ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2 Exhibit)

February 2005

BUDGET ACTIVITY
1 - Basic research

PE NUMBER AND TITLE
0601102A - DEFENSE RESEARCH SCIENCES

	COST (In Thousands)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
	Total Program Element (PE) Cost	151503	163443	137898	142898	146370	147979	149267	150374
305	ATR RESEARCH	1174	1214	1262	1312	1337	1353	1365	1375
31B	INFRARED OPTICS RSCH	2230	2318	2415	2514	2563	2599	2622	2640
52C	MAPPING & REMOTE SENS	2333	2388	2469	2562	2624	2659	2682	2702
53A	BATTLEFIELD ENV & SIG	2562	2798	2895	2961	2943	3019	3044	3067
74A	HUMAN ENGINEERING	2621	2748	2858	2972	3010	3051	3078	3101
74F	PERS PERF & TRAINING	2595	2588	2710	2772	2870	2872	2895	2917
F20	ADV PROPULSION RSCH	1881	2041	2133	2218	2240	2232	2251	2267
F22	RSCH IN VEH MOBILITY	481	491	508	528	541	549	553	558
H42	MATERIALS & MECHANICS	1942	2040	2120	2206	2235	2264	2283	2301
H43	RESEARCH IN BALLISTICS	5923	5962	7101	7324	7461	7411	7475	7531
H44	ADV SENSORS RESEARCH	3791	3844	4000	4162	4214	4281	4318	4349
H45	AIR MOBILITY	2072	2073	2133	2218	2282	2314	2333	2352
H47	APPLIED PHYSICS RSCH	2520	2649	2781	2868	2905	2954	2980	3002
H48	BATTLESPACE INFO & COMM RSC	5241	5526	5735	5957	6074	6086	6141	6188
H52	EQUIP FOR THE SOLDIER	994	1058	1101	1141	1152	1164	1173	1182
H57	SCI PROB W/ MIL APPLIC	52881	53975	61380	63579	65534	66221	66792	67283
H66	ADV STRUCTURES RSCH	1425	1518	1588	1651	1661	1681	1696	1708
H67	ENVIRONMENTAL RESEARCH	1357	1484	828	825	810	893	901	908
H68	PROC POLLUT ABMT TECH	371	364	381	395	412	418	421	425
S04	MIL POLLUTANT/HLTH HAZ	624	616	640	664	689	701	706	711
S13	SCI BS/MED RSH INF DIS	9400	9691	10098	10492	10710	10854	10948	11028
S14	SCI BS/CBT CAS CARE RS	4098	4143	4324	4495	4613	4677	4718	4751
S15	SCI BS/ARMY OP MED RSH	5612	5786	6041	6273	6404	6490	6547	6593
S19	T-MED/SOLDIER STATUS	640	644	689	716	735	750	766	781
T14	BASIC RESEARCH INITIATIVES - AMC (CA)	26094	31059	0	0	0	0	0	0
T22	SOIL & ROCK MECH	1910	1971	2031	2110	2157	2186	2205	2220

T23	BASIC RES MIL CONST	1602	1608	1666	1735	1787	1810	1827	1839
T24	SNOW/ICE & FROZEN SOIL	1189	1292	1361	1413	1412	1425	1438	1448
T25	ENVIRONMENTAL RES-COE	4501	4473	4650	4835	4995	5065	5109	5147
T59	PREDICTION OF LAND-ATMOSPHERE INTERACTIONS	1439	1343	0	0	0	0	0	0
T60	BRAIN IMAGING RESEARCH	0	3738	0	0	0	0	0	0

A. Mission Description and Budget Item Justification: This program element fosters fundamental scientific knowledge and contributes to the sustainment of 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 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 U.S. Army Engineer Research and Development Center (ERDC); 3) the Army Medical Research and Materiel Command laboratories; and 4) the Army Research Institute for Behavioral and Social Sciences (ARI). 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 inter-service 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. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the DoD Basic Research Plan (BRP). Work in this PE is managed by: the U.S. Army Research Laboratory (ARL); the U.S. Army Aviation and Missile Research, Development and Engineering Center (AMRDEC); the U.S. Army Natick Soldier Center (NSC), the Medical Research and Materiel Command (MRMC), the U.S. Army Engineer Research and Development Center (ERDC), and the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI).

B. Program Change Summary	FY 2005	FY 2006	FY 2007
Previous President's Budget (FY 2005)	131206	141023	143310
Current Budget (FY 2006/2007 PB)	163443	137898	142898
Total Adjustments	32237	-3125	-412
Net of Program/Database Changes			
Congressional Program Reductions	-2371		
Congressional Rescissions			
Congressional Increases	37700		
Reprogrammings			
SBIR/STTR Transfer	-3092		
Adjustments to Budget Years		-3125	-412

Change Summary Explanation:

Fourteen FY05 Congressional Adds totaling $37700 were added to this PE.

FY05 Congressional Adds with no R-2As:
($1918) Advanced Carbon Nanotechnology Program, Project T14: The purpose of this one year Congressional add is to fund a basic research program in carbon nanotechnology. No additional funds are required to complete this project.

($959) 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.

($2685) Advanced Research and Technology Initiative, Project T14: The purpose of this one year Congressional add is to fund basic research at the University of North Texas. No additional funds are required to complete this project.

($1438) Army Knowledge Management Fusion Center, 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.

($959) Bioterrorists Agents in Military Drinking Water Systems, 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.

($3738) Brain Imaging Research, Project T60: The purpose of this one year Congressional add is to fund basic research in brain imaging. No additional funding is required to complete this project.

($1918) Center for Advanced Research and Technology (CART), Project T14: The purpose of this one year Congressional add is to fund basic research in nanometrology laboratory development to maximize the effectiveness of a high-resolution analytical transmission electron microscope. No additional funds are required to complete this project.

($2877) Desert Terrain Analysis for Enhancing Military Operations, 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.

($1726) Functionally Integrated Reactive Surfaces Technologies (FIRST) Program, Project T14: The purpose of this one year Congressional add is to fund basic research in functionally integrated reactive surfaces. No additional funding is required to complete this project.

($2014) Optical Technologies Research, Project T14: The purpose of this one year Congressional add is to continue research supporting growth, processing, and device analysis of semiconductor materials for sensor, display and laser applications. No additional funding is required to complete this project.

($9589) Perpetually Assailable and Secure Information Systems Research, Training and Education (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.

($1343) Prediction of Land-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.

($3357) Prometheus Spectrometer, Project T14: The purpose of this one year Congressional add is to fund basic research on the Prometheus Spectrometer. No additional funding is required to complete this project.

($1630) Technology Commercialization and Management Network, Project T14: The purpose of this one year Congressional add is to fund research on

an integrated technology transfer network and service management center.

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

COST (In Thousands)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
305 ATR RESEARCH	1174	1214	1262	1312	1337	1353	1365	1375

A. Mission Description and Budget Item Justification: Automatic Target Recognition (ATR) Research seeks to enhance the effectiveness of Army systems through application of ATR technology while simultaneously reducing the workload on the Soldier. 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, and detecting and identifying targets over extended battlefield conditions are needed for the Future Force. The resulting research 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 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. This research supports several technology efforts including multi-domain smart sensors, third generation forward looking infrared radar (FLIR), and advanced multi-function laser radar (LADAR). The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the DoD Basic Research Plan (BRP). Work in this project is performed by the Army Research Laboratory (ARL).

Accomplishments/Planned Program	FY 2004	FY 2005	FY 2006	FY 2007
- Investigate new algorithms to improve unaided target detection and identification. In FY04, devised new models for clutter to improve target detection performance, investigated new methods for feature extraction in target identification, expanded ATR training data by combining synthetic data with real FLIR data, investigated the use of hyperspectral imagery (HSI) for false-alarm reduction, paint identification, mine detection, netted and unnetted target detection, and acquired high resolution HSI for target classification. In FY05, devise detection and tracking algorithms based on FLIR video, incorporate other sensors to complement single sensor ATR algorithms, investigate new methods of feature extraction and classification algorithms, and study the use of polarization to detect water and man-made objects for robotic autonomous mobility. In FY06, will devise false alarm reduction and multiple hypotheses tracking algorithms for FLIR video, study the difference between synthetic and real imagery in the context of machine learning, and investigate new algorithm concepts and methods for target classification and false alarm reduction. In FY07, will investigate motion and change detection algorithms that exploit the benefits of color and FLIR video fusion, study new methods of fusing visible, near-IR, and IR imagery to improve target detection and classification capabilities, and investigate more efficient and effective HSI algorithms for target detection and classification.	1174	1214	1262	1312
Totals	1174	1214	1262	1312

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2005

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

COST (In Thousands)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
31B	INFRARED OPTICS RSCH	2230	2318	2415	2514	2563	2599	2622	2640

A. Mission Description and Budget Item Justification: This project supports Army research in materials and devices for active and passive infrared (IR) imaging systems. The impact of this research is to generate new technologies to obtain unprecedented awareness of the battlefield and to continue to "own the night." To achieve these objectives for the Future Force, IR Focal Plane Arrays (FPAs) and interband cascade lasers (ICLs) 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 IR FPAs and interband cascade lasers. The main efforts are directed towards novel materials for detectors and lasers and to investigate semiconductor energy band-gap engineered structures to enhance the performance of lasers and IR FPAs. IR modeling and nanofabrication techniques are applied to the design and fabrication of IR photonic-crystal waveguide structures having customized IR properties. Micro Electro Mechanical System (MEMS) configurations are incorporated into the waveguide structures to enable reconfigurable IR waveguide properties. Customized III-V IR materials and components are applied to the control of microwaves. The technical barriers in the research program include control of defects in the raw, unprocessed materials, maintaining quality control in the fabrication of the devices and arrays, limiting introduction of impurities in the material, surface passivation of the devices so that they are resistant to degradation with time and thermal management, particularly as it applies to interband cascade lasers. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan and DoD Basic Research Plan (BRP). Work 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**	**31B**

Accomplishments/Planned Program	FY 2004	FY 2005	FY 2006	FY 2007
- The objective of this project is to support the Army's research in materials and devices for active and passive infrared (IR) imaging systems. In FY04, achieved quality growth of antimony-based compound semiconductor materials by Molecular Beam Epitaxy (MBE) and paved the way for producing devices with state-of-the-art performance. Achieved theoretical understanding of these complex materials as a precursor for experimentally accomplishing goals in performance. Validated performance for medium wavelength IR detectors made of antimony-based semiconductors. With the aid of e-beam-lithography nanofabrication, designed, modeled and fabricated IR waveguides incorporating photonic crystal structures and MEMs reconfigurability. In FY05, evaluate IR FPAs made of superlattice material required for robust operation of the arrays. Improve the thermal performance of the IR cascade lasers for continuous wave operation at room temperature. Experimental results will guide the next iteration of design and fabrication of photonic-crystal waveguides. In FY06, will evaluate both long wavelength IR and medium wavelength IR FPAs. In FY07, will assess high power IR lasers for IR countermeasure and chemical/bio sensing applications. Will apply dynamic IR photonic-crystal waveguides to the control of RF signals.	2230	2318	2415	2514
Totals	2230	2318	2415	2514

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February 2005

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

COST (In Thousands)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
52C	MAPPING & REMOTE SENS	2333	2388	2469	2562	2624	2659	2682	2702

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 multi-sensor 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 and tactical geospatial sensor 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 improves situational awareness and enhance information dominance leading to increased survivability, lethality, and mobility capabilities for the Future Force. The research provides the theoretical underpinnings for PE 0602784A Project 855, Mapping and Remote Sensing. The cited work is consistent with the DoD Basic Research Plan (BRP), the Army Science and Technology Master Plan (ASTMP), and the Army Modernization Plan. The U.S. Army Engineer Research and Development Center, headquartered at Vicksburg, Mississippi, performs this work.

Accomplishments/Planned Program	FY 2004	FY 2005	FY 2006	FY 2007
Sensor Phenomenology - In FY04, integrated band resolution and neural network algorithms for hyperspectral image classification. Modeled soil type, soil compaction and moisture effects on terrain signatures. In FY05, conduct multi-image manipulation experiments as well as contrast and special feature manipulation experiments. Will compare lineation patterns between panchromatic and hyperspectral imagery. In FY06, will research capability of new micro and nano sensors to characterize battlespace environment features. In FY07, will research exploitation of multiple types of sensors to characterize critical battlespace environment features. Active and Passive Fluorescence for Remote Sensing - In FY04, enhanced capabilities for identifying biological hazards. Designed polymers/sensor configuration and synthesize polymers using various fluorophores. In FY05, experiment with prototype capabilities for identifying biological hazards in water and test polymer(s) in soil and water for photon recovery and target selectivity. Will experiment with fluorophores energy emission to trigger an electronic circuit powering a very small geolocation device that can detect chemical and biological hazards. In FY06, will experiment with flourophore based detection of chemical and biological hazards under various environmental conditions. In FY07, will experiment with mimicking biological sensory functions to characterize the battlespace environment. Dynamic Situational Awareness - In FY04, defined an initial conceptual framework for Maneuver Course of Action (MCOA) solution analysis. In FY05, investigate and analyze critical measurement values for selection of MCOA solutions. In FY06, will investigate techniques for designing MCOA decision tools. In FY07, will investigate battlespace environment impacts on human decision making to support decision tool development.	2333	2388	2469	2562
Totals	2333	2388	2469	2562

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February 2005

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

COST (In Thousands)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
53A	BATTLEFIELD ENV & SIG	2562	2798	2895	2961	2943	3019	3044	3067

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 Future Force will 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 formulation of future capabilities and techniques in such areas as the characterization and identification of bio-warfare agents, enhanced acoustic and electro-optic propagation modeling techniques for improved target detection and acquisition, and formulation 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. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the DoD Basic Research Plan (BRP). Work in this project is performed by the Army Research Laboratory (ARL).

Accomplishments/Planned Program	FY 2004	FY 2005	FY 2006	FY 2007
- Research in optical and acoustical propagation in the atmosphere for enhanced Intelligence, Surveillance and Reconnaissance (ISR) capabilities for the Future Force and Future Combat Systems(FCS) to support situational understanding and rapid targeting. In FY04, characterized the polarimetric state of reflected thermal radiation on natural and environmentally degraded surfaces to improve target recognition/identification imaging. Investigated techniques to improve performance of battlefield acoustic 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. In FY06, will investigate the capabilities for acoustic array tomography to be used for retrieving meteorological profiles. Will improve the optical technologies and processes used to enhance aerosol characterization. In FY07, will enhance urban acoustic propagation methodologies to improve modeling techniques and model performance.	1508	1727	1766	1830
- Increase survivability of the Future Force and improve 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 FY04, evaluated micro-scale forecast and transport/diffusion models using real data for urban and complex terrain. Designed and performed preliminary investigation of an urban parameterized micro-scale 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 micro-scale models that can account for mean transport and dispersion around individual structures. In FY06, will formulate a new method for use of an improved near real-time three-dimensional environmental model to provide critical input to urban transport and dispersion models. In FY07, will investigate new methods for parameterization of mean heat and moisture fluxes that can be incorporated into an urban micro-scale meteorological model for improved transport/dispersion and signature modeling.	1054	1071	1129	1131
Totals	2562	2798	2895	2961

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February 2005

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

COST (In Thousands)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
74A	HUMAN ENGINEERING	2621	2748	2858	2972	3010	3051	3078	3101

A. Mission Description and Budget Item Justification: This project focuses on improving soldier-system performance in Future Force 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; human performance 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 operations in the Future Force. Accordingly, technical solutions are being pursued in the areas of data generation and algorithm development 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. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the DoD Basic Research Plan (BRP). Work in this project is performed by the Army Research Laboratory (ARL).

Accomplishments/Planned Program	FY 2004	FY 2005	FY 2006	FY 2007
- Research to improve soldier auditory performance. In FY04, examined the effect of vibration on bone-conduction communication devices in a military vehicle and determined that bone-conduction communication effectiveness is primarily limited by vehicle noise rather than vehicle vibration. Completed a study to determine the effect of distance to the sound source on sound localization in a simulated open field and found that localization accuracy decreases with the distance and is affected by the sound source characteristics. Determined the effects of select hearing protection and helmets on speech communication capability of a soldier. In FY05, examine the effects of nonlinear hearing protection on soldier auditory performance in the presence of impulse noise. Investigate and transition optimal bone conduction microphone and vibrator placement to enable Future Force Warrior communication. In FY06, will formulate an algorithm for controlling perceived distance in immersive acoustic environments. Will predict detection of multimodal-spectrum sound in noisy environments. Will evaluate operational constraints of a remotely controlled binaural microphone for the Future Force Warrior (FFW). In FY07, will formulate an algorithm for predicting localization error due to headgear. Will investigate synergy between bone conduction and tactile communication for military applications for sniper detection.	1485	1592	1575	1671
- Research to assess, predict, and improve soldier performance. In FY04, validated the predictive Future Force Warrior (FFW) Cognitive Fightability Index (CogFit) with objective, subjective, and neuro-physiological data. Demonstrated that dynamic visual acuity evaluations were sensitive measures of system influences on soldier performance. Integrated models of soldier physical, cognitive, and decision making performance and transitioned them to the Army modeling community to provide human behavior representation in larger system-of-system simulations. In FY05, collect and integrate data on the effects of multi-modal sensory inputs (voice, digital messages, haptic warnings) to predict areas of high workload and systematically explore mitigation opportunities. In FY06, will expand capabilities for the prediction and maturation of cognitive readiness through assessment of neuro-cognitive functioning and time constraints under conditions of uncertainty. In FY07, will explore integrated use of real-time neuro-physiological and other objective measures and models to manage soldier situational overload in dynamic battlefield environments.	1136	1156	1283	1301
Totals	2621	2748	2858	2972

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

COST (In Thousands)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
74F	PERS PERF & TRAINING	2595	2588	2710	2772	2870	2872	2895	2917

A. Mission Description and Budget Item Justification: This project funds behavioral and social science basic research in areas with high potential to improve personnel selection, training, leader development, and human performance. Research covers areas such as assessment 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 speeding the maturation process; 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 developing non-materiel solutions to transform the "human component" of warfighting 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 DoD Basic Research Plan (BRP). This project is managed by the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI).

Accomplishments/Planned Program	FY 2004	FY 2005	FY 2006	FY 2007
In FY04, research examined practical job knowledge assessment instruments; assessed trainability of sense-making (situation awareness) skills; assessed trainability of skills for rapid interpretation of large volumes of ambiguous electronic data; determined whether speed of response is an ability factor contributing to the quality of task performance; and developed improved electronically delivered instruction. In FY05, identify key individual differences, team characteristics, and learning processes that predict individual and team knowledge and skills needed for adaptive performance; assess spatial and temporal memory in electronic environments; develop test of mental flexibility; and develop models of basic human emotions using genetic algorithms. In FY06, projects will validate tests for measuring mental flexibility; identify optimizing training principles to achieve efficiency, durability, and flexibility in complex task environments; determine the influence of seductive detail on technology-delivered instruction; determine the effects of discrete positive and negative emotions on citizenship and deviant work behaviors; identify moderators of emotion-behavior linkages; and provide insight into how leader behaviors effect emotion-behavior linkages. In FY07, research will integrate existing theories of motivation and design feedback systems to achieve better task performance.	2595	2588	2710	2772
Totals	2595	2588	2710	2772

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February 2005

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

COST (In Thousands)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
F20	ADV PROPULSION RSCH	1881	2041	2133	2218	2240	2232	2251	2267

A. Mission Description and Budget Item Justification: This project funds research to increase the performance of small air-breathing engines and power trains to support improved system mobility, reliability and survivability, and ultimately serve to reduce the logistics cost burden for the Future Force. Problems addressed include the need for greater fuel efficiency and reduced weight in these propulsion systems. Technical barriers to advanced propulsion systems are the inadequacy of today's materials to safely withstand higher temperature demands, 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. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the DoD Basic Research Plan (BRP). Work in this project is performed by the Army Research Laboratory (ARL).

Accomplishments/Planned Program	FY 2004	FY 2005	FY 2006	FY 2007
In FY04, investigated oil-free foil air bearing technology to enable future military turbine engines to operate without oil; reducing engine maintenance costs (50%) and weight (15%). Improved analytical models (incorporating hydrodynamic and compliant structure interactions) for journal and thrust oil-free foil air bearings. Investigated and experimentally measured thermal effects that influence the behavior and limit performance of high-speed and high-temperature foil air. Evaluated a laboratory prototype oil-free turbocharger for diesels and completed a preliminary oil-free turbocharger design for vehicles such as the Army Stryker, and Family of Medium Tactical Vehicles (FMTV). Conducted research in alternative energy conversion processes and energy sources, e.g., advanced constant volume combustion cycles (pulse detonation) and catalytic fuel cell reformation (leveraged NASA's commitment to onboard fuel cell use for flight weight systems). This research enhances engine system durability and performance and reduces logistics burden. In FY05, investigate ceramic materials processing and life prediction methods for high temperature engines; assess novel propulsion concepts for UAVs; investigate the influence of gear tooth surface treatments on gear operation after the loss-of-lubrication; evaluate oil-free foil air bearing misalignment tolerance limits and effects of ambient pressure on bearing performance. In FY06, will evaluate diagnostics techniques for hybrid bearings (ceramic rolling elements with steel races); complete lifing analysis of a first stage ceramic matrix composite turbine; investigate thermal and environmental barrier coating systems with 3000F capability; transition unsteady compressor flow analysis code to industry. In FY07, will analyze autonomous diagnostic and repair concepts for gas turbine engine components; complete baseline experimentation of gear tooth bending strength at elevated temperatures experienced in helicopter transmissions.	1881	2041	2133	2218
Totals	1881	2041	2133	2218

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2005

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

COST (In Thousands)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
H42	MATERIALS & MECHANICS	1942	2040	2120	2206	2235	2264	2283	2301

A. Mission Description and Budget Item Justification: This project funds the Army's basic research 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. The major issue associated with the current approach of using materials to gain added functionality for Army systems is that one must use a layered approach, whereby each layer provides added capability (i.e. ballistic, chem./bio, signature, etc) but ultimately makes the system 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. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the DoD Basic Research Plan (BRP). Work in this project is performed by the Army Research Laboratory (ARL).

Accomplishments/Planned Program	FY 2004	FY 2005	FY 2006	FY 2007
Devise new materials and design capabilities, based upon fundamental concepts derived at the microscopic and nano-structural levels, for the Future Force. In FY04, proved the feasibility of using advanced composites with novel photonic and electromagnetic properties to provide multifunctional performance in lightweight armors; conducted research to narrow and control the size distribution of nano-particles; incorporated into continuum codes the first generation of a new ceramic damage model that includes novel damage kinetics and performed dynamic experiments to obtain critical model parameters for silicon carbide armor; and experimentally characterized dynamic fracture response of candidate anti-armor materials under ballistic loads. In FY05, show specific multifunctional performance gains in power generating structures and assess survivability gains that can be realized using novel photonic materials; examine nano-particle relationships between particle size and morphology for nano-systems synthesized in FY04; perform shock/re-shock/lateral release experiments on relevant armor ceramics to incorporate damaged material parameters into continuum codes and conduct benchmark analyses using new damage models; incorporate second generation dynamic fracture model into computational continuum mechanics code to enable development of improved anti-armor concepts. In FY06, will incorporate photonic materials and communications components into model survivable structures; use directed assembly techniques to control the nano-particle size and distribution of a functional nano-particles in a polymer matrix; fully transition ceramic damage model to armor design codes; and perform ballistic experiments of a fracture resistant penetrator prototype designed using new fracture models. In FY07, will enhance the synergistic effects of structure and electromagnetic interactions within model survivable structures; characterize transport behavior and relevant properties of nanoparticles.	1942	2040	2120	2206
Totals	1942	2040	2120	2206

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2005

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

COST (In Thousands)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
H43	RESEARCH IN BALLISTICS	5923	5962	7101	7324	7461	7411	7475	7531

A. Mission Description and Budget Item Justification: This project seeks to improve 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 basic new knowledge, 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. This effort supports the OSD Advanced Energetics Initiative to mature the fundamental technologies required to transition the next generation of energetic materials into field use. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the DoD Basic Research Plan (BRP). Work in this project is performed by the Army Research Laboratory (ARL).

Accomplishments/Planned Program	FY 2004	FY 2005	FY 2006	FY 2007
- In support of the National Advanced Energetics Initiative and Army-specific basic research, expand and validate physics-based models and experimental techniques to devise and characterize 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 FY04, characterized and modeled the chemical and physical properties of novel energetic materials and established the relationship between particle size, energy density and release rate for insensitive high-energy propellants and explosives; explored the 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 managed energy release of insensitive high-energy propellants and explosives, including multiple-mode applications for energetic materials. In FY06, will devise condensed phase novel energetic materials models to couple and describe energy releasing processes within atomistic/molecular, micro, meso, and macro-scales for propellants and explosives; characterize nano-scale energetics in various stages of decomposition; devise functionally-graded nano-energetics; and model the effects of plasma ignition on multiple propellant grains. In FY07, will derive model-based relationships between energy localization from friction, fracturing, shock, jetting, void collapse, plastic deformation, viscous heating, adiabatic gas compression that control explosive and propellant formulation sensitivity supporting Insensitive Munitions.	3999	3668	4117	4208

Accomplishments/Planned Program (continued)	FY 2004	FY 2005	FY 2006	FY 2007
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 FY04, explored correlations between ballistic performance of armor ceramics and fundamental material properties and material behaviors in the context of non-ballistic evaluation methods; conducted numerical study on the propagation velocity of shear bands as influenced by material imperfections and validated and matured improved models for computational continuum mechanics codes in support of improved analysis of armor/anti-armor interactions; devised 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, develop understanding of damage evolution in ceramic materials and model penetration through advanced ceramic armor, capturing the observed material response for each phase of penetration; incorporate a model for adiabatic shear into simulations of armor/anti-armor interactions and compare with ballistic experiments; and prove capability to model fully coupled steady-roll controlled pitch-up maneuver of precision munitions and validate full high performance computational capability of coupled models employing multiple processors. In FY06, prove ability to accurately depict the degradation of ceramic materials in controlled high-rate experiments; devise generalized failure framework for combined fracture and shear localization of metallic materials; show bank to turn maneuver during vehicle thrust using coupled computational fluid mechanics, rigid body dynamics and guidance, navigation and control. FY07, prove ability to accurately depict the degradation of ceramic materials in the terminal effects environment; apply the generalized fracture framework to simulate failure penetrators.	1924	2294	2984	3116
Totals	5923	5962	7101	7324

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2005

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

COST (In Thousands)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
H44	ADV SENSORS RESEARCH	3791	3844	4000	4162	4214	4281	4318	4349

A. Mission Description and Budget Item Justification: This project funds basic research to enable new sensing capabilities for the Army's Future Force, and to 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 large scale electromagnetic models to predict and explain target and clutter scattering behavior, 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 performed under this project supports 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, biological and chemical environmental sensing, and improved sensor protection. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the DoD Basic Research Plan (BRP). Work in this project is performed by the Army Research Laboratory (ARL).

Accomplishments/Planned Program	FY 2004	FY 2005	FY 2006	FY 2007
- Research addresses the maturation of technologies for adaptive, active, and intelligent optical systems for high-data-rate military communications and directed energy applications. In FY04, investigated wave division multiplexing in a free-space laser communication system; expanded the atmospheric laser optics test bed to include a network of laser communication systems; researched adaptive coding techniques for optical communications; and conducted research into the characterization and mitigation of atmospheric effects (i.e., turbulence, fog, rain, snow) on tactical directed energy weapons systems. In FY05, investigate hand-held laser communication applications; and perform research into adaptive beam control algorithms for target-in-the-loop Army self-defense laser weapon applications. In FY06 will investigate adaptive compression techniques and perform advanced analysis of target-in-the-loop scenarios with both cooperative and non-cooperative targets. In FY07, will perform research into the use of minimal configuration agile adaptive apertures for high-bandwidth optical communications and directed energy applications.	1449	1538	1601	1667

Accomplishments/Planned Program (continued)	FY 2004	FY 2005	FY 2006	FY 2007
- Research focused on improving sensor capabilities to create more survivable/secure systems and displays, and improved environmental monitoring. In FY04, established capabilities to model multiple targets embedded in distributed clutter through L-band frequencies; advanced Surface Enhanced Raman Scattering (SERS) techniques to increase number of detectable biological agents; improved efficiency and optimization of processing techniques for networks of sensors and performed quantum cryptographic (QC) analyses; benchmarked QC demos; collaborated with CECOM on transitioning viable quantum computing systems to Army RDECs and evaluated other quantum computing systems. In FY05, quantify role of Ultra Wideband (UWB) Synthetic Aperture Radar (SAR) imaging artifacts in the ability to detect small and difficult targets and identify improvements; investigate Electron Beam Lithography (EBL) technology for generation of advanced SERS substrates; explore efficient signal processing algorithms for data fusion and networks of sensors of various modalities; make recommendations for applications of quantum information processing. In FY06, will utilize more accurate soil descriptions to determine the role of spatial and temporal variability in difficult target deployments such as underground plastic mines; investigate networking options of QC test beds and new areas in quantum information processing, and validate benchmark QC security analyses; optimize fabrication parameters of EBL substrates and benchmark SERS signatures for reproducibility and enhancements factors. In FY07, will use modeling and imaging tools to evaluate UWB image formation options for building penetration, mapping and personnel detection; collaborate with RDEC partners in performing QC test bed and networking studies, and assess transitionability of QC systems to future combat systems; explore efficient signal processing techniques for identification of biological pathogens using advanced SERS substrates.	2342	2306	2399	2495
Totals	3791	3844	4000	4162

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2005

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

COST (In Thousands)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
H45 AIR MOBILITY	2072	2073	2133	2218	2282	2314	2333	2352

A. Mission Description and Budget Item Justification: This project supports 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 by providing research into technologies that can improve tactical mobility, reduce the logistics footprint, and increase survivability for rotary wing aircraft. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the DoD Basic Research Plan (BRP). 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 2004	FY 2005	FY 2006	FY 2007
- In FY04, completed wind tunnel testing to reduce drag force of mast mount sensor (MMS) shape and fuselage. Conducted performance test for co-axial and ducted-fan unmanned aerial vehicle (UAV) and 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. In FY 06, will investigate rotor-induced power at high advance ratio flight. Will explore new acoustic prediction code for flight maneuvering. In FY 07, will research unsteady aerodynamics for flapping wing for micro UAV. Will conduct water channel test to validate the unsteady aero for flapping wing theory.	2072	2073	2133	2218
Totals	2072	2073	2133	2218

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2005

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

COST (In Thousands)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
H47	APPLIED PHYSICS RSCH	2520	2649	2781	2868	2905	2954	2980	3002

A. Mission Description and Budget Item Justification: This project investigates electronic 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; advanced batteries and more efficient fuel cells for hybrid power; the manipulation of cold atoms in an atom chip environment for application to very sensitive sensors and ultra-stable clocks. Impact of these investigations will be the development of power sources and specialty electronic materials for the Army's Future Force, including improved wide band gap semiconductor performance in electric vehicles and advanced radar systems. Applications of cold atom chips 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. Technical barriers affecting performance, weight, cost, and power consumption will be addressed. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the DoD Basic Research Plan (BRP). Work is performed by the Army Research Laboratory (ARL).

Accomplishments/Planned Program	FY 2004	FY 2005	FY 2006	FY 2007
- 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 FY04, evaluated solid electrolytes for rechargeable high-energy batteries; examined silicon carbide (SiC) structures and ohmic contacts for transition to efficient device designs; and devised a general-purpose laser cooling test system for the study of various cold atom chips with potential for application to ultra sensitive sensors and miniature atomic clocks. In FY05, synthesize/evaluate high energy phosphate cathode materials for Li-ion cells; evaluate catalysts for fuel processing for fuel cells; examine gallium nitride (GaN) structures and ohmic contacts for transition to efficient device designs, and reduce the surface roughness in SiC Metal-Oxide Semiconductor Field Effect Transistor (MOSFET) device structures to improve performance; and research cold atom chip and atom waveguide techniques experimentally and through simulations. In FY06, will show that a field plant in a GaN High Electron Mobility Transistor (HEMT) can be fabricated using ion implantation, and SiC Junction Barrier Shottky (JBS) diodes can be improved using selective area epitaxy; and validate propagation of cold atom condensates in atomic waveguides as a first step to atom chip sensors and clocks. In FY07, will evaluate the improved SiC and GaN devices in test circuits; and advance and validate initial versions of atom chip clock designs.	2520	2649	2781	2868
Totals	2520	2649	2781	2868

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2005

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

COST (In Thousands)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
H48	BATTLESPACE INFO & COMM RSC	5241	5526	5735	5957	6074	6086	6141	6188

A. Mission Description and Budget Item Justification: This project supports basic research to 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 multi-path 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 cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the DoD Basic Research Plan (BRP). Work in this project is performed by the Army Research Laboratory (ARL).

Accomplishments/Planned Program	FY 2004	FY 2005	FY 2006	FY 2007
- 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 to thousands of networked nodes. In FY04, devised 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. In FY06, will conduct laboratory experimentation to mature technologies for adaptive communications in a mobile, wireless, tactical network. In FY07, will perform experimental analysis to incorporate technologies to sensor/radio platforms.	2411	2542	2638	2740
- 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 FY04, incorporated 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; extended language translation capabilities to include posting translations to databases; and performed machine translation evaluation research building statistical models. 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 and conduct experimentation with translation of low density languages. In FY06, will perform laboratory demo of low-density automated language translation and refine evaluation metrics for machine translation and correlation to autonomous robotic and soldier tasks. In FY07, will refine and optimize algorithms for soldier/robotic interface utilizing experimental machine translation.	1362	1381	1428	1483

Accomplishments/Planned Program (continued)	FY 2004	FY 2005	FY 2006	FY 2007
- 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 FY04, incorporated 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; assessed fundamental limits on classifying and separating co-channel signals, transitioned results to Communications-Electronics Research, Development and Engineering Center (CERDEC); and formulated new transceiver architecture for ultra-wideband communications. In FY05, construct and populate tactical environmental assurance lab for mobile ad hoc networks (MANET); and evaluate and implement selected best of breed security services embedded authentication services for unattended static and mobile sensor networks deployable on the battlefield. In FY06, will perform experimentation and research for intrusion detection in MANETS that addresses resource consumption issues. In FY07, will investigate high mobility, channel impairment issues which are MANET-unique.	1468	1603	1669	1734
Totals	5241	5526	5735	5957

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2005

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

COST (In Thousands)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
H52	EQUIP FOR THE SOLDIER	994	1058	1101	1141	1152	1164	1173	1182

A. Mission Description and Budget Item Justification: This project supports basic research to achieve technologies for the Soldier of the future and support 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 Soldier 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. The cited work is consistent with the Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the DoD Basic Research Plan (BRP). Work in this project is performed by the US Army Natick Soldier Center, Natick, MA.

Accomplishments/Planned Program	FY 2004	FY 2005	FY 2006	FY 2007
- In FY04, transitioned nanocomposite technology to warrior protective gear efforts in PE 0602786. Examined cognitive performance as function of nutrient and fluid intake under stressful conditions. Evaluated and quantified water distribution in intermediate moisture foods using magnetic resonance spectroscopy to enhance food safety and stability. Examined the relationship between perceived clothing fit and objective expert assessment of clothing fit for application to clothing design. Identified peptide-based recognition elements for detecting food pathogens. In FY05, determine effects of load distribution and moments of inertia on the biomechanics of gait and performance. Complete data analysis of nutrient effects on cognitive performance during severe cold stress. In FY06, will conduct research in ordered nanoarrays (optical properties/understanding of underlying physics) and transition results to applied research in PE 0602786; will couple modified peptide recognition elements to probe molecules for advanced food pathogen detection. In FY07, will perform basic research in nanocomposite fibers for advanced textiles; examine effects of Soldier knowledge, attitude and beliefs on acceptance of future military rations and clothing.	994	1058	1101	1141
Totals	994	1058	1101	1141

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2005

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

COST (In Thousands)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
H57	SCI PROB W/ MIL APPLIC	52881	53975	61380	63579	65534	66221	66792	67283

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 Future Force 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 a Future Force that is more strategically deployable, more agile, more lethal and more survivable. The breadth of this basic research program covers approximately 900 active, ongoing research grants and contracts with leading academic researchers and approximately 1,600 graduate students yearly, and supports research at nearly 200 institutions in 46 states. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the DoD Basic Research Plan (BRP). Work in this project is performed extramurally by the Army Research Laboratory (ARL).

Accomplishments/Planned Program	FY 2004	FY 2005	FY 2006	FY 2007
- Basic research in environmental and life sciences for Chemical Biological Detection (CBD), mine detection and revolutionary advances in sensors for soldier survivability. In FY04, isolated Phage Lytic enzymes to destroy bacteria that cause infectious diseases and that can be used as bio-warfare agents; discovered novel antifungal compounds produced as a result of plant-microbe interactions; used properties of human vision to reduce the computational complexity associated with processing real-time video streams; used time domain electromagnetic induction to locate and characterize unexploded objects; employed a multisensor approach to mapping of 2D and 3D geologic features from remotely sensed imagery. In FY05, seek to understand mechanisms of pathogenicity to combat terrorism and to aid in CB detection through intervention of organisms that cause disease; use molecular genetics to identify the molecular signals that affect soldier performance and endurance. In FY06, will study the structure of biofilms and the mechanisms of cell-to-cell communication to detect and prevent potential biological threats to water supplies; formulate atmospheric models of boundary layer to improve nighttime forecasts; complete physics-based modeling for microscale particle simulation to improve terrain mobility. In FY07 will conduct research into neuro-cognitively adaptive information displays to automatically match soldier perceptual, cognitive and motor abilities; provide airborne Doppler lidar with 4-D wind measurement capabilities; provide new simulations for soil moisture estimation for Army ground operations.	5263	5370	6110	6549
- Basic research in chemical sciences for advanced power generation, propellants, and protective materials. In FY04, devised a kinetics model for condensed phase combustion; investigated nano-shocks/molecular energy transfer; devised a new family of molecularly reinforced polymers for blast resistant transparent films; formulated a novel micro-fluidic chip for micro-assays of CBD agents. 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 novel architectures for materials with superior protection from all environments. In FY06, will conduct research in high efficiency, low pressure blowers to support fuel-cell based power sources for the soldier; devise new models of the solid state properties of propellants and explosives that do not require large blocks of computer time. In FY07, will transfer new gas/surface interaction theory into Army models for gun erosion; devise user friendly chemical reaction and kinetics models with computational fluid dynamics for chemical weapons incinerators.	5508	5620	6390	6620

Accomplishments/Planned Program (continued)	FY 2004	FY 2005	FY 2006	FY 2007
- Basic research in physics for precision guidance, superior optics and signature management properties and secure communications. In FY04, established the viability of quantum imaging for a potential way to detect stealthy targets; showed superfluidity in Fermi degenerate gases for future sensors and clocks for positioning and precision guidance. In FY05, devise a theory for relativistic quantum information for use in assessing advanced Global Positioning System (GPS) and quantum computing protocols; determine electron dynamics in novel semiconductor heterostructures and nanostructures to guide the development of technology for efficient high power, low threshold lasers. In FY06, will devise negative index materials and photonic materials in the visible range for applications in imaging and sensing; prove a quantum algorithm that simulates hydrodynamics and aerodynamics much more efficiently than existing classical algorithms for improved design of munitions and vehicles; devise instrumentation for study of soft materials systems for soldier protection. In FY07, will provide accurate computational tools for design of new drugs through molecular physics, thereby subsuming biochemistry and quantum biology for a firmer basis for nanoscience.	7627	7785	8855	9170
- Basic research in communications and electronics for unmatched networked Command Control Communications Computing Intelligence Surveillance and Reconnaissance (C4ISR) capabilities. In FY04, used rare earth doped materials for photonic applications, and applied quantum dot intersub-band photo detectors for night vision devices and to create a new class of quantum-dot lasers for Army laser designators; modeled new bio-molecular architectures; showed the first room temperature magnetic semiconductors and greater than 100 GHz optical fiber communications. In FY05, explore advanced countermine techniques to enable faster and more accurate detection of mines by integrating seismo-acoustic and chemical sensors with electro-optics and advanced x-ray imaging. In FY06 will determine effects of 1-D nanostructures on the magnetic properties of ferromagnetic semiconductors; create technologies to design and implement highly mobile ad-hoc wireless tactical and sensor communications networks. In FY07, will devise an integrated nano-scale sensor platform at THz frequencies for biological detection; investigate methods for secure, trustworthy information delivery in mobile tactical systems.	11216	11450	13020	13485

Accomplishments/Planned Program (continued)	FY 2004	FY 2005	FY 2006	FY 2007
- Basic research in mechanical and material sciences for survivable armor and more lethal anti-armor, improved mobility, and flexible displays for soldier systems. In FY04, advanced the understanding of active flow control for projectiles and air vehicles to improve precision strike; identified shear band deformation in bulk amorphous metals leading to improved penetrators; created in-situ X-ray techniques for monitoring stress and morphology for thin film displays; synthesized 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; conduct research in transparent conductive and emissive materials. In FY06, will devise planetary gear analysis tools for improved rotorcraft transmissions; formulate practical micro active flow control schemes for transonic and supersonic projectiles to improve accuracy; explore new concepts of phase inter-compatibility for maturation of passively “smart” materials. In FY07, will create adaptive multiple scale computational models to predict material failure; synthesize carbon nanotube-based damping polymers for vibration reduction in rotor blades; investigate optical switching behavior in novel polymer architectures and excited-state systems for laser protective films.	14312	14610	16615	16990
- Basic research in mathematical and computer sciences as the backbone for complex, multi-system analysis, modeling and simulation, and information systems. In FY04, translated statistical shape analysis to computer programs for improved target classification; devised self-organizing, self-healing mobile ad-hoc networking algorithms in order to facilitate rapid force deployment and reduce the logistics footprint; created conflict resolution architectures for multi-agent hybrid systems for robotics and UAVs. In FY05, devise low-order mathematical models of hysteresis nonlinearity to improve the performance and real-time control of smart materials leading toward 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. In FY06, will devise a computer program containing algorithms for real-time implementation of non-linear filter target tracker. In FY07, will devise software to implement real time algorithms for identifying targets in noisy battlefield scenes.	8955	9140	10390	10765
Totals	52881	53975	61380	63579

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2005

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

COST (In Thousands)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
H66	ADV STRUCTURES RSCH	1425	1518	1588	1651	1661	1681	1696	1708

A. Mission Description and Budget Item Justification: This project funds basic research for 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 identified by the Army Modernization Plan. 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 modeling and simulation; 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 on: 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 Army Aviation 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 vehicle structures basic research within DoD. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the DoD Basic Research Plan (BRP). Work in this project is performed by the Army Research Laboratory (ARL).

Accomplishments/Planned Program	FY 2004	FY 2005	FY 2006	FY 2007
In FY04, assessed unmanned aerial vehicle (UAV) utility of innovative wing designs inspired by naturally based morphologies; analyzed potential of actively-controlled rotor stability augmentation model for tilt rotor UAV; evaluated soft soil and water impact effects on crash occupant survivability; and assessed durability, damage tolerance, and failure mechanisms for embedded sensors/actuators in flexible structure. In FY05, characterize performance of advanced active twist rotor blade; investigate rotorcraft Computational Fluid Dynamic (CFD) modeling techniques to improve multi-body rotor aeroelastic modeling and simulation; investigate structural analysis methods to predict durability, damage tolerance, and failure of composite structures with embedded sensors/actuators. In FY06, will perform modeling and simulation studies of active control concepts for heavy lift rotorcraft; conduct subcomponent experiments to validate durability and damage tolerance predictions for composite structures with embedded sensors/actuators. In FY07, will conduct wind-tunnel experiments of innovative rotor configurations applicable for heavy lift rotorcraft to characterize structural and aeromechanical performance; explore advanced concepts for lightweight, highly tailored and multi-functional composite structures using embedded sensors/actuators.	1425	1518	1588	1651
Totals	1425	1518	1588	1651

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2005

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

COST (In Thousands)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
S13	SCI BS/MED RSH INF DIS	9400	9691	10098	10492	10710	10854	10948	11028

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. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the DoD Basic Research Plan (BRP). Work in this project is performed by the Walter Reed Army Institute of Research, 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, Silver Spring, MD, and its overseas laboratories.

Accomplishments/Planned Program	FY 2004	FY 2005	FY 2006	FY 2007
In FY04, identified, using genomic technology, promising new targets to develop for inclusion into new vaccines against malaria and gained a better understanding of host-parasite interactions. Validated new models for high throughput screening and new drug discovery. In FY05, enhance and integrate techniques to exploit genomic information for vaccine and drug discovery efforts. In FY06, design and develop new drug and vaccine candidates for optimization and animal testing. In FY07, will utilize new genomic/proteomic (study of protein expression and function) technologies to identify new approaches to preventing malaria and evaluate alternative drug delivery systems.	5249	4291	4135	4964
In FY04, conducted studies to assess the incidence and types of diarrhea-causing agents in areas of deployment to determine suitability as vaccine test sites. In FY05, refine field site assessment for suitability for vaccine testing and select best sites. Study genetic diversity of diarrhea-causing strains. In FY06, will assess proteomic expression and study biology of genes of interest and incorporate this information into diarrheal disease vaccine program. In FY07, will perform studies to understand the mechanisms of pathogenesis (pathologic mechanisms occurring in the development of disease) and host/pathogen relationship of diarrheal organisms.	639	669	795	844

Accomplishments/Planned Program (continued)	FY 2004	FY 2005	FY 2006	FY 2007
In FY04, identified alternative approaches to create an effective and safe dengue fever vaccine. Identified genes from other lethal viral diseases such as Rift Valley Fever for incorporation into DNA vaccines. In FY05, identify field sites for testing dengue and hemorrhagic fever vaccines. In FY06, will identify viral and host cellular factors that determine the outcome of dengue virus infection; study the immunological mechanisms of protection in dengue and other lethal viruses. In FY07, will study host-virus interactions between flaviviruses that may affect vaccine strategies.	872	1602	1481	1270
In FY04, refined tests to detect insects carrying diseases transmissible to humans in areas of deployment. In FY05, evaluate effectiveness of integrated dengue vector preventive medicine control system in Central and South America, and Thailand. Assess approaches to sandfly control. In FY06, will enhance web-based insect vector identification resources and expand range of insect-borne diseases detected by current and new test systems. In FY07, will initiate comprehensive review of major mosquito collections to harness information for inclusion in worldwide distribution database for purposes of field identification and risk assessment and move insect-based disease tests to the concept exploration phase.	1832	2037	2664	2444
In FY04, identified infectious disease diagnostic components compatible for use in a Joint Biological Agent Identification and Diagnosis System. In FY05, identify approaches to supplement infectious disease diagnostics not currently compatible with joint system such as point of care diagnostics. In FY06, will evaluate a multiplexed real-time polymerase chain reaction (PCR, a technique to exponentially expand specific portions of DNA) for the simultaneous detection and identification of multiple endemic infectious diseases of military relevance. In FY07, will provide endemic infectious disease reagent sets for JBAIDS.	808	1092	1023	970
Totals	9400	9691	10098	10492

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2005

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

COST (In Thousands)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
S14	SCI BS/CBT CAS CARE RS	4098	4143	4324	4495	4613	4677	4718	4751

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. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the DoD Basic Research Plan (BRP). 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 2004	FY 2005	FY 2006	FY 2007
In FY04, defined measurable indicators of brain injury severity for use in directing treatment; studied potential chemical compounds that may block effects of severe blood loss on vital organs and tissues; defined measurable combat casualty parameters that can be used as indicators of need for immediate medic intervention vs. delayed intervention. Awarded multiple contracts through a consortium with the National Heart, Lung, and Blood Institute (NHLBI) to study shock after severe blood loss; and conducted conceptual development, technology discovery, and early studies to significantly mitigate or eliminate the impacts of battlefield injury, including severe hemorrhage, penetrating head injury, and mutilating soft-tissue and skeletal injury. In FY05, evaluate brain cooling to preserve brain tissue and function after penetrating brain injury (PBI); evaluate molecular mechanisms in response to a PBI; 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; identify markers of resuscitation failure due to hemorrhage; attain regulatory approval for studies in accelerating soft-tissue wound healing. Continue basic research collaboration efforts with NHLBI. In FY06, will evaluate molecular mechanisms in response to PBI following neuroprotective drug treatment; begin testing additives to Ringer's Lactate (a resuscitation fluid) for reduction of response to hemorrhage; identify and characterize agents for accelerating soft-tissue wound healing; investigate results of treatment to reduce hemorrhage-induced tissue damage; continue basic research collaboration efforts with NHLBI. In FY07, will begin to define biomarkers in the PBI model after drug treatment; determine most effective agent for accelerating soft-tissue wound healing; and continue basic research collaboration efforts with NHLBI.	4098	4143	4324	4495
Totals	4098	4143	4324	4495

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2005

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

COST (In Thousands)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
S15	SCI BS/ARMY OP MED RSH	5612	5786	6041	6273	6404	6490	6547	6593

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, 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. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the DoD Basic Research Plan (BRP). 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 2004	FY 2005	FY 2006	FY 2007
In FY04, identified the cytoprotective effect of herbimycin A to protect retinal pigmented epithelial cells (cells joined by small amounts of cementing substances) in culture against laser injury. This class of drugs is a potential therapy for laser eye injury and they will transition for evaluation in the intact eye. Explored the benefits of nutritional supplements to enhance metabolic rate for weight management, cold survival, and cognitive functions. This research will be used to develop rations designed to maximize performance outcomes in adverse environmental conditions. In FY05, apply proteomic and genomic assays to characterize laser injury mechanism and treatment responses. In FY06, will identify mechanism of laser-induced retinal injuries that result in secondary effects of retinal nerve fiber layer degeneration and choroidal (part of the eye) neovascularization (natural or surgically induced development of vessels in a tissue). In FY07, will extend findings from retinal injuries to in-vivo (within the living body) animal model.	1878	1934	1624	2098
In FY04, explored the relationship between sleep restriction (partial sleep loss) and need for recovery sleep in humans to more precisely predict sleep needs following operations that result in sleep restriction. In FY05, conduct studies on sleep genomics in collaboration with extramural genomics researchers. In FY06, will explore genomic basis of individual differences in resilience during sleep deprivation. In FY07, will develop a model of key determinants of individual fatigue resistance.	1864	1981	2811	2146
In FY04, completed a cold injury epidemiology (determination of specific cause of disease) study that identified an ethnogenetic component (unrelated to occupational specialty) associated with susceptibility to cold injury. In FY05, evaluate projected Future Force Warrior factors that increase cold strain and adversely impact performance during cold-weather operations. In FY06, will evaluate countermeasures to sustain performance during cold weather. In FY07, will develop predictive modeling capabilities and software for assessing cold strain and cold-weather performance during wet/water-borne conditions in fatigued soldiers.	1870	1871	1606	2029
Totals	5612	5786	6041	6273

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2005

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

COST (In Thousands)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
T22	SOIL & ROCK MECH	1910	1971	2031	2110	2157	2186	2205	2220

A. Mission Description and Budget Item Justification: This basic research creates the fundamental knowledge of the effects of the micro-scale behavior on the macro-scale performance of geological and structural materials to provide a foundation for the creation of future revolutionary materials and to revolutionize the understanding of sensor data within a heterogeneous geological system. This encompasses geologic and structural material behavior, structural systems, and the interaction with dynamic and static loadings. Research needs include: underlying physics and chemistry that controls the mechanics and electromagnetic behavior of geological and structural materials, new experimental techniques that provide measurements at the fundamental scale, and fundamental theories for relating micro-scale phenomena to macro-scale performance. This research provides the basis for applied research that supports the civil engineering technologies for force projection, mobility, maneuver support, and survivability of the Future Force in PE 0602784A Project T40, Mobility/Weapons Effects Technology. The cited work is consistent with the DoD Basic Research Plan (BRP), the Army Science and Technology Master Plan (ASTMP), and the Army Modernization Plan. The U.S. Army Engineer Research and Development Center, headquartered at Vicksburg, Mississippi, performs this work.

Accomplishments/Planned Program	FY 2004	FY 2005	FY 2006	FY 2007
Structural Materials - In FY04, conducted simulations of dynamic experiments of structural materials using both homogeneous and heterogeneous modeling techniques. Produced technique for mapping dynamic deformation and cracking in quasi-brittle materials. Produced model for predicting material response due to dynamic loading events. Near Surface Soil Behavior - In FY04, provided first-generation reinforcement models describing the interaction between soil particles and nontraditional stabilizers. Conducted laboratory experiments on size effect in compacted soils. In FY05, 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. In FY06, will identify and characterize the magnetic properties of soils that can mask the detection of mines and unexploded ordnance. Will produce techniques for improving the bond between concrete and steel. In FY07, will determine the feasibility of biological stabilization of soils for rapid construction of military surfaces. Will produce techniques for optimizing hardening reactions in organic cements allowing them to become the basis for high-strength, lightweight composites. Will mature concept for low-velocity probe that could provide capability to remotely determine soil properties.	1910	1971	2031	2110
Totals	1910	1971	2031	2110

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2005

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

COST (In Thousands)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
T23	BASIC RES MIL CONST	1602	1608	1666	1735	1787	1810	1827	1839

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) assessing the conceptual feasibility of real-time sensors and agent derived models to simulate terrorist threat scenarios, and (3) developing novel and advanced concepts for mitigating the effect of chemical and geological agents in built structures. These efforts provide basic research leading to improved design capability for a range of facilities that optimize facility mission performance, enhance facility security, 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 PE 0602784A Projects T41 and T45, Military Facilities Engineering Technology and Cold Regions Engineering Technology. The cited work is consistent with the DoD Basic Research Plan (BRP), the Army Science and Technology Master Plan (ASTMP), and the Army Modernization Plan. The U.S. Army Engineer Research and Development Center, headquartered at Vicksburg, Mississippi, performs this work.

Accomplishments/Planned Program	FY 2004	FY 2005	FY 2006	FY 2007
In FY04, investigated fundamental thermodynamics and material properties that describe microencapsulated phase change material performance as it affects heat transfer of thermal fluids. Investigated underlying factors affecting the attenuation of electromagnetic fields under intense transient field conditions and develop models for the non-linear response. In FY05, formulate optimization algorithms suitable for rapid and flexible design of the continuum of facilities needed by the Future Force. In FY06, will determine the conceptual feasibility of using electrokinetic techniques to generate anion and cation species that form biocide films that are lethal to airborne pathogens. In FY07, will develop physics based constitutive equations for modeling the real-time behavior of the dispersion of airborne particulates.	1602	1608	1666	1735
Totals	1602	1608	1666	1735

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2005

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

COST (In Thousands)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
T24	SNOW/ICE & FROZEN SOIL	1189	1292	1361	1413	1412	1425	1438	1448

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 battlespace 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 DoD Basic Research Plan (BRP). 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 2004	FY 2005	FY 2006	FY 2007
Terrain State and Signature Physics – In FY04, extended theory of near surface meteorological variables at the micro-scale and completed theory for distribution of energy components associated with 3-dimensional discontinuous canopies, providing new capability for detection of partially obscured targets. In FY05, establish effects of buildings and barriers on acoustic-seismic propagation in urban settings and define the turbulence and topographic roughness interaction for acoustic signals. Establish understanding of pavement mechanical properties and pavement degradation processes as a function of soil, pavement type, and moisture-temperature variations. Investigate methods to remotely extract or infer soil, moisture, temperature at depth, and vegetation attributes. In FY06, will formulate a new invertible two-dimensional theory of low-frequency acoustic signal propagation that includes the relevant effects of reverberation, diffraction, and scattering to understand acoustic signature modulation between target and sensors and provide a potential means for non line-of-sight source detection. In FY07, will investigate characteristic length scales (one to one thousand meters) of terrain response to atmosphere forcing, and relate to scale effects on electromagnetic and acoustic propagation.	1189	1292	1361	1413
Totals	1189	1292	1361	1413

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2005

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

COST (In Thousands)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
T25	ENVIRONMENTAL RES-COE	4501	4473	4650	4835	4995	5065	5109	5147

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 PE 0602720A, Projects F25, 048, 835, and 896, Military Environmental Restoration Technology, Industrial Operations Pollution Control Technology, Military Medical Environmental Criteria, and Base Facilities Environmental Quality. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the DoD Basic Research Plan (BRP). 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 2004	FY 2005	FY 2006	FY 2007
Environmental and Ecological Fate of Explosives, Energetics, and Other Contaminants – In FY04, determined 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. Established a means to determine the toxicology of selected explosive compounds in mammals using gene expression data. Identified new mechanisms (gene probes, micro arrays, and assays) for detecting the reaction of critical microbial populations to numerous contaminants of military interest. In FY05, correlate the molecular spectral characteristics with computation chemistry to determine the affinity of contaminants to produce fast forming less toxic chemical byproducts. Correlate biosensor response to explosive additions as a function of soil condition. In FY06, will determine the potential mechanisms of toxicity and sublethal effects of individual and interactive mixtures of explosives. Will use bioinformatics (computational biology) as the basis for constructing DNA probes and to characterize DNA isolated from soil. In FY07, will continue to establish a basic understanding of physical, chemical, and biological phenomena specific to contaminant toxicity assessment and environmental risk assessment.	1490	1481	1539	1600
Remediation of Explosives, Energetics, and UXO – In FY04, determined the chemical, physical, and biological transformation of crystalline explosive residues on firing ranges for improved cleanup alternatives and risk-based assessments. Described the microbial physiology, biochemistry and genetics of explosives contaminants on military ranges for tailored in-place site cleanup. In FY05, describe propellant attenuation on ranges via the management of natural soil cycles. Pursue in situ explosive biodegradation mechanisms and direct analysis methods to identify explosives degradation mechanisms of contaminated soils. In FY06, will use thermal desorption with ion trap mass spectrometry to relate the binding/transport properties of explosives to soil characteristics (geochemistry and soil mineralogy), in and on soils. Will establish the relationship of explosives-energetics affinity of being bio/chemically transformed into other toxic/non-toxic chemicals using kinetic models. Will refine UXO signature prediction capabilities with new models that enhance subsurface physical property characterization based on the overall geology of a site and related distributions and amplitudes of naturally occurring geophysical anomalies. In FY07, will continue to establish a basic understanding of physical, chemical, and biological phenomena specific to contaminant mineralization.	1622	1612	1676	1743

Accomplishments/Planned Program (continued)	FY 2004	FY 2005	FY 2006	FY 2007
Training Land Natural Resources – In FY04, determined genetic traits and differences in specific native grasses to enhance resilience for military land rehabilitation. Determined 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, describe physical, chemical, and biological phenomena impacting ecosystem maintenance, mitigation, and rehabilitation for Army lands. Evaluate changes in endangered bats' hearing sensitivity due to shock wave pressure associated with Army test and training ranges. In FY06, will determine viable population levels of threatened and endangered species, as affected by the genetic diversity within populations, and quantify the amount of genetic exchange between populations due to habitat fragmentation. In FY07, will continue to establish a basic understanding of physical, chemical, and biological phenomena specific to ecosystem maintenance, mitigation, and rehabilitation.	1389	1380	1435	1492
Totals	4501	4473	4650	4835