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

February 2003

BUDGET ACTIVITY
1 - Basic research

PE NUMBER AND TITLE
0601102A - DEFENSE RESEARCH SCIENCES

COST (In Thousands)		FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
	Total Program Element (PE) Cost	135535	140493	128798	129586	133740	135895	137338	149836
305	ATR RESEARCH	1166	1170	1196	1201	1273	1296	1313	1345
31B	INFRARED OPTICS RSCH	2352	2369	2267	2273	2421	2469	2505	2571
52C	MAPPING & REMOTE SENS	2213	2318	2389	2406	2492	2535	2578	2639
53A	BATTLEFIELD ENV & SIG	3661	3759	2586	2579	2746	2745	2729	2849
74A	HUMAN ENGINEERING	2589	2629	2656	2657	2837	2889	2919	2993
74F	PERS PERF & TRAINING	2627	2754	2686	2737	2832	2839	2906	2930
F20	ADV PROPULSION RSCH	2462	2482	1898	1893	2044	2082	2104	2125
F22	RSCH IN VEH MOBILITY	461	484	501	502	522	533	543	556
H42	MATERIALS & MECHANICS	1911	1947	1964	1962	2097	2136	2159	2212
H43	RESEARCH IN BALLISTICS	3965	5429	6078	6079	6314	6393	6462	16380
H44	ADV SENSORS RESEARCH	3963	3995	3879	3859	4077	4157	4180	4291
H45	AIR MOBILITY	8405	2048	2134	2146	2222	2266	2310	2364
H47	APPLIED PHYSICS RSCH	3108	3117	2544	2496	2705	2731	2765	2852
H48	BATTLESPACE INFO & COMM RSC	6635	6731	5306	5242	5539	5640	5737	5818
H52	EQUIP FOR THE SOLDIER	959	1009	1004	993	1068	1083	1091	1119
H57	SCI PROB W/ MIL APPLIC	49182	52599	56196	56815	58041	59000	59404	60219
H66	ADV STRUCTURES RSCH	1426	1440	1438	1428	1540	1567	1577	1618
H67	ENVIRONMENTAL RESEARCH	3379	3308	1415	1517	829	806	788	883
H68	PROC POLLUT ABMT TECH	352	367	386	389	401	409	420	429
HA4	PERPETUAL ASSAIL & SECURE INFO SYS, RSCH, TNG & ED	3645	2430	0	0	0	0	0	0
S04	MIL POLLUTANT/HLTH HAZ	594	618	652	659	676	688	704	721
S13	SCI BS/MED RSH INF DIS	8810	9177	9579	9613	10080	10260	10414	10669
S14	SCI BS/CBT CAS CARE RS	3860	4001	4204	4222	4401	4482	4563	4672
S15	SCI BS/ARMY OP MED RSH	5290	5500	5721	5740	6031	6137	6227	6381
S17	MOLECULAR BIOLOGY-HIV	413	0	0	0	0	0	0	0
S19	T-MED/SOLDIER STATUS	587	583	667	688	708	722	740	756

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

February 2003

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1 - Basic research	**0601102A - DEFENSE RESEARCH SCIENCES**

T22	SOIL & ROCK MECH	1775	1882	1950	1960	2031	2067	2098	2150
T23	BASIC RES MIL CONST	1502	1578	1649	1659	1711	1746	1781	1821
T24	SNOW/ICE & FROZEN SOIL	2078	1185	1201	1184	1274	1295	1294	1328
T25	ENVIRONMENTAL RES-COE	4234	4435	4652	4687	4828	4922	5027	5145
T30	ANIMAL MODELING GENETICS RESEARCH	0	953	0	0	0	0	0	0
T55	DISPLAY PERFORMANCE & ENVIRONMENTAL EVALUATION	1931	0	0	0	0	0	0	0
T56	BIOFILM RESEARCH	0	953	0	0	0	0	0	0
T57	DESERT TERRAIN ANALYSIS	0	2669	0	0	0	0	0	0
T58	KNOWLEDGE MANAGEMENT FUSION CENTER	0	2859	0	0	0	0	0	0
T59	PREDICTION OF LAND-ATMOSPHERE INTERACTIONS	0	1715	0	0	0	0	0	0

A. Mission Description and Budget Item Justification: This program element sustains U.S. Army scientific and technological superiority in land war fighting capability, provides new concepts and technologies for the Army's Objective Force, and provides the means to exploit scientific breakthroughs and avoid technological surprises. It fosters innovation in Army niche areas (such as lightweight armor, energetic materials, night vision) and where the commercial incentive to invest is lacking due to limited markets (e.g., vaccines for tropical diseases). It also focuses university single investigators on research in areas of Army interest, such as high density compact power and novel sensor phenomenologies. The in-house portion of the program capitalizes on the Army's scientific talent and specialized facilities to expeditiously transition knowledge and technology into the appropriate developmental activities. The extramural program leverages the research efforts of other government agencies, academia, and industry. This translates to a coherent, well-integrated program which is executed by the five primary contributors: 1) the Army Research Laboratory (ARL), which includes the Army Research Office; 2) the Army Materiel Command Research, Development and Engineering Centers (RDECs); 3) the Army Corps of Engineers Research and Development Center (ERDC); 4) the Army Medical Research and Materiel Command laboratories; and 5) the Army Research Institute. The basic research program is coordinated with the other Services via the Joint Directors of Laboratories panels, Project Reliance, and other interservice working groups. This program responds to the scientific and technological requirements of the Department of Defense Basic Research Plan, the Army Science and Technology Master Plan, and the Army Modernization Plan by enabling the technologies that can significantly improve joint war fighting capabilities. The projects in this Program Element involve basic research efforts directed toward providing fundamental knowledge for the solution of military problems related to long-term national security needs and is appropriately in Budget Activity 1. The program element contains no duplication with any effort within the Military Departments. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

No Defense Emergency Response Funds (DERF) have been provided to this program/project.

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

February 2003

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B. Program Change Summary	FY 2002	FY 2003	FY 2004	FY 2005
Previous President's Budget (FY 2003)	144240	139633	140230	143306
Current Budget (FY 2004/2005 PB)	135535	140493	128798	129586
Total Adjustments	-8705	860	-11432	-13720
Congressional program reductions		-1000		
Congressional rescissions		-8403		
Congressional increases		13550		
Reprogrammings	-6120	-807		
SBIR/STTR Transfer	-2585	-2480		
Adjustments to Budget Years			-11432	-13720

Change Summary Explanation:

FY03 Congressional Adds:
PASIS: Perpetually Assailable and Secure Information Systems, Research, Training and Technology, Project HA4 ($2550); Animal modeling genetics research, Project T30 ($1000); Biofilm Research, Project T56; ($1000); Knowledge Management Fusion Center, Project T58 ($3000); Optical Technologies Research; Project H57 ($1400); Prediction of Land-Atmosphere Interactions, Project T59 ($1800); Integrated Desert Terrain Analysis, Project T57 ($2800)

Projects with no R-2As:
- Research in Vehicle Mobility, Project F22: Conduct research in support of advanced military vehicle technology with emphasis on advanced propulsion, sophisticated vehicle dynamics and simulation, and advanced track and suspension concepts.
- Processes in Pollution Abatement Technology, Project H68: Provide fundamental understanding of the physical, chemical and biological properties of hazardous wastes and mechanisms that control their degradation and treatment on military installations.
- Military Pollutants and Health Hazards, Project S04: Develop innovative, less costly, and less time consuming toxicity assessment methods for determining potential human health and environmental effects of military-unique hazardous wastes and chemicals, including explosives, propellants, and smokes.
- Molecular Biology/Military HIV Research, Project S17: Develop methods for the prevention, early diagnosis, and treatment of human immunodeficiency virus (HIV)

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2 Exhibit)	February 2003

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

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- Telemedicine Soldier Status Research, Project S19: Provide realistic, simulated representations of medical procedures based upon R&D of enabling technologies in tissue modeling, haptics integration, graphics, and physiological representations and overall systems architecture.
- PASIS: Perpetually Assailable and Secure Information Systems, Research, Training and Technology, Project HA4 ($2550): This one year congressional add provides funding to the Center for Perpetually Available and Secure Information Systems for a future-looking, highly multidisciplinary research program investigating all aspects of availability and security of information systems. No additional funding is required to complete this project.
- Animal modeling genetics research, Project T30 ($1000): The purpose of this one year Congressional add is to support modeling the genomics and proteomics (protein based) in research animals to allow for gene-based therapy and diagnosis in humans. No additional funding is required to complete this project.
- Biofilm Research, Project T56; ($1000): This one year congressional add supports research in microbiology and bioremediation to clean up contaminated toxic wastes at Army sites in a cost effective and environmentally benign manner. No additional funding is required to complete this project.
- Knowledge Management Fusion Center, Project T58 ($3000): The purpose of this one year Congressional add is to fund basic research to provide an understanding of fundamental data fusion issues that must be addressed to enhance battlespace situation awareness and leverage net centric warfare. No additional funding is required to complete this project.
- Prediction of Land-Atmosphere Interactions, Project T59 ($1800): The purpose of this one year Congressional add is to examine new techniques for measuring ground conditions from remote sensors and assimilating these data with model predictions for terrain state. No additional funding is required to complete this project.
- Integrated Desert Terrain Analysis, Project T57 ($2800): This one year congressional add supports research on the impacts of Army combat vehicle training on desert ecosystems, in particular vegetative cover, soil, water quality and wildlife with a goal of improving the sustainability of Army desert training lands. No additional funding is required to complete this project.

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit) | February 2003

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

COST (In Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
305 ATR RESEARCH	1166	1170	1196	1201	1273	1296	1313	1345

A. Mission Description and Budget Item Justification: This project focuses on the fundamental underpinnings of aided and unaided target detection and identification techniques for land warfare scenarios. It is increasingly desirable to have Army systems that can act independently of the human operator to detect and track targets. Such capabilities are needed for smart munitions, unattended ground sensors and replacements for existing systems such as land mines. Critical technology issues include low depression angle, relatively short range, and highly competing clutter backgrounds. Electro-optic/infrared imaging systems that use advanced algorithms for compressing data, detecting and identifying targets over extended battlefield conditions, are essential for the warfighter in Future Combat Systems (FCS). The research resulting from this project will provide fundamental capability to predict, explain, and characterize target and background signature content, and reduce the workload on the analyst. This research is aimed at evaluating the complexity and variability of target and clutter signatures that ultimately will utilize that knowledge to conceptualize and design advanced Automatic Target Recognition (ATR) paradigms to enhance robustness and effectiveness of land warfare systems. ATR research strategies include emerging sensor modalities such as spectral and multi-sensor imaging. Research supports several technology efforts including multi-domain smart sensors, third generation forward looking infrared radar (FLIR), and advanced multi-function laser radar (LADAR). The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and Project Reliance.   This program element contains no duplication with any effort within the Military Departments. Work is performed by the Army Research Laboratory (ARL). This program supports the Objective transition path of the Transformation Campaign Plan (TCP).

No Defense Emergency Response Funds (DERF) have been provided to this program/project.

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

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
- In FY02, designed new ATR approach using hyperspectral data cubes and compared hyperspectral ATR algorithms to broadband and dual band ATR performance; provided framework for use of synthetic target image chips in the development of classifier algorithms. In FY03, quantify results of preliminary algorithm development and report results; research the improvement resulting from the formulation; conduct fundamental studies into new detection and clutter rejection techniques and use of composite classifiers over single classifiers in the ATR context. In FY04, determine the minimum number of hyperspectral bands needed for effective target recognition algorithms, and make recommendations for Army applications; investigate and specify the improvement in composite classifiers through the use of enhancing algorithms; investigate relative merits of detection and clutter rejection techniques and document results. In FY05, investigate new methods for feature extraction, including independent component analysis for land warfare applications, to reduce the impact of clutter and lessen the false alarm rate and improve classifiers; make recommendations on use of specific algorithms for land warfare applications, to reduce the impact of clutter and lessen the false alarm rate.	1166	1170	1196	1201
Totals	1166	1170	1196	1201

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)	February 2003

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

COST (In Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
31B INFRARED OPTICS RSCH	2352	2369	2267	2273	2421	2469	2505	2571

A. Mission Description and Budget Item Justification: This project supports the Army's theoretical and experimental research in materials and devices for active and passive infrared (IR) imaging systems. It generates new technologies to obtain unprecedented awareness of the battlefield and to continue to "own the night". To achieve these objectives for the Objective Force, IR Focal Plane Arrays (IRFPAs) with significantly improved performance, lower cost, and increased operating temperatures and compact low cost laser radar (LADAR) architectures are needed. Research is focused on material growth, detector design and processing for large area multicolor IRFPAs. The main efforts are directed towards mercury cadmium telluride (HgCdTe) detector arrays grown on silicon (Si) substrates, antimonide (Sb) base super lattices, and quantum well and dot infrared photon detectors. For the compact frequency modulated/continuous wave (FM/CW) LADAR, research has to be performed for some critical components, especially for a high frequency detector/modulator array. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, Project reliance.   This program element contains no duplication with any effort within the Military Departments. Work is performed by the Army Research Laboratory (ARL). This program supports the Objective transition path of the Transformation Campaign Plan (TCP).

No Defense Emergency Response Funds (DERF) have been provided to this program/project.

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

February 2003

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

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
- In FY02, various detector structures were grown, fabricated and tested using HgCdTe and semi-conducting materials; impurity levels in HgCdTe materials were reduced and high operating temperatures (HOT) structures were grown and IR detectors fabricated and tested for improved LADAR performance; fabricated and characterized a 32 x 32 detector array for the Army LADAR program. In FY03, complete fabricate and test mid-wave infrared (MWIR) large-format (1024 x 1024 pixal detector arrays on silicon; evaluate MWIR high operating temperature detectors. In FY04, characterize large format MWIR IR FPAs staring passive ladar detector arrays and grow and characterize LWIR detector structures on Si. In FY05, grow and characterize large area LWIR detector structures, HOT detector arrays, and evaluate integrated passive and active LADAR detector arrays.	2352	2369	2267	2273
Totals	2352	2369	2267	2273

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

February 2003

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

COST (In Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
52C MAPPING & REMOTE SENS	2213	2318	2389	2406	2492	2535	2578	2639

A. Mission Description and Budget Item Justification: Basic research in topographic sciences focuses on increasing knowledge of the terrain through improved generation, management, analysis/reasoning, and modeling of geospatial data, including the exploitation of multisensor data. This fundamental knowledge forms the scientific "springboard" for the future development of applications, techniques, and tools to improve the tactical commander's knowledge of the battlefield; to extract and attribute natural and man-made features from reconnaissance imagery in near-real time; to exploit terrain analysis and reasoning techniques; and to explore the potential of space technology to provide real-time terrain intelligence, command and control, and targeting support. This research investigates new methods of exploiting terrain and environmental data to improve situational awareness and enhance information dominance leading to increased survivability, lethality, and mobility capabilities for the Future Combat Systems and Army Vision/Joint Vision 2020 concepts. The research provides the theoretical underpinnings for program element 0602784A, project 855. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan and Project Reliance. The program element contains no duplication with any effort within the Military Departments. Work is performed by the U.S. Army Engineer Research and Development Center. This project supports the Objective transition path of the Transformation Campaign Plan.

No Defense Emergency Response Funds were provided to the project.

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

February 2003

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

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
Seismic/Acoustic Sensor Placement – In FY02, completed analysis of existing data on overburden estimation. In FY03, investigate modeling approaches which support optimal sensor placement. In FY04, establish methodology for estimating overburden depths and identifying optimal sensor placement locations. Terrain Categorization (TERCAT) – In FY02, collected and analyzed raw emittance and reflectance data signatures against defined target sets. In FY03, investigate appropriate spectral bands for TERCAT applications, and analyze classification algorithms. In FY04, test prototype automated classification algorithms utilizing bi-directional reflectance data from corrected overhead imagery. Test prototype hyperspectral signal exploitation algorithms. In FY05, establish a regime for low-bandwidth hyperspectral data collection and compression of data that is collected. Develop and test prototype hyperspectral thermal exploitation algorithms. Automatic Feature Extraction – In FY03, identify and analyze regional characteristics of several distinct zonal areas. In FY04, investigate prototype algorithms to automate analysis of region specific features. In FY05, define region-specific key terrain for exploitation by automated processes, prototype an automated region-specific feature analysis capability, and test automated feature extraction algorithms against ground-truthed spectral datasets. Laser-induced Fluorescence – In FY02, collected baseline signature data. In FY03, investigate algorithm development for exploiting fluorescence data. In FY04, refine algorithms for identifying biological hazards. In FY05, test prototype algorithms for identifying biological hazards in water. Investigate the use of active remote sensing techniques for standoff detection of chemical and biological hazards.	2213	2318	2389	2406
Totals	2213	2318	2389	2406

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit) | February 2003

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

COST (In Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
53A BATTLEFIELD ENV & SIG	3661	3759	2586	2579	2746	2745	2729	2849

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 characteristics and detection of chemical and biological aerosols, and the propagation of full-spectrum electro-magnetic and acoustic energy. The Army of the future will be required to operate in very complex environments and disparate terrain requiring new approaches to understanding, characterizing, and depicting micro scale atmospheric phenomena. The lack of a complete understanding of the meteorological aspects of the complex micro scale boundary layer in which the Army operates continues to have impacts on abilities to provide accurate and timely tactical weather intelligence to battlefield commanders. This project focuses on boundary layer meteorology over land and urban terrain. It supports the Army's transformation to the Objective Force through the development of future capabilities and applications in such areas as the detection and identification of biowarfare agents, enhanced acoustic and electro-optic propagation modeling techniques for improved target detection and acquisition, and the development of objective analysis tools that can assimilate on-scene weather observations and fuse this information with forecasts to provide immediate now cast 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 the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, the DoD Basic Research Plan and Project Reliance. This program element contains no duplication with any effort within the Military Departments. Work in this project is performed by the Army Research Laboratory (ARL). This program supports the Objective transition path of the Transformation Campaign Plan (TCP).

No Defense Emergency Response Funds (DERF) have been provided to this program/project.

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit) | February 2003

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

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
- Research in optical and acoustical propagation in the atmosphere for enhanced Intelligence, Surveillance and Reconnaissance (ISR) capabilities for the Objective Force and FCS for situational understanding and rapid targeting. FY02, improved tactical target acquisition by employing new imaging techniques like polarization characterization and determined the atmospheric effects in forest canopies on acoustic propagation for improving acoustic sensors. FY03, conduct lab and field measurements in the infrared (IR) domain leading to the discrimination of polarimetric signatures. Also, analyze acoustic characteristics for intermittent turbulence conditions of a stable nocturnal boundary layer and develop a neural network for making acoustic propagation predictions. FY04, improve target recognition/identification using imaging techniques that more completely characterize the state of reflected thermal radiation. Investigate techniques to make battlefield acoustics sensors systems self-aware of their environment for improved performance capabilities in degraded atmospheric conditions. FY05, investigate technologies for quantifying turbulence effects on imaging sensors in a real battlefield situation. Perform research in high-fidelity acoustic signature simulation systems for developing synthetic acoustic signatures.	1875	2100	1772	1571
- Survivability of Objective Force and improved situational awareness through research to improve the accuracy of high-resolution meteorology focused on urban and complex terrain in order to account for the natural atmospheric and battle induced variability. FY02, advanced the capability of high-resolution forecast models for the Objective Force operating in target areas. Additionally, conducted initial field measurements of natural background aerosol particles to distinguish between hazardous and non-hazardous particulates. FY03, perform field experiments and data analysis for an urban area furthering the knowledge of forecast model accuracy and improving standoff detection and classification of hazardous aerosols. FY04, evaluate microscale forecast and transport/diffusion models using real data for urban and complex terrain. FY05, investigate new methods to determine the accuracy of small scale/limited domain models. Also, develop techniques to predict the detail scattering signature response of aerosols for improved remote sensing and standoff detection and classification of hazardous airborne aerosols.	1786	1659	814	1008
Totals	3661	3759	2586	2579

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

February 2003

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

COST (In Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
74A HUMAN ENGINEERING	2589	2629	2656	2657	2837	2889	2919	2993

A. Mission Description and Budget Item Justification: This project focuses on research on soldier-system performance in Interim- and Transformation-relevant environments. Research is on key underlying soldier performance phenomena such as judgment under uncertainty; echo-location and distance-estimation under degraded conditions; extending and protecting auditory and cognitive performance; humans in automated, mixed-initiative (human control-machine control) environments; associated neurological dynamics; communications in hearing-degraded conditions; collaborative (team) and independent multi-task, multi-modal, multi-echelon soldier-system performance, all cast against the influx of emerging Transformation-driven technological solutions and opportunities. Technical barriers include lack of methods for describing, measuring, and managing the interplay of these relatively novel phenomena in the consequent task and situational complexity and ambiguity which characterize the ramp-up to Transformation. Accordingly, technical solutions are being pursued in the areas of data generation and algorithm development, given that soldiers have never operated in these emerging environments, in order to update and improve our understanding of performance boundaries and requirements. These solutions include multi-disciplinary partnerships, metrics, simulation capabilities, and modeling tools with which to characterize soldier-system performance phenomena, and provide a sharable conceptual and operational framework for militarily purposeful research on cognitive and perceptual processes. All of the work in this program is included in the Army Strategic Research Objective (SRO) titled "Enhancing Soldier Performance". The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan and Project reliance. This program element contains no duplication with any effort within the Military Departments. Work is performed by the Army Research Laboratory (ARL). Program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

No Defense Emergency Response Funds (DERF) have been provided to this program/project.

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

February 2003

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

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
- Research to improve soldier auditory performance: In FY02: Conducted research to determine the best approach for improving spatial perception of combat important sounds in adverse listening conditions. Matured the Callsign Acquisition Test for assessing speech intelligibility of Military Communications Systems. Evaluated methods to quantify the combat arms earplug on speech recognition and signal source detection. In FY03: Identify critical aspects of recognition of acoustic signatures and warning signal. Determine human capabilities in auditory distance estimation and quantify soldier auditory performance in the presence of impulse noise. Determine sound quality metrics and controlling algorithms for evaluation and standardization of immersive acoustic environments to improve soldier simulation experiments. Identify and quantify the effects of whole-head helmet on speech communication and auditory detection and optimize head mapping for bone conduction microphone placement. FY 04: Determine auditory requirements and trade-offs for an acoustically transparent whole-head helmet for the Objective Force Warrior. FY05:Mature remotely controlled binaural microphone system for the Future Combat System (FCS).	1082	1115	1148	1136
- Research to improve soldier cognitive performance: In FY02: Studied electrophysiological measures of cognitive performance; generated multivariate and hierarchical models of soldier performance under a variety of stressful conditions and transitioned results to continue refinement of Improved Performance Research Tool (IMPRINT) for human dimension analyses. In FY03: Investigate cognitive readiness assessment tools to measure war fighting effectiveness. Document soldier performance effects of individual differences and situational characteristics in multi-tasking scenarios. Link data from brain and behavior research to feed and validate cognitive models of soldier performance. Devise models of perceptual, cognitive, and multi-tasking workload representing Objective Force soldier performance with proposed enhanced sensory input technology. In FY04: Provide tools, models, and results to Objective Force design and development teams; field-validate predictive models and integrate models and results with large-scale representations of system and unit performance. In FY05: advance error prediction and decision making models to complex Objective Force environments for technology design evaluation and design cognitive modeling interface for rapid propagation of cognitive models in Army models and simulations.	1507	1514	1508	1521
Totals	2589	2629	2656	2657

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

February 2003

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

COST (In Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
74F PERS PERF & TRAINING	2627	2754	2686	2737	2832	2839	2906	2930

A. Mission Description and Budget Item Justification: This project covers behavioral science research in areas with high payoff opportunities for improved personnel selection, training, leadership, and performance, including: assessments of practical intelligence as an aptitude that can be measured across job domains; identify principles and potential methods for training and sustaining complex tasks arising from digital, semi-automated, and robotic systems requirements; identifying potential methods for faster learning and improved skill retention; identifying likely methods for developing leader adaptability and flexibility and for accelerating leader development; discovering and testing the basic cognitive principles that underlie effective leader-team performance; and improving the match between soldier skills and their jobs to optimize performance. Research is focused on issues fundamental to transforming the human component of war fighting in synchronization with the transformations in systems, technologies, weapons, and operational requirements to meet the goals of the Objective Force. This project is managed by the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI). The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and Project Reliance. This project contains no duplication with any effort within the Military Departments. This project supports the Objective Force transition path of the Transformation Campaign Plan (TCP). It does not contain Defense Emergency Response Funds (DERF).

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

February 2003

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

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
- FY 02, identified behavioral factors that enhance or diminish speed, durability, and transferability of training of verbal and spatial tasks; developed and validated tacit knowledge inventory to assess leadership problem-solving experience levels; identified differential factors and life-course trends affecting the propensity of high school males and females to enlist in the Army. FY03, develop multi-source measure of socially intelligent job performance; develop computerized diagnosis of leadership training needs and assessment of leadership training effectiveness; identify potential training requirements for leaders of electronic-based teams. FY04, explore practical job knowledge assessment instruments; assess trainability of sense-making (situation awareness) skills; assess trainability of skills for rapid interpretation of large volumes of ambiguous electronic data. FY05, validate test battery for measuring mental flexibility; assess memory for spatial and temporal events in electronic environments.	2627	2754	2686	2737
Totals	2627	2754	2686	2737

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)		February 2003

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

COST (In Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
F20 ADV PROPULSION RSCH	2462	2482	1898	1893	2044	2082	2104	2125

A. Mission Description and Budget Item Justification: The goal of this effort is increased performance of small air-breathing engines and power trains that will support Army Transformation in the areas of system mobility, reliability and survivability, and ultimately serve to reduce the logistics cost burden for the Objective Force. Problems include the ability to achieve greater fuel efficiency and reduce weight in these propulsion systems. Technical barriers to advanced propulsion systems are the maximum temperature that today's materials can safely withstand, the lack of capability to accurately simulate the flow physics, and the mechanical behavior of these systems, including the engine and drive train. The Army is the lead service in these technology areas (under Project Reliance) and performs basic research in propulsion, as applicable to rotorcraft and tracked and wheeled vehicles. Technical solutions are being pursued through analysis; code generation, experiments and evaluations to improve engine and drive train components and investigate advanced materials. Component level investigations include compressors, combustors, turbines, energy conversion/sources, injectors, pistons, cylinder liners, piston rings, gears, seals, bearings, shafts, and controls. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and Project Reliance. This program element contains no duplication with any effort within the Military Departments. Work is performed by the Army Research Laboratory (ARL). This program supports the Objective transition path of the Transformation Campaign Plan (TCP).

No Defense Emergency Response Funds (DERF) have been provided to this program/project.

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

February 2003

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

<u>Accomplishments/Planned Program</u>	FY 2002	FY 2003	FY 2004	FY 2005
- FY02: Evaluated a MEMS injector hardware design to enhance turbine engine stability and performance; improved structural ceramic life prediction model for engine reliability; and transitioned a new engine weight and safety prediction algorithm into the National Propulsion System Simulation code. Established gear design standards for crack propagation that were adopted by the rotorcraft industry; incorporated elastohydrodynamic effects into advanced journal bearing codes; conducted a preliminary analysis of atmospheric effects on foil bearing performance leading to improved safety, reliability, performance, and durability of future rotorcraft transmission drive systems. FY03: Add environmental effects into propulsion material life prediction and performance models; develop, for the first time, analytical capability to predict onset of compressor stall in full axi-centrifugal compressor system; develop advanced lubrication independent thrust bearing concepts in support of oil-free engines for advanced platforms. FY04: Develop advanced lubrication independent thrust bearing concepts in support of oil-free engines and conduct research into alternative energy conversion processes and energy sources, e.g., fuel cells. FY05: Investigate materials processing and life prediction methods for ceramics. Assess novel concepts for UAVs. Analyze low vibration high load capacity power transmission component, material concepts, and analytical tools.	2462	2482	1898	1893
Totals	2462	2482	1898	1893

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

February 2003

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

COST (In Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
H42 MATERIALS & MECHANICS	1911	1947	1964	1962	2097	2136	2159	2212

A. Mission Description and Budget Item Justification: This project funds the Army's basic research program in materials science which includes research into key phenomena enabling the creation and production of revolutionary materials that will provide higher performance, lighter weight, lower cost, improved reliability, and environmental compatibility for Army unique applications. Technical barrier is that with current materials, to gain added functionality for Army systems, one must use a layered approach whereby each layer provides added capability (ie. ballistic, chem./bio,signature, etc) but ultimately the system is too heavy and too expensive. Technical solutions are being pursued through understanding the fundamental aspects of chemistry and microstructure that influence the performance and failure mechanisms of ceramics, advanced polymer composites, and advanced metals, with the goal of creating hierarchically organized materials systems that possess multifunctional attributes at greatly reduced weight and cost. These advanced materials will enable revolutionary lethality and survivability technologies for the Objective Force. This research supports materials technology applied research in project 0602105A/AH84. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, Project reliance and supports the Objective Force transition path of the Transformation Campaign Plan (TCP). This program element contains no duplication with any effort within the Military Departments. Work is performed by the Army Research Laboratory (ARL).

No Defense Emergency Response Funds (DERF) have been provided to this program/project.

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

February 2003

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

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
FY02, determined complex micro structural relationships between interphase and bulk composite properties of lightweight integral armor materials; correlated morphology and interfacial properties with mechanical performance in multilayered laminates and layered silicate nanocomposites; characterized dynamic and static material properties of advanced ceramics that can be tailored to control the onset of ballistic failure for improved lightweight armors; devised analytic models and experimental techniques for describing material response of dynamically loaded anti-armor concepts; and evaluated large strain viscous models against measured data and completed new internal viscous constitutive model for elastomers. In FY03, extend and validate physics-based models and experimental techniques to enable exploitation of composite material interphase design methodologies for transition to developers of high-performance, lightweight integral armors; refine structure/property relationships and processing techniques for tailoring performance of advanced polymer systems to be used in integrated materiel systems; devise first-principles ceramic design tool; incorporate analytic model of dynamic penetrator fracture into design codes; and improve analyses for inflatable fabric structures. In FY04, conduct basic research to enable design of advanced composite material-based structures with inherent electro-opto-chemical properties enabling revolutionary multifunctional performance of lightweight armors; conduct basic research to create hierarchically organized materials systems that possess multifunctional attributes that will enable revolutionary survivability in Objective Force Warrior systems; validate ceramic design tool with theory critical experiments; and experimentally characterize dynamic fracture response of candidate anti-armor materials under ballistic loads.	1911	1947	1964	0
- In FY05, advance electro-opto-chemical integration capabilities of next-generation composite structures for improved multifunctionality (e.g., sensory, communications, power); advance fundamental understanding of structure-property-processing relationships in hierarchical material systems to produce tailored functionality in Objective Force Warrior systems; verify micro-structure (including fractography) of armor ceramics that have been subjected to impact and conduct mechanical (fracture toughness, hardness) and non-destructive test characterization of armor targets containing silicon carbide and boron carbide armor ceramics; and incorporate second generation dynamic fracture model into computational continuum mechanics code to enable development of improved anti-armor concepts.	0	0	0	1962
Totals	1911	1947	1964	1962

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

February 2003

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

COST (In Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
H43 RESEARCH IN BALLISTICS	3965	5429	6078	6079	6314	6393	6462	16380

A. Mission Description and Budget Item Justification: This project funds the Army's basic research program in ballistics. The goal is to improve the understanding of the chemistry and physics controlling the propulsion and flight of gun launched projectiles and the flight of missiles, and to understand the interaction of these weapons with armored targets. This research results in the science base which allows the formulation of more energetic propellants, more accurate and lethal projectiles and missiles, and advanced armors for increased survivability of Army combat systems for the Objective Force. This research is conducted at the Army Research Laboratory, Aberdeen Proving Ground, MD in support of ballistic technology applied research in project 0602618A/AH80. Effort supports OSD Advanced Energetics Initiative to mature the fundamental technologies required to transition the next generation of energetic materials into field use. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, Project Reliance and supports the Objective Force transition path of the Transformation Campaign Plan (TCP). This program element contains no duplication with any effort within the Military Departments. Work is performed by the Army Research Laboratory (ARL).

No Defense Emergency Response Funds (DERF) have been provided to this program/project.

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)	February 2003

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

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
- In support of the National Advanced Energetics Initiative, expand and validate physics based models and experimental techniques to devise chemical formulations that will enable design of novel insensitive high-energy propellants and explosives with tailored energy release for revolutionary Objective Force lethality and survivability. In FY02, employed fundamental and 3-D interior ballistics models and experimental techniques to understand the interaction of electrically generated plasmas with propellants and explicitly model shock and detonation propagation in propellant beds. In FY03, expand first principles design tools to enable tailoring of chemical formulations. In FY04, characterize/model the chemical and physical properties of novel energetic materials to establish the relationship between particle-size, energy density and release rate for insensitive high-energy propellants and explosives. Explore influence of these parameters on controlling mechanisms for initiation of combustion and detonation. In FY05, Employ fundamental and advanced propulsion/detonation models and experimental techniques to understand tailored energy release of insensitive high-energy propellants and explosives, including multiple-mode applications for energetic materials.	1726	3103	3770	3759

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)		February 2003

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

Accomplishments/Planned Program (continued)	FY 2002	FY 2003	FY 2004	FY 2005
- In FY02, expanded ceramic micro mechanical model to describe inter-granular flow, grain size, orientation, and boundary chemistry and conducted fundamental experiments to determine damage evolution under ballistic load; devised analytic model and conducted fundamental experiments to determine adiabatic shear onset criterion in emerging anti-armor alloys; and coupled high performance computational design tools (aerodynamics/structures) to calculate control aerodynamics of non-axisymmetric munition body shapes. In FY03, validate ceramic micro mechanical model using theory critical experiments and integrate model into numerical code; refine adiabatic shear model based on micro mechanical experiments of candidate alloy materials; and incorporate structural flight vehicle response, aerodynamics, propulsion, guidance, navigation and control to enable a comprehensive design and evaluation capability. In FY04, correlate ballistic performance of armor ceramics with fundamental material properties and material behavior using non-ballistic evaluation methods; investigate shear band velocity as influenced by driving imperfections found in anti-armor devices and validate refined shear model in computational continuum mechanics code to support improved analysis of armor/anti-armor interactions; and devise algorithms to model fully-coupled roll controlled pitch up maneuver employing coupled CFD/ Structures/GN&C and non-axisymmetric high alpha aerodynamics CFD to enable design of complex precision munitions for the Objective Force. In FY05, prove ability to model penetration through advanced ceramic armor and accurately capture the observed material response for each phase of penetration; incorporate adiabatic shear model into computational continuum mechanics code and validate; and prove capability to model fully coupled roll controlled pitch up maneuver and validate full high performance computational capability of coupled models employing multiple processors.	2239	2326	2308	2320
Totals	3965	5429	6078	6079

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit) | February 2003

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

COST (In Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
H44 ADV SENSORS RESEARCH	3963	3995	3879	3859	4077	4157	4180	4291

A. Mission Description and Budget Item Justification: This project exploits the basic sciences to enable new sensing capabilities for the Army's Objective Force. This work will produce future generations of sensors with capabilities beyond those currently being employed. Technical barriers include the fundamental speed and bandwidth limitations of current materials and devices, the efficiency of current algorithms, current computing architectures, organic material lifetimes, the understanding of the fundamental concepts of quantum cryptography and spatial resolution of current RF sensors. The technical approach focus is on exploitation of digital and image processing modules and algorithms, beam propagation material modeling in nonlinear optical materials and devices, remote sensing and intelligent system distributive interactive simulations and battlefield acoustic signal processing algorithms. Research involves fundamental science and engineering principles that support survivable sensor systems, displays, and environmental monitoring, both point and remote. Monolithic and hybrid optoelectronic structures in gallium arsenide and lithium niobate are investigated as integrated processors for novel signal and radar processing and control. Diffractive and micro-optic elements are investigated to enhance performance of imagers and optical processors. For laser protection, nonlinear optical effects are being explored which will allow broadband protection. These nonlinear effects can also be used for optical image processing or holographic displays and storage. Payoffs include low cost diverse displays, improved radar signal processing techniques that will allow existing systems to improve spatial resolution, improved ultra wideband radar technology, improved signal processing techniques for acoustic/seismic sensing systems, improve cryptography techniques, improved language translation, and improved sensor protection. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, Project reliance and supports the Objective Force transition path of the Transformation Campaign Plan (TCP). This program element contains no duplication with any effort within the Military Departments. Work is performed by the Army Research Laboratory (ARL).

No Defense Emergency Response Funds (DERF) have been provided to this program/project.

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

February 2003

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

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
- Research is focused on: investigating and evaluating image-processing techniques for large arrays of opto-electronic feedback circuits and providing computational multilingual tools for machine translation critical to combating terrorism: i.e.: Arabic, Pacific Rim, and Persian-Farsi. In FY02: incorporated advanced theoretical techniques by integrating a micro-mirror array from an ARL/ARO Multi University Research Initiative (MURI) at Boston University with a Very Large Scale Integration (VLSI) chip control into a bench scale adaptive optical system. This capability is a world record for adaptive optics atmospheric turbulence correction systems and is required for high-speed laser targeting and communications systems. In FY03: conduct experiments in the laboratory, the ARL outdoor laser communication, and laser imaging circuit with advanced analytical techniques; conduct characterizations, ontologies, and linguistic structures of Arabic and Persian and test translation modules. In FY04: conduct experiments for imaging for missile and weapons systems applications and transition to RDECs; extend characterizations, ontologies, and linguistic structures to Pacific Rim languages. In FY05: complete experiments for imaging for missile and weapons systems applications and transition to RDECs; (2) transfer language translation prototypes and multilingual search tools to intelligence user community for evaluating and testing.	1578	1600	1474	1419

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

February 2003

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

Accomplishments/Planned Program (continued)	FY 2002	FY 2003	FY 2004	FY 2005
- In FY02: characterized EM model for tactically sized targets at UHF frequencies necessary for locating targets under trees; characterized Surface Enhanced Raman Scattering (SERS) signal from bio agents from bacterial endospores and gram positive and negative bacteria in vegetative state; investigated new advanced processing techniques that exploit multiple networked sensor modalities and information encoded in quantum states; provided more realistic beam propagation codes for eye protection from lasers to address soldier survivability. In FY03: continue to characterize EM model for tactically sized targets at UHF frequencies; measure SERS spectra and compare several different bacterial types and identify relevant markers; investigate time frequency signal processing for detection and classification of transients for applications of networked sensors, and conduct a fundamental investigation into quantum information processing; incorporate low f number propagation to the existing codes.In FY04, establish capabilities to model multiple targets embedded in distributed clutter through L-band frequencies; continue to measure SERS spectra and compare several different bacterial types and identify relevant markers; improve efficiency and optimization of processing techniques for networks of sensors and processing for quantum states. In FY05: quantify improvement in performance available through the application of video enhancement algorithms for passive millimeter wave camera images; mature a neural network capable of identifying selected bacteria; explore efficient signal processing algorithms for data fusion and networks of sensors of various modalities; and make recommendations for applications of quantum information processing; use codes to optimize optical designs for nonlinear material placement in the optical train.	2385	2395	2405	2440
Totals	3963	3995	3879	3859

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)		February 2003

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

COST (In Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
H45 AIR MOBILITY	8405	2048	2134	2146	2222	2266	2310	2364

A. Mission Description and Budget Item Justification: This project provides funding for aviation basic research in aerodynamics for manned and unmanned rotarywing 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 tiltrotor aircraft. The efforts in this project will result in a better understanding of rotorcraft airfoil and rotor performance and will result is improved safety, and ultimately, improved combat effectiveness of the manned and unmanned rotorcraft in the Objective Force. This project supports the Objective Force and Joint Vision 2020 by providing research into technologies that can improve tactical mobility, reduce the logistics footprint, and increase survivability for rotarywing aircraft. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, Project Reliance, and supports the Objective Force Transition path of the Transformation Campaign Plan (TCP). This program element contains no duplication with any effort within the Military Departments. The U.S. Army Aviation and Missile Command, Redstone Arsenal, Alabama performs the work in this project. No Defense Emergency Response Funds were provided to the program/project.

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

February 2003

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

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
- In FY02, performed test to take necessary data for far wake measurement for helicopter and tiltrotor; investigated experimental data to quantify Tiltrotor Vortex ring state measurement; conducted fundamental research for autonomous control of rotorcraft unmanned aerial vehicles; conducted test of 2D variable droop leading edge airfoil; investigated active flow control impact on rotorcraft, and evaluated active twist rotor concepts using neural net closed loop controllers; using simulation, generated a synthetic vision database for sensor fusion requirements. In FY03, design and fabricate a high lift 2D airfoil for low Reynolds number flow, CFD code development for ducted-fan and co-axial rotor, conduct 2D airfoil test with Gunny flap to increase lift and reduce drag. In FY04, conduct wind tunnel test to reduce drag force of mast mount sensor (MMS)shape, conduct performance test for co-axial and ducted-fan UAV. In FY05, conduct rotor test to study the off-axis stability to increase helicopter handling quality.	8405	2048	2134	2146
Totals	8405	2048	2134	2146

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

February 2003

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

COST (In Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
H47 APPLIED PHYSICS RSCH	3108	3117	2544	2496	2705	2731	2765	2852

A. Mission Description and Budget Item Justification: The objective of this project is to investigate electronic semiconductor materials and structures and energetic batteries and fuel cells to enable higher performance and more efficient electronic systems. This includes emissive nonlinear and nanophase electrode and electronic materials; thin heterostructure systems where quantum confinement effects are important; and advanced batteries and more efficient fuel cells for hybrid power. Specifically, this project addresses research to determine carrier transport properties and lifetimes of a variety of important optoelectronic materials and structures, such as those used in light emitting devices, high power lasers, detector/modulators for laser radar (LADAR), IR detector structures, and eye safe laser sources. In addition, this project addresses enhancing the molecular mechanisms that give rise to nonlinear optical effects such as sensor and eye protection. Investigate electronic materials and structures to improve wide band gap semiconductor performance in electric vehicles and advanced radar systems. Technical barriers affecting performance, weight, cost, and power consumption will be addressed. These investigations will support the development of optoelectronic devices, power sources and specialty electronic materials for the Army's Objective Force. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and Project Reliance. The program element contains no duplication with any effort within the Military Departments. Work is performed by the Army Research Laboratory (ARL). This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

No Defense Emergency Response Funds (DERF) have been provided to this program/project.

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

February 2003

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

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
- This research is focused on: Diode pumped Erbium Ytterbium (Er/Yb) glass laser for designators, range finders and radars; electrolyte 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; Organic Light Emitting Diodes (OLED) for future Army displays; nonlinear optical (NLO) materials for sensor & eye protection; and Inter-sub-band device theory, simulation, and experiment for imagers. FY02: Completed 3D laser cavity model with passive Q-switch; synthesized nanophase electrode materials for advanced batteries and direct methanol fuel cells; designed new higher-power higher-reliability gate-turn-off (GTO) thyristor from simulation; established new OLED model that permitted the characterization of transport properties; measured limit-curves of several NLO materials for comparison to eye damage thresholds; and matured model and designed intersub-band transition based laser. FY03: design new catalyst for hydrocarbon fuel reformers; fabricate low-defect gallium nitride (GaN) films; establish OLED fabrication techniques and material synthesis; investigated bichromophores & dendrimers with NLO chromophores; and create simulation of electrical & spectral properties of materials for novel IR imaging applications. FY04: evaluate solid electrolytes for rechargeable high-energy batteries; examine silicon carbide (SiC) structures, and ohmic contacts for transition to efficient device designs; investigate hybrid organic/inorganic OLED structures; design a dendrimer NLO material; and adapt successful EM model for IR focal plane arrays (FPA). FY05: provide fire-retardant electrolyte for batteries & catalysts for fuel cells; examine GaN structures, and ohmic contacts for transition to efficient device designs; and transition OLED technology to rugged flexible substrates.	3108	3117	2544	2496
Totals	3108	3117	2544	2496

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

February 2003

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

COST (In Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
H48 BATTLESPACE INFO & COMM RSC	6635	6731	5306	5242	5539	5640	5737	5818

A. Mission Description and Budget Item Justification: This project addresses fundamental research in technologies that will enable intelligent and survivable command, control, communication, and intelligence systems for the Objective Force. As the combat force structure becomes smaller and operates in more dispersed formations, information systems must be more robust, intelligent, interoperable, and survivable if the Army is to retain both information and maneuver dominance. The goal of this research is to address the areas of information assurance and the related signal processing for wireless battlefield communications along with intelligent systems for C4I. Major barriers to achieving the goals are overcoming the inherent vulnerabilities associated with using standardized protocols and commercial technologies while addressing survivability in a unique hostile military environment that includes highly mobile nodes and infrastructure, bandwidth-constrained communications at lower echelons, diverse networks with dynamic topologies, high level multipath interference and fading, jamming and multi-access interference, and information warfare threats. The intelligent systems for C4I research will focus on providing the agent technology capabilities that will reduce the cognitive load on the commander, improve the timeliness, quality and effectiveness of actions and in the long run speed the decision-making process and reduce the size of tactical operation center (TOC) staffs. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and Project Reliance. The program element contains no duplication with any effort within the Military Departments. Work is performed by the Army Research Laboratory (ARL). This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

No Defense Emergency Response Funds (DERF) have been provided to this program/project.

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

February 2003

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

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
- Perform research to provide communications capability for a fully mobile, fully-communicating, situation-aware force operating in a highly dynamic, wireless, mobile networking environment populated by hundreds of networked nodes. In FY 02, showed improvements in information flow in a mobile ad hoc network with a prototype suite of networking and control protocols; investigated and designed techniques to enhance the performance of networks of unattended ground sensors. In FY03, investigate and identify a suite of signal processing techniques to provide bandwidth on demand in interference and jamming scenarios, including challenging urban and foliage scenarios. In FY04, devise signal processing techniques to work under severe interference and poor channel conditions to maintain wide network coverage for disparate soldier, sensor, and airborne networks. In FY05, enhance signal processing for smart radios, coupled with network protocols, to provide intelligent multiple radio coexistence and radio frequency spectrum reuse to enable rapid deployment and networked information dominance in future threat scenarios.	2691	2521	2403	2436
- Design and implement a laboratory scale common information-processing infrastructure that aids in the transformation of data to knowledge to support decision making under uncertainty. In FY02, provided laboratory infrastructure and computational multilingual tools to support tactical, intelligence, and coalition operations that provide language independent representations of meanings and translingual information search and retrieval; identified theoretical architecture for human interaction with physical and software agents; enhanced control infrastructure for cooperating physical agents in laboratory demonstrations; tested formal representation concepts with a universal primary key naming convention. In FY03, explore/devise scalability of information processing techniques and natural human interfaces with software agents to reduce soldier cognitive load in maintaining situational awareness on the battlefield , where hundreds to thousands of computer objects and human operators interact constantly. In FY04, incorporate mathematical and statistical techniques to accommodate uncertainty factors both in data and information during the aggregation process to create ready knowledge for the soldier to enhance decision making. In FY05, devise devise analytical techniques to interface soldiers and robotic elements in a seamless manner in the battlefield information system.	2250	2406	1417	1293

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

February 2003

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

Accomplishments/Planned Program (continued)	FY 2002	FY 2003	FY 2004	FY 2005
- Perform research in protecting information in highly mobile wireless tactical environments with severe bandwidth, energy, and processing constraints and operating without reliance on centralized security services. In FY 02, conducted laboratory experiments and validated the robustness of intelligent based vulnerability assessment over a low bandwidth network; extended agent based vulnerability assessment techniques to incorporate secure key management. In FY03, identify intelligent agent and mobile code techniques to address emerging and evolving information attacks by potential adversaries on sensor networks on the future battlefield to protect data input to situational awareness systems. In FY04, incorporate analytical and protocol techniques into mobile communication devices and systems to enhance robustness to unattended network intrusion and sensor spoofing for deployable sensor networks with operating under severe energy constraints. In FY05, evaluate and implement selected best of breed security services embedded authenication sevices for unattended static and mobile sensor networks deployable on the battlefield.	1694	1804	1486	1513
Totals	6635	6731	5306	5242

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

February 2003

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

COST (In Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
H52 EQUIP FOR THE SOLDIER	959	1009	1004	993	1068	1083	1091	1119

A. Mission Description and Budget Item Justification: This project supports basic research required to achieve the Objective Soldier and the Army Transformation. The research is focused on five core technology areas critical to soldier systems: mathematical modeling, physical performance measurement, polymer science/textile technology, nanotechnology and food technology. Research is targeted on enhancing the mission performance, survivability, and sustainability of the soldier by advancing the state of the art in defense against battlefield threats and hazards such as ballistics, chemical agents, lasers, environmental extremes, and rations shortfalls. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and Project Reliance. The program element contains no duplication with any effort within the Military Departments. Work is performed by the US Army Natick Soldier Center, Natick, MA. This program supports the Objective transition path of the Transformation Campaign Plan (TCP).

No Defense Emergency Response Funds (DERF) have been provided to this program/project.

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

February 2003

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

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
In FY02: Validated the utility of a model to assist in the design of better methods to carry loads. Developed biomechanical and motor control methodologies to provide guidelines for improved load carriage and reduced soldier fatigue. Measured effects of electric fields on alignment of carbon nanotubes. These materials exhibit properties which suggest they can be used in transparent polymers for eye protection and ballistic shields for body armor. Transitioned models on high rate phenomena occurring during ballistic impact events to 6.2 nanocomposites program. Developed cognitive testing paradigm for detection of food based performance enhancement under stressful conditions. Determined dispersion in the binding of water molecules to various components of amorphous food systems as they relate to ration stability and safety. Created a new mechanics based theory for fiber-to-fiber interfacial behavior that can provide guidelines for the development of improved fibrous materials for a soldier's advanced combat uniform. Synthesized peptide conducting polymer complexes for sensor applications in clothing and food.	959	0	0	0

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

February 2003

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

Accomplishments/Planned Program (continued)	FY 2002	FY 2003	FY 2004	FY 2005
FY03: Develop new experiments to quantify and assess the mechanical behavior of hybrid (blended) yarns in conjunction with the new fiber-to-fiber theory to create prototypes of improved materials for the soldier system. Validate model and use imaging methods to determine formulations that improve food quality and ensure safety. Formulate and implement a novel computer based biomechanics model to assess gait and muscle control to further improve soldier load carriage performance. Evaluate effect of nanoparticle geometry on nanocomposite mechanical and barrier properties for application to ballistic and chemical biological protection. Conduct laboratory research on cognitive performance and food based performance enhancement under severe stress. Conduct research to examine the relationship among comfort, fit, and perceived fit on form fitting military clothing. FY04: Transition nanocomposite technology to chemical protection program and ballistic protection program. Evaluate potential of prototype advanced hybrid yarns to provide improved performance under ballistic impact of textile body armor. Examine cognitive performance as it relates to nutrient and fluid intake under stressful conditions related to military operational environments. Create a neural oscillator model which will be incorporated into a planer model of human walking as the primary control mechanism for application to analysis of load carriage. Examine effect of perceived fit and comfort on the use and performance of protective clothing and individual equipment. FY05: Extend first generation neural oscillator model to three dimensional human locomotion and load carriage. Integrate cognitive testing paradigm into new and ongoing warrior performance efforts.	0	1009	1004	993
Totals	959	1009	1004	993

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

February 2003

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

COST (In Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
H57 SCI PROB W/ MIL APPLIC	49182	52599	56196	56815	58041	59000	59404	60219

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 Objective Force. The Army Research Office of the Army Research Laboratory maintains a strong peer-reviewed scientific research program through which leap-ahead technological solutions may be discovered, matured and transitioned to overcome the technological barriers associated with next generation capabilities. Included are research efforts for increasing knowledge and understanding in fields related to long-term Transformation needs in the physical sciences (physics, chemistry, biology, and materials science), the engineering sciences (mechanical sciences, electronics, and mathematical, computer and information sciences), and environmental sciences (atmospheric and terrestrial sciences). Targeted research programs in nanotechnology, smart structures, multifunctional and microminiature sensors, intelligent systems, countermine, compact power, such as microturbines, and other mission-driven areas will lead to an Objective Force that is more strategically deployable, more agile, more lethal and more survivable. The breadth of this basic research program covers approximately 800 research grants and contracts with leading academic researchers and approximately 1,600 graduate students yearly, and supports research at 227 institutions in 49 states. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and Project Reliance. The program element contains no duplication with any effort within the Military Departments. Work is performed by the Army Research Laboratory (ARL). This program supports the Objective transition path of the Transformation Campaign Plan

No Defense Emergency Response Funds have been provided to this program/project.

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

February 2003

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

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
- Basic research in biological sciences for revolutionary advances in Command, Control, Communications, Computing, Intelligence, Surveillance, and Reconnaissance (C4ISR) and soldier survivability. In FY02, used unique biomolecular combinatorial approaches to find peptides to nuclear electronic materials allowing enhancements in electronic transport and optical efficiency for signature reduction; and adapted enzymes which will detect nerve agents in water to combat terrorism. In FY03, create biologically-derived materials with self-assembly and multifunctional capabilities for protective materials (including armor) and for nanometer-scale biocellular electronics. In FY04, direct macromolecular evolution of biological electron transfer components for microsystems with application to power and energy management and logistics footprint minimization, biologically design and construct nanometer scale electronic and photonic structures for application to precision strike weapons. In FY05, understand mechanisms of pathogenicity to combat terrorism and to aid in chemical-biological detection (CBD) through intervention of organisms that cause disease; and use molecular genetics to identify the molecular signals that affect soldier performance and endurance.	6885	7415	8100	8200
- Basic research in chemical sciences for advanced power generation and CBD. In FY02, synthesized novel dendrimers and polymer-based nanocomposites for chem/bio sensors and protective coatings which will rapidly detoxify agents; devised advanced energetic materials for propellants and explosives for small-diameter munitions with increased lethality and range; and advanced the ability to fabricate materials able to withstand an extraordinary number of revolutions per second leading to dime-sized micro turbines for combat power. In FY03, devise multifunctional coatings that will be able to detect and decontaminate threat agents, use computational chemistry to enable the design of light-weight, high energy density fuel cells. In FY04, devise new approaches to build molecular machines for CBD, signature management and laser protection; In FY05, expand research in computational electrochemistry for electrochemical power sources; explore the physics of operating molecular machines for CBD, signature management and laser protection; and devise polymers, fibers and develop novel architectures for materials with superior protection from all environments.	7775	8515	9000	9000

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

Accomplishments/Planned Program (continued)	FY 2002	FY 2003	FY 2004	FY 2005
- Basic research in physics for precision guidance, superior signature management properties and secure communications. In FY02, created atom gyroscopes for passive, jam-proof navigation with an accuracy that exceeds Global Positioning System capabilities for precision strike; discovered the breakthrough that will lead to ultra sensitive gravity gradiometers to detect underground bunkers and tunnels; and conducted research in quantum information science to provide survivable communications, anti-access capabilities and covert electronic attack for uninterrupted access to information. In FY03, use non-linear optics to improve remote sensing and survivable communications and condensed matter physics to provide CBD and end-to-end interoperable communications. In FY04, develop high frequency superparamagnetic dot arrays to increase the area density of information storage. In FY05, develop tools in the Terahertz frequency regime for interrogation of CB agents.	8675	9323	10294	10615
- Basic research in communications and electronics for unmatched C4ISR capabilities. In FY02, synthesized and assembled molecules to form alternatives to silicon-based electronic circuits; devised ultraviolet detectors and digital focal plane arrays based on novel photodiodes for improved night vision devices; and combined complex proteins in an active electronic device making possible revolutionary photo detectors. In FY03, enable adaptive and secure communications addressing extremely high data rates, transmission over complex terrain, and networked communication system issues; devise multifunctional, ultra broadband sensing devices and circuit architectures, including molecular and biomolecular, for higher speed, more functional, and higher memory devices for all Army electronic systems. In FY04, use rare earth doped materials for photonic applications and apply quantum dot intersub-band photo detectors for night vision devices and to create a new class of quantum-dot lasers for Army laser designators. In FY05, research advanced countermine techniques to enable faster and more accurate detection of mines; integrate seismo-acoustic and chemical sensors with electro-optics and x-ray imaging for advanced landmine detection.	8282	8719	9805	9900

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

Accomplishments/Planned Program (continued)	FY 2002	FY 2003	FY 2004	FY 2005
- Basic research in mechanical and material sciences for survivable armor, improved mobility, C4ISR components, and flexible display initiative for soldier systems. In FY02, devised a high-fidelity model for fuel combustion and heat release for advanced, low emission/high efficiency gas turbine engines; a dendrimer-based polymer composite to provide a solid state solution to sensor and eye protection from laser threats; and a novel magneto-Rheological shock absorber to control vibration of helicopter rotor blades. In FY03, improve computational modeling of materials for enhanced survivability and sustainability; control assembly of ceramics and polymers to improve fabrication and manufacturing techniques to lower costs of production; understand the structure and dynamics of shear bands in metallic glasses and nanophase composites to create improved, highly lethal penetrators; improve computational techniques and novel analytical tools to model material failure to create lightweight, damage tolerant armor materials. In FY04, understand active flow control for projectiles and air vehicles to improve precision strike; understand high impact dynamics of composite materials; and synthesize new hybrid biomimetic materials for high-performance structural, mechanical, optical and electronic materials thereby improving a wide range of Army components. In FY05, devise wafer-scale fabrication techniques to manufacture microturbines at reduced costs; fabricate micro-rocket engines from previous advances in microturbine research; and conduct research in transparent conductive and emissive materials.	7775	8435	9200	9300

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)			February 2003		
BUDGET ACTIVITY **1 - Basic research**	PE NUMBER AND TITLE **0601102A - DEFENSE RESEARCH SCIENCES**			PROJECT **H57**	

Accomplishments/Planned Program (continued)	FY 2002	FY 2003	FY 2004	FY 2005
- Basic research in mathematical and computer sciences as the backbone for complex, multisystem analysis, modeling and simulation, and information systems. In FY02, devised high assurance embedded system methodologies leading to improved combat casualty care medical devices; devised computational design methods based on new Chimera-related flow analysis techniques leading to enhanced helicopter and missile performance; and devised small footprint parallel Hoffman encoding and decoding at previously unattainable rates for ultra-fast secure communications. In FY03, devise new intelligent control algorithms for autonomous systems and for networked, real-time command and control; statistical decision and network theory for automatic data fusion for extremely low power, high bandwidth micro sensor networks. In FY04, translate statistical shape analysis to computer programs for improved target classification; self-organizing, self-healing mobile ad-hoc networking algorithms in order to facilitate rapid force deployment and reduce the logistics footprint; conflict resolution architectures for multi-agent hybrid systems for robotics and unmanned aerial vehicles (UAVs). In FY05, develop low-order mathematical models of hysteresis nonlinearity to improve the performance and real-time control of smart materials to create micro electro-mechanical (MEM) actuators for rotor-blade surface flow control; and integrate research in mathematics, electrical engineering and signal processing to create digital communications based on principles of nonlinear dynamics and chaos for uninterrupted digital communications.	7850	8880	9797	9800
-Optical Technologies. This congressional add supports research on growth, processing, and device analysis of semiconductor materials for sensor, display and laser applications to upgrade Army capabilities in sensing and signal processing. No additional funding is required to complete this project.	970	1312	0	0
-Advanced Target Recognition Using Nanotechnologies. This one year congressional add supported basic research to develop advanced target recognition techniques using nanotechnologies. No additional funding is required to complete this project.	970	0	0	0
Totals	49182	52599	56196	56815

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit) | February 2003

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

COST (In Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
H66 ADV STRUCTURES RSCH	1426	1440	1438	1428	1540	1567	1577	1618

A. Mission Description and Budget Item Justification: The goal of this effort is to provide improved tools and methods to enable the design and use of composite structures that can better address the cost, weight, performance, and dynamic interaction requirements of future platforms for the Future Combat Systems and Unmanned Combat Armed Rotorcraft supporting Army Transformation. Ultimately, these technologies result in safer, more affordable vehicles with a greatly reduced logistics footprint. This project is a joint Army/NASA effort that includes structures technology research into: structural integrity analyses; failure criteria; inspection methods which address fundamental technology deficiencies in both metallic and composite Army rotorcraft structures; use of composite materials in the design and control of structures through structural tailoring techniques; rotorcraft aeroelastic and aeromechanical stability; helicopter vibration (rotating and fixed systems); and the design and analyses of composite structures with crashworthiness as a goal. The problems in structures are inaccurate structural analysis and validation methods to predict durability and damage tolerance of composite and metallic rotorcraft structures and inadequate structural dynamics modeling methods for both the rotating and fixed system components to address reliability issues for future aircraft. The technical barriers include a lack of understanding of failure mechanisms, damage progression, residual strength, high-cycle fatigue, the transfer of aerodynamic loads on the rotor to the fixed system, and impact of these unknown loads on aircraft components. Technical solutions are focused in: advanced fatigue methodologies for metallic structures, improved composites technology throughout the vehicle, long-term maturation of an integrated stress-strength-inspection, advanced methods for rotor system vehicle vibratory loads prediction, improved methods to predict vehicle stability, and improved analyses to address Unmanned Rotorcraft specific requirements. These advancements will extend service life, reduce maintenance costs, enhance durability, and reduce the logistics footprint of existing and future Army vehicles. As agreed under Project Reliance, this is the only project for rotorcraft and ground structures basic research within the DoD. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and Project Reliance. The program element contains no duplication with any effort within the Military Departments. Work is performed by the Army Research Laboratory (ARL). This program supports the Objective transition path of the Transformation Campaign Plan (TCP).

No Defense Emergency Response Funds (DERF) have been provided to this program/project.

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

February 2003

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

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
In FY02: analyzed delamination and failure models, fatigue life, low velocity impact effects, and flaw size characteristics of structural composite components to reduce the weight and cost for future rotorcraft; investigated advanced technology macrofiber composite actuators for rotor blade twist and vibration control; evaluated the first forward flight performance of a 'closed loop' twist actuated active rotor system; correlated model predictions with wind tunnel experiments to verify significant vibration reductions. In FY03: Perform residual strength predictions for composite sandwich panel damage due to low velocity impact. Establish new industry test standards for hybrid composite delamination. Analyze methodologies to determine the probability of small crack fatigue life for aging Army vehicles. In FY04, assess UAV utility of innovative wing designs inspired by naturally-based morphologies. Analyze potential of actively-controlled rotor stability augmentation model for tiltrotor UAV. Evaluate soft soil and water impact effects on crash occupant survivability. Evaluate durability, damage tolerance, and failure mechanisms for embedded sensors/actuators in flexible structure. In FY05, Investigate static/dynamic characteristics of naturally based morphologies for vehicle wing designs using finite-element modeling.Evaluate advanced concepts for UAV primary flight control and vibration reduction.	1426	1440	1438	1428
Totals	1426	1440	1438	1428

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

February 2003

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

COST (In Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
H67 ENVIRONMENTAL RESEARCH	3379	3308	1415	1517	829	806	788	883

A. Mission Description and Budget Item Justification: The objective of this project is to focus basic research on innovative technologies for both industrial pollution prevention (P2) that directly supports the Army production base and weapon systems as well as non-stockpile chemical warfare (CW) site remediation. The pollution prevention work invests in next generation manufacturing, maintenance, and disposal methods that will result in significantly reducing the usage of hazardous and toxic substances and their associated costs. The goal is to decrease the overall life-cycle costs of Army systems by 15-30% through the application of advanced pollution prevention technologies. The CW remediation efforts concentrate on the application of biotechnology in the characterization and physical clean up of agent contaminated soils and groundwater and reduced corrosive and more environmentally benign decontamination of biological warfare (BW) agents on field equipment and weapon systems. The goal is to reduce the cost of remediating a site by at least 50% versus the use of conventional methods. CW thrusts include establishing the ecotoxicity of CW compounds, environmental fate and effect of CW compounds in soils and biodegradation of CW compounds. Pollution prevention thrusts include: environmentally acceptable, advanced, non-toxic processes to manufacture lightweight alternative structural materials to enhance weapon system survivability; clean synthesis of more powerful and improved energetic compounds to eliminate the use of hazardous materials and minimize the generation of wastes; and surface protection alternatives to hazardous paints, cadmium, chromium, and chromate conversion metal and composite surfaces. This project is linked to the Army Environmental Requirements Technology Assessment (AERTA) requirements. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan and Project Reliance. The program element contains no duplication with any effort within the Military Departments. Work is under the direction of the U.S. Army Armament, Research, Development and Engineering Center. This project supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

No Defense Emergency Response Funds were provided to the program/project.

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

February 2003

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

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
In FY02, produced nanocomposites with improved thermal properties. Mechanically tested aqueous processed and spun silk fibers. Measured effect of carbon, hydrogen and carbon migration to gun barrel substrate and further evaluated models associated with cylindrical magnetron sputtering. Characterized 16 natural products bacteriocins. Improvements made to synthesis of CL-20 and Differential Absolute Delay Equalization explosives. Established first ecotoxicological data base for CW agents and developed soil analytical method for HD and VX. In FY03, conduct target meals-ready-to-eat injection molding and biodegradation studies. Characterize variables affecting spin solution fiber properties. Continue longer term measurement of element migration to chrome and tantalum steel interfaces at higher temperatures. Evaluate adhesion of ion beam assisted deposition coatings applied to depleted uranium (DU) coupons. Assess supercritical fluids crystallization. Conduct instrument measurements on actual contaminant samples. Identify enzymatic alternatives in membrane research. In FY04, scale-up prototype nanocomposite materials processes. Assess impact of new nitrogen-rich propellant gases on gun barrel coatings. Survey commercial off-the-shelf corrosion inhibitor post-treatment to close DU penetrator pinholes. Cormulate cellulose gel to test on potentially contaminated concrete surfaces. Broaden decontamination studies to include viral surrogates and additional bacterial enzymes. Down select candidate molecular recognition elements and test components for electrical and ionic conductivity. In FY05, Investigate alternative coating systems capable of depositing onto more complex geometries. Conduct nitration studies on intermediates derived from ethylene diamine. Isolate and assess variety of bacteriocins. Incorporate improved detector strains into gel compounds. Test polyelectrolytes for energy storage.	3379	3308	1415	1517
Totals	3379	3308	1415	1517

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

February 2003

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

COST (In Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
S13 SCI BS/MED RSH INF DIS	8810	9177	9579	9613	10080	10260	10414	10669

A. Mission Description and Budget Item Justification: This project supports focused research for healthy, medically protected soldiers for the Objective Force. Research efforts focus on investigation of medical countermeasures for naturally occurring diseases that are militarily significant due to their historically severe impact on military operations. Establishment of medical countermeasures will protect the force from infection and sustain operations by preventing hospitalizations and evacuations from the theater of operations. The cited work is consistent with the Army Science and Technology Master Plan, the Army Modernization Plan, and Project Reliance. The program element contains no duplication with any effort within the Military Departments. Work is managed by the US Army Medical Research and Materiel Command. This program supports the Objective Force transition path of the Transformation Campaign Plan.

There are no Defense Emergency Response Funds provided to this program or project.

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

February 2003

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

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
FY02, achieved a major accomplishment in the fight against malaria by publishing with The Institute for Genomic Research and other consortium members the Plasmodium falciparum malaria genome. Studied new approaches to more effectively and rapidly test malaria vaccines. Discovered potential antimalarial compounds to address the spread of resistance to current drugs; identified mechanisms by which the malaria parasite develops drug resistance; incorporated bioinformatics technology to more effectively search genomic information resulting in discovery of a new target within the malaria parasite. FY03, adapt DNA microarray technology to rapidly screen potential antimalaria drugs and vaccine targets. Identify new malaria drug targets and mechanisms of the parasite's drug resistance; assess the presence of malaria drug resistance in different regions of the world. FY04, identify, using genomic technology, promising new targets to develop for inclusion into new vaccines against P. falciparum and P. vivax. Develop models that can be used for high throughput screening and new drug discovery. FY05, enhance and integrate techniques to exploit genomic information for vaccine and drug discovery efforts.	5415	4638	4825	4845
FY02, investigated new vaccine components and other prevention methods to protect deployed soldiers against diarrheal diseases. FY03, conduct studies of new vaccine additives that enhance the protection induced by antidiarrheal vaccines. FY04, conduct studies to assess the incidence and types of diarrhea causing agents in areas of deployment to determine suitability as vaccine test sites. FY05, incorporate genomic information into vaccine discovery efforts.	1086	528	508	522
FY02, studied the diversity of dengue virus strains currently causing disease in Indonesia, Thailand, Peru, and Venezuela; identified and generated a DNA-based vaccine against Rift Valley fever; and developed animal model for Hanta pulmonary syndrome. FY03, conduct studies on dengue disease progression; conduct studies to design a combined vaccine against several different hemorrhagic fever and other lethal viruses. FY04, identify alternative approaches to create effective and safe dengue fever vaccine. Identify genes from other lethal viral diseases such as Rift Valley for incorporation into DNA vaccines. FY05, develop field sites for testing dengue and hemorrhagic fever vaccines.	1309	1604	1706	1682
FY02, developed a computerized mosquito identification system for use by military preventive medicine teams to assess risk of exposure. FY03, evaluate insect-borne disease exposure in Central Command region of responsibility. FY04, develop tests to detect, in insects, insect-borne diseases in areas of deployment. FY05, study integrated dengue vector preventive medicine control system in Central and South America and Thailand to evaluate effectiveness.	1000	1248	1338	1338

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

February 2003

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

Accomplishments/Planned Program (continued)	FY 2002	FY 2003	FY 2004	FY 2005
FY03, conduct necessary basic research to define, acquire, and evaluate approaches to provide infectious disease diagnostics to the battlefield; identify microbial DNA sequences that are adaptable to the first generation military common diagnostics system. FY04 identify infectious disease diagnostic components compatible for use in a joint services biological agent identification and diagnostic system. FY05, develop approaches to supplement infectious disease diagnostics not compatible with joint system.	0	1159	1202	1226
Totals	8810	9177	9579	9613

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit) | February 2003

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

COST (In Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
S14 SCI BS/CBT CAS CARE RS	3860	4001	4204	4222	4401	4482	4563	4672

A. Mission Description and Budget Item Justification: This project supports research for healthy, medically protected soldiers for the Objective 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. Research under this project is conducted at the US Army Medical Research and Materiel Command's Walter Reed Army Institute of Research and US Army the Institute of Surgical Research. The cited work is consistent with the Army Science and Technology Master Plan, the Army Modernization Plan, and Project Reliance. The program element contains no duplication with any effort within the Military Departments. This program supports the Objective Force transition path of the Transformation Campaign Plan.

There are no Defense Emergency Response Funds provided to this program or project.

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

February 2003

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

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
FY02, identified additives for resuscitation fluids to improve patient response for use by combat medics. FY03, conduct basic research to further enhance resuscitation capabilities of combat medics; define mechanisms of organ injury associated with blood clotting and bleeding; identify additional additives or means to improve patient response to resuscitation fluids. FY04, define measurable combat casualty parameters that can be used as indicators of need for immediate medic intervention vs. delayed intervention. Begin basic research, in collaboration with the National Institute of Health (NIH), conduct conceptual development, technology discovery, and early studies to significantly mitigate or eliminate the impacts of battlefield injury, including severe hemorrhage and other body fluid losses, penetrating head injury, and mutilating soft-tissue and skeletal injury. FY05, define the impact of stabilizing body potassium concentrations on casualty survival. Continue basic research collaboration efforts with NIH.	2288	2732	2878	2872
FY02, investigated means to remotely determine wound severity to maximize medical responder effectiveness on the battlefield; studied gene expression after brain trauma and showed that actions taken in response to specific gene expression may help mitigate brain injury; demonstrated a proof-of-concept that a candidate drug (CGX-1007) protects brain tissue after injury; identified chemical food additives that may help reduce dental disease in deployed warfighters. FY03, study methods for medics to exploit Land Warrior capabilities to remotely diagnose, triage, and treat casualties, evaluate new candidate drugs to preserve brain tissue after penetrating head injury. FY04, define measurable indicators of brain injury severity for use in directing treatment. FY05, evaluate brain cooling as a means to preserve brain tissue and function after penetrating head injury.	1572	1269	1326	1350
Totals	3860	4001	4204	4222

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

February 2003

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

COST (In Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
S15 SCI BS/ARMY OP MED RSH	5290	5500	5721	5740	6031	6137	6227	6381

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

There are no Defense Emergency Response Funds provided to this program or project.

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

February 2003

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

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
FY02, demonstrated that ultra wide-band radiation causes a prolonged drop in blood pressure in rats. Documented the effectiveness of consuming supplemental carbohydrate beverages to enhance vigilance during simulated combat operations, and began exploration of the interactions of neurotoxins and radio frequency radiation on the central nervous system to identify potential health consequences. FY03, develop a simple eye model to study real-time photoreceptor changes during laser exposure, evaluate models of water requirements, and develop biomedical strategies to reduce water requirements for soldiers in operational environments. FY04, explore the benefits of nutritional supplements to enhance metabolic rate for weight management, cold survival, and cognitive functions. FY05, apply DNA chip technologies to mechanisms and treatment responses to laser eye injury.	1972	1918	1914	1919
FY02, completed preliminary identification of patterns of gene responses in worms exposed to military-relevant reproductive toxins. FY03, explore brain imaging to determine whether increased mental activity aggravates brain changes associated with sleep deprivation. FY04, explore the effect of caffeine activation on sleep processes in a non-human primate to explain fundamentals of sleep in humans. FY05, investigate the use of genomics (study of genes and their functions) and proteomics (study of protein expression and function) to explain individual variability of sleep and performance.	1360	1815	1898	1965
FY02, demonstrated that antifreeze proteins protected skin cells in extreme cold weather operations and calcium reduced organ damage caused by hypothermia. FY03, explore heart rate variability as a predictor of cold injury and identify molecular markers related to altitude adaptation. FY04, explore the effects of prolonged cold exposure on the immune system to determine soldiers' susceptibility to illness. FY05, identify molecular markers of cold acclimation and study the effects of carbohydrate supplements on muscle metabolism at high altitudes to determine their potential value in sustaining soldier performance in high-altitude operations. Explore mechanisms of cell damage that result in performance impairment at high altitude.	1958	1767	1909	1856
Totals	5290	5500	5721	5740

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)		February 2003

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

COST (In Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
T22 SOIL & ROCK MECH	1775	1882	1950	1960	2031	2067	2098	2150

A. Mission Description and Budget Item Justification: This basic research creates the fundamental knowledge for new construction materials that provide greater ballistic and penetration protection, improved control of the visual, infrared, and radar signatures, and more rapid soil stabilization. This research will improve the physics-based understanding of geologic and structural materials due to dynamic loading. These technologies provide the basis for applied research that supports the civil engineering technologies for deployment, sustainment, mobility, and survivability of the Objective Force in program element 0602784A, project T40. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan and Project Reliance. The program element contains no duplication with any effort within the Military Departments. This work is performed by the U.S. Army Engineer Research and Development Center. This project supports the Objective transition path of the Transformation Campaign Plan.

No Defense Emergency Response Funds were provided to the project.

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

February 2003

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

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
Multi-Spectral Technologies for Fixed Facilities - In FY02, produced experimental quantity of electro-chromic material for evaluation as a responsive/passive camouflage, cover, and deception technology. In FY03, evaluate multispectral characteristics of experimental quantities of electro-chromic camouflage, cover, and deception material. Hardened Construction Materials - In FY02, linked improved 3-dimensional penetration curve model (PENCRV3D) for fractured/jointed rock with explicit finite element code (EPIC) projectile response code, and evaluated PENCRV3D against results from instrumented projectile experiments. Performed mechanical property tests on concrete and aggregate specimens and on finite element (FE) meshes that included cubic and spherical aggregates. In FY03, conduct FE simulation of mechanical property tests on concrete specimens by modeling the mortar and aggregate independently. In FY04, conduct FE simulation of dynamic experiments using both homogeneous and heterogeneous modeling techniques. Produce technique for mapping dynamic deformation and cracking in quasi-brittle materials. Pavements Research - In FY02, investigated fundamental soil reinforcement mechanisms for non-traditional stabilization additives. In FY03, complete asphalt dynamic model. In FY04, provide first-generation reinforcement models describing the interaction between soil particles and nontraditional stabilizers. In FY05, mature concept for low-velocity probe that could provide capability to remotely determine soil properties. Vehicle-Terrain Interaction - In FY03, produce physics-based generalized soil theory for large deformations in soil from maneuver operations. In FY04, complete vehicular surface interactive models for Future Combat Systems (FCS). In FY05, delineate a continuum mechanics theory critical to predictive models of vehicle-terrain interaction.	1775	1882	1950	1960
Totals	1775	1882	1950	1960

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit) | February 2003

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

COST (In Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
T23 BASIC RES MIL CONST	1502	1578	1649	1659	1711	1746	1781	1821

A. Mission Description and Budget Item Justification: This project supports facilities research in forming a fundamental understanding of the long-term durability of composite materials, the behavior of structural elements, and collaborative design theories to support Army Installation Transformation. Seismic Engineering research supports the Army's need to have capability to more easily retrofit those structures that are at seismic risk or at risk of collapse when explosions occur. These efforts provide basic research leading to improved design capability for a range of facilities that optimize facility mission performance, reduce design and construction errors and omissions, meet the users' needs, reduce resource requirements, and reduce the environmental burdens over the facility's life. The project will lead to leap-ahead technologies to solve military-unique problems in the planning, programming, design, construction, and sustaining of deployed facilities (buildings, etc.) and energy and utility infrastructure. This project supports exploratory development efforts in program element 0602784A, projects T41 and T45. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan and Project Reliance. The program element contains no duplication with any effort within the Military Departments. Work is performed by the U.S. Army Engineer Research and Development Center. This project supports the Objective transition path of the Transformation Campaign Plan.

No Defense Emergency Response Funds were provided to the project.

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

February 2003

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

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
Facility Design Improvement and Seismic Engineering – In FY02, investigated ability of collaborative design theory to simulate the design process and product engineering conflict. Also enhanced fundamental micro-mechanical stiffness and strength models of infrastructure fiber reinforced polymer composites for improved ductility of seismic connection. In FY03, investigate algorithms to optimize facility planning/design processes to improve transformation requirements match and increase throughput. Formulate moisture/temperature material property transport models for long-term performance modeling of structural composite materials. In FY04, investigate fundamental thermodynamics and material properties that describe microencapsulated phase change material performance as it affects heat transfer of thermal fluids. Investigate underlying factors affecting the attenuation of electromagnetic fields under intense transient field conditions and develop models for the non-linear response. In FY05, determine fundamental aspects of multi-agent computational modeling as a next generation approach to facility threat protection. Formulate optimization algorithms suitable for rapid and flexible design of the continuum of facilities needed by the objective force.	1502	1578	1649	1659
Totals	1502	1578	1649	1659

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

February 2003

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

COST (In Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
T24 SNOW/ICE & FROZEN SOIL	2078	1185	1201	1184	1274	1295	1294	1328

A. Mission Description and Budget Item Justification: This basic research focuses on material characterization, physical and chemical processes, and energy propagation applicable to predicting state of the terrain, the effects of the environment on target and target background signatures, and future mobility enhancements in support of the materiel development community. It thus provides the knowledge base for understanding and assessing environmental impacts critical to battle space visualization. Terrain State research investigates weather-driven terrain material changes and sensing/inferring subsurface properties. Signature Physics research focuses on understanding the dynamic changes to electromagnetic, acoustic and seismic signatures in response to changing terrain state. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan and Project Reliance. The program element contains no duplication with any effort within the Military Departments. This work is performed by the U.S. Army Engineer Research and Development Center. This project supports the Objective transition path of the Transformation Campaign Plan.

No Defense Emergency Response Funds were provided to the project.

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)	February 2003

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

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
Terrain State and Signature Physics – In FY02, investigated terrain geometry and material properties controlling millimeter-wave signatures as it affects obstacle detection systems. Determined military unique seismic/acoustic signatures to improve sensor target detection and classification in urban areas and snow covered terrain. In FY03, investigate a new modeling approach for snow and other materials to formulate a physics-based theory in support of conceptual vehicle mobility design and performance evaluation. Identify environmental enablers to communication technologies as low-detectability, wireless alternatives to traditional airwave and wire communications. Determine the physical property dynamics related to environmental transitions of electromagnetic signatures in support of model formulation to improve predictions of sensor performance in complex terrain. Investigate sensor fusion strategies to measure aerosolized endospores in complex natural environments in support of remote detection and identification. In FY04, investigate near surface meteorological variables at the micro scale and develop all-season 3-dimensional discontinuous canopy model providing improved modeling for target detection and scene visualization. In FY05, establish effects of buildings and barriers on acoustic-seismic propagation in urban settings and define the turbulence and topographic roughness interaction for acoustic signals. Establish understanding of pavement mechanical properties and pavement degradation processes as a function of soil, pavement type, and moisture-temperature variations. Investigate methods to remotely extract or infer soil, moisture, temperature at depth, and vegetation attributes.	1116	1185	1201	1184
Cold Weather Sensor Performance - This one year Congressional Add investigated physical properties of snow affecting microwave extinction for deep snow conditions and frozen ground chemistry affecting the complex dielectric constant of soil. No additional funding is required to complete this project.	962	0	0	0
SBIR/STTR	0	0	0	0
Totals	2078	1185	1201	1184

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

February 2003

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

COST (In Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
T25 ENVIRONMENTAL RES-COE	4234	4435	4652	4687	4828	4922	5027	5145

A. Mission Description and Budget Item Justification: Environmental quality basic research investigates the technologies needed to address Army issues in the restoration, compliance, conservation, and non-industrial pollution prevention areas. These efforts foster technology progress and innovation directed toward: investigating and monitoring contaminated sites, including chemical contamination and unexploded ordnance (UXO) detection/discrimination; better characterization of contaminants through improved risk-based assessment; destruction, containment or rendering harmless waste in water, soil and sediments from military activities; adhering to applicable federal, state and local environmental laws and regulations; monitoring and controlling noise generation and transport; protecting and enhancing natural and cultural resources; and reducing pollution associated with military activities. The project supports applied research under program element 0602720A, projects F25, 048, and 896. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), Army Modernization Plan and Project Reliance. The program element contains no duplication with any effort within the Military Departments. Work is performed by the U.S. Army Engineer Research and Development Center. This project supports the Objective transition path of the Transformation Campaign Plan.

No Defense Emergency Response Funds were provided to the project.

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

February 2003

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

Accomplishments/Planned Program	FY 2002	FY 2003	FY 2004	FY 2005
Environmental and Ecological Fate of Explosives, Energetics, and Other Contaminants – In FY02, determined soil invertebrate screening benchmark levels for propellants and explosives to aid in risk-based environmental assessments. In FY03, determine the effects of soil physical and chemical properties on the bioaccumulation and toxicity of explosive contaminants for soil invertebrates such as earthworms to improve the basis for risk-based site assessments of explosive contaminated sites. Determine whether explosive vapors diffuse up through frozen soil as functions of soil temperature and moisture content to improve site characterization. In FY04, determine the chemical, physical, and biological transformation of crystalline explosive residues on firing ranges. Investigate remote techniques for long term monitoring of military unique compounds in the environment. In FY05, determine the molecular toxicology of selected explosive compounds in mammals.	686	1508	1336	1415
Remediation of Explosives, Energetics, and UXO – In FY02, determined mechanisms of adsorption, transformation, and immobilization of explosives and their by-products in soils and groundwater to provide the bases for improved tools for characterizing and treating contaminated sites. In FY03, identify/characterize the types of micro-organisms in the ground to aid in the development and use of biological in situ treatment processes. Describe the fundamental behavior of micro-organisms when introduced into chemical contaminant destruction processes. Show how TNT and TNT transformation products (nitroaromatics) bind to the organic and mineral fractions of soil and identify mechanisms for how the nitroaromatics can be extracted from the soil fractions. Describe the chemical behavior and transport of cyclodextrins and explosive compounds under different environmental regimes for in situ remediation using electrokinetic processes. Determine the response signatures of electromagnetic induction sensors to UXO comp osed of composite materials to improve detection. In FY04, determine the effects of microbial and geochemical processes associated with manganese oxides on the environmental fate of metals and inorganics in groundwater and soil to model transport of contaminants and to improve treatment processes. In FY05, describe propellant attenuation on ranges via the management of natural soil cycles.	2059	1330	1401	1375

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

February 2003

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

Accomplishments/Planned Program (continued)	FY 2002	FY 2003	FY 2004	FY 2005
Threatened and Endangered Species – In FY02, formulated theories for acoustic behavior near weapons blast waves for use in predicting noise absorption and mitigating weapons noise. In FY03, evaluate physiological response and habituation of endangered bird species to military stressors to assess relative effects of military training disturbances. In FY04, determine genetic differences in native species of diploid grass populations to enhance resilience for land rehabilitation and map candidate genome traits. Determine the effects of military training noise on the feeding, roosting, and flight behaviors of endangered bats. In FY05, describe physical, chemical, and biological phenomena impacting ecosystem maintenance, mitigation, and rehabilitation for Army lands. Evaluate the degradation of auditory sensitivity for bats due to shock wave pressure.	1489	1597	1915	1897
Totals	4234	4435	4652	4687