model. In FY08, integrate fatigue prediction into biomechanical model; verify and validate integrated model; exercise the model to design a prototype set of extremity body armor; define cognitive performance metrics; conduct human experiments to evaluate decrements in performance related to physical demands of warfighting, and establish a model for predicting these decrements. In FY09, will define additional complex Soldier output measures for incorporation into biomechanical model, scale biomechanical tools to range of human anthropometry; conduct human experiments to refine fatigue prediction into short term and long term components; refine awareness model with additional human experimental data and conduct research on strategies for mitigating decrements in awareness documented by preceding experiments.		1962	2125	1687
Electrotexiles - Self Powered, Conductive, and Smart Materials: - In FY07, matured novel weave and interconnect technologies for photovoltaic fibers and explored power generation and electrical conductivity in unique fiber-based compositions; investigated several lightweight, wearable, low profile, connectors, and demonstrated interconnections for current Soldier electronic systems; investigated new power generating, and electrically conductive textile-based compositions. In FY08, mature technologies for first active photovoltaic fabric		1957	2118	2651

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PROJECT
H98

and for unmanned photovoltaic ground sensors and camo-patterned photovoltaic devices; mature flexible conductive networks and connector technologies for shelters and wearable electronics; investigate current polymer-based optical conductors for secure, non-emissive, high-speed data transmission for optical networks; and mature new optical materials with high flexibility. In FY09, will integrate a variety of electronic, optical and sensing devices into photovoltaic fabrics to demonstrate a new class of self-powered, smart electrotexile applications; develop wearable connectors and interconnection methods for optical fibers; explore various textile integration methods to provide additional strength and protection to electronic and optical fibers.

Soldier Borne Microclimate Cooling: In FY07, downselected material and design approaches, and began the integration of technological elements and components into a breadboard system. In FY08, complete the integration of the technological elements and components, and test the breadboard systems. Using the test results, downselect cooling technologies for Soldier applications and establish a baseline. In FY09, will transition downselected technologies to 6.3 for advanced technology development. Will size, design, and select components for the next generation microclimate cooling device.

Small Business Innovative Research/Small Business Technology Transfer Programs

Total

1537

1158

885

282

13878

15419

14262

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BUDGET ACTIVITY 2 - Applied Research		PE NUMBER AND TITLE 0602786A - Warfighter Technology					PROJECT H99	
COST (In Thousands)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	
H99 JOINT SERVICE COMBAT FEEDING TECHNOLOGY	4937	5193	5316	5380	5421	5541	5667	

A. Mission Description and Budget Item Justification: The Joint Services Combat Feeding Technology project researches, evaluates and applies combat ration and field food service equipment technologies with potential to revolutionize the manner in which we sustain and support the Armed Forces, ensuring optimal nutritional intake for individual Warfighter. In addition, this project investigates novel ration packaging and combat feeding equipment/systems. Efforts funded in this project support all Military Services, the Special Operations Command, and the Defense Logistics Agency. The Army serves as Executive Agent for this Department of Defense (DoD) program, with oversight and coordination provided by the DoD Combat Feeding Research and Engineering Board. This project supports the Army Transformation in the areas of sustainability and reduced logistics footprint, with goals to demonstrate technology to reduce field feeding logistics by over 75 percent (i.e., weight, cube, fuel, and water) and labor requirements by 50 percent, while improving the quality of food service in comparison with current systems. The goal of the Combat Feeding Equipment Technologies effort is to research and evaluate component technologies with potential to reduce the logistics footprint of field feeding while enhancing operational efficiency of field feeding. The Ration Stabilization and Novel Nutrient Delivery Technologies effort focuses on technologies which enhance nutrient composition and consumption to maximize cognitive and physical performance on the battlefield; minimizing physical, chemical and nutritional degradation of combat rations during storage; and tailoring rations to the combat situation and provide an "eat on the move" capability, thereby improving mobility. In addition, research is conducted with the goal of reducing replenishment demand by extending shelf-life, permitting more extensive pre-positioning of stocks, while maintaining initial food quality. The Packaging and Food Safety Technologies effort explores methods and evaluates novel packaging materials and concepts to reduce ration weight/volume and food packaging waste to reduce logistics burdens associated with combat feeding. Long term data collected in this effort will assist in generating protocols for ration developers and US Army Veterinary Command to more effectively conduct surveillance inspections of rations. The cited work is consistent with the Department of Defense Research and Engineering Strategic Plan, the Army Science and Technology Master Plan, the Army Modernization Strategy, and the Army Posture Statement. Work in this project is performed by the U.S. Army Natick Soldier Research, Development and Engineering Center, Natick, MA, and this project has collaborative efforts with the US Army Research Institute for Environmental Medicine.

<u>Accomplishments/Planned Program:</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
Combat Feeding Equipment Technologies: In FY07, down selected four competing Waste to Energy (WEC) systems to two (a gasifier and supercritical water depolymerization process), verified that both WEC systems produced an economically viable quantity of gas from waste, integrated components, and containerized the processors; completed experimental development, test, and evaluation of individual water chiller; completed experimental development of two Solar Powered Refrigerated Containers. In FY08, complete experimental development of an inline water heater as an initial application of flameless combustion; complete experimental development of an air-activated, self-contained, exothermic, chemical heater for the Meals Ready to Eat (MRE) including all safety/health/environmental regulatory compliance; and investigate novel co-generators for potential to operate on a range of fuels from the WEC producer gas to JP8. In FY09, will complete evaluations of inline water heater (initial application of flameless combustion); will complete experimental development of an ethylene control system for fresh fruits and vegetables. Technologies developed within this effort transition to PE 0603001A, Warfighter Advanced Technology, for maturation.	2110	2325	2392
Ration Stabilization and Novel Nutrient Delivery Technologies: In FY07 validated performance of novel delivery systems and optimized	1313	1505	1559

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nutrient delivery/absorption to enhance First Strike and other individual rations; incorporated encapsulated protein into these rations to assess stability and optimize bioavailability; and verified/evaluated retention of performance enhancers in rations over time by focusing on enhancers requiring protection to maintain efficacy; designed multiple tray food sterilizer using radio frequencies or microwaves in combination with high pressure. In FY08, continue incorporation and testing of probiotics (beneficial bacteria) for improved gastrointestinal health; incorporate selected performance enhancers for delivery via the mouth allowing for the immediate movement of the molecules into the blood; and transition protein encapsulation effort to PE 0603001A; validate Hybrid Optimal Processing (HOP) effectiveness to reduce processing time and increase food quality and nutrient retention, and scale-up design with selected model ration components; plan scale-up HOP design and engineering to produce high quality components; and develop additional shelf-stable combat ration breakfast items and transition to PE 0603001A. In FY09, will evaluate shelf stability of probiotic enhanced ration components; ensure microbiological, chemical stability analyses of advanced shelf-stable meat products; and investigate stability and functional effectiveness of encapsulated oils for ration systems.				
Packaging and Food Safety Technologies: In FY07, continued modification and evaluation of food sampling procedures used for biosensor systems to improve their accuracy and sensitivity to pathogenic organisms; conducted study to assess rates of ration quality degradation using reaction rates (quality kinetics) correlated with sensory analysis. In FY08, continue optimization of array technologies for pathogen detection; develop food degradation profiles for quality kinetics ration storage study to correlate accelerated storage conditions to predict combat ration shelf life. In FY09, will investigate multiplexing of electrospun nanofibers for improved capture of pathogens and initiate incorporation into array systems to enable multiple pathogen detection from one sample; will investigate molecular beacon signal enhancement as an alternative to identifying pathogens using array-based (matrix) systems; will calculate quality data reaction rates and determine kinetic correlations based on storage studies conducted in FY08; will continue long-term storage study to include extensive analytical, microbiological, and sensory testing; will complete food degradation profiles for quality kinetics.	1514	1319	1365	
Small Business Innovative Research/Small Business Technology Transfer Programs		44		
Total	4937	5193	5316	