ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2 Exhibit)

February 2006

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

	COST (In Thousands)	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	164449	173533	137568	141819	143742	143434	144323
305	ATR RESEARCH	1213	1181	1216	1326	1341	1353	1363
31B	INFRARED OPTICS RSCH	2317	2259	2328	2540	2576	2600	2619
52C	MAPPING & REMOTE SENS	2387	2311	2380	2662	2696	2720	2741
53A	BATTLEFIELD ENV & SIG	2797	2709	2790	2917	2992	3018	3042
74A	HUMAN ENGINEERING	2747	2674	2754	2984	3025	3052	3076
74F	PERS PERF & TRAINING	2587	2535	3476	2508	2511	2534	2557
F20	ADV PROPULSION RSCH	2040	1996	2056	2236	2230	2252	2270
F22	RSCH IN VEH MOBILITY	491	475	490	549	557	561	566
H42	MATERIALS & MECHANICS	2039	1983	2043	2215	2245	2264	2283
H43	RESEARCH IN BALLISTICS	5959	6645	6839	6390	6341	6387	6423
H44	ADV SENSORS RESEARCH	3842	3743	3855	4174	4242	4281	4313
H45	AIR MOBILITY	2072	1996	2056	2313	2346	2366	2385
H47	APPLIED PHYSICS RSCH	2648	2603	2680	2879	2928	2956	2980
H48	BATTLESPACE INFO & COMM RSC	5504	5366	6527	6022	6032	6089	6138
H52	EQUIP FOR THE SOLDIER	1057	1030	1061	949	960	969	978
H57	SCI PROB W/ MIL APPLIC	55051	57433	61156	62843	63472	63923	64226
H66	ADV STRUCTURES RSCH	1518	1485	1530	1655	1675	1692	1705
H67	ENVIRONMENTAL RESEARCH	1484	775	798	822	906	915	921
H68	PROC POLLUT ABMT TECH	364	356	367	419	425	428	432
S04	MIL POLLUTANT/HLTH HAZ	616	599	617	698	710	716	721
S13	SCI BS/MED RSH INF DIS	9686	9449	9614	10579	10908	10247	10313
S14	SCI BS/CBT CAS CARE RS	4141	4046	4128	4552	4700	4420	4447
S15	SCI BS/ARMY OP MED RSH	5783	5650	6287	6367	6537	6246	6286
S19	T-MED/SOLDIER STATUS	643	645	664	725	753	717	731
T14	BASIC RESEARCH INITIATIVES - AMC (CA)	31045	37852	0	0	0	0	0
T22	SOIL & ROCK MECH	1970	1901	1957	2188	2217	2236	2252

T23	BASIC RES MIL CONST	1608	1558	1606	1812	1836	1853	1865
T24	SNOW/ICE & FROZEN SOIL	1291	1273	1312	1433	1446	1460	1471
T25	ENVIRONMENTAL RES-COE	4471	4351	4981	5062	5135	5179	5219
T59	PREDICTION OF LAND-ATMOSPHERE INTERACTIONS	1342	0	0	0	0	0	0
T60	BRAIN IMAGING RESEARCH	3736	1233	0	0	0	0	0
T61	Basic Research Initiatives - MRMC (CA)	0	5421	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 warfighting 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 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 (MRMC) laboratories; and 4) the Army Research Institute for Behavioral and Social Sciences (ARI). The basic research program is coordinated with the other Services via Defense Science & Technology Reliance (Defense Basic Research Advisory Group), 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 technologies that can significantly improve joint war fighting capabilities. The projects in this Program Element involve basic research efforts directed toward providing fundamental knowledge that will contribute to 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 Defense Basic Research Plan (DBRP). 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 2006)	163443	137898	142898
Current BES/President's Budget (FY 2007)	164449	173533	137568
Total Adjustments	1006	35635	-5330
Congressional Program Reductions		-7765	
Congressional Rescissions		-1750	
Congressional Increases		45150	
Reprogrammings	1006		
SBIR/STTR Transfer			
Adjustments to Budget Years			-5330

Seventeen FY06 Congressional adds totaling $45150 were added to this PE.

FY06 Congressional adds with no R-2A (appropriated amount is shown):
($3500) Advanced Carbon Nanotechnology Program
($1000) Advanced Ground Vehicle Reliability Research
($2300) Advanced Research and Technology Initiative
($1000) Advanced Portable Power Institute
($1000) Biological Raman and Optical Imaging Program
($1250) Brain Imaging and Deception Detection Research
($5500) Cyber TA
($2100) Desert Research Institute Desert Terrain Analysis for Enhancing Military Operations
($3500) Document Exploitation Technology Upgrade
($1800) Functionally Integrated Reactive Surfaces Technology Program
($1000) Knowledge Integration and Management Center of Excellence
($4500) Neurochemically-Based Mood Disorders
($4100) Optical Technologies Research
($6800) PASIS (Perpetually Assailable and Secure Information Systems)
($1000) Plastic-bone Artificial Bone Graft Development
($3400) Technology Commercialization and Management Network
($1400) Terrain Processes Research to Optimize Battlefield Operations

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February 2006

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

COST (In Thousands)	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
305 ATR RESEARCH	1213	1181	1216	1326	1341	1353	1363

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 Defense Basic Research Plan (DBRP). Work in this project is performed by the Army Research Laboratory (ARL).

Accomplishments/Planned Program	FY 2005	FY 2006	FY 2007
- Investigate new algorithms to improve unaided target detection and identification. In FY05, devised detection and tracking algorithms based on FLIR video, incorporated other sensors to complement single sensor ATR algorithms, investigated new methods of feature extraction and classification algorithms, and studied 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, and research and investigate the performance of new algorithm concepts and methods, such as kernel methods, to determine if there can be improvement in performance and reduction of false alarms. 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 hyperspectral imagery () algorithms for target detection and classification.	1213	1181	1216
Total	1213	1181	1216

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February 2006

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

COST (In Thousands)	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	2317	2259	2328	2540	2576	2600	2619

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 not only own the night but also dominate it. 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 Defense Basic Research Plan (DBRP). Work is performed by the Army Research Laboratory (ARL).

Accomplishments/Planned Program	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 IR imaging systems to enable increased situational awareness in open and complex terrain; improvements in target detection, identification and discrimination; and enhanced IR countermeasure (IRCM) protection against missile threats. This research has direct application to Army ground vehicles, aviation platforms, weapon systems, and the individual Soldier. In FY05, paved the way for producing state of the art imaging systems by investigating advanced IR materials and devices that will result in enhanced performance, reduced cost and logistics support for IR FPAs. Fabricated and evaluated medium wave IR (MWIR) FPA made of Type II superlattice material for high background applications. Evaluated Long Wave IR (LWIR) FPA made of Mercury Cadmium Telluride (MCT) detectors fabricated on lower cost Silicon (Si) substrates. Designed narrow and broadband large format LWIR FPAs from of lower cost Quantum Well Infrared Photodetectors (QWIP). Designed, modeled and fabricated IR waveguides incorporating photonic crystal structures and MEMs reconfigurability. Fabricated IR cascade lasers for IRCM systems with improved thermal performance for continuous wave operation at higher operating temperatures. In FY06, will investigate active IR materials and devices that will result in higher power output and increased IRCM protection against missiles. Will evaluate LWIR and MWIR FPAs made of Type II superlattice and high efficiency QWIPs. Will fabricate large format LWIR MCT detectors on Si. Will research wavelength beam combined IR lasers for IRCM systems. Will design high operating temperature IR detectors out of MCT and III-V semiconductor material. In FY07, will investigate high power IR lasers for IRCM and chem/bio sensing applications. Research dynamic IR photonic-crystal waveguides for control of Radio Frequency signals.	2317	2259	2328
Total	2317	2259	2328

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

COST (In Thousands)	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	2387	2311	2380	2662	2696	2720	2741

A. Mission Description and Budget Item Justification: The objective of this basic research project is to increase knowledge of the terrain with a focus on improving the generation, management, analysis/reasoning, and modeling of geospatial data, and 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 characterize 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 improve 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 Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the Defense Basic Research Plan (DBRP). The U.S. Army Engineer Research and Development Center, headquartered at Vicksburg, Mississippi, executes the project work.

Accomplishments/Planned Program	FY 2005	FY 2006	FY 2007
Sensor Phenomenology - In FY05, conducted multi-image manipulation experiments, and contrast and special feature manipulation experiments. 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 FY05, experimented with prototype capabilities for identifying biological hazards in water and tested polymer(s) in soil and water for photon recovery and target selectivity. Experimented with flourophores energy emission to trigger an electronic circuit powering a very small geo-location 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 FY05, investigated and analyzed critical measurement values for selection of Maneuver Course of Action (MCOA) solutions. In FY06, will investigate techniques for designing MCOA decision tools, and evaluate spatial-temporal knowledge-discovery concepts and models. In FY07, will investigate battlespace environment impacts on human decision making to support decision tool development, experimentation and simulations of spatial-temporal knowledge discovery models.	2387	2311	2380
Total	2387	2311	2380

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

COST (In Thousands)	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	2797	2709	2790	2917	2992	3018	3042

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 Defense Basic Research Plan (DBRP). Work in this project is performed by the Army Research Laboratory (ARL).

Accomplishments/Planned Program	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 FY05, improved technologies that better quantify optical turbulence and characterize its different effects on performance of imaging sensors in battlefield environments. Performed 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.	1726	1653	1724
- 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 FY05, investigated new methods to determine the accuracy of small scale/limited domain models. Improved Army tactical urban meteorology modeling to include simplified physics and parametric micro-scale models that can account for mean transport and dispersion around individual structures. In FY06, will formulate new methods for use of improved near real-time three-dimensional environmental models 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.	1071	1056	1066
Total	2797	2709	2790

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February 2006

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

COST (In Thousands)	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
74A HUMAN ENGINEERING	2747	2674	2754	2984	3025	3052	3076

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 Defense Basic Research Plan (DBRP). Work in this project is performed by the Army Research Laboratory (ARL).

Accomplishments/Planned Program	FY 2005	FY 2006	FY 2007
- Research to improve soldier auditory performance. In FY05, examined the effects of nonlinear hearing protection on soldier auditory performance in the presence of impulse noise. Investigated and transitioned 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 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.	1591	1474	1548
- Research to assess, predict, and improve soldier performance. In FY05, investigated task performance and readiness as predictors of Soldier multimodal input and processing capacity in the field. 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.	1156	1200	1206
Total	2747	2674	2754

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

COST (In Thousands)	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	2587	2535	3476	2508	2511	2534	2557

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; understanding the role of emotions in regulating behavior; and improving the match between Soldier skills and their jobs to optimize performance. Research is focused on fundamental issues that are likely to improve the Army's capability to: (1) select, classify, train, and/or develop Soldiers and leaders who are adaptable in novel missions and operational environments, can function effectively in digital, information rich, and semi-autonomous environments, can effectively collaborate in quickly formed groups and when distributed in high stress environments, and possess interpersonal and intercultural skills/attributes relevant to joint-service and multi-national operations; (2) accelerate the training of leadership, interpersonal and emotional skills that traditionally develop over long periods of time and through direct experience; and (3) support the Army's new Network Science initiative by focusing on the human cognitive and social domains - understanding individual, unit, and organizational behavior within the context of complex networked environments - that will be essential for synergy between technology and human performance. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the Defense Basic Research Plan (DBRP). This project is managed by the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI).

Accomplishments/Planned Program	FY 2005	FY 2006	FY 2007
In FY05, identified key individual differences, team characteristics, and learning processes that predicted individual and team knowledge and skills needed for adaptive performance; and assessed spatial and temporal memory in electronic environments; developed test of mental flexibility. In FY06, will develop models of basic human emotions using genetic algorithms; 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 affect emotion-behavior linkages. In FY07, will examine the human dimensions for optimizing training and performance for complex tasks; investigate methods for accelerating leader development; identify and model the development and relationships among the psychological, demographic and motivational factors that influence recruit enlistment, Soldier retention, productivity, and citizenship.	2587	2535	2476
In FY07, as part of the Army's new initiative in Network Science, will begin research on human networks with a focus on cognitive and social domains (research focused on individual, unit, and organizational behavior in context of networked environments). This work will be conducted in collaboration with researchers at the Army's University Affiliated Research Centers, the Institute for Creative Technology at the University of Southern California, and the Institute for Collaborative Biotechnology at the University of California - Santa Barbara.	0	0	1000
Total	2587	2535	3476

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

COST (In Thousands)		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	2040	1996	2056	2236	2230	2252	2270

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 Defense Basic Research Plan (DBRP). Work in this project is performed by the Army Research Laboratory (ARL).

Accomplishments/Planned Program	FY 2005	FY 2006	FY 2007
In FY05, investigated ceramic materials processing and life prediction methods for high temperature engines; assessed novel propulsion concepts for UAVs; investigated the influence of gear tooth surface treatments on gear operation after the loss-of-lubrication; evaluated oil-free foil air bearing misalignment tolerance limits and effects of ambient pressure on bearing performance. In FY06, evaluate diagnostics techniques for hybrid bearings (ceramic rolling elements with steel races); complete fatigue life 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.	2040	1996	2056
Total	2040	1996	2056

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

COST (In Thousands)	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
H42 MATERIALS & MECHANICS	2039	1983	2043	2215	2245	2264	2283

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 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 FY05, showed specific multifunctional performance gains in power generating structures and assessed survivability gains that can be realized using novel photonic materials; examined nano-particle relationships between particle size and morphology for nano-systems synthesized in FY04; performed shock/re-shock/lateral release experiments on relevant armor ceramics to incorporate damaged material parameters into continuum codes and conducted benchmark analyses using new damage models; incorporated 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.	2039	1983	2043
Total	2039	1983	2043

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2006

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

COST (In Thousands)	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	5959	6645	6839	6390	6341	6387	6423

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 Defense Basic Research Plan (DBRP). Work in this project is performed by the Army Research Laboratory (ARL).

Accomplishments/Planned Program	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 FY05, employed 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.	3665	3766	4086
- 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 FY05, advanced understanding of damage evolution in ceramic materials and model penetration through advanced ceramic armor, captured the observed material response for each phase of penetration; incorporated a model for adiabatic shear into simulations of armor/anti-armor interactions and compared with ballistic experiments; and proved 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, will 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. In FY07, will prove ability to accurately depict the degradation of ceramic materials in the terminal effects environment; apply the generalized fracture framework to simulate failure penetrators.	2294	1943	2153
- Extramural research in non-lethal (NL) control methods to exploit potentially innovative approaches that offer unique battlefield and homeland defense capabilities. In FY06, will conduct research in NL Directed Energy Stimuli/Exposure, RF, Laser, NL Directed Energy Weapons, material, counter-capability missions and various NL flight body & new NL munition payloads for long range remote engagement; and other NL reactants. In FY07, conduct research analysis of precision targeting, and blunt impact issues, new	0	936	600

technologies and payloads, development of compact mm-wave and high powered microwave denial systems.			
Total	5959	6645	6839

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2006

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

COST (In Thousands)	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	3842	3743	3855	4174	4242	4281	4313

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 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 FY05, investigated hand-held laser communication applications; and performed 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.	1537	1498	1544
- Research focused on improving sensor capabilities to create more survivable/secure systems and displays, and improved environmental monitoring. In FY05, developed improvements to ultra wideband (UWB) synthetic aperture radar (SAR) image formers to mitigate effects of uncompensated motion and high levels of radio frequency interference. Investigated Electron Beam Lithography (EBL) technology for generation of advanced Surface Enhanced Raman Scattering (SERS) substrates; explored efficient signal processing algorithms for data fusion and networks of sensors of various modalities; made 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 Quantum Cryptographic (QC) test beds and new areas in quantum information processing, and investigate and report on sensitivity of magnetic field sensors. Will optimize fabrication parameters of EBL substrates for maximum SERS efficacy, 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,	2305	2245	2311

personnel detection, and arms cache location to include multi-static, airborne and ground-based sensor array configurations. Will collaborate with RDEC partners in performing QC test bed and networking studies, and assess transitionability of QC systems to future combat systems. Will procure and adapt commercially available Raman instrumentation for use in coordination with SERS substrate technology Research decentralized signal processing for ad-hoc sensor networks and report results.			
Total	3842	3743	3855

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2006

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

COST (In Thousands)	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	1996	2056	2313	2346	2366	2385

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 2005	FY 2006	FY 2007
In FY05, conducted rotor test to study the off-axis stability to increase helicopter handling quality. Conducted test to measure the Reynolds stress of the synthetic jet for blunt body drag reduction. In FY06, investigate rotor-induced power at high advance ratio flight and explore new acoustic prediction code for flight maneuvering. In FY07, will research unsteady aerodynamics for flapping wing for micro UAV. Will conduct water channel test to validate the unsteady aerodynamics for flapping wing theory.	2072	1996	2056
Total	2072	1996	2056

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2006

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

COST (In Thousands)	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	2648	2603	2680	2879	2928	2956	2980

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 Defense Basic Research Plan (DBRP). Work is performed by the Army Research Laboratory (ARL).

Accomplishments/Planned Program	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 FY05, synthesized and evaluated high energy phosphate cathode materials for Lithium (Li)-ion cells; evaluated catalysts for fuel processing for fuel cells; examined gallium nitride (GaN) structures and ohmic contacts for transition to efficient device designs, and reduced the surface roughness in Silicon Carbide (SiC) Metal-Oxide Semiconductor Field Effect Transistor (MOSFET) device structures to improve performance; and researched 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 Schottky (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. Will Explore oxidation stable electrolytes for Li ion batteries and investigate a catalyst for sulfur removal from diesel fuel. In FY07, will evaluate the improved SiC and GaN devices in test circuits; and advance and validate initial versions of atom chip beam splitter designs. Will explore highly reversible electrode materials for fast charge of Li ion batteries, design efficient air electrodes for lithium/oxygen cells, and explore sulfur tolerant catalyst for logistic fuel reformation.	2648	2603	2680
Total	2648	2603	2680

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2006

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

COST (In Thousands)	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	5504	5366	6527	6022	6032	6089	6138

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. This research supports the Army's new Network Science initiative and in the process addresses the areas of information assurance, and the related signal processing for wireless battlefield communications, along with machine translation and 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 produce highly relevant tactical events for mounted/dismounted commanders/leaders/soldiers, improve the timeliness, quality and effectiveness of actions and, in the long run, speed the decision-making process of small teams operating complex or urban terrain. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the Defense Basic Research Plan (DBRP). Work in this project is performed by the Army Research Laboratory (ARL).

Accomplishments/Planned Program	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 FY05, enhanced signal processing for smart radios, coupled with network protocols providing intelligent multiple radio coexistence and radio frequency spectrum reuse, enabling 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.	1554	1514	1565
- 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 FY05, devised analytical techniques to interface soldiers and robotic-based sensor elements in a seamless manner within a net-centric service oriented architecture. In FY06, will develop algorithms to detect tactical behaviors through mining for patterns/events over time/space and begin 3D scene reconstruction using geometry/texture from a moving robotic platform. In FY07, will perform laboratory experiments, evaluate and enhance agent generated patterns/events algorithms to refine and optimize algorithms for 3D scene reconstruction from a robotic platform.	1381	1336	1376
- 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 FY05, constructed and populated tactical environmental assurance lab for mobile ad hoc networks (MANET); and evaluated and implemented selected best of breed security services and embedded authentication services for unattended static and mobile sensor networks deployed 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.	1603	1554	1581

- Design and implement a laboratory scale common information-processing infrastructure that commanders and troops can use to bridge language barriers in order to anticipate adversaries' behaviors and collaborate with allies. In FY05, extended language translation capabilities from printed text to voice capability and conducted 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. In FY07, will refine and optimize algorithms for automated language identification of speech and document machine translation.	966	962	1005
- Beginning in FY07, will study the behavior of Mobile Ad Hoc Networks (MANETs) as part of the Army's new initiative on Network Science. Emphasis will be on highly efficient communications networks in biological systems in collaboration with the researchers at the Army's University Affiliated Research Center, the Institute for Collaborative Biology, at the University of California - Santa Barbara.	0	0	1000
Total	5504	5366	6527

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2006

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

COST (In Thousands)		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	1057	1030	1061	949	960	969	978

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 core technology areas that include mathematical modeling, physical and cognitive performance, polymer science/textile technology, nanotechnology, biotechnology and combat ration research. Effort is targeted on enhancing the mission performance, survivability, and sustainability of the Soldier by advancing the state-of-the-art in the sciences underlying human performance, clothing and protective equipment to defend against battlefield threats and hazards such as ballistics, chemical agents, lasers, environmental extremes, and ration 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 Defense Basic Research Plan (DBRP). Work in this project is performed by the US Army Natick Soldier Center, Natick, MA.

Accomplishments/Planned Program	FY 2005	FY 2006	FY 2007
In FY05, determined independent effects of load distribution and principal moments of inertia on the biomechanics of gait and performance. Completed data analysis of nutrient effects on cognitive performance during severe cold stress. In FY06, will examine effect of the interaction between center of mass location and principal moments of inertia on human biomechanics; improve understanding of thermoregulatory and other factors affecting warfighter appetite; and examine energy conversion and thermal behavior of selected nanomaterials of potential value in Soldier sustainment. In FY07, will perform basic research on nanocomposite fibers for advanced textiles; and will examine effects of warfighter attitude and perceptions on behavior and performance.	1057	1030	1061
Total	1057	1030	1061

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2006

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

COST (In Thousands)		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	55051	57433	61156	62843	63472	63923	64226

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), environmental sciences (atmospheric and terrestrial sciences), and the Army's new initiative - Network Science. 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 Defense Basic Research Plan (DBRP). Work in this project is performed extramurally by the Army Research Laboratory (ARL).

Accomplishments/Planned Program	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 FY05, seek increased understanding of mechanisms of pathogenicity to combat terrorism and to aid in CB detection through intervention of organisms that cause disease; used 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; and 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.	5550	6027	6624
- Basic research in chemical sciences for advanced power generation, propellants, and protective materials. In FY05, expanded research in computational electrochemistry for electrochemical power sources; explored the physics of operating molecular machines for CBD, signature management and laser protection; and devised 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.	5800	6304	6597
- Basic research in physics for precision guidance, superior optics and signature management properties and secure communications In FY05, devised a theory for relativistic quantum information for use in assessing advanced Global Positioning System (GPS) and quantum	7965	8735	8771

computing protocols; determined 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; and 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.			
- Basic research in communications and electronics for unmatched networked Command Control Communications Computing Intelligence Surveillance and Reconnaissance (C4ISR) capabilities. In FY05, explored 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; and 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.	11630	12844	13340
- Basic research in mechanical and material sciences for survivable armor and more lethal anti-armor, improved mobility, and flexible displays for soldier systems. In FY05, devised wafer-scale fabrication techniques to manufacture microturbines at reduced costs; fabricated micro-rocket engines from previous advances in microturbine research; conducted 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; and 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.	14790	13274	12933
- Basic research in mathematical and computer sciences as the backbone for complex, multi-system analysis, modeling and simulation, and information systems. In FY05, devised 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 integrated 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.	9316	10249	10891
- Basic research to gain an understanding of the fundamental aspects of how networks develop, function and adapt to environmental pressures and the rate of information flow across the network in manmade and naturally occurring networks. In FY07, perform research aimed at developing theoretical models that can explain and predict network behavior.	0	0	2000
Total	55051	57433	61156

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2006

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

COST (In Thousands)		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	1518	1485	1530	1655	1675	1692	1705

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 Defense Basic Research Plan (DBRP). Work in this project is performed by the Army Research Laboratory (ARL).

Accomplishments/Planned Program	FY 2005	FY 2006	FY 2007
In FY05, characterized performance of advanced active twist rotor blade; investigated rotorcraft Computational Fluid Dynamic (CFD) modeling techniques to improve multi-body rotor aeroelastic modeling and simulation; investigated 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; and explore advanced concepts for lightweight, highly tailored and multi-functional composite structures using embedded sensors/actuators.	1518	1485	1530
Total	1518	1485	1530

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2006

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

COST (In Thousands)		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	9686	9449	9614	10579	10908	10247	10313

A. Mission Description and Budget Item Justification: This project supports focused research that provides 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. The Army is the lead service for infectious disease research, and work in this project is managed by the U.S. Army Medical Research and Materiel Command. 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 (WRAIR), Silver Spring, MD, and its overseas laboratories; U.S. Army Medical Research Institute of Infectious Diseases, Fort Detrick, MD; and the Naval Medical Research Center (NMRC), Silver Spring, MD, and its overseas laboratories.

Accomplishments/Planned Program	FY 2005	FY 2006	FY 2007
In FY05, enhanced and integrated techniques to exploit genomic information for vaccine and drug discovery efforts. Screened several thousand drugs using a malaria parasite target-directed functional assay for antimalarial activity coupled with computer based rational drug design technologies to provide early safety and stability assessment. Sequenced in partnership with consortium partners the entire genome of P. vivax and completed characterization of P. falciparum proteome. In FY06, continue to screen drug inventory and drug libraries for new classes of drugs against malaria; design new drug and vaccine candidates against malaria for optimization and animal testing. In FY07, will assess new genomic/proteomic (study of protein expression and function) technologies to identify new approaches to prevent malaria including better targets to be used for vaccine and drug discovery and evaluate alternative drug delivery systems; and refine new drug activity and evaluate malaria targets for inclusion in vaccine program.	4289	3080	4342
In FY05, refined field site assessment for diarrheal vaccine testing suitability, including showing that causal agents differ greatly between countries in the Middle East. Studied genetic diversity of diarrhea-causing strains including showing that most Campylobacter strains differed in their gene expression profile, but were still equally infectious. In FY06, 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.	669	686	778
In FY05, determined dengue virus incidence rates and identified possible field sites for testing dengue vaccines in Iquitos, Peru, and Maracay, Venezuela. Generated a Lassa virus infection model in mice providing a valuable tool for characterizing the cellular immune response to the virus, and identified several antiviral reagents for potential to treat Lassa fever. In FY06, identify viral and host cellular factors that determine the outcome of dengue virus infection and study the immunological mechanisms of protection in dengue. In FY07, will study host-virus interactions between different dengue viruses that may affect vaccine strategies.	1601	1501	1266
In FY05, evaluated effectiveness of integrated dengue vector preventive medicine control system in Central and South America and Thailand that included finding a superior trap for capturing mosquitoes. Assessed approaches to sand fly control. Found current bednet ineffective in protecting against sand flies. In FY06, enhance Web-based insect vector identification resources and expand range of insect-borne diseases detected by current and new test systems. In FY07, will move insect-based disease tests to the concept exploration phase.	2036	3098	2440

In FY05, identified approaches to supplement infectious disease diagnostics such as point of care diagnostics. In FY06, evaluate a multiplexed real-time polymerase chain reaction (PCR, a technique to exponentially expand specific portions of DNA) for the detection and identification of rickettsial and other diseases of military importance. In FY07, will assess reagents for potential use in diagnostics systems.	1091	1084	788
Total	9686	9449	9614

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February 2006

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

COST (In Thousands)		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	4141	4046	4128	4552	4700	4420	4447

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 (WRAIR), Silver Spring, MD, and the U.S. Army Institute of Surgical Research (USAISR), Fort Sam Houston, TX.

Accomplishments/Planned Program	FY 2005	FY 2006	FY 2007
In FY05, evaluated brain cooling to preserve brain tissue and function after penetrating brain injury (PBI); evaluated molecular mechanisms in response to a PBI; conducted early preclinical screening studies to select candidate compounds that may block effects of severe blood loss; defined the impact of stabilizing body potassium concentrations on casualty survival; identified markers of resuscitation failure due to hemorrhage; and attained regulatory approval for and completed studies in accelerating soft-tissue wound healing. Continued basic research collaboration efforts with the National Heart, Lung, and Blood Institute (NHLBI). In FY06, evaluate molecular mechanisms in response to PBI following neuroprotective drug treatment; identify and characterize agents for accelerating soft-tissue wound healing; investigate results of treatment to reduce hemorrhage-induced tissue damage; and 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 will continue basic research collaboration efforts with NHLBI.	4141	4046	4128
Total	4141	4046	4128

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2006

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

COST (In Thousands)		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	5783	5650	6287	6367	6537	6246	6286

A. Mission Description and Budget Item Justification: This project supports research for healthy, medically protected soldiers for the Future Force, including delineation of injury, sustainment, and enhancement of the physiological and psychological capabilities of military personnel under combat operations in all environments. 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, including development of medical countermeasures to sustain performance when the opportunity for adequate rest is impaired or impossible due to combat conditions. 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. The six main thrust areas are (1) nervous system regulation of stress and cognition, (2) metabolic regulation, (3) control of regional blood flow, (4) oxidative stress interventions, (5) tissue remodeling/plasticity, and (6) 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 (WRAIR), Silver Spring, MD; U.S. Army Research Institute of Environmental Medicine (USARIEM), Natick, MA; and the U.S. Army Aeromedical Research Laboratory (USAARL), Fort Rucker, AL.

Accomplishments/Planned Program	FY 2005	FY 2006	FY 2007
In FY05, applied proteomic and genomic evaluations to characterize laser injury mechanism and treatment responses. In FY06, identify mechanism of laser-induced retinal injuries that result in secondary effects, such as retinal detachment. In FY07, will extend findings of retinal injury mechanisms to animal models.	1933	1494	1936
In FY05, conducted studies on sleep genomics in collaboration with extramural genomics researchers. In FY06, explore genomic basis of individual differences in resilience during sleep deprivation. In FY07, will mature a model of key determinants of individual fatigue resistance.	1980	2680	1984
In FY05, evaluated projected Future Force Warrior (FFW) factors that increase cold strain and adversely impact performance during cold-weather operations. In FY06, evaluate countermeasures to sustain performance in cold weather. In FY07, will mature models and software applications for predicting cold strain and cold-weather performance during wet/water-borne conditions in fatigued Soldiers.	1870	1476	1867
In FY07, will begin development of computational systems to model biological networks, such as genomic, proteomic or neuronal networks, in support of the Army's new initiative in Network Science. This work will be conducted in collaboration with researchers at the Institute for Collaborative Biotechnology, an Army University Affiliated Research Center.	0	0	500
Total	5783	5650	6287

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

COST (In Thousands)		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	1970	1901	1957	2188	2217	2236	2252

A. Mission Description and Budget Item Justification: The objective of this basic research project is to create 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 Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the DoD Basic Research Plan (BRP). The U.S. Army Engineer Research and Development Center, headquartered at Vicksburg, Mississippi, executes the project work.

Accomplishments/Planned Program	FY 2005	FY 2006	FY 2007
Military Engineering Basic Research - In FY05, investigated the microstructure of a soil system using micro-electrical mechanical sensors. Investigated signal processing techniques that exploit electromagnetic profile inversion to improve anomaly (mine) detection. In FY06, will identify and characterize the magnetic properties of soils that can mask the detection of mines and unexploded ordnance and 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; and wil produce concept for low-velocity probe that could provide capability to remotely determine soil properties.	1970	1901	1957
Total	1970	1901	1957

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

COST (In Thousands)	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	1608	1558	1606	1812	1836	1853	1865

A. Mission Description and Budget Item Justification: The objective of this basic research project is to support facilities research initiatives: forming an explicit and mathematically robust set of algorithms for geometrical reasoning; assessing the conceptual feasibility of applying nanoparticle technology to real-time sensors, thermal conductivity, and high strength materials; and developing novel and advanced concepts for mitigating the effect of chemical and biological 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. This project provides 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 Energy Technology Applied to Military Facilities. 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). The U.S. Army Engineer Research and Development Center, headquartered at Vicksburg, Mississippi, executes the project work.

Accomplishments/Planned Program	FY 2005	FY 2006	FY 2007
Facilities Research - In FY05, formulated optimization algorithms suitable for rapid and flexible design of the continuum of facilities needed by the Future Force. Determined the conceptual feasibility of using electrokinetic techniques to generate anion and cation species that form biocide films that are lethal to airborne pathogens. Used an organic dye-based optical system that produces light with wavelengths that are bacteria-specific for the detection of bacterial simulants for biological warfare agents. In FY06, will investigate the efficiency of mechanisms in a semi-conducting optical system to detect and quantify simulants for spores, such as anthrax. Will complete experimental measurements of anomalous enhanced thermal conductivity using carbon nanotube (CNT) nanoparticles. In FY07, will develop physics based constitutive equations for heat transfer of fluids containing CNT nanoparticles. Will mature molecular level design tool for CNT reinforced composite materials.	1608	1558	1606
Total	1608	1558	1606

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February 2006

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

COST (In Thousands)		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	1291	1273	1312	1433	1446	1460	1471

A. Mission Description and Budget Item Justification: The objective of this basic research project is to increase knowledge in the areas of 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 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). The U.S. Army Engineer Research and Development Center, headquartered at Vicksburg, Mississippi, executes the project work.

Accomplishments/Planned Program	FY 2005	FY 2006	FY 2007
Terrain State and Signature Physics - In FY05, established effects of buildings and barriers on acoustic-seismic propagation in urban settings and defined the turbulence and topographic roughness interaction for acoustic signals. Established an understanding of pavement mechanical properties and pavement degradation processes as a function of soil, pavement type, and moisture-temperature variations. Investigated 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.	1291	1273	1312
Total	1291	1273	1312

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2006

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

COST (In Thousands)	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	4471	4351	4981	5062	5135	5179	5219

A. Mission Description and Budget Item Justification: The objective of this basic research project is to investigate fundamental scientific principles and phenomena necessary to ensure efficient development of the technologies needed to address Army sustainment 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 neutralization of organics in water, soil and sediments resulting 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; reducing pollution associated with military activities; and study ecosystem genomics and proteomics in support of the Army's new Network Science initiative. 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 Defense Basic Research Plan (DBRP). The U.S. Army Engineer Research and Development Center, headquartered at Vicksburg, Mississippi, executes the project work.

Accomplishments/Planned Program	FY 2005	FY 2006	FY 2007
Environmental and Ecological Fate of Explosives, Energetics, and Other Contaminants - In FY05, correlated molecular spectral characteristics with computational chemistry to determine the affinity of contaminants to produce fast forming less toxic chemical byproducts, and correlated biosensor response to explosive additions as a function of soil condition. In FY06, will determine the potential mechanisms of toxicity and sub-lethal effects of individual and interactive mixtures of explosives. Will use bioinformatics (computational biology) as the basis for constructing Deoxyribonucleic Acid (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. As part of the Network Science initiative, will initiate research to gain fundamental knowledge of ecosystem genomic and proteomic issues to understand how ecosystems form and maintain robust communication networks to ensure survival of their members; this research will be done in collaboration with researchers at the Army's University Affiliated Research Center, the Institute for Collaborative Biology at the University of California - Santa Barbara.	1480	1440	1950
Remediation of Explosives, Energetics, and UXO - In FY05, described propellant attenuation on ranges via the management of natural soil cycles. Pursued in situ explosive biodegradation mechanisms and direct analysis methods to identify explosives degradation mechanisms of contaminated soils. Began characterization of explosive degrading microbial communities using molecular methods. 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. Will continue characterization of explosive degrading microbial communities using molecular methods. In FY07, will continue to establish a basic understanding of physical, chemical, and	1611	1568	1628

biological phenomena specific to contaminant mineralization.			
Training Land Natural Resources - In FY05, described physical, chemical, and biological phenomena impacting ecosystem maintenance, mitigation, and rehabilitation for Army lands. Evaluated 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.	1380	1343	1403
Total	4471	4351	4981