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

June 2001

BUDGET ACTIVITY
1 - BASIC RESEARCH

PE NUMBER AND TITLE
0601102A - Defense Research Sciences

COST (In Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
Total Program Element (PE) Cost		123491	136650	138281	0	0	0	0	0	0	0
305	ATR RESEARCH	1121	1194	1237	0	0	0	0	0	0	0
31B	INFRARED OPTICS RSCH	2219	2404	2503	0	0	0	0	0	0	0
52C	MAPPING & REMOTE SENS	2169	2305	2369	0	0	0	0	0	0	0
53A	BATTLEFIELD ENV & SIG	3565	3777	3945	0	0	0	0	0	0	0
74A	HUMAN ENGINEERING	2478	2662	2765	0	0	0	0	0	0	0
74F	PERS PERF & TRAINING	2554	2778	2855	0	0	0	0	0	0	0
F20	ADV PROPULSION RSCH	2423	2487	2611	0	0	0	0	0	0	0
F22	RSCH IN VEH MOBILITY	452	480	494	0	0	0	0	0	0	0
H42	MATERIALS & MECHANICS	1855	1972	2044	0	0	0	0	0	0	0
H43	RESEARCH IN BALLISTICS	3849	4088	4235	0	0	0	0	0	0	0
H44	ADV SENSORS RESEARCH	3866	4106	4243	0	0	0	0	0	0	0
H45	AIR MOBILITY	1880	2016	9096	0	0	0	0	0	0	0
H47	APPLIED PHYSICS RSCH	2971	3153	3274	0	0	0	0	0	0	0
H48	BATTLESPACE INFO & COMM RSC	6447	6863	7118	0	0	0	0	0	0	0
H52	EQUIP FOR THE SOLDIER	918	975	1014	0	0	0	0	0	0	0
H57	SCI PROB W/ MIL APPLIC	51095	51086	52697	0	0	0	0	0	0	0
H66	ADV STRUCTURES RSCH	1366	1449	1508	0	0	0	0	0	0	0
H67	ENVIRONMENTAL RESEARCH	3342	3537	3644	0	0	0	0	0	0	0
H68	PROC POLLUT ABMT TECH	349	372	382	0	0	0	0	0	0	0
S04	MIL POLLUTANT/HLTH HAZ	589	625	643	0	0	0	0	0	0	0
S13	SCI BS/MED RSH INF DIS	8576	9100	9410	0	0	0	0	0	0	0
S14	SCI BS/CBT CAS CARE RS	3770	4005	4135	0	0	0	0	0	0	0
S15	SCI BS/ARMY OP MED RSH	5129	5445	5631	0	0	0	0	0	0	0
S17	MOLECULAR BIOLOGY-HIV	408	435	447	0	0	0	0	0	0	0
S19	T-MED/SOLDIER STATUS	579	614	635	0	0	0	0	0	0	0
S20	SCIENCE BASE EMERGING INFECTIOUS DISEASES	0	3938	0	0	0	0	0	0	0	0

T22	SOIL & ROCK MECH	1759	1870	1923	0	0	0	0	0	0	0
T23	BASIC RES MIL CONST	1487	1581	1626	0	0	0	0	0	0	0
T24	SNOW/ICE & FROZEN SOIL	2080	2413	1207	0	0	0	0	0	0	0
T25	ENVIRONMENTAL RES-COE	4195	4461	4590	0	0	0	0	0	0	0
T51	COUNTER - TERRORISM RESEARCH	0	2972	0	0	0	0	0	0	0	0
T55	DISPLAY PERFORMANCE & ENVIRONMENTAL EVALUATION	0	1487	0	0	0	0	0	0	0	0

A. Mission Description and Budget Item Justification:

PLEASE NOTE: This administration has not addressed FY2003-2007 requirements. All FY 2003-2007 budget estimates included in this book are notional only and subject to change.

This program element sustains U.S. Army scientific and technological superiority in land warfighting capability, provides new concepts and technologies for the Army's Objective Force, and provides the means to exploit scientific breakthroughs and avoid technology surprise. 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 warfighting capabilities. 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 Army's research program promotes quality through activities such as in-depth reviews of the entire basic research program at all levels and the establishment of Strategic Research Objectives. The Army broadened its research base by expanding its basic research investments at Historically Black Colleges and Universities and Minority Institutions (HBCU/MIs) to 5% of its individual investigator program. The basic research program is coordinated with the other Services via the Joint Directors of Laboratories panels, Project Reliance, and other interservice working groups. 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.

B. Program Change Summary	FY 2000	FY 2001	FY 2002	FY 2003
Previous President's Budget (FY2001 PB)	125918	132164	130876	0
Appropriated Value	126613	137914	0	
Adjustments to Appropriated Value	0	0	0	
a. Congressional General Reductions	0	0	0	
b. SBIR / STTR	-2427	0	0	
c. Omnibus or Other Above Threshold Reductions	-370	0	0	
d. Below Threshold Reprogramming	0	0	0	
e. Rescissions	-325	-1264	0	
Adjustments to Budget Years Since FY2001 PB	0	0	7405	
Current Budget Submit (FY 2002/2003 PB)	123491	136650	138281	0

Change Summary Explanation: In FY 2001, Congressional adds were made for Counter-Terrorism Research ($3000); Cold Regions Military Engineering, Project T24 ($1250); and the Display Performance and Environmental Evaluation Project ($1500).
- ($3000) Counter-Terrorism Research: The objective of this one year add is to develop technologies to deter, resolve, and mitigate terrorist acts, including physical structure and weapon's effects research. No additional funding is required to complete this project.
- ($1500) Display Performance and Environmental Evaluation Project: The objective of this one year Congressional add is to develop techniques and instrumentation to evaluate the performance of computer and electronic equipment displays (particularly flat panel displays) in order to guide the selection, development, and implementation of appropriate displays for the Army. No additional funding is required to complete this project.

Projects with no R-2A:
F22:
- (FY02 Funding = $494) Research in Vehicle Mobility (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.

H68:
- ($382) Processes in Pollution Abatement Technology (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.

S04:
- ($643) Military Pollutants and Health Hazards (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.

S17:
- ($447) Molecular Biology/Military HIV Research (S17): Develop methods for the prevention, early diagnosis, and treatment of human immunodeficiency virus (HIV).

S19:
- ($635) Telemedicine Soldier Status Research (S19): Improve combat casualty care for troops through faster diagnosis and treatment by enabling on-site health care providers to consult with specialists worldwide. This effort focuses on advancing the means to determine soldier physiological status and aiding medical diagnosis and treatment.

S20:
- ($3938) Science Base Emerging Infectious Diseases (S20): This one year congressional add focuses on speeding development of infectious disease threat countermeasures to support operations in non-industrialized countries and those in which infrastructure has been damaged or destroyed. No additional funding is required to complete this project.

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

June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - BASIC RESEARCH	**0601102A - Defense Research Sciences**	**305**

COST (In Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
305 ATR RESEARCH	1121	1194	1237	0	0	0	0	0	0	0

A. Mission Description and Budget Item Justification: This project supports basic research on the fundamental underpinnings of aided and unaided target detection and identification techniques for land warfare. Future Army systems must be able to 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 the Objective Force. 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 soldier. This research is aimed at understanding the complexity and variability of target and clutter signatures and ultimately will utilize that knowledge to conceptualize and design advanced Automatic Target Recognition (ATR) paradigms to enhance robustness and effectiveness of land warfare systems. ATR research strategies include emerging sensor modalities such as spectral imaging and multisensor imaging. These research findings support several technology efforts including multidomain smart sensors, third generation forward looking infrared (FLIR), advanced multi-function LADAR technology. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2000 Accomplishments

- 1121 - Assessed quality of ground thermal predictions for various ground vehicle scenarios.
  - Devised algorithms for computing image complexity and applied to relevant data sets.
  - Analyzed the fidelity of synthetic target image chips for use in ATR development.

Total 1121

FY 2001 Planned Program

•	1174	- Assess fidelity of thermal predictions for signature data and improve the models as indicated.
		- Correlate performance of one or more ARL ATR algorithms with image complexity measures.
		- Conduct phenomenological studies of hyperspectral data to assess minimum number of bands needed to achieve high discrimination performance with low cost trade off.
•	20	- Funds reprogrammed for SBIR/STTR programs.
Total	1194	

FY 2002 Planned Program

•	1237	- Provide framework for use of synthetic target image chips in the training and testing new ATR algorithms.
		- Design new ATR approaches using hyperspectral data cubes and compare hyperspectral ATR algorithms to broadband and dualband ATR algorithm performance.
Total	1237	

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

June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - BASIC RESEARCH	**0601102A - Defense Research Sciences**	**31B**

COST (In Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
31B INFRARED OPTICS RSCH	2219	2404	2503	0	0	0	0	0	0	0

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 IR imaging systems. It generates new technologies to obtain unprecedented awareness of the battlefield and to continue to "own the night" notwithstanding foreign competition. 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 therefore 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 superlattices, and quantum well and quantum 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. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2000 Accomplishments

- 2219 - Prototypes of high power 1.5-micron diode laser were built.
  - 0.8-micron detector/modulator for ladar with 600 MHz bandwidth was processed and tested.
  - Validated vertical cavity surface emitting laser (VCSEL) operation at IR Focal Plane Array (FPA) operating temperatures (77°K).
  - First growth of HgCdTe on Si completed.

Total 2219

FY 2001 Planned Program

•	2388	- Examine fundamental aspects of material growth and device design for long wave infrared (LWIR) FPA operating above 100°K.
		- Grow and process detector/modulator for ladar designed for 1.5-micron detection.
		- Examine fundamental aspects of design of IRFPAs to be utilized for active and passive imaging.
•	16	- Funds reprogrammed for SBIR/STTR programs.
Total	2404	

FY 2002 Planned Program

•	2503	- Evaluate chemical and structural properties of HgCdTe for near room temperature operation.
		- Investigate controlled low-defect growth of Sb-based superlattices and quantum dots.
		- Grow and process 2D detector/modulator array for 1.5-micron ladar.
Total	2503	

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

June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - BASIC RESEARCH	**0601102A - Defense Research Sciences**	**52C**

COST (In Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
52C MAPPING & REMOTE SENS	2169	2305	2369	0	0	0	0	0	0	0

A. Mission Description and Budget Item Justification: The objective of this project is to support research in fundamental topographic sciences 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 greatly improves situational awareness capabilities and enhances information dominance that will lead to increased survivability, lethality, and mobility capabilities for the Objective Force, the Future Combat Systems and Joint/Army Vision 2020. The research provides the theoretical underpinnings for program element 0602784A, project 855. This work is managed by the U.S. Army Engineer Research and Development Center (ERDC). This project supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2000 Accomplishments

- 2169 - Investigated multivariate statistical analysis, multivariate interpolation, and enhancements for image analysis.
  - Investigated generating topographic data using a combination of sensor information.
  - Evaluated initial geostatistical models of climatic atmospheric parameters integrated with line-of-sight models for denied areas where limited or no data is available.
  - Evaluated models and their performance to characterize expected battlefield state against actual data sets from operational databases.

Total 2169

FY 2001 Planned Program

•	2257	- Investigate enhancement of neural net and subpixel methods of feature extraction to gain processing speed and increase information detail.
		- Investigate hyperspectral imagery analysis/segmentation to improve feature differentiation and identification.
		- Devise model to predict precipitation frequency data in the absence of weather data in denied areas to permit greater operational use of terrain.
		- Investigate the potential to integrate empirical and inductive analysis systems to increase speed and accuracy of analysis and to enhance descriptive quality of results.
•	48	- Funds reprogrammed for SBIR/STTR program.
Total	2305	

FY 2002 Planned Program

•	2369	- Investigate fluorescence feature extraction for enhanced accuracy and detail.
		- Investigate multispectral and hyperspectral image compression for reducing process time and data storage requirements.
		- Refine precipitation frequency model variables for greater accuracy in terrain condition prediction.
		- Investigate threat/terrain software and models for specific geographic areas.
Total	2369	

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

June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - BASIC RESEARCH	**0601102A - Defense Research Sciences**	**53A**

COST (In Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
53A BATTLEFIELD ENV & SIG	3565	3777	3945	0	0	0	0	0	0	0

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 terrains requiring new approaches to understanding, characterizing, and depicting microscale atmospheric phenomena. The lack of a complete understanding of the meteorological aspects of the complex microscale 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 impacts Army chemical and biological defense operations, electro-optic and acoustic sensors, smoke/obscurant deployments and target acquisition. This project supports Army Strategic Research Objective, Intelligent Systems, provides technology for the Integrated Meteorological System (IMETS) and supports Project Reliance under the Defense Technology Area by providing Tri-Service transport and dispersion research and development. This project is the research leader in boundary layer meteorology over land and urban terrain. This project 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 nowcast products. These capabilities will have a direct impact on ensuring soldier survivability, weapon system lethality, and the mobility required for future combat operations. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2000 Accomplishments

- 3565 - Performed experimentation and modeled acoustic array performance in non line-of-sight and multipath conditions.

  - Completed theory and software linking 3-D atmospheric propagation and radiative transfer models to standard interfaces such as the Total Atmospheric and Oceans Server (TAOS) to improve virtual testing, analysis, and simulation capabilities.

  - Compared coupled 3-D surface layer/boundary layer meteorological model with experimental data for verification and validation of a hazard avoidance tactical decision aid.

  - Investigated methods for real-time discrimination between naturally-occurring and man-made aerosols using both fluorescence and elastic scattering for real-time detection of biological warfare agents.

FY 2000 Accomplishments (Continued)

- Coupled canopy and urban flow technologies into transport and dispersion models for more realistic depiction of smoke, atmospheric clouds, dust aerosols and BW/CW agents on the battlefield.

- Incorporated detailed Surface Energy Balance in Surface Layer Model for improved thermal dynamics.

- Participated in a joint interagency stable boundary layer meteorological field experiment, Cooperative Atmospheric Surface Exchange Study (CASES-99), to achieve a better understanding of stable boundary layer processes for environmental model performance improvements.

- Determined new algorithms for depicting physical processes for better analysis and prediction of icing, low level clouds, and precipitation at time and spatial scales required for accurate quantitative depiction of target area atmospheric conditions.

- Extended capabilities of acoustic target recognition into more complex environments through research on theory and numerical models of propagation of sound through inhomogeneous anisotropic turbulence including refraction and ground reflections.

Total 3565

FY 2001 Planned Program

• 3726

- Use Cooperative Atmospheric Surface Exchange Study (CASES-99) data to model acoustic propagation in diurnal conditions.

- Investigate the feasibility of extracting environmental data from hyperspectral imagery to make possible an enhanced capability for target detection and acquisition.

- Investigate the use of multiple excitation wavelengths and elastic scattering in characterizing aerosol particles, especially biological warfare agents.

- Model and perform experiments on low frequency acoustic propagation in forest canopies and littoral regions to assess environmental impacts on acoustic sensors.

- Evaluate new algorithms for depicting physical processes to better analyze turbulence, wind shear, and visibility at the temporal and spatial scales required for accurate, quantitative depiction of target area atmospheric conditions.

- Integrate a new Cumulus Parameterization Scheme for estimating convective precipitation into hydrostatic mesoscale models that will significantly improve fine-scale predictions of clouds and precipitation in the battlespace area.

- Compare coupled 3-D surface layer/boundary layer meteorological model with experimental data over complex terrain and urban morphology domains for verification and validation.

- Incorporate detailed surface energy balance in surface layer model for improved thermodynamic and stability effects.

FY 2001 Planned Program (Continued)

- Improve the boundary layer model by incorporating algorithms for stable atmospheric conditions.

• 51 - Funds reprogrammed for SBIR/STTR programs.

Total 3777

FY 2002 Planned Program

• 3945 - Improve tactical target acquisition using the additional dimension of polarization to more completely characterize the state of reflected and thermal radiation.

- Model and perform experiments on high-frequency acoustic propagation in forest canopies and littoral regions.

- Research new high resolution, short-range forecasting models that can be initialized with meteorological data from critical areas of the battlefield. Improved models will directly impact nowcast accuracies for Objective Force operating areas and target areas.

- Participate in a multi-agency field experiment investigating dispersion in urban domains to gain an understanding of the impact of urban terrain on dispersion.

- Investigate and correct problems with the transilient turbulence model to decrease computational requirements for counter-gradient dispersion.

- Investigate the scientific foundation for a hazard avoidance decision aid using the coupled 3-D surface layer/boundary layer transport and dispersion model.

- Investigate methods for performing 3-D data assimilation techniques with combined boundary layer and transport and dispersion models.

- Investigate a computationally efficient model for determining weather effects on nighttime illumination that includes cloud cover effects on light pollution from cities and military operations.

- Research a computationally efficient forecast model for surface layer optical turbulence effects and their impacts on target acquisition.

- Conduct field measurements of natural background aerosols in different geographic locations and at different seasons to establish expected backgrounds for bio-aerosols.

Total 3945

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

June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - BASIC RESEARCH	**0601102A - Defense Research Sciences**	**74A**

COST (In Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
74A HUMAN ENGINEERING	2478	2662	2765	0	0	0	0	0	0	0

A. Mission Description and Budget Item Justification: This project provides research on soldier performance, including the areas of visual, auditory, cognitive, and stress-related performance. The goal is to identify, describe and manage underlying human-system interface factors critical to the design of Army weapon systems. The barriers include an incomplete understanding of soldier physical, cognitive and perceptual processes and how to apply this understanding to new missions and systems. All of the work in this program is included in the Army Strategic Research Objective (SRO) titled "Enhancing Soldier Performance", and is consistent with the Army Science and Technology Master Plan (ASTMP) and the DOD Basic Research Plan. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2000 Accomplishments

• 2478 - Completed the analysis and documentation of human auditory perception studies on C2 on-the-move and the effect of feedback on auditory skill development.

- Generated an advanced windows-based version of the auditory hazard model with active middle ear muscles and azimuthal correction capabilities.

- Determined that white phosphor night vision goggles (NVGs) afforded recognition of objects at a 15% to 20% increase in target range compared to the standard green phosphor NVGs.

- Provided an analysis of the effects of selective visual attention on target acquisition in static, optically imaged scenes to AMSAA's soldier-in-the-loop target acquisition modeling effort.

- Conducted a survey of infantry soldiers to establish criteria for mission success and associated information requirements in preparation for a field study on the effects of information availability on the performance of dismounted infantry teams.

- Investigated the effects of specific battlefield stressors on situational awareness and decision-making under conditions of uncertainty that resulted in a field-practical set of operational stress measures.

- Identified stress-related predictors and cognitive processes related to performance in an extended complex, novel situation in direct support of the Strategic Research Objective (SRO) "Enhancing Soldier Performance".

Total 2478

FY 2001 Planned Program

•	2633	- Using the results of previous auditory studies, devise a robust and sensitive speech recognition test specifically applicable to the military environment.
		- Generate hearing protection algorithms and incorporate into Army developed auditory hazard model.
		- Conduct an experiment to examine target and obstacle detection, depth and distance estimation, and size and depth perception with color night vision goggles. This study was delayed from FY00 due to equipment development.
		- Expand studies of selective visual attention on target acquisition to electro-optically (IR and I2) imaged scenes and provide results to AMSAA's soldier-in-the-loop target acquisition modeling effort.
		- Complete field experiment to quantify the effects of the availability of tactical information presented on helmet mounted displays on global and local situation awareness and mission performance of dismounted military teams.
		- Extract findings from intense and novel situations to devise methods for improved information processing and heightened vigilance and awareness within the digitized battlefield.
		- Identify physiological and personality-based correlates of performance, in support of the "Enhancing Soldier Performance" SRO.
•	29	- Funds reprogrammed for SBIR/STTR programs.
Total	2662	

FY 2002 Planned Program

•	2765	- Determine the impact of infantry helmet on the auditory localization to provide guidelines for future helmet designs
		- Identify the effects of spectral signal composition on auditory detection and recognition.
		- Conduct research to determine the best approach for improving spatial perception of combat important sounds in adverse listening conditions.
		- Include blast reflection analysis into the auditory hazard model to predict safe use of weapons in urban environments.
		- Form a blast waveform database and include hazard algorithms used by other NATO countries to compare hazard assessments.
		- Modify an existing model of target acquisition performance to include human cognitive inputs in order to improve predictions of soldier and material performance.

FY 2002 Planned Program (Continued)

- Investigate the effects of display configuration and information format on situation awareness and performance of mission critical tasks.

- Apply streamlined, multi-dimensional, stress assessment battery in high workload and high stress environments in order to quantify the stress-performance relationships directly associated with the retention and effectiveness of experienced soldiers.

- Complete studies of electrophysiological measures of cognitive performance and design follow-on studies with Land Warrior perspective.

- Generate multivariate and hierarchical models of soldier performance under a variety of stressful conditions.

Total 2765

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

June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - BASIC RESEARCH	**0601102A - Defense Research Sciences**	**74F**

COST (In Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
74F PERS PERF & TRAINING	2554	2778	2855	0	0	0	0	0	0	0

A. Mission Description and Budget Item Justification: This project covers behavioral science research in areas with high payoff opportunities for improved training, leadership, and personnel performance, including: methods for faster learning and improved skill retention; leader effectiveness for improved team and unit performance; understanding the impact of societal trends on Army readiness; and improving the match between soldier skills and their jobs to optimize performance. Research is focused on issues of small-team performance, leadership, and training to ensure that personnel performance and training research keep pace with future mission, structural, technological, equipment, and personnel changes. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2000 Accomplishments

• 2554 - Developed leadership model for small, next-century units performing under adversity and techniques for developing the attributes of future leaders.

- Discovered a relationship between military rank and tacit knowledge scores providing support for the importance of tacit knowledge as a predictor of effective performance.
- Completed analysis of how European armies have adjusted to rapid changes in their societies.
- Found that trust in communication may reduce the amount of mutual monitoring, resulting in poorer performance.
- Demonstrated the prediction from Procedural Reinstatement Theory showing that enhancing the difficulty of training improves the durability of the skill and improves skill transfer.

Total 2554

FY 2001 Planned Program

•	2701	- Determine the effects of computer mediated communication on the effectiveness of leader - subordinate relationships.
		- Evaluate the use of latent semantic analysis to assess an individual's knowledge structure and to aid in the automatic analysis of free-range text.
		- Determine the effects of different types of missions and gender issues on cohesion, morale, and performance effectiveness.
		- Model the results of a long-term analysis on the durability of tank gunnery skills in the absence of practice.
		- Contribute to the development of a cognitive model of the commander by incorporating data on the effects of training on the ability of commanders to handle large amounts of information.
•	77	- Funds reprogrammed for SBIR/STTR programs.
Total	2778	

FY 2002 Planned Program

•	2855	- Evaluate predictions from transformational leadership theory on the effectiveness of training transformational leadership skills.
		- Extend Procedural Reinstatement Theory to predict the unique characteristics of digital skills in terms of their effects on learning, durability, and transferability of trained skills.
		- Construct and validate techniques for developing the particular attributes needed for effective leadership of small units.
		- Incorporate the effects of distance communication discovered in emergency medical operations on models of effective leadership.
		- Develop preliminary results on the effectiveness of cohesion training on team performance.
Total	2855	

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

June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - BASIC RESEARCH	**0601102A - Defense Research Sciences**	**F20**

COST (In Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
F20 ADV PROPULSION RSCH	2423	2487	2611	0	0	0	0	0	0	0

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. The problems are a need to have much greater fuel efficiency in propulsion systems, and to achieve reduced weight in these systems. Technical barriers for advanced propulsion systems are a limit on the maximum temperature that today's materials can safely withstand, and a lack of capability to accurately simulate the flow physics and mechanical behavior of propulsion systems, including the engine and drive train. This project is a joint Army/NASA effort and it is the only DoD basic research project focused on turboshaft engine-specific technology and mechanical power transmission technology. 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, injectors, pistons, cylinder liners, piston rings, gears, seals, bearings, shafts, and controls. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2000 Accomplishments

- 2423 - Validated a first principle centrifugal compressor surge model that points to specific causes for stall and surge instabilities and provides a rational basis for defining new stability-enhancing techniques.

  - Obtained Particle Image Velocimetry measurements of diffuser flow fields in a centrifugal compressor that provided detailed information about the nature and location of flow defects that lead to instabilities. The results were successfully used to design and locate flow injection nozzles in a separate 6.2 program.

  - Completed characterization of the coupling between internal convection and external film cooling for turbine blades. The results will enable more accurate predictions of required cooling flows, lead to more effective use of cooling air, and enhance engine efficiency.

  - Conducted 200 hour combustor durability tests to validate thermomechanical life prediction model for structural ceramics and to identify need for improved environmental coating and composite architecture.

  - Completed acquisition of experimental data for analysis of helical gear thermal behavior, which will lead to reduced rotorcraft drive train weight and improved safety.

FY 2000 Accomplishments (Continued)

- Assisted industry with extension of gear tooth crack propagation code (National Rotorcraft Technology Center program).
- Conducted mechanical design and structural analysis of wave rotor for a gas turbine topping unit. Wave rotor topped cycles promise substantial improvements in fuel efficiency and power density compared to the baseline cycle.
- Completed application of microelastohydrodynamic lubrication analysis to superfinished gears and completed gear contact stress analysis. Superfinish gears have the potential to substantially extend gear life over conventionally finished gears.
- Investigated ultrasonic wireless data telemetry system based upon piezoceramic transducers to obtain fine spatial resolution measurements of low frequency (100Hz) internal engine physical phenomenology, i.e. pressure, acceleration and vibration.

Total 2423

FY 2001 Planned Program

• 2473

- Incorporate environmental effects in life prediction model for advanced structural ceramics, including effects due to combustion products.
- Obtain detailed measurements of heat transfer and secondary leakage losses of four port through-flow wave rotor and validate loss mitigation approaches to improve the performance and efficiency of future air and ground propulsion designs.
- Apply and assess validity of newly developed engine weight and safety prediction algorithms. These algorithms will forecast the impact of advanced technologies on the weight and safety of new engines.
- Validate gear fault detection methodology incorporating sensor fusion for improved rotorcraft transmission safety and reliability.
- Validate 2D and 3D gear crack propagation codes for improved life and reliability predictions.
- Use signal processing techniques to improve signal/noise ratio and physical sensing bandwidth for ultrasonic data telemetry data system that more accurately measure and analyze engine phenomena in the 10kHz range.
- Assess MEMS based concept to implement microblowing and synthetic jets as a nonintrusive approach to active stabilization for centrifugal compressors.

• 14 - Funds reprogrammed for SBIR/STTR programs.

Total 2487

FY 2002 Planned Program

•	2611	- Construct MEMS based synthetic jet components for application to flow range extension experiments on centrifugal compressor stage.
		- Assess environmental barrier and impact resistant coatings stable to 1480C; incorporate erosion, impact, and environmental effects in life prediction model for advanced structural ceramics for more reliable engine designs.
		- Integrate combustor module into wave rotor external burner experiment and conduct preliminary design of combustor module for wave rotor topped engine.
		- Establish gear design parameters/charts/standards based on crack propagation prediction code to enable lighter weight and more durable drive systems for future rotorcraft.
		- Include elastohydrodynamic effects in the journal bearing performance code to improve performance analysis and predictions which will lead to engines with extended life, greater reliability and durability, and reduced maintenance.
Total	2611	

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

June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - BASIC RESEARCH	**0601102A - Defense Research Sciences**	**H42**

COST (In Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
H42	MATERIALS & MECHANICS	1855	1972	2044	0	0	0	0	0	0	0

A. Mission Description and Budget Item Justification: This project funds the Army's basic research program in materials science. The goal is to establish the science base allowing the creation and production of advanced materials which will provide higher performance, lower cost, improved reliability, and environmental compatibility for Army unique applications. Emphasis is on understanding the fundamental aspects of chemistry and microstructure that influence the performance and failure mechanisms of ceramics, advanced polymer composites, advanced metals, and multifunctional materials. These advanced materials will enable lethality and survivability technologies for the Objective Force. This research is conducted by the Army Research Laboratory, at the Aberdeen Proving Ground, MD, and at the NASA Langley Research Center in Hampton, VA, in support of materials technology applied research in project 0602105A/AH84. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2000 Accomplishments

• 1855 - Determined the synthesis-microstructure-property relationships in polymer/clay nanocomposite materials.

- Refined low cycle fatigue predictive models for integrally-designed armor composite materials that include effects of material flaws and damage.

- Investigated processing-microstructure effects on elastic properties of a functionally graded material.

- Extended predictive models and experimental techniques for cluster beam and pulsed laser ablation deposition of protective coatings.

- Investigated and devised coupled theoretical models for constitutive laws governing the high strain rate behavior of lightweight metal alloys and hybrid armor candidate materials.

- Extended numerical and design models of elastomeric structures to include higher order plate and shell finite elements, and evaluated large strain combined loads viscous models against measured data.

Total 1855

FY 2001 Planned Program

•	1955	- Explore novel technologies for energy dissipation in lightweight integrally-designed armor composite materials.
		- Investigate the effects of interfacial chemistry on the morphology development in polymer/polymer and polymer/inorganic nanocomposites.
		- Investigate shock response and material damage/failure mechanisms of ballistically impacted ceramics.
		- Determine critical dynamic material properties required for improving the performance of future anti-armor concepts against complex threat armors.
		- Evaluate the application of a new computational, elastomeric material modeling technology to intelligent material systems, including electrorheological fluids, which may lead to less costly and more reliable damper systems.
•	17	- Funds reprogrammed for SBIR/STTR programs.
Total	1972	

FY 2002 Planned Program

•	2044	- Elucidate the complex microstructural relationships between the interphase and bulk composite properties of lightweight integral armor materials.
		- Correlate morphology and interfacial properties with mechanical performance in multilayered laminates and layered silicate nanocomposites.
		- Characterize dynamic and static material properties of advanced ceramics that can be tailored to control the onset of ballistic failure for improved lightweight armors.
		- Devise analytic models and experimental techniques for describing material response of dynamically loaded anti-armor concepts.
		- Evaluate large strain combined loads viscous models against measured data in cooperative program with Penn State, Brunel University, and Lord Corporation, and investigate the use of these new constitutive theories in the modeling of intelligent material systems, including electrorheological fluids.
Total	2044	

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

June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - BASIC RESEARCH	**0601102A - Defense Research Sciences**	**H43**

COST (In Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
H43 RESEARCH IN BALLISTICS	3849	4088	4235	0	0	0	0	0	0	0

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. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2000 Accomplishments

• 3849 - Investigated theoretical chemistry and physics-based models, including 3-dimensional (3-D) ballistics models of future high performance solid propellants, validated models through ignition and combustion experimentation, and predicted mechanical stability, impetus, energy release, flame temperature, and critical intra- and intermolecular propellant properties.

- Coupled computational fluid dynamics/thermal/rigid body dynamics tools for complex aerodynamic shapes and launch dynamics of advanced munitions.

- Incorporated coupled constitutive models into the magneto-solid-mechanics version of the CTH model (a computational solid mechanics model developed by Sandia National Laboratory) being developed as part of the work package on electrodynamic defeat of anti-armor threats.

- Performed shock wave propagation experiments in functionally graded materials to determine the effect of directionality on its shock, release, tensile and energy dissipation properties; Determined the effect of the material property gradient on wave front curvature and amplitude for general directions of propagation.

Total 3849

FY 2001 Planned Program

•	4023	- Refine fundamental chemistry and physics models and expand experimental techniques to elucidate the factors controlling gun and missile propellant initiation, combustion, sensitivity, and vulnerability.
		- Devise advanced computational models, smart munitions aerodynamic prediction capabilities, and flight vehicle control element design tools for low cost precision munitions.
		- Devise micromechanical model and define theory critical experiments to describe the onset and propagation of damage to ballistically impacted ceramics.
		- Investigate the physical processes associated with adiabatic shear band initiation and growth to improve performance of future anti-armor concepts.
•	65	- Funds reprogrammed for SBIR/STTR programs.
Total	4088	

FY 2002 Planned Program

•	4235	- Employ 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.
		- Couple high performance computational design tools to calculate control aerodynamics of smart munitions, missiles, and rocket systems.
		- Expand ceramic micromechanical model to describe intergranular flow, grain size, orientation, and boundary chemistry and conduct fundamental experiments to determine damage evolution under ballistic load.
		- Devise analytic model and conduct fundamental experiments to determine adiabatic shear onset criterion in emerging anti-armor alloys.
Total	4235	

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

June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - BASIC RESEARCH	**0601102A - Defense Research Sciences**	**H44**

COST (In Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
H44 ADV SENSORS RESEARCH	3866	4106	4243	0	0	0	0	0	0	0

A. Mission Description and Budget Item Justification: This project exploits new opportunities in the basic sciences to enable new sensing capabilities for advanced sensors 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, and the efficiency of current algorithms and computing architectures. The focus is on exploitation of digital and image processing modules and algorithms, nonlinear optical materials and devices, remote sensing, emissive materials 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 microoptic elements are investigated to enhance performance of imagers and optical processors. For laser protection, nonlinear optical effects are being explored which will allow broad band protection. These nonlinear effects can also be used for optical image processing or holographic displays and storage. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2000 Accomplishments

- 1303
  - Devised and evaluated iterative algorithms for designing sub-wavelength diffractive optical elements (DOEs).
  - Characterized nonlinear transmission properties of novel material systems such as dendrimers.
  - Achieved single host color phosphors using laser ablation techniques.
- 930
  - Established cross-range super-resolution techniques for complex targets with scan-multiple signal classification (S-MUSIC) for improved automatic target recognition (ATR) thereby providing increased lethality for the Objective Force.
  - Completed an analysis of landmine signatures as a function of soil type, imaging geometry and burial depth using electromagnetic models. Results delivered to CECOM's Night Vision and Electronic Sensors Directorate (NVESD) countermine division.
  - Researched wide-band direction finding (DF)-based adaptive beam-forming algorithms and performed preliminary research on Distributed Sensor Array Processing.
  - Showed low leakage currents on Aluminum Nitride thus making it useful for high power, high temperature electronics for the Objective Force.

FY 2000 Accomplishments (Continued)

•	1633	- Utilized fuzzy logic to control level of object detail and to model volumetric objects while maintaining a constant frame rate.
		- Implemented and evaluated techniques for the real-time rectification of sensor imagery utilizing nonlinear and adaptive optics to improve tactical combat imaging systems.
Total	3866	

FY 2001 Planned Program

•	1364	- Integrate nonlinear beam propagation codes to materials properties
		- Record and fix multiplexed gratings in a 3D hologram.
•	1051	- Extend capabilities of S-MUSIC code and nonlinear super-resolution algorithms for radar and validate applicability using field data for improved ATR thereby providing increased lethality for the Objective Force.
		- Evaluate impact of rough surface clutter layer on the radar detection of land mine signatures using electromagnetic models.
		- Investigate and research advanced acoustic classification techniques such as auditory signal modeling and fuzzy logic. Perform research in wide-band adaptive beam-forming and distributed sensor array processing.
		- Investigate the use of aluminum nitride insulator films grown on silicon carbide for high power, high temp switches for electric drive vehicles.
•	1608	- Establish techniques for real-time rectification of sensor imagery utilizing features with the scene.
		- Investigate the effects of turbulence induced phase and intensity fluctuations on ground-to-ground laser systems and identify techniques to reduce the effects on tactical communications systems for the Objective Force.
		- Devise algorithms for on-the-fly visual information fusion and processing in the presence of atmospheric turbulence-induced phase distortion effects supporting AMCOM/ARL joint research goals.
		- Provide 4D mulitgrid microscale nuclear/biological/chemical (NBC) model and enhance mulitgrid microscale wind model to enable a tactical decision that visualizes chemical effects in context of the physical environment.
•	83	- Funds reprogrammed for SBIR/STTR programs.
Total	4106	

FY 2002 Planned Program

•	1468	- Understand theoretical limits of nonlinear optical materials to provide eye protection from lasers.
		- Understand new display modalities.
		- Demonstrate enhanced organic light emission device lifetimes.
		- Explore limitations of engineered materials to provide eye protection to laser sources.
•	1077	- Determine the effects of noise and clutter on the performance of S-MUSIC for high resolution radars to improve angular accuracy.
		- Report on airborne ground penetrating radar (GPR) utility analysis using knowledge of surface and volumetric clutter.
		- Implement and evaluate efficient encoding and processing schemes between sensor nodes and a centralized gateway.
		- Investigate new advanced target classification techniques that exploit multiple sensor modalities through sensor networks.
		- Improve drive current of voltage controlled switches for high power electric drive vehicles.
•	1698	- Implement and evaluate image processing techniques based on nonlinear spatiotemporal dynamics occurring in large arrays of optoelectronic feedback circuits.
		- Design a prototype of optoelectronic system for moving target tracking from nonstationary platforms, supporting AMCOM/ARL joint research goals.
		- Adapt 4-D multigrid microscale NBC model to exploit the Army High Performance Computing Center capabilities and improve the near-real time responses with which the effects of NBC type information is processed.
Total	4243	

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

June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - BASIC RESEARCH	**0601102A - Defense Research Sciences**	**H45**

COST (In Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
H45 AIR MOBILITY	1880	2016	9096	0	0	0	0	0	0	0

A. Mission Description and Budget Item Justification: This project provides funding for basic research in aerodynamics as applied to rotary wing aircraft. Analysis, code development, and test and evaluation are conducted on rotor-unique aerodynamics, performance, and acoustics. 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 rotary wing vehicles. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2000 Accomplishments

- 1880
  - Completed research of stereo image velocimetry technique.
  - Completed detailed rotor wake geometry measurements during blade/vortex interaction using stereo image velocimetry technique.
  - Completed an axial-flight wind tunnel test to separate induced power from total power measurement.
  - Designed and fabricated scale model rotor blades equipped with oscillating blowing to control flow separation.
  - Performed analytic validation of swept tip blade stability characteristics.
  - Conducted parametric studies of active control with on-blade elevons for low vibration rotors.

Total 1880

FY 2001 Planned Program

- 1969
  - Prepare rotor aerodynamic and acoustic software codes using scalable software.
  - Conduct hover test using model blades equipped with oscillating blowing to control flow separation.
  - Investigate aeroelastic coupling characteristics for improved rotor stability.
  - Validate analytical methods for on-blade control vibration characteristics.
  - Design and fabricate a two dimensional (2D) variable droop leading edge airfoil to delay dynamic stall.

FY 2001 Planned Program (Continued)

- Investigate a new computational fluid dynamics (CFD) tool to design low Reynolds number airfoil using boundary vortex flux technique.

• 47 - Funds reprogrammed for SBIR/STTR programs.

Total 2016

FY 2002 Planned Program

• 2096 - Perform test to take necessary data for far wake measurement for helicopter and tiltrotor.

- Gather experimental data to quantify Tiltrotor Vortex ring state measurement.

- Conduct test of 2D variable droop leading edge airfoil.

• 7000 - Conduct fundamental research for autonomous control of rotorcraft unmanned aerial vehicles.

- Single Investigator program to research active flow control impact on tiltrotor type aircraft, and research active twist rotor evaluations using neural net closed loop controllers.

- Using simulation, collect data for synthetic vision database-sensor fusion requirements.

Total 9096

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

June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - BASIC RESEARCH	**0601102A - Defense Research Sciences**	**H47**

COST (In Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
H47 APPLIED PHYSICS RSCH	2971	3153	3274	0	0	0	0	0	0	0

A. Mission Description and Budget Item Justification: The objective of this project is to investigate the physics of a variety of phenomena occurring in semiconductor materials and structures, including thin heterostructure systems where quantum confinement effects are important. 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 high power infrared lasers, detector/modulators for laser radar (ladar), IR detector structures, and eye safe laser sources. Technical barriers affecting performance, weight, cost, and power consumption will be addressed. These investigations will support the development of optoelectronic devices for the Army's Objective Force. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2000 Accomplishments

- 2256
  - A cylindrical model of a microlaser cavity, including Q-switch, and a long-pulse microlaser model were established to help design pulsed lasers for ladar and range finders.
  - Modeled enhancement in quantum well infrared photon detector sensitivity using patterned structures.
  - Combined 3-D absorption model with thermal conduction model for IR design of thermal detectors.
  - Completed study of transport properties of type II superlattice heterostructures for lasers and detectors.
- 715
  - Formulated new nanophase anode material for next generation (higher specific energy and good low-temperature performance) Li-ion battery for Land Warrior and hybrid power sources for the Objective Force.
  - Synthesized new electrolyte solvents for capacitors and Li batteries with reduced low temperature electrolyte impedance for Land Warrior and hybrid power sources for the Objective Force.
  - Applied combinatorial method for optimization of electrocatalyst compositions for methanol fuel cells for Land Warrior.

Total 2971

FY 2001 Planned Program

•	2493	- Use the microlaser models to predict the threshold and energy output of lasers using various parameters for Er/Yb:glass with given pumping intensities.
		- Determine optical properties of electrically pumped laser and modulator structures.
		- Model antimonide based superlattice and quantum dot IR detectors for high operating temperature.
		- Determine optical and electrical properties of semiconductor superlattice materials.
•	632	- Authenticate new cathode material for low-temperature Land Warrior primary battery.
		- Synthesize low-flammability solvent for safe Li-ion batteries and capacitors for Land Warrior and hybrid power source for the Objective Force.
•	28	- Funds reprogrammed for SBIR/STTR programs.
Total	3153	

FY 2002 Planned Program

•	2624	- Complete 3-D laser cavity model with passive Q-switch for diode pumped Er/Yb:glass laser, and in collaboration with the Night Vision and Electronic Sensors Directorate of the Communication Electronics Command, compare model with experimental results; prepare report for publication.
		- Complete model of carrier transport in semiconductor superlattice materials based on optical, electrical and magnetic measurements.
•	650	- Improve the catalysts for hydrocarbon fuel reformer for fuel cells for Land Warrior and hybrid power sources for the Objective Force.
		- Explore materials for ultra-high energy Li/air battery for Land Warrior.
Total	3274	

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

June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - BASIC RESEARCH	**0601102A - Defense Research Sciences**	**H48**

COST (In Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
H48	BATTLESPACE INFO & COMM RSC	6447	6863	7118	0	0	0	0	0	0	0

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 multiaccess 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. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2000 Accomplishments

- 3898 - Refined secure mobility management techniques for mobile host protocol that support mobile ad-hoc networking on the move.
  - Refined intelligent agents for vulnerability assessment of dynamic tactical networks.
  - Evaluated concept for mobile distributed multiple access Anti-Jam (AJ) communication networks for brigade and below.
  - Completed investigation of survivable information architectures for information protection that address security, software reliability, data integrity and system recoverability.
  - Evaluated and refined hierarchical digital modulation algorithms for classification and identification of signals on battlefield.
  - Designed spatial diversity combining algorithms for tactical communications
  - Evaluated and refined algorithms for performing channel and source coding for tactical communications that are capable of operating in high bit-error battlefield environments.

FY 2000 Accomplishments (Continued)

•	2549	- Validated intelligent agent architecture by testing architecture and alert agent technology in collaboration with the Advanced Battlefield Processing Technology Science and Technology Objective (STO).
		- Documented the critical aspects of human-agent interaction that must be considered in the development of agent applications.
		- Assessed the extensibility and adaptability of the intelligent agent architecture to the synchronization of physical and software agents against a user defined mission plan.
		- Conducted detailed research on the language that will facilitate agent-to-agent communication to expand the theoretical foundations of cooperative intelligent agents.
		- Evaluated the use of soft computing approaches to enhance the ability of agents to deal with uncertainty.
		- Assessed the application of intelligent agent technology to natural language understanding and context tracking.
Total	6447	

FY 2001 Planned Program

•	3888	- Provide efficient algorithms for Internet protocols for highly mobile tactical networks for experimental applications.
		- Review final hierarchical digital modulation algorithms by testing, identifying and classifying complex signals.
		- Utilize a mobile ad-hoc network to interconnect tactical units and higher echelons to show improved information flow.
		- Validate the performance of source and channel coding for tactical communications in high bit error battlefield environments.
		- Validate hierarchical digital modulation algorithms for classification and identification of signals on battlefield.
		- Validate performance of spatial diversity combining algorithms for tactical communications.
•	2855	- Validate intelligent agents for mission planning, rehearsal and status monitoring of a physical agent.
		- In collaboration with the Advanced Battlefield Processing Technology STO, display the state of physical or software agents through a 2D/3D battlespace situation display.
		- Evaluate the robustness of the theoretical foundation for cooperating agents by using its architecture and control language to integrate agents assessing the network vulnerability and agents that monitor the execution of the mission.
		- Validate the performance of natural language and context tracking agents that understand a speaker's intent while visualizing graphical information.

FY 2001 Planned Program (Continued)

• 120 - Funds reprogrammed for SBIR/STTR programs.

Total 6863

FY 2002 Planned Program

• 7118 - Document the improvement in information flow in a mobile ad-hoc network provided by the research suite of networking and control protocols.

- Extend agent-based wireless network vulnerability assessment research to incorporate secure key management techniques.
- Determine the fundamental limits on the detection/estimation of modulated signals and the estimation and synchronization of emerging ultra-wideband sources.
- Investigate techniques to enhance the performance of ad-hoc networks that link unattended microsensors, focusing on routing and control protocols and medium access control algorithms.
- Provide computational multilingual tools to support tactical, intelligence, and coalition operations that provide language-independent representations of meanings (ontologies) and translingual information search and retrieval.
- Investigate format representation concepts for federations of ad hoc data management and wireless information distribution schemes to provide a formal representation of military concepts and facilitate coalition operations.
- Examine the theoretical foundation for cooperating agents architecture and control language by integrating agents that monitor the status of multiple aspects of blue force operations.

Total 7118

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

June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - BASIC RESEARCH	**0601102A - Defense Research Sciences**	**H52**

COST (In Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
H52 EQUIP FOR THE SOLDIER	918	975	1014	0	0	0	0	0	0	0

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, biotechnology 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. This project is managed by the US Army Natick Soldier Center, Natick, MA. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2000 Accomplishments

•	918	- Elucidated photochemical deterioration inherent in nonlinear optical materials used for eye protection.
		- Quantified comfort measures for combat clothing to allow rapid improvements in design without impact on function.
		- Created models for high strain rates in polymeric fabrics that correlate with predicted failure mechanisms.
		- Evaluated biotechnology approaches for developing high performance nanoceramics for lightweight body armor.
Total	918	

FY 2001 Planned Program

•	973	- Prepare nonspherical and nonlinear nanoparticles and evaluate their potential in improving the strength of composites for use in lightweight equipment to be carried or worn by soldiers.
		- Determine if molecular modeling programs correctly predict the one-dimensional strain in polymeric and polymer nanocomposite materials for use in body armor and other protective equipment.
		- Correlate military uniform (clothing) comfort with soldier performance by using a variety of clothing performance indicators.
		- Evaluate cognitive performance assessment methodologies using cold exposure as a stressor.
•	2	Funds reprogrammed for SBIR/STTR programs.
Total	975	

FY 2002 Planned Program

•	1014	- Validate the utility of a model that was created to assist in the design of better methods to carry loads, improving soldier performance.
		- Measure effects of electric fields on the 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.
		- Synthesize antimicrobial peptides to serve as biocides for soldier protection and for ration safety.
		- Transition models on high rate phenonomena occurring during ballistic impact events.
		- Validate cognitive testing paradigm for detection of food based performance enhancement under stressful conditions.
Total	1014	

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

June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - BASIC RESEARCH	**0601102A - Defense Research Sciences**	**H57**

COST (In Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
H57 SCI PROB W/ MIL APPLIC	51095	51086	52697	0	0	0	0	0	0	0

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 Objective Force Capabilities. Current technologies are unable to meet the operational requirements of the Future Combat Systems. The Army Research Office 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 of the Future Combat Systems. Included are research efforts for increasing knowledge and understanding in fields related to long-term Objective Force needs in the physical sciences (physics, chemistry, biology, and materials science), the engineering sciences (mechanical sciences, electronics, and mathematical, computer and information sciences), and environmental sciences (atmospheric and terrestrial sciences). Targeted research programs in nanotechnology, smart structures, multifunctional and microminiature sensors, intelligent systems, compact power 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 560 research grants and contracts with leading academic researchers and approximately 1,400 graduate students yearly, and supports research at 192 institutions in 41 states. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2000 Accomplishments

- 23760
  - Devised real-time, 2D Teraherz imaging using free-space electrooptic sampling for security screening and inspection of soldier chemical/biological agent protective suits.
  - Showed quantum-dot superlattice thermoelectric films for use in cryogenic cooling of Forward Looking Infrared (FLIR) systems.
  - Showed that environmentally friendly peroxide chemistry destroys hazardous materials including chem/bio weapons agents.
  - Engineered bacteriorhodopsin mutants enabling macromolecular elements to improve optoelectronics devices and sensors and increase their survivability.
- 27335
  - Devised a new understanding of combustion dynamics of liquid propellants which has led to redesigned munition fuses for increased safety and reliability.
  - Produced the first Gallium Arsenide 128x128 ultraviolet (UV) focal plane array for missile detection.

FY 2000 Accomplishments (Continued)

- Created new software tools for parallel computing making it easier to port applications to new computer architectures and use computer resources more efficiently.
- Established a methodology for integrating topographic data derived from different sensors.

Total 51095

FY 2001 Planned Program

• 23809
- Produce high impedence ground planes for enhanced performance of GPS, radar, and wireless systems.
- Optimize beryllium-free amorphous alloy composites which will outperform depleted uranium penetrators.
- Conduct theoretical chemistry studies of oxygen reduction catalysts to increase efficiency of small fuel cells for individual soldier power systems.
- Devise an enzyme-based biosensor to detect anticholinesterase chemical nerve agents and their chemical precursors.

• 25975
- Utilize magnetorheological fluid based dampers for improved stability of bearingless helicopter rotorblades.
- Show a square planar antenna with 1/10 the size of dipole antennas, capable of wider bandwidth and which are conformal thereby reducing the antenna signature on ground vehicles.
- Devise new classes of smooth bi- and trivariate macroelements for data compressed visualization of open and urban terrain and to calculate chem/bio agent dispersion.
- Establish a sediment transport model to predict short-term beach conditions for amphibious operations and logistics-over-the-shore.

• 1302
- Funds reprogrammed for SBIR/STTR programs.

Total 51086

FY 2002 Planned Program

- 24412 - Devise ultrasensitive gravity gradiometers to detect underground bunkers and tunnels.
  - Use dendrimer-based polymer composites to provide a solid state solution to sensor and eye protection from laser threats.
  - Adapt enzymes which will detect nerve agents in water.
  - Identify how specific odor molecules, out of many thousands, interact with odorant receptors to detect trace amounts of chemical compounds such as explosives.
- 28285 - Devise a high-fidelity model for fuel combustion and heat release for advanced, low emission/high efficiency gas turbine engines.
  - Devise small footprint parallel Hoffman encoding and decoding at previously unattainable rates for ultra-fast, secure communications.
  - Create high assurance embedded system methodologies leading to improved combat casualty care medical devices.
  - Create robust self-assembled monolayer coatings to ameliorate the adhesion of ice to solid surfaces.

Total 52697

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

June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - BASIC RESEARCH	**0601102A - Defense Research Sciences**	**H66**

COST (In Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
H66 ADV STRUCTURES RSCH	1366	1449	1508	0	0	0	0	0	0	0

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, and ultimately result in safer, more affordable vehicles for the Objective Force supporting Army Transformation. 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, and improved methods to predict vehicle stability. These advancements will extend service life, reduce maintenance costs, and enhance the durability 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. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2000 Accomplishments

- 1366 - Generated an experimental design of the wind tunnel test of twist actuated active rotor system 'open loop' configuration and developed advanced smart structure actuator to reduce rotor vibration and to improve affordability.
  - Implemented analytical model including power train dynamics, and explored vibration reduction potential analyses for a tiltrotor configuration.
  - Completed assessment of actively controlled stability augmentation for tiltrotor configuration.
  - Verified damage resistance and residual strength models that characterize the low velocity impact damage of lightweight composite panels.

FY 2000 Accomplishments (Continued)

- Devised 3D finite element analysis with coupled tension/torsion loading to predict strength and life of flexbeam laminates.
- Investigated structural parameters that influence damage progression in new composite materials.
- Extended Mode II & III and Mixed Mode I & II delamination fracture criteria to include fatigue durability, which will lead to vehicle designs with improved structural integrity.

Total 1366

FY 2001 Planned Program

• 1444
- Conduct wind tunnel tests to study the forward flight characteristics of a twist actuated active rotor system in 'open loop' configuration and to investigate the design of 'closed loop' configured experiments. This work will enhance vibration control in advanced rotorcraft.
- Conduct analyses on control laws for the closed-loop Active Twist Rotor, and devise actuator concepts for the second generation. This will lead to improved vibration control and aerodynamic performance of future advanced rotorcraft.
- Incorporate active control and smart material analytical models into a comprehensive analysis that will result in improved vibration and stability predictions for advanced rotors.
- Perform aeroelastic response studies of active stability controlled tiltrotor systems, and modify analytical tools to allow for a complete modeling of the Quad Tiltrotor concept.
- Research improved damage growth prediction methods to better understand skin/stringer failure modes and to enhance structural reliability of future rotorcraft platforms.
- Complete crippling tests to validate strength and durability predictions for damaged carbon-rod reinforced structures, which will provide for more accurate life usage and maintenance forecasts of current and future Army platforms.
- Prepare draft test standards for mode 2&3 and mixed-mode 1&2 delamination onset criteria which will promote improved composites fatigue durability of future Army platforms.

• 5
- Funds reprogrammed for SBIR/STTR programs.

Total 1449

FY 2002 Planned Program

•	1508	- Investigate advanced macrofiber composite actuator concepts (greater strain capability, but at a reduced cost) to support the Low Cost Active Rotor (LCAR) program. These concepts may eliminate the need for the heavy, bulky, maintenance-intensive, swashplate rotor from future Army rotorcraft platforms.
		- Evaluate forward flight characteristics of twist actuated active rotor system in 'closed loop' configuration to help reduce rotor vibration.
		- Correlate tiltrotor analysis with wind tunnel test data to validate improved vibratory loads prediction capability.
		- Couple human occupant models and transient dynamic Finite Element simulation of vehicle crash tests to improve prediction of occupant exposure loads and survivability in Army aviation platforms.
		- Validate design criteria for skin/stringer failure models to promote structural reliability and durability of future Army rotorcraft designs.
		- Investigate delamination characterization test standards for hybrid and angle-ply composite laminates for improved structural integrity of future advanced rotors.
		- Conduct experiments to understand interaction of delamination and curvature for low-velocity impact damage, in order to provide improved future design guidance for air and ground vehicle industry.
		- Expand fatigue life predictive methods to incorporate probability distributions for bounding metallurgical flaw sizes, which will improve the accuracy of future platform designs.
Total	1508	

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

June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - BASIC RESEARCH	**0601102A - Defense Research Sciences**	**H67**

COST (In Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
H67 ENVIRONMENTAL RESEARCH	3342	3537	3644	0	0	0	0	0	0	0

A. Mission Description and Budget Item Justification: This project focuses basic research on innovative technologies for both industrial pollution prevention (P2) that directly supports the Army industrial base and for non-stockpile chemical warfare (CW) site remediation. The objective of the pollution prevention work is to invest 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. The goal is to reduce the cost of remediating a site by at least 50% versus the use of conventional methods. Pollution prevention thrusts include: environmentally acceptable, advanced, non-radioactive, non-toxic and lightweight alternative structural materials to enhance weapon system performance; substitutes for ozone-depleting chemicals as solvents, refrigerants, and firefighting agents for military unique applications; energetic synthesis and process improvements to eliminate the use of hazardous materials and to minimize the generation of wastes from manufacturing operations; and surface protection alternatives to hazardous paints, cadmium, chromium, and chromate conversion metal and composite surfaces. CW thrusts include establishing the ecotoxicity of CW compounds, environmental fate and effect of CW compounds in soils and biodegradation of CW compounds. This project is linked to the Tri-Service Environmental Quality R&D Strategic Plan and addresses environmental technology requirements addressed in that plan. This project supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2000 Accomplishments

- 3342 - Optimized the environmentally benign CL-20 synthesis process for use in bench scale evaluations.
  - Developed model and tested large caliber Cylindrical Magnetron Sputtering target configurations.
  - Evaluated biodegradable materials for incorporation in montmorillonite clay nanocomposites produced by melt extrusion (solvent-free) methods.
  - Completed studies of self-assembled monolayer-topcoat adhesion and the use of plasma surface treatment for improved adhesion.
  - Developed Soil Ecotoxicological Database for labile CW agent compounds and related compounds in soil, based on soil bioassay measurements.

FY 2000 Accomplishments (Continued)

- Developed an economical manufacturing process for single crystal tungsten alloys and validate the performance of single crystal tungsten penetrators.

- Developed supercritical fluid parameters for processing pyrotechnic binders.

Total 3342

FY 2001 Planned Program

• 3451
- Produce CL-20 and military grade 2,4-dinitrotoluene at bench scale using new environmentally benign processes.
- Apply selected coatings to medium and large caliber gun tubes that will be test fired.
- Characterize microstructural and performance properties of ceramic materials produced by biomimetic processes.
- Optimize soil ecotoxicological screening bioassays and predictive capabilities for labile CW agent compounds in soils.
- Compare the chemical resistance and physical/thermal properties of monolayer topcoats to with heavy-metal based primer-topcoat systems.

• 86
- Funds reprogrammed for SBIR/STTR program.

Total 3537

FY 2002 Planned Program

• 3644
- Scale up ceramic production using conditions determined to produce desirable materials and investigate processing variables.
- Develop initial predictive capabilities for labile CW agent materials in soil.
- Characterize factors important for extending the lifetime of present gun barrels and accelerating the introduction of environmentally friendly coatings.

- Characterize PCL/clay nanocomposites processed as blown films.

Total 3644

COST (In Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
S13	SCI BS/MED RSH INF DIS	8576	9100	9410	0	0	0	0	0	0	0

A. Mission Description and Budget Item Justification: This project supports focused research for healthy, medically protected soldiers in support of the "Medical" technology area of 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. Intramural research under this project is conducted at the U.S. Army Medical Research and Materiel Command's Medical Research Institute of Infectious Diseases, the Walter Reed Army Institute of Research and its overseas laboratories, and the Naval Medical Research Center and its overseas laboratories. Major contractors are The Institute for Genomics Research, Rockville, MD; Harvard University, Cambridge, MA; and the University of Alabama at Birmingham, AL; and the Armed Forces Research Institute of Medical Science, Bangkok, Thailand. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2000 Accomplishments

- 3865 Conducted basic research to support prevention and treatment of malaria.

  - Completed sequencing of nearly 10 million base pairs of DNA sequence on three entire chromosomes from human malaria parasite Plasmodium falciparum. This also resulted in the identification of two novel targets for antimalarial drug discovery. Identified over 100 new sporozoite antigens, which are potential candidate vaccine components.

  - Identified Plasmodium vivax malaria parasite production and sequencing strategies that should allow for the rapid and inexpensive sequencing of additional malaria parasite genomes and began evaluating the P. vivax sequencing strategies, critical in developing vaccines and drugs for protection of soldiers from multiple types of malaria.

  - Determined that volunteers immunized and protected by prototype malaria vaccine RTS,S had immune response patterns distinct from non-protected volunteers.

FY 2000 Accomplishments (Continued)

- Identified new chemical entities that selectively target and disrupt essential enzymes or pathways in the malaria parasite's life cycle. Expressed, purified, and crystallized specific malaria enzymes that were identified as key targets for structure-based drug design. Determined three-dimensional x-ray structure of the enzymes, which provided critical information to design more effective antimalarial compounds. Investigated a novel liver cell line that permits culturing vivax malaria parasites at a high density, which will provide a sufficient source of parasites for drug screening tests.

• 1321 Conducted basic research to support prevention of diarrheal diseases.

- Identified new proteins from strains of the bacteria Enterotoxigenic Escherichia coli (ETEC) found in Egypt that block the ability of this organism to establish itself in human intestines and cause diarrhea. Genetically produced these proteins with the goal of testing them as a vaccine that ultimately could be broadened to also protect against bacterial diarrhea caused by Shigella and Campylobacter. Determined the procedures for producing ETEC bacteria under Good Manufacturing Practices (GMP) conditions, for use in determining effectiveness of ETEC vaccines in human volunteers as required by the Food and Drug Administration (FDA). Compared genetic sequences from Shigella to E. coli as sequences became available in Internet databases with the purpose of determining similarities in genes that cause diarrhea to investigate common vaccine targets. Conducted genetic sequencing in targeted regions of Campylobacter DNA and compared results to published Campylobacter sequences of different organism strains to detect which genes are most important in causing disease.

• 1950 Conducted basic research to support prevention of Group B Neisseria meningitis, Hepatitis E virus (HEV), and scrub typhus and to develop rapid diagnostic tests and insect control measures.

- Studied the immunology of HEV infection in pregnancy to assist with vaccine study design and resulting interpretation. Studied epidemiology of HEV infection in an Egyptian adult population residing in a HEV endemic area. Evaluated the risk of HEV exposure for travelers to endemic areas to define military operational threat, design vaccine studies, and develop doctrine for vaccine use. Determined protective antibody levels in Hepatitis E virus (HEV) disease using an animal model and human intravenous immune globulin. Genetically modified a capsule-negative strain of Group B meningococcal bacteria to decrease reactogenicity and to stabilize a high level of an immunogenic outer membrane protein for use as a candidate vaccine. Developed a Geographic Information System to assess the threat of malaria transmission by the Anopheles dirus mosquito. Studied rapid nucleic acid-based tests as a potential diagnostic product to identify dengue virus, Campylobacter, and drug resistance in Shigella.

- Assessed feasibility of sequenced strain-specific antigens for a candidate scrub typhus vaccine.

• 1440 Conducted basic research to support prevention of viral diseases.

- Identified factors that predict safety and a long-lasting immune response that will provide selection criteria for the best dengue vaccine candidate. Studied epidemiology of hantaviruses in South America and Indonesia to assess risk of infection to deployed soldiers. Identified diagnostic tests for encephalitic and hemorrhagic viral diseases.

Total 8576

FY 2001 Planned Program

- 5622 Conduct basic research to support prevention and treatment of malaria.

  - Produce P. falciparum parasites for all Department of Defense (DoD)-sponsored genome sequencing efforts. Develop and implement methods to close sequencing gaps. Assist the DoD malaria consortium to construct and verify genetic maps.

  - Validate a rapid, high throughput approach to malaria vaccine development that capitalizes on the P. falciparum genomic sequence data. Characterize stage-specific protein expression and location within the malaria parasite to reveal new targets for vaccine and drug development.

  - Identify markers of protective immunity to malaria in naturally exposed populations and also in response to candidate malaria vaccine proteins.

  - Define the epidemiology of severe anemia in northern Ghana to assess that location as a vaccine field trial site.

  - Identify additional new malaria drug targets and mechanisms of the parasite's drug resistance using molecular genetics. Synthesize quantities of drug candidates for safety and efficacy evaluation.

- 816 Conduct basic research to support prevention of diarrheal diseases.

  - Evaluate the immune response to ETEC infection in United States military personnel on deployment in Egypt to predict the effectiveness of candidate ETEC vaccines. Compare different strains of Campylobacter by analyzing proteins and genetic sequences, identifying factors by which these organisms cause disease to determine the best candidates for vaccine development. Identify previously unidentified proteins that allow ETEC to adhere to the gut and cause disease. Study epidemiology of diarrheal disease in Peru to assess that location as a future vaccine field trial site.

- 1379 Conduct basic research to support prevention of HEV infection and evaluate rapid diagnostic tests and insect control measures.

  - Assess risk of non-A-E acute hepatitis in Southeast Asia to determine the threat to deployed warfighters. Assess the epidemiology of tick-borne diseases in Egypt and malaria in Thailand and Western Kenya to determine risk and recommend control measures in areas to which our troops may deploy. Identify mosquito species that carry malaria in diverse regions of Africa (high altitude, urban, dry season) to develop vaccine study sites. Develop a standardized system for assessing dengue risk based on surveillance for adult mosquitoes that transmit dengue virus in Southeast Asia. Validate DNA-based tests for the identification of militarily important pathogens from Southeast Asia.

- 1109 Conduct basic research to support prevention of viral diseases.

  - Determine if immune response to a previous dengue infection is related to severe dengue disease in a subsequent infection, which will help in designing a safe dengue vaccine. Validate a rapid, high throughput, DNA-based test to measure effectiveness of dengue candidate vaccine.

- 174 Funds reprogrammed for SBIR/STTR programs.

Total 9100

FY 2002 Planned Program

- 5962 Investigate new/improved prevention methods and treatment for severe and complicated malaria necessary for protecting and restoring the health of soldiers.

  - Begin genomic sequencing of vivax malaria DNA to support vaccine development against this second most militarily important cause of malaria in ground soldiers.

  - Produce a threat assessment for malaria drug resistance for the Commanders-in-Chief (CINCs) so that they can determine the best preventive measures to protect their soldiers.

  - Discover novel compounds that inhibit essential enzyme pathways in the malaria parasite and thus are potential antimalarial drug candidates. Identify additional new malaria drug targets and mechanisms of the parasite's drug resistance using molecular genetics. New drugs are continually needed to stay ahead of drug resistance that the malaria parasite develops, so that ground forces will be protected from, or can be successfully treated for this disease.

- 1255 Investigate new/improved prevention methods against diarrheal diseases needed to protect and restore the health of soldiers.

  - Conduct epidemiological studies to define the military operational impact and relevance of infection with Norwalk virus and Norwalk-like viruses to determine if a vaccine development effort against this cause of diarrhea is necessary.

- 1109 Conduct basic research to support prevention of disease from scrub typhus and adenovirus infection to ensure there is no adverse operational impact from these diseases on our forces. Design rapid diagnostic tests for identification of scrub typhus and adenovirus. Identify insect control measures for prevention of scrub typhus. Define the range of Orientia tsutsugamushi natural strain variations that would affect immune responses to these organisms that cause scrub typhus in order to determine the necessary components of a broadly protective vaccine. Assess the epidemiology of insect-borne diseases to determine risk and recommend control measures in areas to which our troops may deploy.

- 1084 Conduct basic research to determine if vaccine development efforts to prevent against additional viral causes of disease are necessary. Conduct epidemiological studies to define the operational impact and relevance of flavivirus infections, especially West Nile virus and tick-borne encephalitis virus. Conduct epidemiological studies of hantaviruses to identify potential vaccine field-test sites. Identify potential drug or biological product candidates that could prevent and/or treat infection caused by Lassa virus.

Total 9410

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

June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - BASIC RESEARCH	**0601102A - Defense Research Sciences**	**S14**

COST (In Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
S14	SCI BS/CBT CAS CARE RS	3770	4005	4135	0	0	0	0	0	0	0

A. Mission Description and Budget Item Justification: This project supports focused research for healthy, medically protected soldiers to understand the basic mechanisms of combat-related trauma in support of the "Medical" and "Future Warrior" technology areas of the Objective Force. 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 non-battle injuries, and provide military medical capabilities for far-forward medical/surgical care of battle and non-battle injuries. Intramural research under this project is conducted at the U.S. Army Medical Research and Materiel Command's Walter Reed Army Institute of Research and its overseas laboratories. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2000 Accomplishments

- 995 Conducted basic research to reduce the logistical burden of blood products on the battlefield by assessing new blood storage bags and freeze-drying strategies for plasma. In contrast to previous experiments, the resulting freeze-dried plasma exhibited higher blood clotting factors. These factors are needed to control hemorrhage.
- 889 Conducted basic research to enhance the resuscitation capabilities for combat medics by evaluating biologics for their capabilities to protect wounded combatants from the after effects of wounding and severe blood loss. These included modified hemoglobin, complement activation inhibitors, intracellular protein regulators, and antisense deoxyribonucleic acid (DNA) to decrease lung damage from excessive mucus production following smoke inhalation on the battlefield.
- 1190 Conducted basic research on novel methods to repair and prevent hard and soft tissue injuries by investigating the properties of bones and bone fixator pins to reduce fractures and to prevent post-op infection in bones under field conditions. Assessed the bacteria-killing activity of a synthetic biological agent (peptide) as a potential antiplaque agent to reduce dental disease.
- 696 Conducted basic research on the physiological effects of bleeding to improve patient outcomes. Established improved hemorrhage models for use in developing products, techniques, and guidelines for hemorrhage control on the battlefield.

Total 3770

FY 2001 Planned Program

- 1817 - Conduct basic research to enhance the resuscitation capabilities for combat medics by examining the activation and inhibition of inflammatory proteins in tissues to assess whether their control can limit the extent of injury after trauma.

  - Identify human cell protective agents that can be added to resuscitation fluids to protect against injury due to hemorrhage and other trauma. Investigate methods to measure retinal vessel blood oxygen saturation to diagnose hemorrhage severity and better triage wounded soldiers.

- 1216 Conduct basic research on novel methods to repair and prevent hard and soft tissue injuries by testing germ-killing biologics to improve wound healing and prevent oral infection. Test sustained-release reactive oxygen inhibitors and growth factor to improve wound healing therapy and decrease morbidity. Study head injuries caused by bullets striking helmets to evaluate potential head and neck injuries expected on the battlefield.

- 884 Conduct basic research on novel methods to reduce the damaging effects of brain injuries by testing neuroprotective drugs that reduce the after effects of blood loss to brain tissues.

- 88 Funds reprogrammed for SBIR/STTR programs.

Total 4005

FY 2002 Planned Program

- 1099 Conduct basic research to enhance the resuscitation capabilities for combat medics by evaluating the extent of inflammation in blood vessel dysfunction. Conduct further research to identify human blood vessel protective products that can be added to resuscitation fluids to protect against injury due to hemorrhage and other trauma.

- 1239 Conduct basic research on novel methods to repair and prevent hard and soft tissue injuries by conducting research to identify and develop compounds capable of arresting primary and/or secondary colonization of the mouth by germs that cause gum disease. Determine the best methods to treat and/or stabilize penetrating extremity trauma at far-forward locations to improve battlefield mortality/morbidity rates.

- 897 Conduct basic research on novel methods to reduce the damaging effects of brain injuries by testing drugs with anti-inflammatory actions that act by blocking pathways to reduce inflammation after hemorrhage.

- 900 Conduct basic research to produce physiological sensors and devices aimed at diagnosing and treating injuries. Investigate methods to assess at a distance how severely a soldier is wounded and whether a casualty is alive or dead to reduce exposure of medics to enemy fire. Study methods for noninvasively assessing the presence of air or fluid in chest/abdominal cavities to deliver life-saving treatment far forward.

Total 4135

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)		June 2001
BUDGET ACTIVITY **1 - BASIC RESEARCH**	PE NUMBER AND TITLE **0601102A - Defense Research Sciences**	PROJECT **S14**

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

June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - BASIC RESEARCH	**0601102A - Defense Research Sciences**	**S15**

COST (In Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
S15	SCI BS/ARMY OP MED RSH	5129	5445	5631	0	0	0	0	0	0	0

A. Mission Description and Budget Item Justification: This project supports focused research for healthy, medically protected soldiers, and funds research consistent with the "Medical", "Survivability", and "Future Warrior" technology areas of the Objective Force. This research will develop medical countermeasures to sustain performance when the opportunity for adequate rest is impaired or impossible due to combat conditions. The scientific and technical objectives for this project focus 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 on non-ionizing radiation, directed energy, blast, jolt, vibration, noise, and toxic industrial chemicals as environmental contaminants are also investigated under this project. Specific tasks include delineating injury and sustainment, and enhancement of the physiological and psychological capabilities of military personnel under combat operations in all environments. The six main thrust areas include neuromodulation of stress and cognition, metabolic regulation, control of regional blood flow, oxidative stress interventions, tissue remodeling/plasticity, and biomechanical/biodynamic mechanisms of injury. A portion of this research supports the Strategic Research Objective (SRO) on "Enhancing Soldier Performance." Intramural research under this project is conducted at the following U.S. Army Medical Research and Materiel Command laboratories: the Aeromedical Research Laboratory, the Research Institute of Environmental Medicine, and the Walter Reed Army Institute of Research and its overseas laboratories. Major contractor is McKesson Incorporated, TX. Additionally, numerous Cooperative Research and Development Agreements (CRDAs) are held with universities and independent laboratories. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2000 Accomplishments

- 1690 Discovered non-thermal effects of ultra-wide band radio frequency radiation, which produced a progressive hypotension in rats. This is important because ultra-wide band combat systems are currently being developed and no previous studies of bioeffects and potential hazards have been conducted.
- 645 Expanded the database for the Automated neurological Assessment Metric (ANAM) on cadets from the United States Military Academy and airborne soldiers. This test is important to the measurement of subtle changes in motor function for which other neuropsychological tests are insensitive.
- 1029 Created assay techniques to detect coliform bacteria and toxic agricultural pesticides in food and water within four hours, and the useful application of the Frog Embryo Toxicity Assay for identifying toxic chemical compounds and mixtures that are reproductive health risks. This will provide a rapid assessment of water based environmental hazards.

FY 2000 Accomplishments (Continued)

- 1000 Evaluated the effects of potential treatment candidates for reducing effects by induction of hypothermia and rewarming in animal models.
- 765 Determined, through the use of neuroimaging techniques, the regional brain activity associated with sleep deprivation, identifying specific brain targets for reactivation. This will guide the development of the most effective future countermeasures to diminished performance resulting from sleep deprivation.

Total 5129

FY 2001 Planned Program

- 943 Improve precision methods for studying changes in behavior and in physiological endpoints resulting from non-thermal energy absorption of radio frequency radiation. This helps research that guides materiel developers for future combat systems, body worn antenna, etc., to avoid biologically harmful frequencies and power mixes.
- 924 Explore the feasibility of combined amino acid/carbohydrate supplements on the enhancement of muscle strength through effects on muscle metabolism in men and women.
- 982 Identify the role of antioxidant stress and responses to antioxidant interventions to reduce delayed onset of muscle soreness, musculoskeletal tissue damage and performance decrements associated with strenuous and prolonged training. This will lead to preventive strategies to maximize performance and minimize injury.
- 549 Explore the development of endpoints to detect DNA reactive effects on the different stages of sperm and egg development and detect effects on offspring resulting from parental operations exposures to reproductive toxins. This research will provide a better understanding of the reproductive effects of environmental toxins encountered in operational environments, enabling the development of more effective countermeasures to such exposures.
- 1059 Explore functional magnetic resonance imaging techniques to evaluate brain activity while performing cognitive tasks under sleep deprivation to demonstrate effectiveness of proposed future countermeasures.
- 889 Discover mechanisms of stress fracture and the relationship to bone mineral density to determine if stress fracture incidence can be reduced through interventions to enhance bone mineral accretion. These interventions will save costs from medical treatment and lost duty time from stress fractures and also improve long-term health of soldiers protecting them against osteoporosis later in life.
- 99 Funds reprogrammed for SBIR/STTR programs.

Total 5445

FY 2002 Planned Program

- 5631 - Explore the combined effects on behavior resulting from non-thermal energy absorption of radio frequency radiation and exposure to environmental toxins. This research will reduce the incidence of injuries due to non-thermal battlefield radiation.

  - Determine if muscle injury and inflammatory response impairs thermoregulation and risk of hypothermia in cold. This research program objective will support the Objective Force by preventing non-freezing cold injuries during deployments to adverse environments.

  - Investigate genomic or proteomic levels to facilitate development of bioreporters of reproductive effects utilizing reporter gene technology. This research will aid in the identification of environmental hazards during deployment of the Objective Force.

  - Explore brain imaging as a technique to determine relationships between fatigue, vigilance, and sleepiness. This research will enhance the cognitive performance of the warfighter during sustained operations.

  - Conduct a study on the effects of combined essential amino-acid/carbohydrate supplements on the development of muscle strength in women and men recruits during initial entry military training. This research program objective will provide direct support to the Objective Force by enhancing survivability of soldiers in adverse environments through the use of metabolic regulators.

Total 5631

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

June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - BASIC RESEARCH	**0601102A - Defense Research Sciences**	**T22**

COST (In Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
T22 SOIL & ROCK MECH	1759	1870	1923	0	0	0	0	0	0	0

A. Mission Description and Budget Item Justification: The objective of this project is to develop the fundamental knowledge base required by the Army in the field of civil engineering to directly support the Chief of Staff of the Army's initiative to transform the Army into a more responsive, deployable, agile, versatile, lethal, survivable, and sustainable force. Emphasis is on: (a) developing new materials that provide greater ballistic, impact, and penetration protection; signature manipulation for camouflage, concealment, and deception; and expedient construction and repair of vehicle and aircraft operating surfaces; (b) defining constitutive behavior and penetration mechanics associated with projectile impact on complex geologic and structural materials; mathematical models for first-principle analyses of explosive-induced ground shock and high-velocity projectile impact; and (c) determining and quantifying the complex response of deformable soils to transient loading resulting from high-speed curvilinear vehicle maneuver. These technologies provide the basis for applied research that supports: the deployment of a brigade in 96 hours, a division in 120 hours, and five divisions in 30 days by providing analytical capabilities for mobility assessments; expedient battlefield protection; terrorist protection from asymmetric threats; signature management for camouflage, concealment, and deception; and advanced vertical and horizontal construction material in program element 0602784A, project T40. The work is managed by the U.S. Army Engineer Research and Development Center (ERDC). This project supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2000 Accomplishments

- 1759 - Incorporated projectile erosion algorithms into penetration prediction codes to support the Army Transformation.

  - Developed theoretical formulation for penetration of wheels into partially saturated soils during cross-country movement enabling accurate assessment and prediction of maneuver for future warfighting scenarios.

  - Developed analytic model describing influence of partial soil saturation on surface shear strength which ultimately impacts throughput and maneuver.

  - Verified constitutive models for asphalt pavement materials and implemented constitutive models for granular materials into an advanced pavement system model for accurate and reliable assessment of airfield performance prediction.

Total 1759

FY 2001 Planned Program

•	1815	- Develop finite element approach for response of target joints and fractures to projectile penetration to support the Army Transformation.
		- Model soil response to transient loading patterns of wheeled and tracked vehicles.
		- Evaluate pavement interface, load, dynamic response, and traffic distribution models to realistically represent future aircraft effects on pavement performance.
		- Determine appropriate combinations of responsive/passive composite materials for camouflage, cover, and deception as a function of environment and facility.
		- Determine physics of fiber-soil interaction that facilitates increased soil stability and enables rapid airfield and lines of communication (LOC) construction.
•	55	- Funds reprogrammed for SBIR/STTR program.
Total	1870	

FY 2002 Planned Program

•	1923	- Apply an improved Hybrid Elastic-Plastic Model to rock targets to support the Army Transformation.
		- Develop experimental quantity of responsive/passive camouflage, cover, and deception material.
		- Develop physics-based damage models for incorporation into accurate and reliable pavement performance for future aircraft.
Total	1923	

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

June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - BASIC RESEARCH	**0601102A - Defense Research Sciences**	**T23**

COST (In Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
T23 BASIC RES MIL CONST	1487	1581	1626	0	0	0	0	0	0	0

A. Mission Description and Budget Item Justification: This project supports research in fundamental understanding of long-term durability of composite materials, behavior of structural elements, and collaborative design to support the Army Transformation. The project invests in research that 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 work is managed by the U.S. Army Engineer Research and Development Center (ERDC). This project supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2000 Accomplishments

•	1487	- Developed fundamental understanding of the behavior of structural connections under high cyclic loads (like earthquakes).
		- Analyzed experimental data for the development of response algorithms for frame and shear walls to tri-directional earthquake loading.
		- Completed lab testing of prototype models for determining structural health using Electro Time Domain Reflectrometry (ETDR) techniques.
		- Developed and validated models for the energy dissipation capacity of steel based on fatigue life.
Total	1487	

FY 2001 Planned Program

•	1534	- Complete axiomatic collaboration design theory to facilitate design automation.
		- Develop analytical model for the non-linear response of dual structural systems to seismic inputs.
		- Develop micro-mechanical failure models for infrastructure Fiber Reinforced Polymer (FRP) composite materials.
•	47	- Funds reprogrammed for SBIR/STTR program.
Total	1581	

FY 2002 Planned Program

•	1626	- Develop perspective-based semantic mappings to increase understanding of the fundamental principles of scalable information architecture.
		- Develop individual material property degradation models for long-term performance modeling of structural composite elements.
Total	1626	

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

June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - BASIC RESEARCH	**0601102A - Defense Research Sciences**	**T24**

COST (In Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
T24	SNOW/ICE & FROZEN SOIL	2080	2413	1207	0	0	0	0	0	0	0

A. Mission Description and Budget Item Justification: This project is the only focused Department of Defense basic research effort investigating the physical, chemical, and electrical properties of snow, ice, and frozen soil and characterization of dominant winter and cold regions processes impacting military materiel, operations, and facilities. Objective Force lethality and survivability will be enhanced by exploiting advanced sensor capabilities facilitating standoff engagements in all types of terrain and in all seasons. Characterization of the battlespace environment and forecasting the state of the terrain will enable the Objective Force to fully exploit emerging sensing capabilities and achieve superior mobility and survivability. 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 provides the knowledge base for understanding and assessing environmental impacts critical to battlespace visualization. This work is managed by the U. S. Army Engineer Research and Development Center (ERDC). This project supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2000 Accomplishments

- 2080 - Investigated small-scale heterogeneity for state-of-the-art snow/ground modeling to improve the energy balance methods for computing snowmelt and flow through soils.
  - Analyzed spatial variability of icing processes to enhance the design and doctrine for lines of communications and air operations.
  - Determined efficiency of snow as a filter for chemical particulates that would protect the soil/ground if subjected to a chemical attack.
  - Identified cold unique conditions for Homeland Security issues such as bio-terrorism and chemical agent releases that need to be considered when designing methods to combat such threats.

Total 2080

FY 2001 Planned Program

•	1137	- Develop a model for parameterizing the boundary layer turbulent energy exchange over snow for validating sensor design parameters and performance expectation.
		- Investigate background seismic and acoustic wave propagation in snow-covered and frozen ground urban terrains for use with wide area mine technology sensors for targeting.
		- Determine the effectiveness of current decontamination solution "decon green" to destroy surrogate bio/chemical agents (anthrax type spores) in a winter environment for battlefield and Homeland Security areas.
•	1209	- FY2001 Congressional add to enable research for characterization of cold weather process impacts on Objective Force materiel, operations and facilities.
•	67	- Funds reprogrammed for SBIR/STTR program.
Total	2413	

FY 2002 Planned Program

•	1207	- Develop a new snow deformation modeling approach using the discrete element technique to improve mobility predictions in snow.
		- Measure radiometric properties of battlefield materials in the 35-100 mm wavelength for use as an airborne and or targeting sensor.
		- Determine military unique seismic/acoustic signatures to improve Wide Area Mine (WAM)/Raptor performance in urban areas with snow covers.
		- Improve the performance of decon solutions for attacking chemical agents (anthrax type spores) in winter environments.
Total	1207	

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

June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
1 - BASIC RESEARCH	**0601102A - Defense Research Sciences**	**T25**

COST (In Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
T25	ENVIRONMENTAL RES-COE	4195	4461	4590	0	0	0	0	0	0	0

A. Mission Description and Budget Item Justification: The objective of this project is to provide the basic research needed to develop the technologies to address Army issues in the restoration, compliance, conservation, and non-industrial pollution prevention areas. The focus in restoration provides the basic knowledge needed to develop physical, chemical and biological technologies to clean up the Army's contaminated sites. Compliance and pollution prevention efforts address knowledge gaps for troops installations and compliance at industrial installations. The focus in conservation is on landform and ecological modeling, the feasibility of development and propagation of resilient plant species for rehabilitation of damaged lands. This project will also examine the underlying requirements for comprehensive environmental modeling and simulation products to address environmental issues. The project supports applied research under program element 0602720A, projects F25, 048, and 896. Funds in this project are used to support basic research via university contracts for in-house laboratory efforts. The work is managed by the U.S. Army Engineer Research and Development Center (ERDC). This project supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2000 Accomplishments

- 4195 - Investigated photocatalytic destruction mechanisms for nitroaromatic compounds which are highly explosive in nature and are present in multiple types of Army waste streams.

  - Identified and isolated enzymes that degrade Royal Demolition eXplosive (RDX) and High Melting eXplosive (HMX) for use in developing an enzyme-based reactor to treat explosive contaminated wastewater.

  - Investigated non-linear theories for low frequency, rigid-frame absorbers to build corresponding analytical models for noise mitigation in the near field from blast waves caused by large weapons noise mitigation.

  - Developed a protocol to predict reaction rates for a new treatment process to destroy explosive contaminants in wastewater.

  - Investigated field condition microbiology that defines the interrelationships between soil microbial composition and the effect on plant community growth, reproduction, and recover from external stresses.

  - Completed investigation of the fundamentals of magnetic and electromagnetic induction spectroscopy and pan-spectral electromagnetic sensing to support enhanced discrimination and identification of buried unexploded ordnance.

  - Completed a description of how micro-organisms that have ecologically adapted themselves to cold regions environments cause the major explosives types to biologically degrade into different types of chemicals.

FY 2000 Accomplishments (Continued)

- Completed the determination of the phenomenology for predicting Non-Aqueous Phase Liquid (NAPL) interfacial properties and multiphase soil hydraulic properties using computational molecular thermodynamics for a better understanding of how it may be possible to degrade and treat this fuel and solvent residue that can not be broken down and treated by conventional means.

- Determined mechanisms of adsorption and transformation of explosives in low carbon aquifer soils for the later (applied) development of physical and biological treatment methods under these less conditions that are currently difficult to address.

- Investigated the means by which to identify/characterize the types of micro-organisms in the ground by way of how/what they breath to aid in the development and use of biological in-situ treatment processes.

Total 4195

FY 2001 Planned Program

• 4328

- Complete investigation of bacterial enzymes for biodegradation of nitroaromatics identifying RDX-digesting bacteria from a munitions wastewater treatment plant for use in next-generation biodegradation technologies.

- Evaluate RDX and HMX biodegradation under identical conditions and excess hydrogen to determine the resistance to biodegradation that might hinder the degradation process.

- Identify physiological indicators of stress in surrogate endangered bird species to develop cost-effective techniques to evaluate effects of military training on federally-listed endangered species.

- Complete determination of fundamental mechanisms of how soils erode under soil freeze/thaw conditions.

- Complete determination of genetic characteristics of native plants in cold regions for use in developing improved training range erosion control methods.

- Complete description of the fundamental mechanisms by which micro-organisms biologically stabilize (restrict the movement and chemical transform to more hazardous chemicals) of Polycyclic Aromatic Hydrocarbons (PAHs) for soils and sediments where the nitrogen content has been reduced/eliminated.

- Complete the determination of ratios 15N/14N ratio of TNT versus the concentration of TNT in environmental systems to develop improved and less costly means of chemical analysis of TNT.

- Investigate other concepts by which to identify/characterize the types of micro-organisms in the ground by way of how/what they breath to aid in the development and use of biological in-situ treatment processes.

- Explore the fundamental behavior of micro-organisms when introduced as part of zero-valent iron in-situ contaminant treatment systems.

FY 2001 Planned Program (Continued)

- Determine the dielectric and conductive properties of contaminated fine-grained sediments to provide the bases for the development of improved tools to characterize contaminated sites and to support the development of improved explosives treatment processes.

- Investigate basic principles required to determine if simple, on-site soil invertebrates assays can be used to tell if explosives are present in soils.

- Develop micro-scale methods for the identification of TNT and TNT biologically rendered byproducts in soil for the development of improved characterization methods and to support the development of improved explosives treatment processes.

• 133 - Funds reprogrammed for SBIR/STTR program.

Total 4461

FY 2002 Planned Program

• 3338 - Complete non-linear theories for acoustic behavior in the near-field from blast wave for use in predicting noise absorption using corresponding analytical models for noise mitigation in the near field from blast waves caused by weapons noise mitigation.

- Initiate field evaluation of physiological response and habituation of endangered bird species to military stressors to assess relative effects of military training disturbance, environmental variability and geographic variability in physiological stress response of federally-listed endangered species.

- Determine genetic differences in native species diploid populations to enhance resilience for land rehabilitation.

- Complete the determination of mechanisms of adsorption and transformation of explosives in low carbon aquifer soils for the later (applied) development of physical and biological treatment methods under these less conditions that are currently difficult to address.

- Complete determination of the basic principles of the physical and biological immobilization of 2,4- and 2,6-Dinitrotoluenes (particularly toxic explosives byproducts) in soils based upon concentration levels and soil physical and chemical characteristics.

- Complete determination of the dielectric and conductive properties of contaminated fine-grained sediments to provide the bases for the development of improved tools to characterize contaminated sites and to support the development of improved explosives treatment processes.

- Investigate other concepts by which to identify/characterize the types of micro-organisms in the ground by way of how/what they breath to aid in the development and use of biological insitu treatment processes.

- Explore the fundamental behavior of micro-organisms when introduced as part of zero-valent iron in-situ contaminant treatment systems.

FY 2002 Planned Program (Continued)

- Determine whether explosives vapors diffuse up through frozen soil as functions of soil temperature and moisture content to support the development of improved site characterization under frozen soil conditions.

- Investigate how TNT and TNT transformation products (nitroaromatics) bind to the organic and mineral fractions of soil and determine how the nitroaromatics can be extracted from the soil fractions to support the development of improved in-situ treatment processes.

• 1252 - Establish basic understanding of physical, chemical, and biological phenomena specific to contaminant toxicity assessment and mineralization and to ecosystem maintenance, mitigation, and rehabilitation.

Total 4590