ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2 Exhibit)

February 2007

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

	COST (In Thousands)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
	Total Program Element (PE) Cost	172510	170122	137676	141423	141597	142349	145609	149014
305	ATR RESEARCH	1172	1202	2251	2305	2353	2363	2393	2424
31B	INFRARED OPTICS RSCH	2248	2105	2441	2541	2585	2589	2632	2670
52C	MAPPING & REMOTE SENS	2287	2156	2641	2691	2720	2741	2801	2863
53A	BATTLEFIELD ENV & SIG	2707	2561	2835	2987	3018	3022	3059	3122
74A	HUMAN ENGINEERING	2669	2525	2961	3020	3052	3071	3144	3213
74F	PERS PERF & TRAINING	2475	3338	3481	3505	3534	3557	3613	3671
F20	ADV PROPULSION RSCH	1996	1935	2198	2253	2252	2260	2290	2342
F22	RSCH IN VEH MOBILITY	468	484	545	556	561	566	578	591
H42	MATERIALS & MECHANICS	1983	2020	2198	2253	2309	2362	2408	2472
H43	RESEARCH IN BALLISTICS	6536	5775	6142	6130	6187	6223	6364	6509
H44	ADV SENSORS RESEARCH	3708	3516	4023	4185	4281	4313	4363	4505
H45	AIR MOBILITY	1959	1836	2295	2342	2366	2385	2437	2491
H47	APPLIED PHYSICS RSCH	2603	2453	2807	2873	2906	2930	2971	3063
H48	BATTLESPACE INFO & COMM RSC	5366	6158	6720	6870	6999	7038	7123	7261
H52	EQUIP FOR THE SOLDIER	1030	1049	942	958	971	994	1013	1041
H57	SCI PROB W/ MIL APPLIC	58285	59295	56840	58406	59416	59477	61104	62566
H66	ADV STRUCTURES RSCH	1485	1513	1619	1659	1700	1740	1773	1820
H67	ENVIRONMENTAL RESEARCH	772	740	816	904	915	921	941	962
H68	PROC POLLUT ABMT TECH	352	363	416	424	428	432	442	451
S04	MIL POLLUTANT/HLTH HAZ	591	611	693	709	716	721	737	753
S13	SCI BS/MED RSH INF DIS	9345	8518	10497	10889	10247	10313	10540	10772
S14	SCI BS/CBT CAS CARE RS	3996	3687	4517	4692	3990	4007	4097	4185
S15	SCI BS/ARMY OP MED RSH	5623	5773	6318	6525	6246	6336	6524	6716
S19	T-MED/SOLDIER STATUS	626	608	719	752	717	731	747	764
T14	BASIC RESEARCH INITIATIVES - AMC (CA)	36805	34070						

T22	SOIL & ROCK MECH	1889	1787	2171	2213	2236	2252	2302	2352
T23	BASIC RES MIL CONST	1532	1440	1649	1713	1753	1815	1876	1948
T24	SNOW/ICE & FROZEN SOIL	1273	1150	1422	1443	1460	1471	1503	1536
T25	ENVIRONMENTAL RES-COE	4259	4531	5519	5625	5679	5719	5834	5951
T60	BRAIN IMAGING RESEARCH	1199							
T61	Basic Research Initiatives - MRMC (CA)	5271	6923						

A. Mission Description and Budget Item Justification: This program element fosters fundamental scientific knowledge and contributes to the sustainment of US 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 US 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 and Technology Reliance (Defense Basic Research Advisory Group), 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 (PE)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 US Army Research Laboratory (ARL); the US Army Aviation and Missile Research, Development, and Engineering Center (AMRDEC); the US Army Natick Soldier Center (NSC), the Medical Research and Materiel Command (MRMC), the US Army Engineer Research and Development Center (ERDC), and the US Army Research Institute for the Behavioral and Social Sciences (ARI).

B. Program Change Summary	FY 2006	FY 2007	FY 2008	FY 2009
Previous President's Budget (FY 2007)	173533	137568	141819	143742
Current BES/President's Budget (FY 2008/2009)	172510	170122	137676	141423
Total Adjustments	-1023	32554	-4143	-2319
Congressional Program Reductions		-7650		
Congressional Rescissions				
Congressional Increases		41450		
Reprogrammings	-1023	-1246		
SBIR/STTR Transfer				
Adjustments to Budget Years			-4143	-2319

Twenty-three FY07 congressional adds totaling $39728 were added to this PE.

($2493) Advanced Carbon Nanotechnology Program
($3835) Advanced Research and Technology Initiative (ARTI)
($4793) PASIS (Perpetually Assailable and Secure Info Sys)
($1917) Optical Technologies Research
($2875) Functionally Integrated Reactive Surfaces Tech
($1534) Technology Commercialization and Mgmt Network
($3835) Cyber TA
($958) Document Exploitation Technology Upgrade
($1246) Terrain Processes Res to Optimize Battlefield OPS
($958) Biological Raman and Optical Imaging Program
($958) Army Landscape Dynamics Support Program
($958) Chemical Mechanical Planarization
($958) Flexible Electronics Tesearch Initiative
($958) Fuel Logistics Reduction Through Enhanced Eng Perf
($1869) Illicit Narcotics Lab Detection System
($958) Integrated Nanosensor Tech for NBC Detection Apps
($958) Nanomaterials for ISR
($958) Organic Semiconductor Modeling & Simulation Resch
($1438) Plasti-Bone Artificial Bone Graft Development
($958) Broad Spect Anti-Viral Host Oriented Therapeutics
($2492) Combat Mental Health Initiative

($863) Imaging Research Center for Research of Disorders
($958) Viral Biosensors

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

COST (In Thousands)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
305 ATR RESEARCH	1172	1202	2251	2305	2353	2363	2393	2424

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 including Tagging, Tracking, and Locating (TTL) of non-traditional targets. It is increasingly desirable to have Army systems that can act independently of the human operator to detect and track targets including clandestine tracking of non-cooperative 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 utilizing 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 (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 2006	FY 2007	FY 2008	FY 2009
Investigate new algorithms to improve unaided target detection and identification. In FY06, devised false alarm reduction and tracking algorithms for FLIR video, and conducted researched on the performance of new algorithm concepts and nonlinear methods, such as kernel methods, which were determined to improve performance and the reduction of false alarms. In FY07, 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. In FY08, will explore advanced methods for aided tracking via fusion of video modalities and detection likelihoods; investigate statistical algorithms for application in hyperspectral imagery; evaluate methods to classify tracked objects in color and FLIR video; and investigate novel nonlinear fusion methods for anomaly detection using hyperspectral and synthetic aperture radar (SAR). In FY09, will research novel behavior characterization algorithms for color and FLIR video; will research methods to develop ATR algorithms that exploit the fusion of disparate spatial views of a target for unattended ground sensor (UGS) network applications; and design advanced nonlinear band selection methods and implement new hyperspectral algorithms based on the selected bands.	1172	1193	1251	1305
Conduct basic research to support advances in state-of-the-art clandestine Targeting, Tracking, and Locating (TTL) for non-traditional hostile force and non-cooperative targets. Specific technical objectives, products, and deliverables are classified and in accordance with the Hostile Forces TTL Capabilities Development Document (HFTTL CDD) and the TTL Science and Technology Roadmap. This effort will directly support ARL's efforts in applied research and CERDEC's advanced research in clandestine TTL. It will be synchronized with the Micro Autonomous Systems and Technology (MAST) Collaborative Technology Alliance, also beginning in FY08. In FY08,			1000	1000

technologies to be investigated and researched will be extremely wide ranging and may include but are not limited to microtechnology, Micro Electro Mechanical System (MEMS), nanotechnology, quantum dot technology, aptamer based sensors, nanomicroencapsulation of taggants, hyperspectral imaging algorithms, biomimetics, and carbon nanotubes. Technologies that have potential to achieve the goals of clandestive TTL will be identified and research to mature these areas will be conducted. In FY09 technologies selected for further exploration will begin to be matured. This will include both device and algorithm development. Technologies that are of sufficient technology readiness will transition to applied research.				
Small Business Innovative Research/Small Business Technology Transfer Programs		9		
Total	1172	1202	2251	2305

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2007

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

COST (In Thousands)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
31B INFRARED OPTICS RSCH	2248	2105	2441	2541	2585	2589	2632	2670

A. Mission Description and Budget Item Justification: This project supports Army research in materials and devices for active and passive infrared (IR) imaging systems. This research aims to generate new technologies for unprecedented battlefield situational awareness and to continue the dominance of Army units during night operations. 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. This research has direct application to Army ground vehicles, aviation platforms, weapon systems, and the individual Soldier. Research is focused on material growth, detector and laser design, and processing for large area multicolor IR FPAs and interband cascade lasers. The principal efforts are directed towards novel materials for detectors and lasers, and investigating energy band-gap structures in semi-conductor materials 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 photonic-crystal waveguide structures to enable reconfigurable IR waveguide properties. Customized IR photonic 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 over 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 2006	FY 2007	FY 2008	FY 2009
The objective of this project is to support Army research in materials and devices for active and passive IR imaging systems to increase situational awareness in open and complex terrain; improve target detection, identification, and discrimination; and enhance IR countermeasure (IRCM) protection against missile threats. In FY06, researched IR laser materials and devised new laser devices that resulted in higher operating temperatures and output powers for increased protection against thermally guided missiles. Characterized the radiometric properties of large format medium-wave IR (MWIR) FPAs made of Type II superlattice and high efficiency Quantum Well Infrared Photodetectors (QWIPs). Designed, grew, and evaluated Long Wave IR (LWIR) Type II superlattice detectors. Fabricated large format LWIR Mercury Cadmium Telluride (MCT) detectors on silicon substrates. Researched wavelength beam-combined IR lasers for IRCM systems. Designed high operating temperature IR detectors out of MCT and III-V semiconductor material. Fabricated MEMS activated IR waveguide on semiconductor Photonic Crystal structures. In FY07, investigate high power IR lasers for IRCM and chem/bio sensing applications, research dynamic IR photonic-crystal waveguides for control of Radio Frequency signals, and evaluate dry etching and surface passivation procedures for LWIR Type II FPAs. In FY08, will investigate high-power IR lasers for free space (ground-to-satellite and satellite-to-ground) communications, design 2-color MWIR/LWIR detector structures, and research nano-scale photonic crystal waveguide device that can reconfigure by a MEMS feature. In FY09, will research frequency modulated IR lasers for covert communication applications, fabricate high operating temperature 2-color MWIR/LWIR Type II FPAs, and design and research chip-scale integrated IR-photonic circuit based on the reconfigurable photonic crystal-MEMS waveguide devices for microwave radar application.	2248	2099	2441	2541
Small Business Innovative Research/Small Business Technology Transfer Programs		6		

Total	2248	2105	2441	2541

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February 2007

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

COST (In Thousands)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
52C MAPPING & REMOTE SENS	2287	2156	2641	2691	2720	2741	2801	2863

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. Results of this research are used 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 exploits 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 program element (PE) 0602784A (Military Engineering Technology) 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 US Army Engineer Research and Development Center, headquartered at Vicksburg, MI, executes the project work.

Accomplishments/Planned Program:	FY 2006	FY 2007	FY 2008	FY 2009
Sensor Phenomenology: In FY06, researched capability of new micro and nano sensors to characterize battlespace environment features. Experimented with fluorophore-based detection of chemical and biological hazards under various environmental conditions. Investigated techniques for designing maneuver decision tools that incorporated dynamic battlefield variables and evaluated knowledge-discovery concepts that carefully considered both time and geographic space as critical model components. In FY07, research exploitation of multiple types of sensors to characterize critical battlespace environment features. Experiment with mimicking biological sensory functions to characterize the battlespace environment. Investigate numerous factors believed to influence human behavior in an effort to better understand cause and effect within the battlespace. Similarly, increased understanding between cause and effect will assist in tool development, future experimentation, and simulations of spatial-temporal knowledge discovery models. In FY08, will investigate innovative approaches to hyperspectral sensing of labeled targets by third-party illumination, as well as research fluorescent nanowire arrays and molecular prisms as tunable chemical/biological/radiological sensors. In FY09, will research social network concepts to better assess important interaction within and between our adversaries, directly relating events and actions to time and geographic space. Will mature research on innovative sensing science, focusing on micro-nano sensors and multi-sensory approaches to identifying specific target phenomenology.	2287	2132	2641	2691
Small Business Innovative Research/Small Business Technology Transfer Programs		24		
Total	2287	2156	2641	2691

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February 2007

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

COST (In Thousands)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
53A BATTLEFIELD ENV & SIG	2707	2561	2835	2987	3018	3022	3059	3122

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 impact our 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 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 2006	FY 2007	FY 2008	FY 2009
Research in optical and acoustical propagation in the atmosphere for enhanced Intelligence, Surveillance and Reconnaissance capabilities for the Future Force to support situational understanding and rapid targeting. In FY06, investigated capabilities for acoustic array tomography to be used for retrieving meteorological profiles. Improved optical technologies and processes used to enhance aerosol characterization and bio-hazard identification through laboratory investigation. Investigated effects of atmosphere on active imaging Short Wavelength Infra Red (SWIR) systems through a NATO characterization experiment that identified imaging system improvements. In FY07, simulate atmospheric effects on aerial mounted acoustic arrays to enhance urban acoustic propagation methodologies to improve model performance. Evaluate results of SWIR system field experiments against model for SWIR performance under a range of optical turbulence conditions to improve system designs. In FY08, will measure Two-Dimensional Angular Optical Scattering (TAOS) of atmospheric particles using improved instrumentation designed to improve detection and identification of chem/bio hazards. Implement an inversion technique to extract the optical constants of the spherical atmospheric aerosol particles to enhance capabilities for discrimination/identification of chem/bio hazards. Investigate effects of single urban structure on sound fields to enhance detection and avoidance capabilities. Implement model for propagation through atmospheric water vapor fluctuations at TeraHertz frequencies to improve sensor accuracy. In FY09, will devise and employ a model for radiative transfer effects of clouds on night vision illumination to improve visibility, investigate techniques for classification of non-spherical aerosol particles for improved chem/bio aerosol identification, and investigate effects of multiple urban structures on sound fields to enhance detection avoidance.	1652	1609	1769	1863
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 FY06, formulated new methods for use of improved near real-time three-dimensional environmental models to provide critical input to	1055	952	1066	1124

urban transport and dispersion models, including applications for wake and canopy flow parameterizations. In FY07, investigate critical stable boundary layer phenomena in complex terrain for improved understanding of boundary layer characteristics as they apply to an urban environment; investigate and evaluate the use of coupled modeling capabilities to investigate methods for identifying plume source location that will improve plume tracking; and simulate co-located Doppler radar and Doppler lidar to evaluate the ability to improve wind and cloud detection for enhanced capabilities of transport and dispersion models for chem/bio hazards. In FY08, will explore the fine-scale structure within the urban boundary layer for input to models depicting transport of chemical/biological and other dispersants. Will investigate the vertical flux effects of water vapor in the boundary layer to determine their effects on near-millimeter wavelengths sensor atmospheric propagation models. In FY09, will investigate atmospheric modeling technology for very fine-scale flows to improve local area forecast timeliness and accuracy. Will investigate water vapor fluctuation spectra as influenced by the urban boundary layer for propagation effects in complex terrain that affects sensor performance and imaging capabilities.				
Total	2707	2561	2835	2987

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

COST (In Thousands)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
74A HUMAN ENGINEERING	2669	2525	2961	3020	3052	3071	3144	3213

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 due to situational complexity and ambiguity that 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 for characterizing Soldier-system performance, and provide a shared conceptual and operational framework for militarily relevant 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 2006	FY 2007	FY 2008	FY 2009
Research to improve Soldier auditory performance. In FY06, formulated and tested an algorithm to estimate the location of sound sources in outdoor environments. Evaluated Soldier's ability to use information carried by sound reflections from various walls (e.g., brick, glass, wood) for improved spatial orientation in urban environments In FY07, explore applications of localization algorithms to maximize audibility of unidentified sound sources; compare noise attenuation provided by the new Improved Combat Arms Earplug (ICAE) with that of the current Combat Arms Earplug (CAE); determine the effects of ICAE on Soldier auditory performance (e.g., localization, speech intelligibility, acoustic signature detection) in the presence of both continuous and impulse noise. In FY08, will determine feasibility and limitations of ultrasonic hearing. Will explore the effect of sound duration on auditory localization accuracy. In FY09, will investigate synergy between bone conduction and tactile communication for military applications. Will formulate an algorithm for predicting localization error due to headgear.	1474	1433	1247	1181
Research to assess, predict, and improve Soldier performance. In FY06, expanded capabilities for the prediction and maturation of cognitive readiness through assessment of neuro-cognitive functioning and time constraints under conditions of uncertainty. In FY07, explore integrated use of real-time neuro-physiological and other objective measures and models to manage Soldier situational overload in dynamic battlefield environments. In FY08, will investigate temporal cognition via dynamic Soldier task performance, cognitive modeling, and neuro-physiological evidence. In FY09, will identify differences in task performance as a function of individual versus team cognition. Will investigate prediction of team decision making using cognitive models.	1195	1092	1714	1839
Total	2669	2525	2961	3020

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

COST (In Thousands)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
74F PERS PERF & TRAINING	2475	3338	3481	3505	3534	3557	3613	3671

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, human performance, and network science. 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, improved skill retention, and adaptable transfer of training to new tasks; 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 US Army Research Institute for the Behavioral and Social Sciences (ARI). Research in this project is related to and fully coordinated with efforts funded in program element (PE) 62785 project 790.

Accomplishments/Planned Program:	FY 2006	FY 2007	FY 2008	FY 2009
In FY06, continued developing models of basic human emotions using genetic algorithms; validated tests for measuring mental flexibility; continued work to identify optimizing training principles to achieve efficiency, durability, and flexibility in complex task environments; determined the influence of seductive detail on technology-delivered instruction; determined the effects of discrete positive and negative emotions on organizational citizenship behaviors (individual interpersonal and work behaviors that are beneficial to the organization, are discretionary, and have an important impact on the effectiveness, efficiency, and productivity of work teams and organizations); identified moderators of emotion-behavior linkages; and provided insight into how leader behaviors affect emotion-behavior linkages. In FY07, examine the human dimensions for optimizing training and performance for complex tasks; investigate methods for accelerating leader development; and identify and model the development and relationships among the psychological, demographic, and motivational factors that influence recruit enlistment, Soldier retention, productivity, and organizational citizenship. In FY08, will develop methods to identify individuals most susceptible to information biases in complex environments and methods to assess motivation for leadership self-development. Will also identify and measure individual-difference variables that predict organizational citizenship and adaptive performance. In FY09, will identify and measure individual attributes and learning principles that foster adaptive performance and promote rapid adaptability skill acquisition. Will also develop a new, culture free measure of self-control that will allow prediction of achievement above and beyond cognitive ability.	2475	2298	2481	2505
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		955	1000	1000

social domains (research focused on individual, unit, and organizational behavior in context of networked environments). In FY08, will conduct research on human use of networks, communication, and command and control technologies to include automated agents, distributed environments, and improved, integrated assessment. Will create new technologies for collaborative scientific inquiries into network science, working with the Army Research Laboratory and Army Research, Development, and Engineering Centers. In FY09, will conduct research on modeling and simulation of the human use of networks, communication, and command and control technologies to create semantic networks of common sense knowledge in tactical military settings. Will create new technologies to integrate the human, biological, mathematical, and engineered domains of network science, to extract higher level principles that illuminate each domain in new ways. In all years, research will be done in collaboration with the Army Research Laboratory and Army Research, Development, and Engineering Centers and with researchers at the Army's University Affiliated Research Centers, i.e., the Institute for Creative Technology at the University of Southern California, the Institute for Collaborative Biotechnology at the University of California, Santa Barbara, the Massachusetts Institute of Technology, and Carnegie Mellon University.				
Small Business Innovative Research/Small Business Technology Transfer Programs		85		
Total	2475	3338	3481	3505

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2007

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

COST (In Thousands)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
F20 ADV PROPULSION RSCH	1996	1935	2198	2253	2252	2260	2290	2342

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 sources and conversion, 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 2006	FY 2007	FY 2008	FY 2009
This research investigates new materials needed to withstand the higher temperature regimen of advanced high performance engines, and evaluates improved tools and methods that will accurately simulate the flow physics and the mechanical behavior of future engines and drive trains and enable the design of more fuel efficient and reliable propulsion systems. In FY06, evaluated diagnostics techniques for hybrid bearings (ceramic rolling elements with steel races); completed fatigue life analysis of a first stage ceramic matrix composite turbine; investigated thermal and environmental barrier coating systems with 3000F capability; transitioned unsteady compressor flow analysis code to industry. In FY07, analyze autonomous diagnostic and repair concepts for gas turbine engine components, and complete baseline experimentation of gear tooth bending strength at elevated temperatures experienced in helicopter transmissions. In FY08, will formulate life prediction models for low conductivity thermal barrier coatings to improve turbine design process and complete the face gear dynamic load prediction modeling computer code to improve the transmission design process. In FY09 will investigate synchronized speed control shifting algorithms that could enable variable speed helicopter transmissions and formulate diagnostic fault detection methods to improve the safety and reliability of helicopter transmissions.	1996	1935	2198	2253
Total	1996	1935	2198	2253

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2007

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

COST (In Thousands)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
H42 MATERIALS & MECHANICS	1983	2020	2198	2253	2309	2362	2408	2472

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 program element (PE), project 0602105A/H84. 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 2006	FY 2007	FY 2008	FY 2009
Devise new materials and design capabilities, based upon fundamental concepts derived at the microscopic and nano-structural levels, for the Future Force. In FY06, incorporated photonic materials and communications components into scaled survivable structures; used directed assembly techniques to control the nano-particle size and distribution of functional nano-particles in a polymer matrix; fully transitioned ceramic damage model to armor design codes; and performed ballistic experiments of a fracture resistant penetrator prototype designed using new fracture models. In FY07, enhance the synergistic effects of structure and electromagnetic interactions within scaled survivable structures, and characterize transport behavior and relevant properties of nanoparticles. In FY08, will implement and validate models for fragmentation, reactive materials, and ballistic penetration; enhance processing and non-destructive evaluation for improved armor ceramics; use directed assembly to embed functionality into polymer materials; and validate multifunctional material performance. In FY09, will perform comprehensive materials characterization for damage-tolerant sub-micron SiC ceramic materials, and develop 1st-generation phenomenological constitutive and failure model for SiC-N ceramic materials for armor.	1983	2020	2198	2253
Total	1983	2020	2198	2253

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2007

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

COST (In Thousands)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
H43 RESEARCH IN BALLISTICS	6536	5775	6142	6130	6187	6223	6364	6509

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 non-lethal/lethal projectiles and missiles, and advanced armors for increased survivability of Army combat systems for the Future Force. This effort supports the Office of the Secretary of Defense Advanced Energetics Initiative to mature the fundamental technologies required to transition the next generation of energetic materials into field use. This research supports survivability and lethality technology applied research in program element, project 0602618A/H80. 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 2006	FY 2007	FY 2008	FY 2009
In support of the National Advanced Energetics Initiative, expand and validate physics-based models and experimental techniques to enable design of novel insensitive propellants/explosives with tailored energy release for revolutionary Future Force survivability and weapons effectiveness. In FY06, devised condensed phase novel energetic materials models to couple and describe energy releasing processes across the length scales for propellants/explosives; characterized nano-scale energetics in various stages of decomposition; devised functionally-graded nano-energetics; and modeled effects of plasma ignition on multiple propellant grains. In FY07, devise predictive meso/multiscale molecular models for design of insensitive propellant/explosive formulations; characterize/model ignition and combustion of multi-purpose reactive materials; and derive computational theory for energy storage and release mechanisms in energetic, strained solids/metastable states. In FY08, will simulate energy transfer and conversion within shocked and heated energetic materials formulations; fabricate and characterize reduced sensitivity nano-engineered energetic materials; derive theoretical descriptions and produce hyper-energetic polymeric nitrogen; characterize structural bond energy release materials; and refine models to include hot fragment impact, shear ignition sensitivity, emerging multiphase fluid dynamics, thermo-mechanical coupling, and reactive materials initiation. In FY09, will design smart, molecularly engineered energetics; design insensitive, nano-reactive energetic materials/structural energetic composites; differentiate initiation reactions caused by conductive versus shear stimuli; explore turbulent mixing and combustion in late-time energy release; and characterize sensitivity and performance of insensitive warhead explosive fills and validate refined propellant models.	3404	2770	2751	2723
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 FY06, proved ability to accurately depict the degradation of ceramic materials in controlled high-rate experiments; devised generalized failure framework for combined fracture and shear localization of metallic materials; and showed bank-to-turn maneuver during vehicle thrust using coupled computational fluid mechanics, rigid body dynamics and guidance, navigation, and control. In FY07, prove ability to accurately depict the degradation of ceramic materials in the terminal effects environment; apply the generalized fracture framework to simulate failure penetrators and armor materials; and study failure and damage of urban structural materials for terminal ballistic events. In FY08, will quantify damage in select ceramics using destructive and non-destructive techniques; devise reactive material ignition model; devise a controlled fragmentation model; and	2861	2522	2511	2509

implement models for urban structural material failure in continuum codes. In FY09, will devise 1st-generation physically consistent phenomenological constitutive and failure model for select damage-tolerant ceramics; implement both controlled fragmentation and reactive material ignition models into a continuum mechanics code; and model effects of secondary debris on humans and compare model results with actual human injury data obtained from the medical community.				
Extramural research in non-lethal (NL) control methods to exploit potentially innovative approaches that offer unique battlefield and homeland defense capabilities. In FY06, conducted research with the aim of understanding kinetic energy effects on the human with the aim of temporarily incapacitating the aggressor. This research focused on a macroscopic level understanding of the response of human tissue and/or protective clothing against ballistic impacts. It addressed the mid-to-high-strain rate behavior of soft materials including clothing and human tissue as well as hard protective materials such as ceramics. Developed micro-machined vacuum electronic devices operating at 94 GHz and demonstrated use of large area single mode fiber for high energy laser emission. In FY07, employ efforts to increase computational horsepower, and advances in tissue engineering to develop integrated modeling and experimental approaches to link kinetic energy loading conditions to human injury at the macroscale. Design and fabricate diffractive optical elements for better light extraction from high energy laser slabs. In FY08, will exploit advances in biotechnology to develop more refined modeling and experimental techniques to ascertain the effects of blunt trauma and impulse loading at the cellular level. Will attempt to coherently combine multiple optical fibers to enhance high intensity laser output at kilowatt levels. In FY09, will focus research efforts on bridging gaps that link these governing mechanisms and lay the groundwork for the prediction of overall response, including human functions such as cognitive and physical performance. Will attempt to demonstrate man-portable microwave sources operating at 94 GHz for active denial and crowd control, intending to leverage the development of the micro-machined VE sources in FY06.	271	400	880	898
Small Business Innovative Research/Small Business Technology Transfer Programs		83		
Total	6536	5775	6142	6130

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2007

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

COST (In Thousands)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
H44 ADV SENSORS RESEARCH	3708	3516	4023	4185	4281	4313	4363	4505

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 Radio Frequency (RF) sensors. The technical approach is to exploit large scale electromagnetic (EM) 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, hazardous material detection, remote sensing and intelligent system distributive interactive simulations, and battlefield acoustic signal processing algorithms. Research performed under this project supports survivable sensor systems, affordable rugged flexible displays, and hazardous material monitoring, both point and remote. Payoffs include low cost compact flexible displays for the soldier and for the Army's Future Force, improved radar signal processing techniques that will allow existing systems to improve spatial resolution, improved ultra wideband (UWB) radar technology for detection of explosives including mine detection, through the wall sensing and robotics perception, improved signal processing techniques for acoustic/seismic sensing systems, improved cryptography techniques, and hazardous material sensing. 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 2006	FY 2007	FY 2008	FY 2009
Research addresses the maturation of technologies for adaptive, active, and intelligent optical systems for high-data-rate military communications and directed energy applications. In FY06, investigated adaptive compensation techniques and performed advanced analysis of target-in-the-loop scenarios with both cooperative and non-cooperative targets. In FY07, perform research into the use of an active Hybrid/RF/optical laser communications and imaging network for Army applications including laser designation and explosives detection. In FY08, will research potential configurations for small agile adaptive apertures for high-bandwidth optical communications and directed energy applications, and begin to define conformal adaptive optical components for Gigabit free-space laser communications and directed energy configurations. In FY09, will research parameters and define the operational envelop for the use of ultrashort (femtosecond) laser illumination for the Army's active imaging and directed energy applications.	1480	1327	1585	1658
Research focused on improving sensor capabilities to create more survivable/secure systems and displays, and improved hazardous material monitoring. In FY06, included the variability of soil characteristics in EM models to support assessments of forward-looking radar against explosive threats; investigated networking options of Quantum Cryptographic (QC) test beds and new areas in quantum information processing; and investigated sensitivity of magnetic field sensors; optimized fabrication parameters for maximum Surface Enhanced Raman Scattering (SERS) efficacy for hazardous material sensing; and transitioned organic light emitting device (OLED) blue emitters to the Flexible Display Center for evaluation. In FY07, use modeling and imaging tools to evaluate UWB image formation options; collaborate with RDEC partners to assess transition possibilities of QC systems; research decentralized signal processing for ad-hoc sensor networks; study noise in MEMS flux concentrators and accelerometers; and improve organic thin film transistor (OTFT) and photovoltaic performance for flexible displays. In FY08, will develop methods to mitigate sensitivity of imaging radar to multipath-	2228	2169	2438	2527

induced false alarms; conduct limited error rate analyses to assess the potential for compromising quantum systems; research distributed spatial and temporal processing and data fusion algorithms for networks of heterogeneous and possibly mobile sensor nodes; investigate new magnetic sensor technologies for personnel detection; and produce final SERS hazardous material sensing assessment report. In FY09, will research target and clutter scattering phenomena to support radar detection of a multitude of concealed targets; evaluate completed signal processing algorithms for networks of heterogeneous sensor nodes; assess biologically-inspired techniques for advanced photonic structures, and integrate OLEDs with OTFTs to investigate stability of system for next generation flexible displays.				
Small Business Innovative Research/Small Business Technology Transfer Programs		20		
Total	3708	3516	4023	4185

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2007

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

COST (In Thousands)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
H45 AIR MOBILITY	1959	1836	2295	2342	2366	2385	2437	2491

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 Defense Basic Research Plan (BRP). Work in this program element is performed by the US Army Aviation and Missile Research, Development, and Engineering Center, Redstone Arsenal, AL.

Accomplishments/Planned Program:	FY 2006	FY 2007	FY 2008	FY 2009
In FY06, investigated rotor power required during high advance ratio flight for high-speed rotorcraft application, explored new acoustic prediction code for maneuvering flight, measured hub drag improvements using vortex generators. In FY07, demonstrate tightly coupled CFD/CSD methods for calculating helicopter airloads and structural loads in maneuvering flight. Explore aeromechanical benefits and issues for advanced rotorcraft configurations. In FY08, will develop new methods for accurate aeroelastic stability prediction. Will explore rotor fuselage interactions for complex configurations using advanced CFD methods. Will investigate aeromechanics issues for high altitude rotors. In FY09, will demonstrate active rotor modeling tool using National Full-scale Aerodynamic Complex validation data, develop improved turbulence models for rotorcraft application and assess improved modeling and simulation tools on heavy-lift interactional aerodynamics validation data.	1959	1803	2295	2342
Small Business Innovative Research/Small Business Technology Transfer Programs		33		
Total	1959	1836	2295	2342

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2007

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

COST (In Thousands)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
H47 APPLIED PHYSICS RSCH	2603	2453	2807	2873	2906	2930	2971	3063

A. Mission Description and Budget Item Justification: This project performs basic research on electronic materials and structures as well as energetic batteries and fuel cells to enable higher performance and more efficient electronic systems. This includes nanoelectronic devices for low-power and high-frequency applications; sensors, 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; and the manipulation of cold atoms on a chip for application to very sensitive sensors and ultra-stable atomic clocks. These investigations will impact 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 2006	FY 2007	FY 2008	FY 2009
This research focuses on nanoelectronic devices and sensors; 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 advanced sensors and ultra-stable atomic clocks. In FY06, experimentally validated selective area growth of carbon nanotubes (CNT) for heat extraction, designed and fabricated a CNT-based transistor, created a cold-atom cloud in a magneto-optic trap - a first step to atom chip sensors and clocks; explored Li-ion battery lectrolytes for use at low temperatures; and investigated a sorbent for sulfur removal from JP-8 fuel. In FY07, investigate the fabrication and characterization of prototype CNT and other nanowire-based sensor devices, create a protocol for determining fundamental failure mechanisms in Silicon Carbide (SiC) and Gallium Nitride (GaN) Schottky diodes, and evaluate the improved SiC and GaN devices in test circuits; trap a cold-atom cloud on a chip and transport the cloud using optical tweezers and a magnetic waveguide to construct miniature sensors; 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 JP-8 reformation. In FY08, will investigate CNT and other nanowire-based active electronic devices, explore thermal characteristics of relevant nanostructures, and detect atom interference in a waveguide; will investigate regenerable sulfur sorbents for JP8 reformation and materials for high power Li-ion batteries. In FY09, will investigate system insertion for nanoelectronic devices and sensors and failure mechanisms for wide-bandgap electronic devices; will sense a gravitational field gradient using a waveguide atom interferometer for possible use as inertial navigation; and will study thin-film battery materials.	2603	2443	2807	2873
Small Business Innovative Research/Small Business Technology Transfer Programs		10		
Total	2603	2453	2807	2873

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2007

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

COST (In Thousands)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
H48 BATTLESPACE INFO & COMM RSC	5366	6158	6720	6870	6999	7038	7123	7261

A. Mission Description and Budget Item Justification: This project supports basic research to enable intelligent and survivable command and 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, the related signal processing for wireless battlefield communications, document and speech machine translation, and intelligent systems for C4I. Major barriers to achieving the goals are 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, resource-constrained sensor networks, diverse networks with dynamic topologies, high-level multi-path interference and fading, jamming and multi-access interference, levels of noise in speech signals and document images, new low-density languages, 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 in complex natural 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 2006	FY 2007	FY 2008	FY 2009
Perform research to provide communications capability for a fully mobile, fully communicating, situationally aware force operating in a highly dynamic, wireless, mobile networking environment populated by hundreds to thousands of networked nodes. In FY06, conducted laboratory experimentation to mature networking technologies (i.e. component based routing, performance, and scaling, robustness) using network visualization, logging, and analysis tools for adaptive communications in a mobile, wireless, tactical network. In FY07, analyze experimental data, to determine scalable routing algorithms for protocols (proactive/reactive) using communications traffic and topology scenario generation. In FY08, will refine scalable algorithms to incorporate technologies in sensor radios. In FY09, will perform experimental analysis to incorporate technologies in mobile radio units.	1514	1433	1605	1653
Design and implement a laboratory scale common information-processing infrastructure, inclusive of service oriented architecture for networking processes that aids in the transformation of data into actionable intelligence to support decision-making under uncertainty. In FY06, designed algorithms to detect tactical behaviors through mining for patterns/events over time/space and began 3D scene reconstruction using geometry/texture from a moving robotic platform. In FY07, implement first-order laboratory experiments to evaluate and enhance algorithms describing agent generated patterns and events used to refine and optimize algorithms for 3D scene reconstruction from a robotic platform. In FY08, will investigate the application of information mediation service techniques to produce fused actionable intelligence for military mission planning and execution such that data providers, including robotic sensors, Soldiers, and agency-based data systems, are connected using service oriented architecture networking techniques and information agents. Investigate pose recognition from imagery to determine location in GPS-denied areas. In FY09, will experiment with and evaluate 3-D scene reconstruction and pose recognition for enhanced situational awareness, along with information mediation improvements to the military	1336	1244	1399	1448

operational and tactical decision and planning process.				
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 FY06, performed research on intrusion detection in Mobile Ad Hoc Networks (MANETs) that addressed tradeoff issues in power, bandwidth, computation, and connectivity. In FY07, investigate high mobility, channel impairment issues which are MANET-unique. Algorithms will be tailored to MANETS that are severely constrained including topology variation and fading wireless channels. In FY08, will design and evaluate intrusion detection algorithms on mobile ad hoc networking protocols, including under hostile conditions, using formal methods to represent protocols. In FY09, will design and evaluate analytically and via simulation/emulation, robust classes of algorithms that will provide a dynamic architecture that will support detection of attackers under conditions of mobility.	1554	1448	1621	1671
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 FY06, performed laboratory demo of low-density automated language translation and refined evaluation metrics for machine translation. In FY07, refine and optimize algorithms for automated language identification of speech and document machine translation and link test bed with AFRL and NRL. In FY08, will investigate, evaluate, and implement Service Oriented Architecture (SOA) concepts required to transition language technologies to Deployable Harmony Document Exploitation (DOCEX) System (DHDS) and Distributed Common Ground System-Army (DCGS-A). In FY09, will experiment with algorithms for processing and exploiting handwritten documents such as Arabic and Farsi, which are input to machine translation.	962	1005	1095	1098
Beginning in FY07, study the behavior of MANETs as part of the Army's new initiative on Network Science. Emphasis will be on mobile communications networks for the Army's University Affiliated Research Center, the Institute for Collaborative Biotechnology at the University of California - Santa Barbara. In FY08, will design formal models, abstractions, and metrics for mobile ad hoc networking and extend to simulations, and conduct scalability analyses and design models of mobile ad hoc routing protocols and their functional concepts, incorporating biological paradigms where applicable. In FY09, will conduct component-based performance modeling and analysis of routing protocols and design networking protocols that adapt to varying operating environments in order to optimize performance.		1000	1000	1000
Small Business Innovative Research/Small Business Technology Transfer Programs		28		
Total	5366	6158	6720	6870

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2007

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

COST (In Thousands)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
H57 SCI PROB W/ MIL APPLIC	58285	59295	56840	58406	59416	59477	61104	62566

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 and information sciences (mathematics, 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, supporting research at nearly 200 institutions in 46 states. This project also funds assessments of international technologies. 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 2006	FY 2007	FY 2008	FY 2009
Basic research in environmental and life sciences Soldier performance, Soldier protection, and novel biotechnologies and biomaterials for new Army capabilities. In FY06, exploited advances in genomics, proteomics, and systems biological capabilities to understand the molecular basis of Soldier cognitive and physical performance, high performance biomaterials for Army use and host-pathogen interactions to counter new natural or man-made biological threats; exploited advances at the interface of molecular biology and nanoengineering to develop new electronics capabilities, and formulated atmospheric boundary layer models to improve nighttime forecasts. Researched environmental phenomenology associated with landmine emplacement, and extended statistical signal processing techniques and inverse scattering algorithms to improve landmine and unexploded ordnance (UXO) detection. In FY07, investigate new bioremediation approaches to maintain usable Army training facilities with reduced Soldier toxin exposure and operational and environmental compliance costs; advance capabilities in bionanoengineering, neurophysiology, and molecular biology for improved Soldier protection; devise airborne Doppler lidar with 4-D wind measurement capabilities; develop new simulations for soil moisture estimation; develop understanding of phenomenological modeling approaches applicable to various sensor types to discriminate low-metal targets and buried UXO from anthropogenic environmental clutter and to separate closely spaced object sensor signatures; and improve explosives detection from airborne surveillance imagery. In FY08, will focus on lower cost technologies for bioremediation, on biomaterials for better Soldier protection and on landmine and UXO detection. In FY09, will focus on new biotechnologies for soldier protection; bionanoengineering for new biomaterials; and devise a Soldier scale atmospheric test bed addressing unique atmospheric Army operational needs.	6122	6165	6030	6233
Basic research in chemical sciences for advanced power generation, propellants, protective materials, and threat detection. In FY06,	6397	6138	6003	6205

developed polymers, fibers and novel architectures for materials with superior protection from all environments; advanced fuel cell electrocatalysts and electrolytes; and codes for prediction of materials properties. In FY07, increase research on selective transport, systems integration of compact power sources, and multi-scale modeling for materials damage based on molecular interactions. In FY08, will emphasize research on fuel reformers, molecular control for chem./bio/explosive detection, and new initiative on chemical information theory for armor materials. In FY09, will focus on optimum design for chemically reacting systems, microreactors for threat detection and health assessment, and structure/function relations for membrane transport.				
Basic research in physics for precision guidance, superior optics, and signature management properties, ultra-sensitive sensors, quantum computing, and secure communications. In FY06, devised a theory for a communications protocol to send secure images; obtained highest laser intensity ever (1022 W/cm2); demonstrated low energy ion scattering techniques to measure quantum-confined electronic states of nanostructures; generated multiple qubit operations; generated single photons on demand; demonstrated quantum teleportation, error correction, and quantum Fourier transform operations in ion trap; attained first steps in quantum simulations; grew quantum cascade lasers structures by Metal Oxide Chemical Vapor Deposition. In FY07, devise negative index materials and photonic materials in the visible range for imaging & sensing applications; provide accurate computational tools to aid in design of new drugs and functional materials, beginning the process of subsuming biochemistry and quantum biology for a firmer basis for nanoscience; explore existence of new superfluid matter w/unequal spin; develop theories to determine quantum phases/phase transitions & controls to simulate condensed-matter. In FY08, will develop negative-index materials w/attempts to build flat lenses & demonstrate sub-wavelength images; explore 1 to 2 band loading of optical lattices; conduct preliminary simulations of Hubbard & Heisenberg models; develop continuously tunable microwave filters & sources (10-100 GHz) for communications & imaging RADAR. In FY09, will develop novel quantum cascade lasers & IR photodetectors for remote Chem/bio detection (CBD), enhanced Light Detection and Ranging (LIDAR) for target tracking, and high power (>100 KW) fiber lasers; will explore use of light filament based sensors for remote CBD, environmental sensing by novel enhanced spectroscopies, solar power at greater than 50% conversion efficiency (as a Soldier power source), and free space communications.	8864	8312	8154	8378
Basic research in electronics, photonics, and communications for unmatched networked Command, Control, Communications, and Computing and Intelligence, Surveillance, and Reconnaissance (C4ISR) capabilities. In FY06, established the feasibility of achieving thermoelectric cooling using HgCdTe-based materials grown by molecular beam epitaxy. In FY07, devise an integrated nano-scale sensor platform at THz frequencies for biological detection. In FY08, will complete a comprehensive model providing fundamental insights into high power quantum dot lasers. In FY09, will develop extremely small tactical antennas operating with high system efficiency across the HF, VHF, and UHF bands.	13033	12881	12673	12941
Basic research in mechanical and material sciences for survivable armor, more lethal anti-armor, improved mobility, and flexible displays for Soldier systems. In FY06, devised planetary gear analysis tools for improved rotorcraft transmissions; formulated practical micro active flow control schemes for transonic/supersonic projectiles to improve accuracy; explored new concepts of phase inter-compatibility for maturation of passively "smart" materials; synthesized first reversible aluminumphilic peptide to provide controlled adhesives for paints and other surfaces; devised inexpensive nanocomposite ceramic materials with novel plasma processing; devised inexpensive nanocomposite ceramic materials with novel plasma processing; created a novel nanomechanical testing technique to investigate the viscoelastic properties of ultra thin polymer films; established new diffraction methods for understanding the structure and function of organic molecules. In FY07, 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; fabricate fully dispersed single-wall carbon nanotube composites, devise the first simultaneously ferroelectric and ferromagnetic materials; synthesize prototype electron gas piezoelectric sensors. In FY08, will obtain full flowfield diagnostics around an oscillating rotor blade under realistic helicopter flow conditions; perform precise experiments and detailed	13469	12474	12270	12534

simulations to understand the dynamic response and failure of multilayered micro-electro-mechanical systems (MEMS) at both the material and structural levels. In FY09 will validate chemical kinetic mechanisms for high temperature and pressure alternative hydrocarbon-based fuels in diesel and turbine engine application.				
Basic research in mathematical and computer sciences as the backbone for complex, multi-system analysis, modeling and simulation, and information systems. In FY06, implemented complex geometric algorithms for searching, line of site, and route planning for the One Semi-Automated Force (OneSAF) training simulation and established fundamental results for algorithms to run on Graphics Processing Unit/Central Processing Unit (GPU/CPU) systems. Developed image processing software for targeting and terrain modeling, developed algorithms for fusion of electro-optical and millimeter wave data for concealed weapons detection, developed algorithms to support rotorcraft formation flying based on a non-linear predictive control model with formation manager. In FY07, develop intelligent processing systems to improve fusion of hard (sensor)/soft (human) information, and also to exploit the network centric nature of the fusion problem. In FY08, will develop a theory to support creation of tools for design of heterogeneous swarms for desired tactical emergent behavior. In FY09, will demonstrate the effectiveness of the developed products and tools on swarming in laboratory test-beds.	10400	10430	10250	10495
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 basic research to extract the common elements of networks across various disciplines, perspectives, layers, theories, and applications to create a sound basis for a science of networks. The science is aimed at developing theoretical models that can explain and predict network behavior. In FY08, will explore the science aimed at developing experimental/theoretical/computational models that can explain and predict the overall behavior of the layered structure of networks of importance to the Army. At the base of the layer cake is the physical network, followed, for example, by the information network, then the communication network and terminating in the social network, with multiple nonlinear interactions within each layer and among the various layers. In FY09, will examine candidate mechanisms by which different layers interact with one another. In particular a universal representation of information (information theory, metrics, topology, etc.) within physical, biological, and social networks will be constructed to enable network interfacing and control across multiple scales. Moreover the barriers (lack of mathematical infrastructure) to network control across multiple scales will be addressed in this general information context.		1540	1460	1620
Small Business Innovative Research/Small Business Technology Transfer Programs		1355		
Total	58285	59295	56840	58406

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2007

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

COST (In Thousands)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
H66 ADV STRUCTURES RSCH	1485	1513	1619	1659	1700	1740	1773	1820

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 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 2006	FY 2007	FY 2008	FY 2009
This research devises new structural analysis and validation methods to more accurately predict durability and damage tolerance of composite and metallic rotorcraft structures, and evaluates structural dynamics modeling methods to address critical reliability issues in the rotating and fixed system components of future aircraft. In FY06, performed modeling and simulation studies of active control concepts for heavy lift rotorcraft; and conducted subcomponent experiments to validate durability and damage tolerance predictions for composite structures with embedded sensors/actuators. In FY07, conduct wind-tunnel experiments of innovative rotor configurations applicable for heavy lift rotorcraft to characterize structural and aeromechanical performance; explore advanced concepts for lightweight, highly tailored and multi-functional composite structures using embedded sensors/actuators. In FY08, will analyze computational fluid dynamic methods to support unsteady low Reynolds number aerodynamic models for flapping wing Microsystems. In FY09 will evaluate multibody-compatible thin-walled elastic finite element methods to enable aeroelastic predictions for small scale air vehicle systems.	1485	1513	1619	1659
Total	1485	1513	1619	1659

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2007

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

COST (In Thousands)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
S13 SCI BS/MED RSH INF DIS	9345	8518	10497	10889	10247	10313	10540	10772

A. Mission Description and Budget Item Justification: This project supports basic research that provides for healthy, medically-protected Soldiers for the Future Force. This research investigates medical countermeasures for naturally occurring diseases that have had historically severe impacts on military operations. Malaria is the most significant military infectious disease threat. The malaria parasite becomes resistant to fielded drugs making it necessary to continually search for new drugs to feed the development and licensure pipeline. A vaccine to prevent malaria infection would be ideal but has been elusive, requiring additional basic research for novel vaccine approaches. Basic research to discover what components of an infectious organism causes disease and how the human reacts to these organisms will provide new approaches to prevent disease. In addition, identification of unique features of disease organisms will aide in developing diagnostics tools. Research into the transmission of disease by insects and other organisms (vectors) that carry the disease organisms will help to direct new interventions into preventing disease transmission. The Army is the Department of Defense's lead service for military infectious diseases research, and work in this project is managed by the US 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; the US 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 2006	FY 2007	FY 2008	FY 2009
Prevention/Treatment of Parasitic Diseases: Conduct basic research to better understand malaria parasites, a necessary foundation to discover medical countermeasures to protect Soldiers from infection. In FY06, designed chemical compounds using predictive computer modeling, screened over 3000 drugs for antimalarial activity, and selected several candidate compounds for additional study. Established a technology for synthesizing individual malaria proteins identified through genomic databases without any need of the living parasite; these proteins will allow for small scale testing of malaria countermeasures. Used a mouse model to identify several new malarial proteins to assess as potential vaccine candidates. In FY07, design and screen new drug compounds and new parasite molecules (such as proteins critical for parasite growth) as malaria drug targets. In FY08, will continue molecular approaches to find new technological advances to address malaria continue with modeling and screening thousands of drugs for antimalarial activity; search for new malaria proteins as drug targets and vaccine candidates. In FY09, will apply new technologies as they become available to identify novel approaches to attack malaria, such as improved computer modeling for drug discovery, and bioinformatics to better identify important parasite genes and proteins that can be used for drug screening and vaccine targets.	3040	3758	4234	4703
Bacterial Threats Vaccine Programs: Conduct basic research to better understand the biology of bacterial organisms and how to prevent diarrhea and scrub typhus. In FY06, studied possible factors that increase the warfighter's risk or probability of contracting diarrhea (such as the genetic makeup of bacterial strains), and incorporated these findings into the Diarrheal Vaccine Program. Studied a newly discovered layer in the cell wall surface of the Campylobacter bacterium (a cause of severe diarrhea) to understand its chemistry and potential for use in developing a vaccine. In FY07, conduct basic research to understand how bacteria cause diarrhea (such as interactions between bacteria and humans), with a focus on discovering new approaches to prevent diarrheal diseases. In FY08, will conduct basic research to expand discoveries/studies of those bacterial components that are integral in the disease process and assess them as potential	802	777	1832	1802

vaccine or other countermeasure candidates. Will also assess proteins from the scrub typhus organism to better define their roles in causing disease and use as potential vaccine targets. In FY09, will continue to assess the proteins and other components expressed on diarrheal and scrub typhus organisms for their roles in disease and possible use in protection.				
Viral Threats Vaccine Programs: Conduct basic research to better understand highly lethal or incapacitating viruses, including those that cause hemorrhagic diseases (leakage of blood from vessels), such as dengue hemorrhagic fever and hantaviruses like Korean hemorrhagic fever. Basic research includes global risk to the warfighter, virus biology, disease process, and interaction with human body. In FY06, continued to identify viral and human factors that determine the hemorrhagic outcome of dengue fever; continued to study the mechanisms the human body naturally uses to protect against hemorrhagic viral diseases to better understand how to approach vaccine development. Studied individual human gene expression during vaccine responses to assess correlation of specific gene activity with vaccine protection. In FY07, conduct basic research to better understand hemorrhagic viruses and potential prevention approaches including studies of human-virus interactions between different dengue viruses that may affect vaccine strategies. Continue to study genes of highly lethal viruses to better understand which may provide protection if incorporated into a vaccine. In FY08, will perform long-term studies to understand how naturally induced changes in the virus impact the virus's ability to cause disease. In FY09, will conduct basic research to understand hemorrhagic viral diseases and other lethal viruses of military importance and to assess emerging viral threats for their potential to impact military operations to determine whether any identified new threat requires further studies.	1231	1284	1482	1844
Insect Vector Control and Infectious Disease Diagnostics Programs: Conduct basic research to investigate the biology of biting insects and other organisms that transmit disease (called disease vectors) and their control (including leishmania-carrying sand flies) and to expand medical diagnostic and disease surveillance capabilities in the field. In FY06, conducted field studies to identify new insect species responsible for transmitting malaria. Studied the response of insects to insecticides to better understand insecticide-resistance of disease bearing vectors. Demonstrated that the fat-tailed jird (a small rodent) can be use to study transmission of leishmania in the laboratory. In FY07, conduct basic research to identify suitable markers (proteins or other disease-specific molecules) for potential use in insect-based pathogen detection systems, and for field clinical diagnosis of human infection. Assemble insect identification keys for use by Preventive Medicine Units (PMUs) in CENTCOM region. In FY08, will conduct basic research to investigate the biology of insect vectors including vector identification, and assembly of insect identification aids for use by PMUs focusing on SOUTHCOM and PACOM regions. Study biology of insects to better understand ways to control them through novel repellents or insect attractants and insecticides. In FY09, will explore the biology of insect vectors and methods of control, in order to expand medical diagnostic and disease surveillance capabilities with a focus on providing new approaches.	4272	2602	2949	2540
Small Business Innovative Research/Small Business Technology Transfer Program		97		
Total	9345	8518	10497	10889

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2007

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

COST (In Thousands)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
S14 SCI BS/CBT CAS CARE RS	3996	3687	4517	4692	3990	4007	4097	4185

A. Mission Description and Budget Item Justification: This project supports basic 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 US Army Institute of Surgical Research (USAISR), Fort Sam Houston, TX.

Accomplishments/Planned Program:	FY 2006	FY 2007	FY 2008	FY 2009
In FY06, completed characterization and validation of a new combat-relevant model of ballistic-type brain injuries, began studies of the basic cellular responses to penetrating ballistic-type brain injury (PBBI); discovered a novel protein biomarker that can differentiate between different types of brain injuries; discovered a novel application for an experimental neuroprotectant drug, NNZ2566, to treat silent seizures caused by brain trauma; and continued collaboration with the National Heart, Lung and Blood Institute (NHLBI) on six studies supporting trauma care: (1) zinc compounds as carbon monoxide inhibitors to prevent circulatory collapse and maintain blood pressure, (2) a noninvasive tool for earlier recognition of tissue dysfunction or damage in a model of circulatory collapse, (3) very small doses of an oxygen carrying fluid to treat potentially fatal shock from blood loss, (4) direct peritoneal dialysis that can be quickly administered and easily stopped to halt post-trauma swelling, (5) animal hemoglobin molecules modified to prevent high blood pressure and decreased heart output, and (6) mechanisms for recovery from cardiovascular collapse that may provide adequate blood flow at the microcirculation level. In FY07, complete mechanism of action studies for NNZ2566, further define the role of brain inflammation and delayed cell death genes/proteins in secondary injury; and complete the collaborative studies with NHLBI. In FY08, will study the effect of novel neuroprotection therapies on cellular responses to injury, and continue molecular mechanism studies of PBBI to include studies to identify secondary insults that provoke electrical brain malfunction after a brain injury. In FY09, continue basic research in PBBI and delayed cell death mechanisms, and conduct preclinical biomarker studies to support early diagnosis of PBBI.	3996	3637	4517	4692
Small Business Innovative Research/Small Business Technology Transfer Programs		50		
Total	3996	3687	4517	4692

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2007

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

COST (In Thousands)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
S15 SCI BS/ARMY OP MED RSH	5623	5773	6318	6525	6246	6336	6524	6716

A. Mission Description and Budget Item Justification: This project supports basic research required to sustain a future force of healthy, medically-protected warfighters, 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. This includes development of concepts for 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 non-ionizing 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; the US Army Research Institute of Environmental Medicine (USARIEM), Natick, MA; and the US Army Aeromedical Research Laboratory (USAARL), Fort Rucker, AL.

Accomplishments/Planned Program:	FY 2006	FY 2007	FY 2008	FY 2009
In FY06, identified and tracked functional changes to the eye resulting from laser-induced retinal injuries; identified potential interventions for laser-induced retinal injuries that will decrease injury rates and enhance Soldier survivability; identified current surgical therapies to be ineffective in treating laser-induced eye injuries. In FY07, explore, through an in-depth literature review, bone marrow-derived stem cell research as an innovative therapeutic mechanism for traumatic retinal injury and initiate identification and isolation of stem cells derived from bone cell injections. In FY08, if FY07 results support further study, will conduct bone marrow stem cell research as a potential therapeutic intervention for laser-induced eye injury. In FY09, explore the mechanism of stem cell interactions with laser induced injury to retinal cells by use of proteomics and genomics.	1494	1454	1510	519
In FY06, applied gene chip technology to explore the basis of individual differences in resilience during sleep loss and identified physiological indicators that could lead to innovative fatigue interventions. In FY07, expand the mathematical model for predicting performance to include individual differences between personnel. In FY08, will examine, within a laboratory environment, the individual components of the performance prediction model. In FY09, will refine the individual difference components in order to establish a more robust prediction model.	2653	1330	1170	2032
In FY06, examined model components and parameters required for investigation of the effects of prolonged exposure to cold, which indicated an increased susceptibility to injury and death. These findings will influence the development of cold weather doctrine. In FY07, explore cold-temperature regulation and its impact on physical activity. In FY08, will explore tissue protein analysis as a predictor of performance degradation from exposure to cold. In FY09, will investigate treatment interventions to reduce death and illness incidence rates resulting from environmental exposures to cold.	1476	2439	3138	3474

In FY07, begin developing computational approaches to identify networks of specific organisms and cellular processes in support of the Army's new initiative in Network Science. This work is conducted in close coordination with researchers at the Army's University Affiliated Research Center, the Institute for Collaborative Biotechnology, at the University of California, Santa Barbara. In FY08, will begin to characterize newly-discovered networks by developing new mathematical and computational methods that address identified gaps. Investigate whether protein-protein network models, developed for a particular pathogen, are portable to a different pathogen sharing a common set of proteins. In FY09, will transfer knowledge and techniques gained from studies of biological networks, by an inter-disciplinary team of physical science and life science researchers, to general physical networks.		500	500	500
Small Business Innovative Research/Small Business Technology Transfer Programs		50		
Total	5623	5773	6318	6525

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2007

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

COST (In Thousands)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
T22 SOIL & ROCK MECH	1889	1787	2171	2213	2236	2252	2302	2352

A. Mission Description and Budget Item Justification: The objective of this basic research project is to correlate 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 understand the sensor data within a heterogeneous geological system. This research encompasses geologic and structural material behavior, structural systems, and the interaction with dynamic and static loadings. Research includes: 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 in program element 0602784A (Military Engineering Technology) project T40, Mobility/Weapons Effects Technology, that supports the civil engineering technologies for force projection, mobility, maneuver support, and survivability of the Future Force. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the Defense Basic Research Plan (BRP). The US Army Engineer Research and Development Center, headquartered at Vicksburg, MI, executes the project work.

Accomplishments/Planned Program:	FY 2006	FY 2007	FY 2008	FY 2009
Military Engineering Basic Research: In FY06, identified and characterized the magnetic properties of soils that can mask the detection of mines and unexploded ordnance. Developed techniques for improving the bond between concrete and steel. In FY07, determine the feasibility of biological stabilization of soil surfaces for rapid construction on these surfaces; produce techniques for optimizing hardening reactions in organic cements allowing them to become the basis for high-strength, lightweight composites; and produce a concept for low-velocity probe that could provide the capability to remotely determine soil properties. In FY08, will produce simulation capabilities for a full, dynamic, micro-scale air-water-solid system and for molecular dynamics of selected carbon nanotubes. In FY09, will extract macro-scale models from the micro-scale simulation capability (air-water-solid) and will produce final molecular dynamics modeling for the understanding of cement-based and ceramic materials.	1889	1774	2171	2213
Small Business Innovative Research/Small Business Technology Transfer Programs		13		
Total	1889	1787	2171	2213

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2007

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

COST (In Thousands)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
T23 BASIC RES MIL CONST	1532	1440	1649	1713	1753	1815	1876	1948

A. Mission Description and Budget Item Justification: The objective of this basic research project is to support facilities research initiatives. The project is focused on 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 in a range of facilities to 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 program element 0602784A (Military Engineering Technology) 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 Defense Basic Research Plan (DBRP). The US Army Engineer Research and Development Center, headquartered at Vicksburg, MI, executes the project work.

Accomplishments/Planned Program:	FY 2006	FY 2007	FY 2008	FY 2009
Facilities Research: In FY06, investigated the efficiency of mechanisms in a semi-conducting optical system to detect and quantify simulants for spores, such as anthrax. Completed experimental measurements of anomalous enhanced thermal conductivity using carbon nanotube (CNT) nanoparticles. In FY07, develop physics based constitutive equations for heat transfer of fluids containing CNT nanoparticles. Mature molecular level design tool for CNT reinforced composite materials. In FY08, will develop robust model-based support for the "Sensing Through Walls" (STW) problem, taking into account critical high-level building design logic and constraints. Will determine the complex interactions between a forest edge and an acoustic wave, including the dependence on acoustic ground impedance, microclimate, and biomass structure. Will develop predictive understanding of blast wave interaction with man-made barriers. In FY09 will conduct experimentation to be used in developing next generation nanotechnology for facilities, sensor coatings, and constituitive models for micro-particle dispersion.	1532	1415	1649	1713
Small Business Innovative Research/Small Business Technology Transfer Programs		25		
Total	1532	1440	1649	1713

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2007

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

COST (In Thousands)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
T24 SNOW/ICE & FROZEN SOIL	1273	1150	1422	1443	1460	1471	1503	1536

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, and energy propagation in response to changing terrain state and near surface atmosphere. 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 US Army Engineer Research and Development Center, headquartered at Vicksburg, MI, executes the project work.

Accomplishments/Planned Program:	FY 2006	FY 2007	FY 2008	FY 2009
Terrain State and Signature Physics: In FY06, formulated 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, 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. In FY08, will investigate how high frequency radio waves propagate over topographically and electrically complex ground (roughness); specifically, the degree to which roughness controls local and extensive RF coverage and develop theory to predict coverage given surface roughness and electrical variability. In FY09, will investigate the variance in disturbed and undisturbed soil physical, thermal, and optical properties to establish physical parameters that govern the signature response and variance in changing environmental conditions, thus optimizing below surface target detection in prevailing environmental conditions.	1273	1150	1422	1443
Total	1273	1150	1422	1443

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2007

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

COST (In Thousands)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
T25 ENVIRONMENTAL RES-COE	4259	4531	5519	5625	5679	5719	5834	5951

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 include: 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 the study of ecosystem genomics and proteomics in support of the Army's new Network Science initiative. The project supports applied research under program element (PE) 0602720A (Environmental Quality Technology), projects 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 US Army Engineer Research and Development Center, headquartered in Vicksburg, MI, executes the project work.

Accomplishments/Planned Program:	FY 2006	FY 2007	FY 2008	FY 2009
Environmental and Ecological Fate of Explosives, Energetics, and Other Contaminants: In FY06, determined the potential mechanisms of toxicity and sub-lethal effects of individual and interactive mixtures of explosives. Used bioinformatics (computational biology) as the basis for constructing Deoxyribonucleic Acid (DNA) probes and to characterize DNA isolated from soil. In FY07, continue to establish a basic understanding of physical, chemical, and biological phenomena specific to contaminant toxicity assessment and environmental risk assessment. 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. Identify DNA gene sequences involved in the anaerobic biodegradation and alterations of cell wall pass-thru proteins for use in probe biosensors for an explosive nitroamine (Cyclonite-RDX) and Perchlorate. Determine the physiological response of soil bacteria to identify protein biomarkers of Hexanitrohexaazaisowurtzitane (CL-20) exposure and metabolism. In FY08, will apply computational chemistry to identify molecular structural reactivity to predict degradation mechanisms and products and define the molecular mechanisms of neurotoxicity for an invertebrate neurobiology model to assess sublethal neurotoxic effects of CL-20 and other munitions constituents (MCs). Will investigate detection of biomolecule binding and cleavage events using biomolecules as switches for ultra-sensitive monitoring of MCs. Will identify chemical reactions between the DNA sequence and contaminant for applications toward contaminant-unique biosensors. Will integrate toxicogenomics data with biological network analysis to serve as a basis to identify mechanisms and interactive toxicity effects of MC mixtures. Will improve estimates of waterborne lead absorption, distribution, and subcellular partitioning in prey invertebrates and reptiles.	2576	2682	3336	3400
Remediation of Explosives, Energetics, and UXO: In FY06, used 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. Established the	1214	1260	1575	1606

relationship of explosives-energetics affinity of being bio/chemically transformed into other toxic/non-toxic chemicals using kinetic models. Refined 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. Continued characterization of explosive degrading microbial communities using molecular methods. In FY07, identify RDX microbial and molecular interactions, regulatory genetic networks, breakdown modes and pathways, and novel signaling molecules that lead to improved capability to assess, control, design, and track progress of RDX bioremediation. Determine the physiological response of soil bacteria to identify protein biomarkers of CL-20 exposure and metabolism. Continue to establish a basic understanding of physical, chemical, and biological phenomena specific to contaminant mineralization. In FY08, will define mechanisms of high explosives movement through the unsaturated soil zone to the groundwater to support range management and remediation approaches. Will investigate the application of the unique physical, chemical, and biological interactions with the environment of DoD specific nanomaterials to potentially support advanced environmental technologies. Will continue to establish a basic understanding of physical, chemical, and biological phenomena specific to contaminant mineralization. In FY09, will continue to establish a basic understanding of physical, chemical, and biological phenomena specific to contaminant mineralization.				
Training Land Natural Resources: In FY06, determined viable population levels of threatened and endangered species, as affected by the genetic diversity within populations, and quantified the amount of genetic exchange between populations due to habitat fragmentation. In FY07, define the fundamental relationships between landscape structure - habitat feature and effects on the genetic viability of threatened and endangered bird populations. Continue to establish a basic understanding of physical, chemical, and biological phenomena specific to ecosystem maintenance, mitigation, and rehabilitation. In FY08, will determine potential use of bioassay guided fractionation (BGF) to assess reptilian developmental and reproductive effects, toxicity, and risk of endocrine active compounds for a large number of contaminants. Will continue to establish a basic understanding of physical, chemical, and biological phenomena specific to ecosystem maintenance, mitigation, and rehabilitation. In FY09, will continue to establish a basic understanding of physical, chemical, and biological phenomena specific to ecosystem maintenance, mitigation, and rehabilitation.	469	488	608	619
Small Business Innovative Research/Small Business Technology Transfer Programs		101		
Total	4259	4531	5519	5625