ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2 Exhibit)

February 2004

BUDGET ACTIVITY
1 - Basic research

PE NUMBER AND TITLE
0601102A - DEFENSE RESEARCH SCIENCES

	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	138432	156146	131206	141023	143310	144733	157091
305	ATR RESEARCH	1150	1186	1243	1312	1338	1344	1371
31B	INFRARED OPTICS RSCH	2328	2248	2370	2512	2564	2576	2634
52C	MAPPING & REMOTE SENS	2277	2367	2456	2537	2581	2607	2661
53A	BATTLEFIELD ENV & SIG	3694	2564	2839	3011	3020	2959	3059
74A	HUMAN ENGINEERING	2583	2633	2799	2972	3031	3027	3093
74F	PERS PERF & TRAINING	2709	2663	2693	2783	2793	2851	2873
F20	ADV PROPULSION RSCH	2439	1882	2071	2218	2262	2252	2261
F22	RSCH IN VEH MOBILITY	476	497	506	527	538	544	556
H42	MATERIALS & MECHANICS	1913	1947	2076	2205	2249	2247	2295
H43	RESEARCH IN BALLISTICS	5334	6026	6149	6372	6455	6488	16118
H44	ADV SENSORS RESEARCH	0	3846	3950	4160	4244	4237	4338
H45	AIR MOBILITY	2013	2116	2144	2218	2262	2294	2345
H47	APPLIED PHYSICS RSCH	3063	2522	2689	2892	2925	2922	2994
H48	BATTLESPACE INFO & COMM RSC	6614	5261	5565	5858	5962	5991	6050
H52	EQUIP FOR THE SOLDIER	992	995	1073	1145	1163	1158	1179
H57	SCI PROB W/ MIL APPLIC	52128	55718	56045	63055	64047	65082	66270
H66	ADV STRUCTURES RSCH	1415	1426	1541	1651	1683	1670	1704
H67	ENVIRONMENTAL RESEARCH	3250	1403	1532	861	842	814	905
H68	PROC POLLUT ABMT TECH	361	383	379	391	397	409	418
HA4	PERPETUAL ASSAIL & SECURE INFO SYS, RSCH, TNG & ED	2429	0	0	0	0	0	0
S04	MIL POLLUTANT/HLTH HAZ	608	645	643	658	669	685	701
S13	SCI BS/MED RSH INF DIS	8856	9498	9930	10374	10569	10636	10862
S14	SCI BS/CBT CAS CARE RS	3931	4168	4272	4442	4527	4581	4680
S15	SCI BS/ARMY OP MED RSH	5405	5672	5930	6206	6320	6359	6495
S19	T-MED/SOLDIER STATUS	475	661	671	689	702	720	735
S20	SCIENCE BASE EMERGING INFECTIOUS DISEASES	3926	0	0	0	0	0	0

T14	BASIC RESEARCH INITIATIVES - AMC (CA)	0	26969	0	0	0	0	0
T22	SOIL & ROCK MECH	1849	1931	2021	2087	2126	2142	2187
T23	BASIC RES MIL CONST	1550	1634	1664	1712	1747	1775	1812
T24	SNOW/ICE & FROZEN SOIL	1165	1190	1311	1398	1423	1402	1426
T25	ENVIRONMENTAL RES-COE	4357	4608	4644	4777	4871	4961	5069
T30	ANIMAL MODELING GENETICS RESEARCH	952	0	0	0	0	0	0
T56	BIOFILM RESEARCH	952	0	0	0	0	0	0
T57	DESERT TERRAIN ANALYSIS	2667	0	0	0	0	0	0
T58	KNOWLEDGE MANAGEMENT FUSION CENTER	2857	0	0	0	0	0	0
T59	PREDICTION OF LAND-ATMOSPHERE INTERACTIONS	1714	1487	0	0	0	0	0

A. Mission Description and Budget Item Justification: This program element sustains U.S. Army scientific and technological superiority in land war fighting capability, provides new concepts and technologies for the Army's Future Force, and provides the means to exploit scientific breakthroughs and avoid technological surprises. It fosters innovation in Army niche areas (such as lightweight armor, energetic materials, night vision) and where the commercial incentive to invest is lacking due to limited markets (e.g., vaccines for tropical diseases). It also focuses university single investigators on research in areas of Army interest, such as high-density compact power and novel sensor phenomenologies. The in-house portion of the program capitalizes on the Army's scientific talent and specialized facilities to expeditiously transition knowledge and technology into the appropriate developmental activities. The extramural program leverages the research efforts of other government agencies, academia, and industry. This translates to a coherent, well-integrated program which is executed by the four primary contributors: 1) the Army Research, Development and Engineering Command (RDECOM); 2) the Army Corps of Engineers Research and Development Center (ERDC); 3) the Army Medical Research and Materiel Command laboratories; and 4) the Army Research Institute. The basic research program is coordinated with the other Services via the Joint Directors of Laboratories panels, the Defense Basic Research Technology Area Review and Assessment (TARA) process and other interservice working groups. This program responds to the scientific and technological requirements of the Department of Defense Basic Research Plan by enabling the technologies that can significantly improve joint war fighting capabilities. The projects in this Program Element involve basic research efforts directed toward providing fundamental knowledge for the solution of military problems related to long-term national security needs and is appropriately in Budget Activity 1. 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).

B. Program Change Summary	FY 2003	FY 2004	FY 2005
Previous President's Budget (FY 2004)	140493	128798	129586
Current Budget (FY 2005 PB)	138432	156146	131206
Total Adjustments	-2061	27348	1620
Congressional program reductions		-1352	
Congressional rescissions			
Congressional increases		28700	
Reprogrammings	-2061		
SBIR/STTR Transfer			
Adjustments to Budget Years			1620

Significant Change Explanation:
FY04 - Thirteen FY04 Congressional Adds totaling $28700 were added to this PE.

FY04 Congressional Adds with no R-2As:
($1443) Terrain Atmosphere Interactions, Project T59: The purpose of this one year congressional add is to examine new techniques for measuring ground conditions from remote sensors and assimilating these data with model predictions for terrain state. No additional funding is required to complete this project.

($2890) Advanced Carbon Nanotechnology Program, Project T14: The purpose of this one year Congressional add is to fund Vanderbilt University's basic research program in carbon nanotechnology. No additional funds are required to complete this project.

($1156) Research Center for Advanced Deployable Nano-Sensors, Project T14: The purpose of this one year Congressional add is to fund basic research in nano-sensing capabilities. No additional funds are required to complete this project.

($2984) Advanced Research and Technology, Project T14: The purpose of this one year Congressional add is to fund basic research at the University of Texas, Austin. No additional funds are required to complete this project.

($962) Alternative Energy Research, Project T14: The purpose of this one year Congressional add is to fund basic research into alternative energy sources. No additional funds are required to complete this project.

($2022) Biofilms – Terrorist Agents in Drinking Water, Project T14: The purpose of this one year Congressional add is to fund basic research in biofilms at Montana State University to identify terrorist agents in drinking water. No additional funds are required to complete this project.

($1155) Buffalo Center of Excellence in Bioinformatics, Project T14: The purpose of this one year Congressional add is to fund bioinformatics research at the University of Buffalo, Buffalo, NY. No additional funds are required to complete this project.

($2888) Desert Terrain Analysis, Project T14: The purpose of this one year Congressional add is to fund research on the impacts of Army combat vehicle training on desert ecosystems. No additional funding is required to complete this project.

($962) Knowledge Management Fusion, Project T14: The purpose of this one year Congressional add is to fund basic research on data fusion issues. No additional funding is required to complete this project.

($962) Nano-Materials Research, Project T14: The purpose of this one year Congressional add is to fund basic research in the properties of nano-materials. No additional funding is required to complete this project.

($962) Nano-Photonic Systems Fabrication, Project T14: The purpose of this one year Congressional add is to fund basic research at the University of Alabama in fabricating nano-photonic systems. No additional funding is required to complete this project.

($3370) Optical Technologies Research, Project T14: The purpose of this one year Congressional add is to continue research at Lehigh University supporting growth, processing, and device analysis of semiconductor materials for sensor, display and laser applications. No additional funding is required to complete this project.

($5873) Perpetually Assailable and Secure Information Systems Research, Training and Educations (PASIS), Project T14: The purpose of this one year Congressional add is to provide funding to the Center for Perpetually Available and Secure Information Systems at Carnegie Mellon University investigating the availability and security of information systems. No additional funding is required to complete this project.

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

February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**305**

COST (In Thousands)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
305	ATR RESEARCH	1150	1186	1243	1312	1338	1344	1371

A. Mission Description and Budget Item Justification: This project focuses on the fundamental underpinnings of aided and unaided target detection and identification techniques for land warfare scenarios. It is increasingly desirable to have Army systems that can act independently of the human operator to detect and track targets. Such capabilities are needed for smart munitions, unattended ground sensors and as replacements for existing systems such as land mines. Critical technology issues include low depression angle, relatively short range, and highly competing clutter backgrounds. Electro-optic/infrared imaging systems that use advanced algorithms for compressing data, detecting and identifying targets over extended battlefield conditions, are essential for the war fighter in Future Combat Systems (FCS). The research resulting from this project will provide fundamental capability to predict, explain, and characterize target and background signature content, and reduce the workload on the analyst. This research is aimed at evaluating the complexity and variability of target and clutter signatures and ultimately will utilize that knowledge to conceptualize and design advanced Automatic Target Recognition (ATR) paradigms to enhance robustness and effectiveness of land warfare systems. ATR research strategies include emerging sensor modalities such as spectral and multi-sensor imaging. Research supports several technology efforts including multi-domain smart sensors, third generation forward looking infrared radar (FLIR), and advanced multi-function laser radar (LADAR). This 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
- Investigate new algorithms to improve unaided target detection and identification. In FY03, quantified results of preliminary algorithm development and reported results to AMRDEC, CERDEC and others; researched the improvement resulting from the formulation; conducted fundamental studies into new detection and clutter rejection techniques and the use of composite classifiers over single classifiers for Automatic Target Recognition. In FY04, determine the minimum number of hyperspectral bands needed for effective target recognition algorithms, and make recommendations for Army applications; investigate and specify the improvement in composite classifiers through the use of enhancing algorithms; investigate relative merits of detection and clutter rejection techniques and document results. In FY05, investigate new methods for feature extraction, including independent component analysis for land warfare applications, to reduce the impact of clutter and lessen the false alarm rate and improve classifiers; make recommendations on use of specific algorithms for land warfare applications, to reduce the impact of clutter and lessen the false alarm rate.	1150	1175	1243
Small Business Innovative Research/Small Business Technology Transfer Programs	0	11	0
Totals	1150	1186	1243

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

February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**31B**

COST (In Thousands)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
31B	INFRARED OPTICS RSCH	2328	2248	2370	2512	2564	2576	2634

A. Mission Description and Budget Item Justification: This project supports the Army's theoretical and experimental research in materials and devices for active and passive infrared (IR) imaging systems. It generates new technologies to obtain unprecedented awareness of the battlefield and to continue to "own the night". To achieve these objectives for the Objective Force, IR Focal Plane Arrays (IRFPAs) and interband cascade lasers with significantly improved performance, lower cost, and increased operating temperatures are needed. Research is focused on material growth, detector and laser design and processing for large area multicolor IRFPAs and interband cascade lasers. The main efforts are directed towards novel materials for detectors and lasers, and quantum well and dot infrared photon detectors. Develop photonic –bandgap structures to enhance the performance of lasers and IRFPAs. For the compact frequency modulated/continuous wave (FM/CW) LADAR, research has to be performed for some critical component performance, especially for a high frequency detector/modulator array. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan and Defense technology Area Plan (DTAP). This program element contains no duplication with any effort within the Military Departments. Work is performed by the Army Research Laboratory (ARL).

Accomplishments/Planned Program	FY 2003	FY 2004	FY 2005
- Investigate technologies to enable unprecedented battlefield awareness and the ability to own the night. In FY03 various detector and laser structures were grown, fabricated and tested. Conducted experiments that showed continuous-wave operation for the cascade laser. Increased the operating temperature of IR detectors and lasers through reducing the defects in superlattice materials. In FY04, show new cascade laser packaging techniques for reduced cooling requirements. Fabricate and test near infrared photonic bandgap components. Extend modeling to midwave infrared wavelengths. In FY05, further reduce defects in the superlattice material and incorporate photonic bandgap structures into cascade laser to improve beam quality.	2328	2232	2370
Small Business Innovative Research/Small Business Technology Transfer Programs	0	16	0
Totals	2328	2248	2370

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February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**52C**

COST (In Thousands)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
52C	MAPPING & REMOTE SENS	2277	2367	2456	2537	2581	2607	2661

A. Mission Description and Budget Item Justification: Basic research in topographic sciences focuses on increasing knowledge of the terrain through improved generation, management, analysis/reasoning, and modeling of geospatial data, including the exploitation of multisensor data. This fundamental knowledge forms the scientific "springboard" for the future development of applications, techniques, and tools to improve the tactical commander's knowledge of the battlefield; to extract and attribute natural and man-made features from reconnaissance imagery in near-real time; to exploit terrain analysis and reasoning techniques; and to explore the potential of space technology to provide real-time terrain intelligence, command and control, and targeting support. This research investigates new methods of exploiting terrain and environmental data to improve situational awareness and enhance information dominance leading to increased survivability, lethality, and mobility capabilities for the Future Combat Systems and Army Vision/Joint Vision 2020 concepts. The research provides the theoretical underpinnings for program element 0602784A, project 855. 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 U.S. Army Engineer Research and Development Center that is headquartered at Vicksburg, Mississippi.

Accomplishments/Planned Program	FY 2003	FY 2004	FY 2005
Sensor Phenomenology - In FY03, developed a prototype classification using Bi-Directional Reflectance Distribution Function. Developed band and data reduction algorithm software for both hyperspectral image processing and digital evaluation models. In FY04, integrate band resolution and neural network algorithms for hyperspectral image classification. Model soil type, soil compaction and moisture effects on terrain signatures. In FY05, will conduct multi-image manipulation experiments as well as contrast and special feature manipulation experiments. Will compare lineation patterns between panchromatic and hyperspectral imagery. Active and Passive Fluorescence for Remote Sensing - In FY03, developed algorithms for exploiting fluorescence data. In FY04, enhance algorithms for identifying biological hazards. Design polymers/sensor configuration and synthesize polymers using various fluorophores. In FY05, will experiment with prototype algorithms for identifying biological hazards in water. Will test polymer(s) in soil and water for photon recovery and target selectivity. Dynamic Situational Awareness - In FY03, analyzed and compared various approaches to learn region-specific information. In FY04, develop a conceptual framework for Maneuver Course of Action (MCOA) solution space structural specifications. In FY05, will analyze search procedures versus MCOA. Geographic Information - In FY04, collect data to support the initial analysis of predicting understory characteristics using vegetation overstory properties. In FY05, will conduct comprehensive analyses, testing and validation of prediction model(s) for understory identification.	2277	2333	2456
Small Business Innovative Research/Small Business Technology Transfer Programs	0	34	0
Totals	2277	2367	2456

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February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**53A**

COST (In Thousands)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
53A	BATTLEFIELD ENV & SIG	3694	2564	2839	3011	3020	2959	3059

A. Mission Description and Budget Item Justification: This project provides an in-depth understanding of the complex atmospheric boundary layer associated with high-resolution meteorology, the transport, dispersion, optical properties and characterization of chemical and biological aerosols, and the propagation of full-spectrum electro-magnetic and acoustic energy. The Army of the future will be required to operate in very complex environments (e.g. urban) and disparate terrain requiring new approaches to understanding, characterizing, and depicting micro-scale atmospheric phenomena. The lack of a complete understanding of the meteorological aspects of the complex micro scale boundary layer in which the Army operates continues to have impacts on abilities to provide accurate and timely tactical weather intelligence to battlefield commanders. This project focuses on boundary layer meteorology over land and urban terrain. It supports the Army's transformation to the Future Force and the Future Combat Systems (FCS) through the development of future capabilities and techniques in such areas as the characterization and identification of biowarfare agents, enhanced acoustic and electro-optic propagation modeling techniques for improved target detection and acquisition, and the development of objective analysis tools that can assimilate on-scene weather observations and fuse this information with forecasts to provide immediate nowcast products. These capabilities will have a direct impact on ensuring soldier survivability, weapon system lethality, and the mobility required for future combat operations. This 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
- Research in optical and acoustical propagation in the atmosphere for enhanced Intelligence, Surveillance and Reconnaissance (ISR) capabilities for the Future Force and FCS for situational understanding and rapid targeting. In FY03, conducted lab and field polarimetric signature measurements in the infrared (IR) domain and analysis leading to enhanced detection and discrimination of targets to improve identification. Analyzed acoustic characteristics for intermittent turbulence conditions of a stable nocturnal boundary layer and created a neural network for making rapid acoustic propagation predictions for improving the next generation Acoustic Battlefield Decision Aid (ABFA). In FY04, characterize the polarimetric state of reflected thermal radiation on natural and environmentally degraded surfaces to improve target recognition/identification imaging. Investigate techniques to improve performance of battlefield acoustics sensor systems in degraded atmospheric conditions by incorporating self-awareness of their environment. In FY05, improve technologies that better quantify optical turbulence and characterize its different effects on performance of imaging sensors in battlefield environments. Perform research in high-fidelity acoustic signature simulation systems for devising synthetic acoustic signatures.	2035	1750	1732
- Survivability of Future Force and improved situational awareness through research to improve the accuracy of high-resolution meteorology focused on urban and complex terrain in order to account for the natural atmospheric and battle induced variability. In FY03, performed field experiments in a specific urban environment that allowed for data analysis and model improvement for an urban area, thereby improving forecast model accuracy and standoff tracking of hazardous aerosols. In FY04, evaluate microscale forecast and transport/diffusion models using real data for urban and complex terrain. Design and perform preliminary investigation of an urban parameterized microscale meteorological model for Army decision aid applications in urban domains. In FY05, investigate new methods to determine the accuracy of small scale/limited domain models. Improve the Army tactical urban meteorology model to include simplified physics and parametric microscale models that can account for mean transport and dispersion around individual structures.	1659	814	1107
Totals	3694	2564	2839

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February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**74A**

COST (In Thousands)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
74A	HUMAN ENGINEERING	2583	2633	2799	2972	3031	3027	3093

A. Mission Description and Budget Item Justification: This project focuses on research on soldier-system performance in Transformation-relevant environments. Research is on key underlying soldier performance phenomena such as judgment under uncertainty; echo-location and distance-estimation under degraded conditions; extending and protecting auditory and cognitive performance; humans in automated, mixed-initiative (human control-machine control) environments; associated neurological dynamics; communications in hearing-degraded conditions; collaborative (team) and independent multi-task, multi-modal, multi-echelon soldier-system performance, all cast against the influx of emerging Transformation-driven technological solutions and opportunities. Technical barriers include lack of methods for describing, measuring, and managing the interplay of these relatively novel phenomena in the consequent task and situational complexity and ambiguity, which characterize the ramp-up to Transformation. Accordingly, technical solutions are being pursued in the areas of data generation and algorithm development, given that soldiers have never operated in these emerging environments, in order to update and improve our understanding of performance boundaries and requirements. These solutions include multi-disciplinary partnerships, metrics, simulation capabilities, and modeling tools with which to characterize soldier-system performance phenomena, and provide a sharable conceptual and operational framework for militarily purposeful research on cognitive and perceptual processes. This 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
- Research to improve soldier auditory performance: In FY03, determined human capabilities in auditory distance estimation. Determined the effect of reverberation on the Callsign Acquisition Test. Identified baseline effects of whole-head helmet on auditory detection. In FY 04, investigate auditory trade-offs for an acoustically transparent whole-head helmet for improved communications for the Objective Force Warrior. In FY05, mature remotely controlled binaural microphone system for the Future Combat System (FCS) for improved battlefield communications.	1115	1115	1204

Accomplishments/Planned Program (continued)	FY 2003	FY 2004	FY 2005
- Research to improve soldier cognitive performance. In FY03, investigated cognitive readiness assessment tools to measure war-fighting effectiveness. Investigated soldier performance effects of individual differences and situational characteristics in multi-tasking scenarios. Examined brain and behavioral correlates to feed and validate cognitive models of soldier performance. Created framework for models of perceptual, cognitive, and multi-tasking workload representing Future Force soldier performance. In FY04, provide tools, models, and results to Natick Soldier Center (NSC), Objective Force Warrior (OFW) Integrated Product Teams, and to FCS contractors; field-validate high pay-off predictive models and integrate models and results with large-scale representations of system and unit performance. In FY05, advance error prediction and decision making models to complex Future Force environments for technology design evaluation and design cognitive modeling interface for rapid propagation of cognitive models in Army models and simulations.	1468	1508	1595
Small Business Innovative Research/Small Business Technology Transfer Programs	0	10	0
Totals	2583	2633	2799

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February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**74F**

COST (In Thousands)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
74F PERS PERF & TRAINING	2709	2663	2693	2783	2793	2851	2873

A. Mission Description and Budget Item Justification: This project covers behavioral science research in areas with high payoff opportunities for improved personnel selection, training, leadership, and performance, including: assessments of practical intelligence as an aptitude that can be measured across job domains; identifying principles and potential methods for training and sustaining complex tasks arising from digital, semi-automated, and robotic systems requirements; identifying potential methods for faster learning and improved skill retention; identifying likely methods for developing leader adaptability and flexibility and for accelerating leader development; discovering and testing the basic cognitive principles that underlie effective leader-team performance; and improving the match between Soldier skills and their jobs to optimize performance. Research is focused on issues fundamental to transforming the human component of war fighting in synchronization with the transformations in systems, technologies, weapons, and operational requirements to meet the goals of the Future Force. 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). This project is managed by the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI).

Accomplishments/Planned Program	FY 2003	FY 2004	FY 2005
In FY03, developed multi-source measure of socially intelligent job performance; developed computerized diagnosis of leadership training needs and assessment of leadership training effectiveness; identified potential training requirements for leaders of electronic-based teams. In FY04, explore practical job knowledge assessment instruments; assess trainability of sense-making (situation awareness) skills; assess trainability of skills for rapid interpretation of large volumes of ambiguous electronic data; determine whether speed of response is an ability factor contributing to the quality of task performance; develop improved electronically delivered instruction; and integrate theories of motivation. In FY05, validate test battery for measuring mental flexibility; assess memory for spatial and temporal events in electronic environments.	2709	2595	2693
Small Business Innovative Research/Small Business Technology Transfer Programs	0	68	0
Totals	2709	2663	2693

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February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**F20**

COST (In Thousands)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
F20	ADV PROPULSION RSCH	2439	1882	2071	2218	2262	2252	2261

A. Mission Description and Budget Item Justification: The goal of this effort is increased performance of small air-breathing engines and power trains that will support Army Transformation in the areas of system mobility, reliability and survivability, and ultimately serve to reduce the logistics cost burden for the Future Force. Problems include the ability to achieve greater fuel efficiency and reduce weight in these propulsion systems. Technical barriers to advanced propulsion systems are the maximum temperature that today's materials can safely withstand, the lack of capability to accurately simulate the flow physics, and the mechanical behavior of these systems, including the engine and drive train. The Army is the lead service in these technology areas (under Project Reliance) and performs basic research in propulsion, as applicable to rotorcraft and tracked and wheeled vehicles. Technical solutions are being pursued through analysis; code generation, experiments and evaluations to improve engine and drive train components and investigate advanced materials. Component level investigations include compressors, combustors, turbines, energy conversion/sources, injectors, pistons, cylinder liners, piston rings, gears, seals, bearings, shafts, and controls. This 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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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**F20**

Accomplishments/Planned Program	FY 2003	FY 2004	FY 2005
- - FY03: Added environmental effects into propulsion material life prediction and performance models; devised, for the first time, analytical capability to predict onset of compressor stall in full axi-centrifugal compressor system; devised advanced lubrication independent thrust bearing concepts in support of oil-free engines for advanced platforms and transition results to Aviation and Missile Research Development and Engineering Center (AMRDEC). FY04: Investigate thrust foil air bearings in support of oil-free engines, e.g. enhanced thrust bearing load capacity; foil bearing hydrodynamic and structural modeling and verification; and high temperature start/stop coatings (tribology). Transition mature oil-free technologies to AMRDEC and industry for use in turbochargers for military diesel engine systems; conduct research into alternative energy conversion processes and energy sources, e.g., advanced constant volume combustion cycles (pulse detonation) and catalytic fuel cell reformation (to leverage NASA's commitment to on-board fuel cell use for flight weight systems). This research will enhance engine systems durability and performance and reduce the logistics burden. FY05: Investigate materials processing and life prediction methods for ceramics. Assess novel concepts for UAVs. Analyze low vibration high load capacity power transmission component, material concepts, and analytical tools.	2439	1882	2071
Totals	2439	1882	2071

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February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**H42**

COST (In Thousands)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
H42 MATERIALS & MECHANICS	1913	1947	2076	2205	2249	2247	2295

A. Mission Description and Budget Item Justification: This project funds the Army's basic research program in materials science which includes research into key phenomena enabling the creation and production of revolutionary materials that will provide higher performance, lighter weight, lower cost, improved reliability, and environmental compatibility for Army unique applications. Technical barrier is that with current materials, to gain added functionality for Army systems, one must use a layered approach whereby each layer provides added capability (i.e. ballistic, chem./bio, signature, etc) but ultimately the system is too heavy and too expensive. Technical solutions are being pursued through understanding the fundamental aspects of chemistry and microstructure that influence the performance and failure mechanisms of ceramics, advanced polymer composites, and advanced metals, with the goal of creating hierarchically organized materials systems that possess multifunctional attributes at greatly reduced weight and cost. These advanced materials will enable revolutionary lethality and survivability technologies for the Future Force. This research supports materials technology applied research in project 0602105A/AH84. This 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
In FY03, extended and validated physics-based models and experimental techniques enabling exploitation of composite material interphase design methodologies and transitioned to developers of high-performance, lightweight integral armors; refined structure/property relationships and processing techniques for tailoring performance of advanced polymer systems to be used in integrated materiel systems; devised first-principles ceramic design tool; incorporated analytic model of dynamic penetrator fracture into design codes; and improved analyses capability for inflatable fabric structures.	1913	0	0

Accomplishments/Planned Program (continued)	FY 2003	FY 2004	FY 2005
- In FY04, explore fundamental concepts that will enable design of advanced composite material-based structures with inherent electro-opto-chemical properties enabling revolutionary multifunctional performance of lightweight armors; conduct basic research to create hierarchically organized materials systems that possess multifunctional attributes that will enable revolutionary survivability in Future Force Warrior systems; validate ceramic design tool with theory critical experiments; and experimentally characterize dynamic fracture response of candidate anti-armor materials under ballistic loads. In FY05, advance electro-opto-chemical integration capabilities of next-generation composite structures for improved multifunctionality (e.g., sensory, communications, power); advance fundamental understanding of structure-property-processing relationships in hierarchical material systems to produce tailored functionality in Future Force Warrior systems; verify micro-structure (including fractography) of armor ceramics that have been subjected to impact and conduct mechanical (fracture, toughness, hardness) and non-destructive test characterization of armor targets containing silicon carbide and boron carbide armor ceramics; and incorporate second generation dynamic fracture model into computational continuum mechanics code to enable development of improved anti-armor concepts.	0	1943	2076
Small Business Innovative Research/Small Business Technology Transfer Programs	0	4	0
Totals	1913	1947	2076

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

February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**H43**

COST (In Thousands)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
H43	RESEARCH IN BALLISTICS	5334	6026	6149	6372	6455	6488	16118

A. Mission Description and Budget Item Justification: This project funds the Army's basic research program in ballistics. The goal is to improve the understanding of the chemistry and physics controlling the propulsion, launch, and flight of gun launched projectiles and missiles, and to understand the interaction of these weapons with armored targets. This research results in the science base which allows the formulation of more energetic propellants, more accurate and lethal projectiles and missiles, and advanced armors for increased survivability of Army combat systems for the Future Force. Effort supports OSD Advanced Energetics Initiative to mature the fundamental technologies required to transition the next generation of energetic materials into field use. This 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
- In support of the National Advanced Energetics Initiative, expand and validate physics based models and experimental techniques to devise chemical formulations that will enable design of novel insensitive high-energy propellants and explosives with tailored energy release for revolutionary Future Force lethality and survivability. In FY03, expanded first principles design tools that can be employed to tailor chemical formulations and validated model relating sensitivity of bulk energetic materials to molecular structure of notional energetic materials. In FY04, characterize/model the chemical and physical properties of novel energetic materials to establish the relationship between particle-size, energy density and release rate for insensitive high-energy propellants and explosives. Explore influence of these parameters on controlling mechanisms for initiation of combustion and detonation. In FY05, employ fundamental and advanced propulsion/detonation models and experimental techniques to understand tailored energy release of insensitive high-energy propellants and explosives, including multiple-mode applications for energetic materials.	3008	3625	3812

Accomplishments/Planned Program (continued)	FY 2003	FY 2004	FY 2005
- Improve the fundamental understanding of the mechanisms controlling the launch and flight of gun launched projectiles and missiles, and understand the interaction of these weapons with armored targets. In FY03, validated first generation ceramic micro mechanical model using theory critical experiments and integrated model into numerical code; refined adiabatic shear model based on micro mechanical experiments of alloy materials under consideration for use in advanced penetrators; and incorporated structural flight vehicle response, aerodynamics, propulsion, guidance, navigation and control behavior into models to enable a comprehensive design and evaluation capability for smart munitions. In FY04, correlate ballistic performance of armor ceramics with fundamental material properties and material behavior using non-ballistic evaluation methods; investigate shear band velocity as influenced by material imperfections found in anti-armor devices and validate refined shear model in computational continuum mechanics code to support improved analysis of armor/anti-armor interactions; and devise algorithms to model fully-coupled roll controlled maneuver employing coupled Computational Fluid Dynamics(CFD)/ Structures and non-axisymmetric aerodynamics CFD to enable design of complex precision munitions for the Future Force. In FY05, prove ability to model penetration through advanced ceramic armor and accurately capture the observed material response for each phase of penetration; incorporate adiabatic shear model into computational continuum mechanics code and validate; and prove capability to model fully coupled roll controlled pitch up maneuver and validate full high performance computational capability of coupled models employing multiple processors.	2326	2298	2337
Small Business Innovative Research/Small Business Technology Transfer Programs	0	103	0
Totals	5334	6026	6149

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

February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**H44**

COST (In Thousands)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
H44	ADV SENSORS RESEARCH	0	3846	3950	4160	4244	4237	4338

A. Mission Description and Budget Item Justification: This project exploits the basic sciences to enable new sensing capabilities for the Army's Future Force. This work will produce future generations of sensors with capabilities beyond those currently being employed. Technical barriers include the fundamental speed and bandwidth limitations of current materials and devices, the efficiency of current algorithms, current computing architectures, organic material lifetimes, the understanding of the fundamental concepts of quantum cryptography and spatial resolution of current RF sensors. The technical approach focus is on exploitation of digital and image processing modules and algorithms, beam propagation and material modeling of nonlinear optical effects, environmental detection, remote sensing and intelligent system distributive interactive simulations and battlefield acoustic signal processing algorithms. Research involves fundamental science and engineering principles that support survivable sensor systems, displays, and environmental monitoring, both point and remote. Monolithic and hybrid optoelectronic structures in gallium arsenide and lithium niobate are investigated as integrated processors for novel signal and radar processing and control. Diffractive and micro-optic elements are investigated to enhance performance of imagers and optical processors to include the transmission of laser energy through the atmosphere for directed energy applications and high-data-rate optical communications; and the investigation and development of novel adaptive, active, and intelligent optical systems and techniques. Payoffs include low cost diverse displays, improved radar signal processing techniques that will allow existing systems to improve spatial resolution, improved ultra wideband radar technology, improved signal processing techniques for acoustic/seismic sensing systems, improved cryptography techniques, improved language translation, biological and chemical environmental sensing and improved sensor protection. This 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
- Research is focused on investigating and evaluating image-processing techniques for large arrays of opto-electronic feedback circuits and adaptive optics for optical communications and active imaging to improve battlefield awareness and communications. In FY03, conducted experiments using various ARL testbeds, tested outdoor laser communication, and laser imaging circuit with advanced analytical techniques; conducted characterizations of atmospheric propagation path for laser communications for improved situational awareness and C2 decision making; matured liquid crystal and MEMS adaptive systems to remove atmospheric distortions in imaging systems, and reduce signal fading in free-space laser communications; and investigated adaptive optical control systems and algorithms to enhance the delivery of tactical directed energy weapons. Optical communications provide covert, high bandwidth communications for the Future Force Warrior. In FY04, investigate wave division multiplexing in a free-space laser communication system; expand the atmospheric laser optics test bed to include a network of laser communication systems; research adaptive coding techniques for optical communications; and conduct research into the characterization and mitigation of atmospheric effects on tactical directed energy weapons systems with a view toward transitioning to the RDECs. In FY05, complete laboratory experiments for imaging for missile and weapons systems applications and transition to RDECs.	0	1508	1935

Accomplishments/Planned Program (continued)	FY 2003	FY 2004	FY 2005
- Research focused on future generations of sensors improving capabilities to create more survivable/secure sensor systems, displays, and improved environmental monitoring. In FY03, using electromagnetic modeling tools, identified unique aspect angle-dependent signature of tactically sized targets at UHF frequencies; utilized Surfaced Enhanced Raman Spectroscopy (SERS) to develop novel techniques to detect potentially harmful biological agents; investigated time frequency signal processing techniques for detection and classification of time-varying targets for applications in networked sensors, and benchmark quantum information processing experiments were identified. In FY04, establish capabilities to model multiple targets embedded in distributed clutter through L-band frequencies; continue to develop SERS techniques to increase number of detectable biological agents; improve efficiency and optimization of processing techniques for networks of sensors and perform quantum cryptographic analyses. In FY05, quantify improvement in the performance of passive millimeter wave cameras through the application of video enhancement algorithms; mature a chemometric algorithm capable of discriminating among several selected bacteria; explore efficient signal processing algorithms for data fusion and networks of sensors of various modalities; and make recommendations for applications of quantum information processing; use codes to optimize optical designs for nonlinear material placement in the optical train.	0	2284	2015
Small Business Innovative Research/Small Business Technology Transfer Programs	0	54	0
Totals	0	3846	3950

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

February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**H45**

COST (In Thousands)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
H45 AIR MOBILITY	2013	2116	2144	2218	2262	2294	2345

A. Mission Description and Budget Item Justification: This project provides funding for aviation basic research in aerodynamics for manned and unmanned rotary wing aircraft. The goal of this effort is to develop improved tools and methods to analyze, evaluate and test rotorcraft unique aerodynamic properties in conventional helicopter and tilt rotor aircraft. The efforts in this project will result in a better understanding of rotorcraft aeromechanics and will result in improved performance, safety, and ultimately, improved combat effectiveness of the manned and unmanned rotorcraft in the Future Force. This project supports the Future Force and Joint Vision 2020 by providing research into technologies that can improve tactical mobility, reduce the logistics footprint, and increase survivability for rotarywing aircraft. This 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 PE is performed by the U.S. Army Aviation and Missile Research, Development, and Engineering Center, Redstone Arsenal, Alabama.

Accomplishments/Planned Program	FY 2003	FY 2004	FY 2005
- In FY03, designed and fabricated a high lift 2D airfoil for low Reynolds number flow, CFD code development for ducted-fan and co-axial rotor, conducted 2D airfoil test with Gunny flap to increase lift and reduce drag. In FY04, conduct wind tunnel test to reduce drag force of mast mount sensor (MMS) shape and fuselage drag, conduct performance test for co-axial and ducted-fan UAV, conduct interactional aero tests of diverse UAV fuselage shapes. In FY05, conduct rotor test to study the off-axis stability to increase helicopter handling quality. Conduct test to measure the Reynolds stress of the synthetic jet for blunt body drag reduction.	2013	2072	2144
Small Business Innovative Research/Small Business Technology Transfer Programs	0	44	0
Totals	2013	2116	2144

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

February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**H47**

COST (In Thousands)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
H47	APPLIED PHYSICS RSCH	3063	2522	2689	2892	2925	2922	2994

A. Mission Description and Budget Item Justification: The objective of this project is to investigate electronic semiconductor materials and structures and energetic batteries and fuel cells to enable higher performance and more efficient electronic systems. This includes emissive nonlinear and nanophase electrode and electronic materials; thin heterostructure systems where quantum confinement effects are important; and advanced batteries and more efficient fuel cells for hybrid power. A further objective is to mature and understand techniques for the manipulation of cold atoms in an atom chip environment for application to very sensitive sensors and ultra stable clocks. Applications include gyroscopes and accelerometers for inertial navigation units, gravitational sensors for detecting underground facilities, very low phase noise precision oscillators for low velocity Doppler radar, and atomic clocks for space applications. Investigate electronic materials and structures to improve wide band gap semiconductor performance in electric vehicles and advanced radar systems. Technical barriers affecting performance, weight, cost, and power consumption will be addressed. These investigations will support the development of power sources and specialty electronic materials for the Army's Future Force. 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). The program element contains no duplication with any effort within the Military Departments. Work is performed by the Army Research Laboratory (ARL).

Accomplishments/Planned Program	FY 2003	FY 2004	FY 2005
- This research is focused on; materials for advanced batteries, fuel cells and reformers for soldier and vehicle power; electronic materials structures and defects of high-temperature wide-band-gap semiconductors for high-power electronic applications; and cold atom chip devices for sensitive gravitational, electric, and magnetic field sensors and ultra stable clocks. In FY03, synthesized new nanophase catalyst with good thermal stability for hydrocarbon fuel reformers leading to improved energy production; fabricated low-defect gallium nitride (GaN) films for high power, high temperature electronic applications. In FY04, evaluate solid electrolytes for rechargeable high-energy batteries; examine silicon carbide (SiC) structures and ohmic contacts for transition to efficient device designs; and develop a general-purpose laser cooling test system for the study of various cold atom chips with potential for application to ultrasensitive sensors and miniature atomic clocks. In FY05, provide fire-retardant electrolyte for batteries & catalysts for fuel cells; examine GaN structures and ohmic contacts for transition to efficient device designs; and fabricate and test basic cold atom chip devices such as gyroscopes and accelerometers for inertial navigation as well as gravimeters for basic underground facility detection applications.	3063	2522	2689
Totals	3063	2522	2689

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

February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**H48**

COST (In Thousands)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
H48	BATTLESPACE INFO & COMM RSC	6614	5261	5565	5858	5962	5991	6050

A. Mission Description and Budget Item Justification: This project addresses fundamental research in technologies that will enable intelligent and survivable command, control, communication, computing and intelligence (C4I) systems for the Future Force. As the combat force structure becomes smaller and operates in more dispersed formations, information systems must be more robust, intelligent, interoperable, and survivable if the Army is to retain both information and maneuver dominance. The goal of this research is to address the areas of information assurance and the related signal processing for wireless battlefield communications along with intelligent systems for C4I. Major barriers to achieving the goals are overcoming the inherent vulnerabilities associated with using standardized protocols and commercial technologies while addressing survivability in a unique hostile military environment that includes highly mobile nodes and infrastructure, bandwidth-constrained communications at lower echelons, diverse networks with dynamic topologies, high level multipath interference and fading, jamming and multi-access interference, and information warfare threats. The intelligent systems for C4I research will focus on providing the agent technology capabilities that will reduce the cognitive load on the commander, improve the timeliness, quality and effectiveness of actions and in the long run speed the decision-making process and reduce the size of tactical operation center (TOC) staffs. 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
- Perform research to provide communications capability for a fully mobile, fully-communicating, situation-aware force operating in a highly dynamic, wireless, mobile networking environment populated by hundreds of networked nodes. In FY03, investigated, identified, and transitioned to CERDEC a suite of signal processing techniques to provide bandwidth on demand in interference and jamming scenarios, including challenging urban and foliage scenarios. In FY04, devise signal processing techniques to work under severe interference and poor channel conditions to maintain wide network coverage for disparate soldier, sensor, and airborne networks. In FY05, enhance signal processing for smart radios, coupled with network protocols, to provide intelligent multiple radio coexistence and radio frequency spectrum reuse to enable rapid deployment and networked information dominance in future threat scenarios.	2521	2413	2560
- Design and implement a laboratory scale common information-processing infrastructure that aids in the transformation of data to knowledge to support decision-making under uncertainty. In FY03, explored and devised scalability of information processing techniques and natural human interfaces with software agents to reduce soldier cognitive load in maintaining situational awareness on the battlefield, where hundreds to thousands of computer objects and human operators interact constantly. Enhanced automatic language translation capabilities in support of translingual capability to provide the capability for field translation of documents for intelligence gathering. In FY04, incorporate mathematical and statistical techniques to accommodate uncertainty factors both in data and information during the aggregation process to create ready knowledge for the soldier to enhance decision making. Extend language translation capabilities to include posting translations to databases. In FY05, devise analytical techniques to interface soldiers and robotic elements in a seamless manner in the battlefield information system. Extend language translation capabilities from printed text to voice capability.	2289	1363	1391

Accomplishments/Planned Program (continued)	FY 2003	FY 2004	FY 2005
- Perform research in protecting information in highly mobile wireless tactical environments with severe bandwidth, energy, and processing constraints and operating without reliance on centralized security services. In FY03, identified intelligent agent and mobile code techniques to address emerging and evolving information attacks by potential adversaries on sensor networks on the future battlefield to protect data input to situational awareness systems. In FY04, incorporate analytical and protocol techniques into mobile communication devices and systems to enhance robustness to unattended network intrusion and sensor spoofing for deployable sensor networks when operating under severe energy constraints. In FY05, evaluate and implement selected best of breed security services embedded authentication services for unattended static and mobile sensor networks deployable on the battlefield.	1804	1468	1614
Small Business Innovative Research/Small Business Technology Transfer Programs	0	17	0
Totals	6614	5261	5565

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

February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**H52**

COST (In Thousands)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
H52	EQUIP FOR THE SOLDIER	992	995	1073	1145	1163	1158	1179

A. Mission Description and Budget Item Justification: This project supports basic research required to achieve technologies for the of the future and the Army Transformation. The research is focused on six core technology areas critical to systems: mathematical modeling, physical performance measurement, polymer science/textile technology, nanotechnology, biotechnology and food safety. Research is targeted on enhancing the mission performance, survivability, and sustainability of the by advancing the state of the art in defense against battlefield threats and hazards such as ballistics, chemical agents, lasers, environmental extremes, and rations shortfalls. This program supports the Future Force transition path of the Transformation Campaign Plan (TCP). The cited work is consistent with the Transformation 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 US Army Natick Center, Natick, MA.

Accomplishments/Planned Program	FY 2003	FY 2004	FY 2005
In FY03, quantified fiber interaction behavior in hybrid yarns, providing a basis for prototype advanced yarn designs for body armor. Formulated and implemented a novel biomechanics model to assess gait and muscle control in carrying loads. Evaluated the effect of nanoparticle geometry on nanocomposite mechanical properties for ballistic protection applications. Conducted research on cognitive performance enhancement under severe stress. Conducted laboratory studies and modeling to examine the relationship among comfort, fit, and perceived fit on form-fitting military textiles. Verified and transitioned mathematical model for understanding tear propagation in airbeam shelter fabrics. In FY04, transition nanocomposite technology to warrior protective gear S&T efforts in PE 0602786. Examine cognitive performance as function of nutrient and fluid intake under stressful conditions. Evaluate water distribution in intermediate moisture foods using magnetic resonance spectroscopy to enhance food safety and stability. Model the relationship between perceived clothing fit and objective expert assessment of clothing fit. Identify peptide-based recognition elements for detecting food pathogens. In FY05, will determine effects of distribution and location of backpack loads and moments on the biomechanics of gait and performance. Will conduct basic research in combining nanomaterials with other materials for advanced applications. Will complete data analysis of nutrient effects on cognitive performance during severe cold stress.	992	995	1073
Totals	992	995	1073

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

February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**H57**

COST (In Thousands)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
H57	SCI PROB W/ MIL APPLIC	52128	55718	56045	63055	64047	65082	66270

A. Mission Description and Budget Item Justification: This extramural research project seeks to discover and exploit new scientific opportunities and technology breakthroughs, primarily at universities, to improve the Army's Transformational Capabilities. Current technologies are unable to meet the operational requirements of the Future Force. The Army Research Office of the Army Research Laboratory maintains a strong peer-reviewed scientific research program through which leap-ahead technological solutions may be discovered, matured and transitioned to overcome the technological barriers associated with next generation capabilities. Included are research efforts for increasing knowledge and understanding in fields related to long-term Transformation needs in the physical sciences (physics, chemistry, biology, and materials science), the engineering sciences (mechanical sciences, electronics, and mathematical, computer and information sciences), and environmental sciences (atmospheric and terrestrial sciences). Targeted research programs in nanotechnology, smart structures, multifunctional and microminiature sensors, intelligent systems, countermine, compact power, and other mission-driven areas will lead to an Future Force that is more strategically deployable, more agile, more lethal and more survivable. The breadth of this basic research program covers approximately 900 research grants and contracts with leading academic researchers and approximately 1,600 graduate students yearly, and supports research at over 200 institutions in 50 states. 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
- Basic research in environmental and biological sciences for revolutionary advances in sensors, electronics and information processing, and for soldier survivability. In FY03, produced quantum dot wires for next generation fast accurate information processing; devised a fast algorithm for feature extraction, and constructed a neural network for real-time recognition of 2D objects; designed de nova beta sheet proteins for the fabrication of novel biologically-derived materials with self-assembly and multifunctional capabilities for protective materials; and devised a new supercomputer approach for modeling proteins with extremely high resolution, enabling the rapid identification of therapeutic agents for countering CB weapons. In FY04, direct macromolecular evolution of biological electron transfer components for microsystems with application to power and energy management and logistics footprint minimization, biologically design and construct nanometer scale electronic and photonic structures for application to precision strike weapons. In FY05, understand mechanisms of pathogenicity to combat terrorism and to aid in chemical-biological detection (CBD) through intervention of organisms that cause disease; and use molecular genetics to identify the molecular signals that affect soldier performance and endurance.	7336	7590	8075
- Basic research in chemical sciences for advanced power generation and CBD. In FY03, devised nanostructured polymer gels for sensors able to detect threat agents, devised a polyphosphazene-based membrane for direct methanol fuel cells that are easier to fabricate; advanced the understanding of thermal run-away events in batteries for safer battery systems in munitions; explored a new class of materials (azulenes) for protection of eyes and sensors from lasers; synthesized molecular rotors for applications including laser protection, molecular memory and electronics; and explored the potential for single walled carbon nanotubes to be used as sorbents for chemical agents. In FY04, devise new approaches to build molecular machines for CBD, signature management and laser protection. In FY05, expand research in computational electrochemistry for electrochemical power sources; explore the physics of operating molecular machines for CBD, signature management and laser protection; and devise polymers, fibers and devise novel architectures for materials with superior protection from all environments.	8436	8790	8865

Accomplishments/Planned Program (continued)	FY 2003	FY 2004	FY 2005
- Basic research in physics for precision guidance, superior signature management properties and secure communications. In FY03, devised and applied for a patent for the first compact and tunable X-ray laser which has enormous scientific and practical applications in the material and health sciences for direct 3D visualization with the molecular scale spatial resolution to faithfully reveal full molecular architectures; devised photoconductive semiconductors which adaptively compensates for atmospheric turbulence effects in ground-to-ground laser communication links; and devised unique radiation scattering surfaces for IFF, target acquisition and countermeasures. In FY04, devise high frequency superparamagnetic dot arrays to increase the area density of information storage. In FY05, devise tools in the Terahertz frequency regime for interrogation of CB agents.	9245	9884	10480
- Basic research in communications and electronics for unmatched networked C4ISR capabilities. In FY03, first ever 3D evasion-pursuit model involving Unmanned Aerial Vehicles (UAV) and Unmanned Ground Vehicles (UGV); designed a more energy efficient digital circuit for longer battery life; devised high quality deformable micro mirror array for adaptive optics; devised a protocol to work with mobile ad hoc network protocols in conjunction with compression and beam steering with the ultimate goal of live video transmissions; devised an advanced physics-based modeling algorithm for molecular electronics; and devised retrodirective arrays for low power/low noise wireless electronics and for “smart antennas”. In FY04, use rare earth doped materials for photonic applications and apply quantum dot intersub-band photo detectors for night vision devices and to create a new class of quantum-dot lasers for Army laser designators. In FY05, research advanced countermine techniques to enable faster and more accurate detection of mines; integrate seismo-acoustic and chemical sensors with electro-optics and x-ray imaging for advanced landmine detection.	8640	9685	9765

Accomplishments/Planned Program (continued)	FY 2003	FY 2004	FY 2005
- Basic research in mechanical and material sciences for survivable armor, improved mobility, C4ISR components, and flexible display initiative for soldier systems. In FY03, fabricated micro-layered polymeric materials for hardened optical components; devised a procedure for making a nanocrystalline aluminum alloy that retains stable structure at elevated temperatures and that can be shaped while retaining desirable properties such as high strength and toughness; showed glassy carbon phonic band gap materials from polyarylenes for use as optical filters and as very sensitive chemical sensors; and devised a new method for microstructure-sensitive materials design which can predict the fatigue life of various combinations of material microstructures. In FY04, understand active flow control for projectiles and air vehicles to improve precision strike; understand high impact dynamics of composite materials; and synthesize new hybrid biomimetic materials for high-performance structural, mechanical, optical and electronic materials thereby improving a wide range of Army components. In FY05, devise wafer-scale fabrication techniques to manufacture microturbines at reduced costs; fabricate micro-rocket engines from previous advances in microturbine research; and conduct research in transparent conductive and emissive materials.	8357	9146	9195
- Basic research in mathematical and computer sciences as the backbone for complex, multisystem analysis, modeling and simulation, and information systems. In FY03, devised a mathematical theory of zonal function networks for the analysis of multi-source direction finding with degraded antennas and intelligent sensor fusion; devised multivariate analysis techniques which allows for the extraction and reconstruction of objects with no specific boundaries of objects for greatly improved target recognition; and produced a mathematical model based on complex dynamical systems and dynamic game theory for safe maneuver of multiple aircraft. In FY04, translate statistical shape analysis to computer programs for improved target classification; self-organizing, self-healing-mobile ad-hoc networking algorithms in order to facilitate rapid force deployment and reduce the logistics footprint; conflict resolution architectures for multi-agent hybrid systems for robotics and unmanned aerial vehicles (UAVs). In FY05, devise low-order mathematical models of hysteresis nonlinearity to improve the performance and real-time control of smart materials to create micro electro-mechanical (MEM) actuators for rotor-blade surface flow control; and integrate research in mathematics, electrical engineering and signal processing to create digital communications based on principles of nonlinear dynamics and chaos for uninterrupted digital communications.	8802	9290	9665
- Optical Technologies. This congressional add supports research on growth, processing, and device analysis of semiconductor materials for sensor, display and laser applications to upgrade Army capabilities in sensing and signal processing. No additional funding is required to complete this project.	1312	0	0

Accomplishments/Planned Program (continued)	FY 2003	FY 2004	FY 2005
Small Business Innovative Research/Small Business Technology Transfer Programs	0	1333	0
Totals	52128	55718	56045

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

February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**H66**

COST (In Thousands)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
H66	ADV STRUCTURES RSCH	1415	1426	1541	1651	1683	1670	1704

A. Mission Description and Budget Item Justification: The goal of this effort is to provide improved tools and methods to enable the design and use of composite structures that can better address the cost, weight, performance, and dynamic interaction requirements of future platforms for the Future Combat Systems (FCS) and Unmanned Combat Armed Rotorcraft (UCAR) supporting Army Transformation. Ultimately, these technologies result in safer, more affordable vehicles with a greatly reduced logistics footprint. This project is a joint Army/NASA effort that includes structures technology research into: structural integrity analyses; failure criteria; inspection methods which address fundamental technology deficiencies in both metallic and composite Army rotorcraft structures; use of composite materials in the design and control of structures through structural tailoring techniques; rotorcraft aeroelastic and aeromechanical stability; helicopter vibration (rotating and fixed systems); and the design and analyses of composite structures with crashworthiness as a goal. The problems in structures are inaccurate structural analysis and validation methods to predict durability and damage tolerance of composite and metallic rotorcraft structures and inadequate structural dynamics modeling methods for both the rotating and fixed system components to address reliability issues for future aircraft. The technical barriers include a lack of understanding of failure mechanisms, damage progression, residual strength, high-cycle fatigue, the transfer of aerodynamic loads on the rotor to the fixed system, and impact of these unknown loads on aircraft components. Technical solutions are focused in: advanced fatigue methodologies for metallic structures, improved composites technology throughout the vehicle, long-term maturation of an integrated stress-strength-inspection, advanced methods for rotor system vehicle vibratory loads prediction, improved methods to predict vehicle stability, and improved analyses to address Unmanned Rotorcraft specific requirements. These advancements will extend service life, reduce maintenance costs, enhance durability, and reduce the logistics footprint of existing and future Army vehicles. As agreed under Project Reliance, this is the only project for rotorcraft and ground structures basic research within the DoD. 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
In FY03, performed residual strength predictions for composite sandwich panel damage due to low velocity impact; established new industry test standards for hybrid composite delamination; evaluated methodologies to incorporate small crack effects in predicting the fatigue life for aging Army vehicles; conducted preliminary analysis of "on-blade" actuation for vibration and flight attitude control and evaluated advanced actuators; validated an innovative rotor system model to improve tilt rotor stability; studied biological system structures and materials as improved models for future rotorcraft wing designs; and validated new vehicle crash model and simulation data for all-composite fuselages. In FY04, assess unmanned aerial vehicle (UAV) utility of innovative wing designs inspired by naturally based morphologies; analyze potential of actively-controlled rotor stability augmentation model for tilt rotor UAV; evaluate soft soil and water impact effects on crash occupant survivability; and evaluate durability, damage tolerance, and failure mechanisms for embedded sensors/actuators in flexible structure. In FY05, investigate static/dynamic characteristics of naturally based morphologies for vehicle wing designs using finite-element modeling; and evaluate advanced concepts for UAV primary flight control and vibration reduction.	1415	1426	1541
Totals	1415	1426	1541

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

February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**H67**

COST (In Thousands)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
H67	ENVIRONMENTAL RESEARCH	3250	1403	1532	861	842	814	905

A. Mission Description and Budget Item Justification: The objective of this project is to focus basic research on innovative technologies for both industrial pollution prevention (P2) that directly supports the Army production base and weapon systems as well as non-stockpile chemical warfare (CW) site remediation. The pollution prevention work invests in next generation manufacturing, maintenance, and disposal methods that will result in significantly reducing the usage of hazardous and toxic substances and their associated costs. The goal is to decrease the overall life-cycle costs of Army systems by 15-30% through the application of advanced pollution prevention technologies. The CW remediation efforts concentrate on the application of biotechnology in the characterization and physical clean up of agent contaminated soils and groundwater and reduced corrosive and more environmentally benign decontamination of biological warfare (BW) agents on field equipment and weapon systems. The goal is to reduce the cost of remediating a site by at least 50% versus the use of conventional methods. CW thrusts include establishing the ecotoxicity of CW compounds, environmental fate and effect of CW compounds in soils and biodegradation of CW compounds. Pollution prevention thrusts include: environmentally acceptable, advanced, non-toxic processes to manufacture lightweight alternative structural materials to enhance weapon system survivability; clean synthesis of more powerful and improved energetic compounds to eliminate the use of hazardous materials and minimize the generation of wastes; and surface protection alternatives to hazardous paints, cadmium, chromium, and chromate conversion metal and composite surfaces. This project is linked to the Army Environmental Requirements Technology Assessment (AERTA) requirements. 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 is under the direction of the U.S. Army Armament, Research, Development and Engineering Center.

Accomplishments/Planned Program	FY 2003	FY 2004	FY 2005
In FY03, assessed advanced high-nitrogen gun propellant formulations to reduce erosion on gun barrel coatings. Completed spectroscopic investigations, designed initiator simulator and validated modeling on laser ignition system for medium caliber munitions. Determined whether direct propellant ignition is feasible. Conducted meals-ready-to-eat injection molding and biodegradation studies with new barrier coatings. Characterized variables affecting spin solution fiber properties. Continued longer-term measurement of element migration to chrome and tantalum steel interfaces at higher temperatures. Evaluated adhesion of ion beam assisted deposition coatings applied to depleted uranium (DU) coupons. Assessed supercritical fluids crystallization of CL-20 particles. Conducted instrument measurements on actual contaminant samples. Identified enzymatic alternatives in membrane research. Investigate use of carbon nanotubes in energetic thermoplastic elastomers to eliminate hazardous materials and VOCs in propellant manufacture. In FY04, will scale-up prototype nanocomposite materials processes for new MRE barrier coating. Model impact of new nitrogen-rich propellant gases on gun barrel coatings and ability to eliminate chrome. Broaden decontamination studies to include viral surrogates and additional bacterial enzymes. Down-select candidate molecular recognition elements and test components for electrical and ionic conductivity. Develop liquid and vapor phase natural products decontaminants. In FY05, will investigate alternative coating systems capable of depositing tantalum onto more complex geometries. Conduct nitration studies on intermediates derived from ethylene diamine. Isolate and assess variety of bacteriocins. Incorporate improved detector strains into gel compounds for VX and food and water monitoring. Test polyelectrolytes for energy storage for lightweight, flexible batteries.	3250	1379	1532
Small Business Innovative Research/Small Business Technology Transfer Programs	0	24	0
Totals	3250	1403	1532

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

February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**S13**

COST (In Thousands)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
S13	SCI BS/MED RSH INF DIS	8856	9498	9930	10374	10569	10636	10862

A. Mission Description and Budget Item Justification: This project supports focused research for healthy, medically protected soldiers for the Future Force. Research efforts focus on investigation of medical countermeasures for naturally occurring diseases that are militarily significant due to their historically severe impact on military operations. Establishment of medical countermeasures will protect the force from infection and sustain operations by preventing hospitalizations and evacuations from the theater of operations. Work in this project is managed by the U.S. Army Medical Research and Materiel Command. The Army is the lead service for infectious disease research. This project contains no duplication with any effort within the Military Departments. This project supports the Future Force transition path of the Transformation Campaign Plan. The cited work is consistent with Transformation Planning Guidance, the Army Science and Technology Master Plan, the Army Modernization Plan, and the Defense Technology Area Plan. Work in this project is performed by the Walter Reed Army Institute of Research (WRAIR), Silver Spring, MD and its overseas laboratories; U.S. Army Medical Research Institute of Infectious Diseases, Fort Detrick, MD; and the Naval Medical Research Center (NMRC), Silver Spring, MD and its overseas laboratories.

Accomplishments/Planned Program	FY 2003	FY 2004	FY 2005
In FY 03, adapted DNA microarray technology to rapidly screen potential antimalaria drugs and vaccine targets. Screened nearly 800 compounds for antimalarial activity and will mature one drug into the optimization process; identified new malaria drug targets and mechanisms of the parasite's drug resistance; and assessed the presence of malaria drug resistance in different regions of the world. Completed, with partners, the genomic sequencing of Plasmodium vivax, the second major human malaria parasite; and used gene chip technology to identify previously unexamined correlates of protection in vaccinated and challenged humans. In FY 04, identify, using genomic technology, promising new targets to develop for inclusion into new vaccines against P. falciparum and P. vivax and develop a better understanding of host/parasite interactions. Develop new models for high throughput screening and new drug discovery. In FY 05, enhance and integrate techniques to exploit genomic information for vaccine and drug discovery efforts; continue to maintain a pipeline of new drug candidates for optimization and animal testing.	4827	5377	4584
In FY 03, investigated new vaccine additives for enhanced protection by antidiarrheal vaccines, and defined additional components for a more protective Campylobacter vaccine. In FY 04, conduct studies to assess the incidence and types of diarrhea-causing agents in areas of deployment to determine suitability as vaccine test sites. In FY 05, refine field site assessment for suitability for vaccine testing and select best sites. Incorporate new genomic information into vaccine discovery efforts and assess discoveries for incorporation into diarrheal disease vaccine program.	1035	863	1027
In FY 03, conducted studies on dengue disease progression; conducted studies to design a combined vaccine against several lethal viruses; identified a candidate Lassa fever DNA vaccine. In FY 04, identify alternative approaches to create an effective and safe dengue fever vaccine. Identify genes from other lethal viral diseases such as Rift Valley for incorporation into DNA vaccines. In FY 05, develop field sites for testing dengue and hemorrhagic fever vaccines.	647	795	924
In FY 03, evaluated insect-borne disease risk exposure in Central Command region of responsibility. In FY 04, develop tests to detect, in insects, insect-borne diseases in areas of deployment. In FY 05, evaluate effectiveness of integrated dengue vector preventive medicine control system in Central and South America and Thailand.	1237	1590	2287

Accomplishments/Planned Program (continued)	FY 2003	FY 2004	FY 2005
In FY 03, conducted necessary basic research to define, acquire, and evaluate approaches to provide infectious disease diagnostics to the battlefield; identified microbial DNA sequences of selected agents that are adaptable to the first-generation military common diagnostics system. In FY 04, identify infectious disease diagnostic components compatible for use in a joint services biological agent identification and diagnostic system. In FY 05, develop approaches to supplement infectious disease diagnostics not compatible with joint system.	1110	779	1108
Small Business Innovative Research/Small Business Technology Transfer Programs	0	94	0
Totals	8856	9498	9930

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

February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**S14**

COST (In Thousands)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
S14	SCI BS/CBT CAS CARE RS	3931	4168	4272	4442	4527	4581	4680

A. Mission Description and Budget Item Justification: This project supports research for healthy, medically protected soldiers for the Future Force, focusing on a basic understanding of the mechanisms of combat-related trauma. This research identifies trauma-related topic areas for basic techniques and the experimental models necessary to support in-depth trauma research studies. Research conducted under this project forms the basis for the advancement of trauma treatment and surgical procedures to delay cell death and reduce bleeding following traumatic injury, minimize lost duty time from minor battle and nonbattle injuries, and provide military medical capabilities for far-forward medical/surgical care of battle and nonbattle injuries. This project contains no duplication with any effort within the Military Departments. This project supports the Future Force transition path of the Transformation Campaign Plan (TCP). The cited work is consistent with Transformation 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 Walter Reed Army Institute of Research, Silver Spring, MD, and the U.S. Army Institute of Surgical Research, Fort Sam Houston, TX.

Accomplishments/Planned Program	FY 2003	FY 2004	FY 2005
In FY03, conducted basic research to enhance resuscitation capabilities of combat medics; defined mechanisms of organ injury associated with blood clotting and bleeding; identified and characterized candidate additives to enhance resuscitation fluids and other means to improve patient response to resuscitation fluids; demonstrated naturally occurring host factors (auto-antibodies) that induce tissue injury in the presence of severe blood loss and that can be inhibited or blocked, potentially useful to protect soldiers in shock. In FY04, study potential chemical compounds that may block effects of severe blood loss on vital organs and tissues; define measurable combat casualty parameters that can be used as indicators of need for immediate medic intervention vs. delayed intervention. Begin basic research in collaboration with the National Institutes of Health (NIH) and conduct conceptual development, technology discovery, and early studies to significantly mitigate or eliminate the impacts of battlefield injury, including severe hemorrhage and other body fluid losses, penetrating head injury, and mutilating soft-tissue and skeletal injury. In FY05, conduct early preclinical screening studies to select candidate compounds that may block effects of severe blood loss; define the impact of stabilizing body potassium concentrations on casualty survival. Continue basic research collaboration efforts with NIH.	2685	2805	2906
In FY03, explored conceptual means and devices for medics to exploit Land Warrior/Objective Force Warrior capabilities to remotely diagnose, triage, and treat casualties; explored new candidate drugs to preserve brain tissue after penetrating head injury; established consortium with National Heart, Lung, and Blood Institute (NHLBI) to pool resources to study the occurrence of brain injury and its treatment in the presence of severe blood loss (shock), 12 proposals are pending award. In FY04, define measurable indicators of brain injury severity for use in directing treatment. In FY05, further define indicators of brain injury severity; evaluate brain cooling as a means to preserve brain tissue and function after penetrating head injury.	1246	1292	1366
Small Business Innovative Research/Small Business Technology Transfer Programs	0	71	0
Totals	3931	4168	4272

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

February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**S15**

COST (In Thousands)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
S15	SCI BS/ARMY OP MED RSH	5405	5672	5930	6206	6320	6359	6495

A. Mission Description and Budget Item Justification: This project supports research for healthy, medically protected soldiers for the Future Force, focused on developing medical countermeasures to sustain performance when the opportunity for adequate rest is impaired or impossible due to combat conditions. The focus is on physiological and psychological factors limiting soldier effectiveness, and on the characterization of health hazards generated by military systems and resulting from military operations. Research is conducted on militarily relevant aspects of environmental physiology and the neurobehavioral aspects of stress. The hazards of exposure to several classes of nonionizing radiation, directed energy, blast, jolt, vibration, noise, and toxic industrial chemicals as environmental contaminants are also investigated under this project. Specific tasks include delineation of injury and sustainment and enhancement of the physiological and psychological capabilities of military personnel under combat operations in all environments. The six main thrust areas include nervous system regulation of stress and cognition, metabolic regulation, control of regional blood flow, oxidative stress interventions, tissue remodeling/plasticity, and biomechanical/biodynamic mechanisms of injury. This project contains no duplication with any effort within the Military Departments. This project supports the Future Force transition path of the Transformation Campaign Plan (TCP). The cited work is consistent with Transformation 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 Walter Reed Army Institute of Research, Silver Spring, MD; U.S. Army Research Institute of Environmental Medicine, Natick, MA; U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL.

Accomplishments/Planned Program	FY 2003	FY 2004	FY 2005
In FY03, developed a simple eye model to study real-time photoreceptor changes during laser exposure, evaluated models of water requirements, and developed biomedical strategies to reduce water requirements for soldiers in operational environments. In FY04, explore the benefits of nutritional supplements to enhance metabolic rate for weight management, cold survival, and cognitive functions. In FY05, apply DNA chip technologies to mechanisms and treatment responses to laser eye injury.	1886	1879	1982
In FY03, explored brain imaging to determine whether increased mental activity aggravates brain changes associated with sleep deprivation. In FY04, explore the relationship between sleep restriction (partial sleep loss) and need for recovery sleep in humans. In FY05, investigate the changes in gene expression (activation and deactivation) following sleep deprivation.	1783	1863	2030

Accomplishments/Planned Program (continued)	FY 2003	FY 2004	FY 2005
In FY03, explored heart rate variability as a predictor of cold injury and identified molecular markers related to altitude adaptation. Explored the effects of prolonged cold exposure on the immune system to determine soldiers' susceptibility to illness. In FY04, perform cold injury epidemiology study for U.S Army. In FY05, identify performance-enhancing nutritional supplements for incorporation into rations for various altitudes.	1736	1872	1918
Small Business Innovative Research/Small Business Technology Transfer Programs	0	58	0
Totals	5405	5672	5930

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

February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**T22**

COST (In Thousands)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
T22	SOIL & ROCK MECH	1849	1931	2021	2087	2126	2142	2187

A. Mission Description and Budget Item Justification: This basic research creates the fundamental knowledge for new construction materials that provide greater ballistic and penetration protection, improved control of the visual, infrared, and radar signatures, and more rapid soil stabilization. This research will improve the physics-based understanding of geologic and structural materials due to dynamic loading. These technologies provide the basis for applied research that supports the civil engineering technologies for deployment, sustainment, mobility, and survivability of the Future Force in program element 0602784A, project T40. 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 U.S. Army Engineer Research and Development Center that is headquartered at Vicksburg, Mississippi.

Accomplishments/Planned Program	FY 2003	FY 2004	FY 2005
Multi-Spectral Technologies for Fixed Facilities - In FY03, evaluated multispectral characteristics of experimental quantities of electro-chromic camouflage, cover, and deception material. Structural Materials - In FY03, conducted simulations of mechanical property tests on concrete specimens by modeling the mortar and aggregate independently. In FY04, conduct simulations of dynamic experiments using both homogeneous and heterogeneous modeling techniques. Produce technique for mapping dynamic deformation and cracking in quasi-brittle materials. Produce model for predicting material response due to dynamic loading events. Pavements Research - In FY03, completed asphalt dynamic model. Near Surface Soil Behavior - In FY03, produced physics-based generalized soil theory for large deformations in soil from maneuver operations. In FY04, provide first-generation reinforcement models describing the interaction between soil particles and nontraditional stabilizers. Conduct laboratory experiments on size effect in compacted soils. In FY05, will mature concept for low-velocity probe that could provide capability to remotely determine soil properties, determine mechanics of pressurized fabric structures for military logistics, and delineate a continuum mechanics theory critical to predictive models of vehicle-terrain interaction.	1849	1910	2021
Small Business Innovative Research/Small Business Technology Transfer Programs	0	21	0
Totals	1849	1931	2021

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

February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**T23**

COST (In Thousands)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
T23	BASIC RES MIL CONST	1550	1634	1664	1712	1747	1775	1812

A. Mission Description and Budget Item Justification: This project supports facilities research initiatives: (1) forming an explicit and mathematically robust set of algorithms for geometrical reasoning, (2) understanding failure mechanisms of complex structural systems subjected to large displacements, and (3) assessing the conceptual feasibility of real-time sensors and agent derived models to simulate terrorist threat scenarios. These efforts provide basic research leading to improved design capability for a range of facilities that optimize facility mission performance, reduce design and construction errors and omissions, reduce resource requirements, and reduce the environmental burdens over the facility's life. The project will lead to leap-ahead technologies to solve military-unique problems in the planning, programming, design, construction, and sustainment of deployed facilities and energy and utility infrastructure. This project supports exploratory development efforts in program element 0602784A, projects T41 and T45. 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 U.S. Army Engineer Research and Development Center that is headquartered at Vicksburg, Mississippi.

Accomplishments/Planned Program	FY 2003	FY 2004	FY 2005
Infrastructure Optimization and Performance – In FY03, investigated algorithms to optimize facility planning/design processes to improve transformation requirements match and increase throughput. Formulated moisture/temperature material property transport models for long-term performance modeling of structural composite materials. In FY04, investigate fundamental thermodynamics and material properties that describe microencapsulated phase change material performance as it affects heat transfer of thermal fluids. Investigate underlying factors affecting the attenuation of electromagnetic fields under intense transient field conditions and develop models for the non-linear response. In FY05, will determine fundamental aspects of multi-agent computational modeling as a next generation approach to facility threat protection. Will formulate optimization algorithms suitable for rapid and flexible design of the continuum of facilities needed by the future force. Will develop new model for agent transport and biocide kinetics.	1550	1602	1664
Small Business Innovative Research/Small Business Technology Transfer Programs	0	32	0
Totals	1550	1634	1664

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

February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**T24**

COST (In Thousands)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
T24	SNOW/ICE & FROZEN SOIL	1165	1190	1311	1398	1423	1402	1426

A. Mission Description and Budget Item Justification: This basic research focuses on two interrelated topic areas, Terrain State and Signature Physics. Projects include fundamental material characterization, investigation of physical and chemical processes, and examination of energy/mass transfer applicable to predicting state of the terrain, which control the effects of the environment on targets and target background signatures, and mobility in support of the materiel development community. It thus provides the knowledge base for understanding and assessing environmental impacts critical to battle space awareness. The Terrain State area of terrestrial sciences investigates weather-driven terrain material changes and sensing/inferring subsurface properties. The Signature Physics area of terrestrial sciences focuses on understanding the dynamic changes to electromagnetic, acoustic and seismic signatures in response to changing terrain state. 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 U.S. Army Engineer Research and Development Center that is headquartered at Vicksburg, Mississippi.

Accomplishments/Planned Program	FY 2003	FY 2004	FY 2005
Terrain State and Signature Physics – In FY03, investigated details of terrain-atmosphere interaction in close proximity to the surface at short space and time scales. Investigated new modeling approaches for soil, snow and other materials to formulate a physics-based theory in support of conceptual vehicle mobility design and performance evaluation. Explored a groundwave antennae approach as a low-detectability, wireless alternatives to traditional airwave and wire communications for short-range needs such as those for elements of an unattended sensor array. Determined the physical property dynamics of natural surfaces related to environmental transitions of electromagnetic signatures to improve predictions of sensor performance in complex terrain. Investigated sensor fusion strategies to measure aerosolized endospores in complex natural environments in support of remote detection and identification. In FY04, extend theory of near surface meteorological variables at the micro scale and complete theory for distribution of energy components associated with 3-dimensional discontinuous canopies providing new capability for detection of partially obscured targets. In FY05, will establish effects of buildings and barriers on acoustic-seismic propagation in urban settings and define the turbulence and topographic roughness interaction for acoustic signals. Will establish understanding of pavement mechanical properties and pavement degradation processes as a function of soil, pavement type, and moisture-temperature variations. Will investigate methods to remotely extract or infer soil, moisture, temperature at depth, and vegetation attributes.	1165	1190	1311
Totals	1165	1190	1311

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

February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**	**T25**

COST (In Thousands)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
T25	ENVIRONMENTAL RES-COE	4357	4608	4644	4777	4871	4961	5069

A. Mission Description and Budget Item Justification: Environmental quality basic research investigates fundamental scientific principles and phenomena necessary to ensure efficient development of the technologies needed to address Army issues in the restoration, compliance, conservation, and non-industrial pollution prevention areas. These efforts foster technology progress and innovation directed toward: investigating and monitoring contaminated sites, including chemical contamination and unexploded ordnance (UXO) detection/discrimination; better characterization of contaminants through improved risk-based assessment; destruction, containment or rendering harmless waste in water, soil and sediments from military activities; adhering to applicable federal, state and local environmental laws and regulations; monitoring and controlling noise generation and transport; protecting and enhancing natural and cultural resources; and reducing pollution associated with military activities. The project supports applied research under program element 0602720A, projects F25, 048, 835, and 896. 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 U.S. Army Engineer Research and Development Center that is headquartered at Vicksburg, Mississippi.

Accomplishments/Planned Program	FY 2003	FY 2004	FY 2005
Environmental and Ecological Fate of Explosives, Energetics, and Other Contaminants – In FY03, determined the effects of soil physical and chemical properties on the uptake, accumulation, and toxicity of explosives for soil invertebrates forming an improved baseline for risk-based assessments of explosive contaminated sites. Determined that explosive vapors diffuse up through frozen soil as a complex function of soil moisture and temperature such that improved site characterization can be made on a site-by-site basis. Benchmarked pharmaceutical models/approaches as the technical basis for predicting risk of chemical mixtures. Established a new soil toxicity assay for obtaining the major factors affecting the availability of explosives contaminants. In FY04, determine the effects of microbial and geochemical processes associated with manganese oxides on the environmental fate of metals and inorganics in groundwater and soil to model the transport of contaminants and to improve treatment processes. Establish the means to determine the toxicology of selected explosive compounds in mammals using gene expression data. In FY05, will establish the premise in using molecular spectral characteristics correlated with computation chemistry to determine the affinity of contaminants to produce fast forming less toxic chemical byproducts.	1481	1709	1997
Remediation of Explosives, Energetics, and UXO – In FY03, identified/characterized the types of micro-organisms in the ground in a variety of military sites aiding in the development and use of biological in-place treatment processes. Described the fundamental behavior of micro-organisms applicable to chemical contaminant destruction processes. Determined how TNT and its transformed products (nitroaromatics) bind to the organic and mineral fractions of the soil and identified mechanisms for how these contaminants can be extracted. Used electrokinetic processes to describe the chemical behavior and transport of explosive compounds and specialized treatment additives under various site conditions to enhance in-place cleanup. Determined electromagnetic induction sensors response to UXO composed of composite materials enabling improved UXO detection. In FY04, determine the chemical, physical, and biological transformation of crystalline explosive residues on firing ranges for improved cleanup alternatives and risk-based assessments. Describe the microbial physiology, biochemistry and genetics of explosives contaminants on military ranges for tailored in-place site cleanup. In FY05, will describe propellant attenuation on ranges via the management of natural soil cycles. Will pursue in situ explosive biodegradation mechanisms and direct analysis methods to identify explosives degradation mechanisms of contaminated soils.	1307	1575	1765

Accomplishments/Planned Program (continued)	FY 2003	FY 2004	FY 2005
Training Land Natural Resources – In FY03, evaluated the physiological response and habitat characteristics of endangered bird species to military training disturbances for improved design and maintenance of Army ranges. In FY04, determine genetic traits and differences in specific native grasses to enhance resilience for military land rehabilitation. Determine the effects of military training noise on the feeding, roosting, and flight behaviors of endangered bats for improved design/maintenance of Army ranges. In FY05, will describe physical, chemical, and biological phenomena impacting ecosystem maintenance, mitigation, and rehabilitation for Army lands. Will evaluate changes in endangered bats' hearing sensitivity due to shock wave pressure associated with Army test and training ranges.	1569	1215	882
Small Business Innovative Research/Small Business Technology Transfer Programs	0	109	0
Totals	4357	4608	4644