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

February 2002

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

COST (In Thousands)		FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
	Total Program Element (PE) Cost	133081	144240	139633	140230	143306	148831	152021
305	ATR RESEARCH	1174	1226	1305	1317	1345	1414	1446
31B	INFRARED OPTICS RSCH	2247	2482	2659	2671	2725	2866	2934
52C	MAPPING & REMOTE SENS	2258	2348	2554	2586	2646	2727	2785
53A	BATTLEFIELD ENV & SIG	3780	3912	4284	4317	4439	4705	4821
74A	HUMAN ENGINEERING	2633	2741	2974	2996	3057	3227	3303
74F	PERS PERF & TRAINING	2600	2830	2923	2957	3036	3139	3200
F20	ADV PROPULSION RSCH	2472	2589	2834	2885	2942	3115	3192
F22	RSCH IN VEH MOBILITY	471	490	528	533	541	563	575
H42	MATERIALS & MECHANICS	1955	2026	2162	2229	2274	2400	2458
H43	RESEARCH IN BALLISTICS	4023	4200	5945	4489	4585	4818	4927
H44	ADV SENSORS RESEARCH	4023	4206	4371	4453	4550	4761	4867
H45	AIR MOBILITY	1965	9018	2193	2236	2276	2354	2405
H47	APPLIED PHYSICS RSCH	3125	3246	3557	3579	3653	3860	3951
H48	BATTLESPACE INFO & COMM RSC	6690	7057	7429	7597	7805	8206	8378
H52	EQUIP FOR THE SOLDIER	973	1005	1177	1179	1196	1262	1292
H57	SCI PROB W/ MIL APPLIC	49784	52612	54699	55463	56747	58386	59578
H66	ADV STRUCTURES RSCH	1445	1495	1678	1684	1715	1817	1862
H67	ENVIRONMENTAL RESEARCH	3451	3613	3777	3833	3899	4033	4115
H68	PROC POLLUT ABMT TECH	359	378	385	390	396	409	418
HA4	PERPETUAL ASSAIL & SECURE INFO SYS, RSCH, TNG & ED	0	3800	0	0	0	0	0
S04	MIL POLLUTANT/HLTH HAZ	607	637	649	658	670	689	702
S13	SCI BS/MED RSH INF DIS	8927	9330	10780	11087	11316	11781	12037
S14	SCI BS/CBT CAS CARE RS	3917	4100	4446	4507	4591	4769	4874
S15	SCI BS/ARMY OP MED RSH	5346	5582	6262	6346	6478	6758	6910
S17	MOLECULAR BIOLOGY-HIV	422	443	0	0	0	0	0
S19	T-MED/SOLDIER STATUS	464	630	611	673	700	722	737

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BUDGET ACTIVITY
1 - Basic research

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S20	SCIENCE BASE EMERGING INFECTIOUS DISEASES	3821	0	0	0	0	0	0
T22	SOIL & ROCK MECH	1815	1906	1939	1965	2002	2062	2103
T23	BASIC RES MIL CONST	1534	1613	1641	1663	1691	1742	1779
T24	SNOW/ICE & FROZEN SOIL	2346	2189	1244	1246	1257	1328	1354
T25	ENVIRONMENTAL RES-COE	4128	4551	4627	4691	4774	4918	5018
T51	COUNTER - TERRORISM RESEARCH	2884	0	0	0	0	0	0
T55	DISPLAY PERFORMANCE & ENVIRONMENTAL EVALUATION	1442	1985	0	0	0	0	0

A. Mission Description and Budget Item Justification: This program element sustains U.S. Army scientific and technological superiority in land 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. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

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

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

B. Program Change Summary	FY 2001	FY 2002	FY 2003
Previous President's Budget (FY2002 PB)	136650	138281	133309
Appropriated Value	137914	145450	0
Adjustments to Appropriated Value	0	0	0
a. Congressional General Reductions	0	-1210	0
b. SBIR / STTR	-2993	0	0
c. Omnibus or Other Above Threshold Reductions	0	0	0
d. Below Threshold Reprogramming	-578	0	0
e. Rescissions	-1262	0	0
Adjustments to Budget Years Since FY2002 PB	0	0	6324
Current Budget Submit (FY 2003 PB)	133081	144240	139633

Change Summary Explanation:

FY02 - Congressional adds were made for Advanced Target Recognition Using Nanotechnologies, Project H57 ($1000); Perpetually Assailable and Secure Information Systems, Research, Training, and Education, Project HA4 ($3800); Display Performance and Environmental Evaluation Lab Project, Project T55 ($2000); Cold Weather Sensor Performance, Project T24 ($1000); and Optical Technologies, Project H57 ($1000).

Projects with no R-2A:
Project F22:
- FY02 Funding = $490 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.

Project H68:
- FY02 Funding = $378 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.

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

Project HA4:
- FY02 Funding = $3800 Perpetually Assailable and Secure Information Systems, Research, Training, and Education : The objective of this one year add is to conduct basic research into developing technologies to enable Perpetually Assailable and Secure Information Systems with military applications. No additional funding is required to complete this effort.

Project S04:
- FY02 Funding = $637 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.

Project S17:
- FY02 Funding = $443 Molecular Biology/Military HIV Research (S17): Develop methods for the prevention, early diagnosis, and treatment of human immunodeficiency virus (HIV).

Project S19:
- FY02 Funding = $630 Telemedicine Soldier Status Research (S19): Provide realistic, simulated representations of medical procedures based upon R&D of enabling technologies in tissue modeling, haptics integration, graphics, and physiological representations and overall systems architecture.

Project T55:
- FY02 Funding = $2000 Display Performance and Environmental Evaluation Lab Project : The objective of this one year add is to expand the capability to adequately measureand evaluate operator display performance in all military environments. No additional funding is required to complete this effort.

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

February 2002

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

COST (In Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
305 ATR RESEARCH	1174	1226	1305	1317	1345	1414	1446

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 laser radar (LADAR) technology. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and Project Reliance, and supports the Objective Force transition path of the Transformation Campaign Plan (TCP). This program element contains no duplication with any effort within the Military Departments. Work is performed by the Army Materiel Command.

FY 2001 Accomplishments:

- 1174   - Determined the fidelity of analytical thermal predictions for signature data and refined prediction models to economically generate real world imagery data on which to assess ATR algorithms.

  - Correlated performance of one or more ARL ATR algorithms with image complexity measures. Complexity measures allow a quantitative measurement of how difficult it may be to find a target in a given image and can assess how closely a synthetic image reproduces a real image.

  - Conducted phenomenological studies of hyperspectral data to assess minimum number of spectral bands needed to achieve high discrimination performance with low cost trade off. Initial studies showed that perhaps as few as 6 to 9 bands may provide all the information needed for superior automatic/aided target recognition results.

Total   1174

FY 2002 Planned Program

- 1226   - 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   1226

FY 2003 Planned Program

- 1305   - Correlate complexity measures of imagery with robustness and effectiveness measures of ARL ATR algorithms.

         - Determine the minimum number of hyperspectral bands needed for effective target recognition algorithms.

         - Assess significance of hyperspectral ATR for battlefield applications and report results.

Total   1305

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

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

COST (In Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
31B INFRARED OPTICS RSCH	2247	2482	2659	2671	2725	2866	2934

A. Mission Description and Budget Item Justification: This project supports the Army's theoretical and experimental research in materials and devices for active and passive infrared(IR) imaging systems. It generates new technologies to obtain unprecedented awareness of the battlefield and to continue to "own the night" 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. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, Project reliance and supports the Objective Force transition path of the Transformation Campaign Plan (TCP). This program element contains no duplication with any effort within the Military Departments. Work is performed by the Army Materiel Command.

FY 2001 Accomplishments:

- •   2247   - Determined fundamental aspects of material growth and device design required for long wave infrared (LWIR) FPA operating above 100°K.

        - Grew and processed 0.8micron detector/modulator and incorporated into breadboard LADAR. Initialized growth for 1.5-micron detector/modulator..

        - Designed IRFPAs to be utilized for active and passive imaging.

Total   2247

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

FY 2002 Planned Program

- 2482 - Evaluate chemical and structural properties of HgCdTe for application to IR FPAs operating near room temperature.

  - Investigate the controlled low-defect growth of Sb-based superlattices and quantum dots for application to IR FPAs operating near room temperature..

  - Finish fabrication of a high temperature 2D detector/modulator array for 1.5-micron LADAR.

Total   2482

FY 2003 Planned Program

- 2659 - Determine best material system and detector structure for a large area, staring, multicolor IRFPA operating near room temperature.

  - Optimize fabrication processes necessary to produce high temperature IR/LIDAR FPA devices.

Total   2659

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

February 2002

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

COST (In Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
52C MAPPING & REMOTE SENS	2258	2348	2554	2586	2646	2727	2785

A. Mission Description and Budget Item Justification: This project supports research in 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 investigates new methods of exploiting terrain and environmental data to improve situational awareness and enhance information dominance leading to increased survivability, lethality, and mobility capabilities for the Future Combat Systems and Army Vision/Joint Vision 2020 concepts. The research provides the theoretical underpinnings for program element 0602784A, project 855. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan and Project Reliance. The program element contains no duplication with any effort within the Military Departments. Work is performed by the U.S. Army Engineer Research and Development Center. This project supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2001 Accomplishments:

- 2258 - Investigated an enhancement of neural net and subpixel methods of feature extraction to gain processing speed and increase information detail.

    - Investigated hyperspectral imagery analysis/segmentation to improve feature differentiation and identification.

    - Created a prototype model to predict precipitation frequency data in the absence of weather data in denied areas to permit greater operational use of terrain.

    - Investigated the potential to integrate empirical and inductive analysis systems to increase speed and accuracy of analysis and to enhance descriptive quality of results.

Total   2258

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

FY 2002 Planned Program

- 2348   - Investigate fluorescence feature extraction for enhanced accuracy and detail.

       - Investigate multispectral and hyperspectral image compression for reducing process time and data storage requirements.

       - Generate classification algorithms for thermal imagery.

       - Investigate threat/terrain software and models for specific geographic areas.

Total   2348

FY 2003 Planned Program

- 2554   - Investigate Light Detection and Ranging (LIDAR) feature extraction to provide high resolution terrain data to enhance situational awareness on the battlefield.

       - Investigate high resolution data fusion to enhance seamless integration of data and a common operating picture of the battlefield.

       - Investigate and refine initial threat/terrain data analysis software to provide higher fidelity situational awareness resulting in improved Tactical Decision Aids.

Total   2554

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

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

COST (In Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
53A BATTLEFIELD ENV & SIG	3780	3912	4284	4317	4439	4705	4821

A. Mission Description and Budget Item Justification: This project provides an in-depth understanding of the complex atmospheric boundary layer associated with high-resolution meteorology, the transport, dispersion, optical characteristics and detection of chemical and biological aerosols, and the propagation of full-spectrum electro-magnetic and acoustic energy. The Army of the future will be required to operate in very complex environments and disparate terrain requiring new approaches to understanding, characterizing, and depicting 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. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, Project reliance and supports the Objective Force transition path of the Transformation Campaign Plan (TCP). This program element contains no duplication with any effort within the Military Departments. Work is performed by the Army Corps of Engineers.

FY 2001 Accomplishments:

- 3780   - Utilized the Cooperative Atmospheric Surface Exchange Study (CASES-99) data to model acoustic propagation in diurnal conditions.

    - Investigated the feasibility of extracting environmental data from hyperspectral data. Results indicate that development of an enhanced capability for target detection and acquisition using hyperspectral data is possible.

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

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

FY 2001 Accomplishments: (Continued)

- Initiated experiments on low frequency acoustic propagation in forest canopies and regions to enable assessment of the environment impact on acoustic sensors.

- Evaluated 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.

- Integrated a new Cumulus Parameterization Scheme for estimating convective precipitation into hydrostatic mesoscale models that has shown the potential to significantly improve fine-scale predictions of clouds and precipitation in the battlespace area. and enhance lethality and survivability.

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

- Incorporated a detailed surface energy balance in the surface layer model for improved thermodynamic and stability effects.

- Improved the boundary layer atmospheric model by incorporating algorithms for depicting 3-D wind and temperature fields for both stable and unstable atmospheric conditions.

Total   3780

FY 2002 Planned Program

- 3912   - 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 acoustic propagation in forest canopies.

- 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 accuracy 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 transcient 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.

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

FY 2002 Planned Program (Continued)

- 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   3912

FY 2003 Planned Program

- • 4284   - Establish an experimental capability for polarimetric discriminators in hyperspectral ground-based remote sensing imaging to enable improved target identification and acquisition.

- Research high-fidelity acoustic signature simulation system for generating synthetic acoustic signatures.

- Analyze data obtained in a multi-agency field experiment for the purposes of validating and/or improving dispersion modeling in urban domains.

- Use simulated and actual fluorescent particle counter measurements to pinpoint sources and predict dispersion of biological agents in urban environments.

- Explore, examine and integrate an explicit cloud microphysics scheme in the Battlescale Forecast Model for enhanced cloud depictions.

Total   4284

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

COST (In Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
74A HUMAN ENGINEERING	2633	2741	2974	2996	3057	3227	3303

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". The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, Project reliance and supports the Objective Force transition path of the Transformation Campaign Plan (TCP).. This program element contains no duplication with any effort within the Military Departments. Work is performed by the Army Materiel Command.

FY 2001 Accomplishments:

- 2633   - Completed development of a robust and sensitive speech recognition test specifically applicable to noisy military environment. Validation efforts were completed in December 2001.

    - The hearing hazard model was refined and transitioned to other Army, government, and standards organizations (American Inst. Biological Sciences, SAE, NIOSH) as an improved method for auditory injury and occupational health risk assessment due to impulse noise.

    - Created a blast waveform database that includes hazard assessments used by NATO countries to compare auditory health risk criteria.

    - Expanded studies of selective visual attention on target acquisition to electro-optically (IR and I2) imaged scenes and provided results to AMSAA's soldier-in-the-loop target acquisition modeling effort.

    - Completed 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. Data are being analyzed and findings will be transitioned to SBCCOM-NSC in 2Q FY02.

    - Transitioned results from stress research findings to assist in the development of information processing models and methods for improved vigilance and readiness within the digitized battlefield.

    - Identified resiliency characteristics and biochemical correlates, such as baseline amylase, of successful performance of junior enlisted personnel in support of the "Enhancing Soldier Performance" SRO.

Total   2633

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

FY 2002 Planned Program

- 2741   - Determine the impact of infantry helmet on the auditory localization to provide guidelines for future helmet designs.

  - Conduct research to determine the best approach for improving spatial perception of combat important sounds in adverse listening conditions.

  - 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 Objective Force Warrior perspective.

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

  - Determine software architecture requirements for optimal representation of human behaviors in battlefield scenarios and for communication with other wargame models and validate specific models through experimental and field research paradigms.

Total   2741

FY 2003 Planned Program

- 2974   - Identify and begin to quantify the effects of spectral signal composition on auditory detection and recognition of acoustic signatures and warning signals.

  - Validate the multivariate and hierarchical models of soldier performance under conditions of high stress and high workload. Validate metric for measuring real-time alertness monitoring for detection and recognition of visual targets or related cues.

  - Conduct follow-on study to further define the effect of specific combat stressors in areas of situation awareness and decision making under uncertainty to improve management and control of battlefield stressor effects.

  - Transition data from localized brain activity and behavior research to cognitive models of soldier performance, field-validate predictive models, and integrate models and results with large-scale representations of system and unit performance.

Total   2974

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

COST (In Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
74F PERS PERF & TRAINING	2600	2830	2923	2957	3036	3139	3200

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. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, Project reliance and supports the Objective Force transition path of the Transformation Campaign Plan (TCP). This program element contains no duplication with any effort within the Military Departments. Work is performed by the Army Research Institute.

FY 2001 Accomplishments:

- 2600   - Determined the effects of computer mediated communication on the effectiveness of leader - subordinate relationships.

    - Evaluated the use of latent semantic analysis to assess an individual's knowledge structure and to aid in the automatic analysis of free-range text.

    - Determined the effects of different types of missions and gender issues on cohesion, morale, and performance effectiveness.

    - Modeled the results of a long-term analysis on the durability of tank gunnery skills in the absence of practice.

    - Advanced 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.

Total   2600

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

FY 2002 Planned Program

- 2830   - 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   2830

FY 2003 Planned Program

- 2923   - Validate the ability to develop tacit leadership knowledge by direct training.

    - Determine the role of working memory and other cognitive abilities on higher level comprehension and long-term memory tasks.

    - Develop a model of how individuals value time in making long-term decisions.

    - Determine the value of latent semantic analysis and scenario-strategy to contribute to the training of leadership skills.

Total   2923

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

February 2002

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

COST (In Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
F20 ADV PROPULSION RSCH	2472	2589	2834	2885	2942	3115	3192

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. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, Project reliance and supports the Objective Force transition path of the Transformation Ca mpaign Plan (TCP).. This program element contains no duplication with any effort within the Military Departments. Work is performed by the Army Materiel Command.

FY 2001 Accomplishments:
- 2472 - Incorporated environmental effects in service life prediction model for advanced structural ceramics, including effects due to combustion products, which will enable transition of high temperature materials into advanced fuel-efficient propulsion systems.

  - Conducted detailed measurements of heat transfer and secondary leakage losses of four port through-flow wave rotor to validate loss mitigation approaches and to improve the performance and efficiency of future air and ground propulsion designs.

  - Confirmed through investigation the 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.

  - Validated gear fault detection methodology incorporating sensor fusion for improved rotorcraft transmission safety and reliability.

  - Validated 2D and 3D gear crack propagation codes for improved life and reliability predictions.

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

FY 2001 Accomplishments: (Continued)

    - Applied signal processing techniques to improve signal/noise ratio and physical sensing bandwidth for ultrasonic data telemetry data system.   Proved feasibility evaluation of microelectromechanical systems (MEMS) SiC pressure transducer concept at 600C, enabling internal measurements of flow phenomena in the 10kHz range.

    - Proved the feasibility of MEMS based concept to implement microblowing and synthetic jets for non-intrusive active stabilization of centrifugal compressors, which offers enhanced engine performance and operability.

Total   2472

FY 2002 Planned Program

•   2589   - Conduct device-level evaluation of MEMS based synthetic injectors to establish the feasibility for flow range extension experiments on centrifugal compressor stage to enhance engine performance and efficiency.

    - 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.

    - Validate loss mitigation approaches to improve wave rotor performance.

    - 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   2589

FY 2003 Planned Program

•   2834   - Complete conceptual integration and hardware design of MEMS injectors for compressor component testing.

    - Complete evaluation of higher temperature range MEMS sensor for operation substantially above 600C, enabling internal measurements in advanced engine hot sections.

    - Conduct component experimentation of a self cooled 6-port wave rotor concept to achieve increased engine power without having to resort to costly advanced high temperature materials or augmented cooling systems. This arrangement will substantially reduce cooling requirements to the wave rotor and associated engine components.

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)	February 2002	
BUDGET ACTIVITY **1 - Basic research**	PE NUMBER AND TITLE **0601102A - DEFENSE RESEARCH SCIENCES**	PROJECT **F20**

FY 2003 Planned Program (Continued)

      - Complete validation and delivery of new engine weight and safety prediction algorithms, which will forecast the impact of advanced technologies on the weight and safety of new engines.

      - Evaluate use of ultrasonic data telemetry concept in a high temperature experimental environment that simulates engine conditions.

      - Characterize effects of reduced atmospheric pressure (altitude) on foil bearing performance. Foil bearings are an essential enabling technology for oil-free turbomachinery and the elimination of lubrication support system hardware.

Total   2834

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

February 2002

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

COST (In Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
H42 MATERIALS & MECHANICS	1955	2026	2162	2229	2274	2400	2458

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. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, Project reliance and supports the Objective Force transition path of the Transformation Campaign Plan (TCP). This program element contains no duplication with any effort within the Military Departments. Work is performed by the Army Materiel Command.

FY 2001 Accomplishments:

- 1955   - Explored novel technologies for energy dissipation in lightweight integrally-designed armor composite materials.

    - Quantified the effects of interfacial chemistry on the morphology development in polymer/polymer and polymer/inorganic nanocomposites. Identified the most promising candidates for further investigation.

    - Determined shock response and material damage/failure mechanisms of ballistically impacted ceramics likely to be used in lightweight armor configurations.

    - Identified critical dynamic material properties required for improving the performance of future anti-armor concepts against complex threat armors.

    - Evaluated 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 for ground vehicles.

Total   1955

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

FY 2002 Planned Program

- 2026 - Conduct basic research to determine 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   2026

FY 2003 Planned Program

- 2162 - Extend design models and experimental techniques to enable exploitation of composite material interphase design methodologies for high-performance lightweight integral armors.

  - Refine structure/property relationships and processing techniques for tailoring performance of advanced polymer systems to be used in integrated Objective Force Warrior systems.

  - Incorporate fundamental understanding of ceramics property behavior into a first-principles ceramic design tool for development of improved lightweight armors.

  - Incorporate analytic model of dynamic penetrator fracture into design codes for improved anti-armor concepts.

  - Investigate computational difficulties of simulating the manufacture of composite structures made with elastomers, and apply new constitutive models to viscoelastic damper problems in the Army fleet that will improve the Army's ability to predict thermodynamic effects.

Total   2162

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)	February 2002

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

COST (In Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
H43 RESEARCH IN BALLISTICS	4023	4200	5945	4489	4585	4818	4927

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. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, Project Reliance and supports the Objective Force transition path of the Transformation Campaign Plan (TCP). This program element contains no duplication with any effort within the Military Departments. Work is performed by the Army Materiel Command.

FY 2001 Accomplishments:

- 4023   - Refined fundamental chemistry and physics models and expanded experimental techniques to elucidate the factors controlling gun and missile propellant initiation, combustion, sensitivity, and vulnerability.

    - Devised advanced computational models, smart munitions aerodynamic prediction capabilities, and flight vehicle control element design tools for low cost precision munitions.

    - Devised micromechanical model and defined theory critical experiments that describe the onset and propagation of damage to ballistically impacted ceramics.

    - Identified the physical processes associated with adiabatic shear band initiation and growth to improve performance of future anti-armor concepts.

Total   4023

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)	February 2002

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

FY 2002 Planned Program

- 4200   - 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   4200

FY 2003 Planned Program

- 5945   - Expand first principles design tools to tailor propellant chemical formulation that will enable design of insensitive high-energy propellants for the Objective Force.

     - Incorporate structural flight vehicle response, aerodynamics, propulsion, guidance, navigation and control to enable a comprehensive design and evaluation capability for smart munitions, missiles, and rocket systems.

     - Validate ceramic micromechanical model using theory critical experiments and integrate model into numerical code to guide ceramic armor material developers.

     - Refine adiabatic shear model based on micromechanical experiments of candidate alloy materials and integrate into computational continuum mechanics code to enable improved design of anti-armor concepts.

Total   5945

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

February 2002

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

COST (In Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
H44 ADV SENSORS RESEARCH	4023	4206	4371	4453	4550	4761	4867

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 the performance of image 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. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, Project reliance and supports the Objective Force transition path of the Transformation Campaign Plan (TCP). This program element contains no duplication with any effort within the Military Departments. Work is performed by the Army Materiel Command.

FY 2001 Accomplishments:

- 1364 - Integrated nonlinear beam propagation codes with the materials properties required for sensor/eye protection.

    - Recorded and fixed multiplexed gratings in a 3D hologram required for true 3 dimensional display.

- 1051 - Created simulation that showed the capability of Scan MUSIC algorithm to resolve complex targets with a single antenna radar beam there by allowing improvements in real beam target detection.

    - Completed improved processing techniques to enable modeling of tactical vehicles on a dielectric halfspace of UHF frequencies.

    - Investigated and performed research on advanced acoustic classification techniques such as auditory signal modeling and fuzzy logic. Performed research in wide-band adaptive beam-forming and distributed sensor array processing so that multiple targets can be tracked and identified for attack.

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

FY 2001 Accomplishments: (Continued)

- 1608   - Devised algorithms for on-the-fly visual information fusion and processing in the presence of atmospheric turbulence-induced phase distortion effects.

  - Created the Atmospheric Laser Optics Testbed (ALOT), a first of its kind facility located in the National Capital Area. ALOT provides a research laboratory environment for studying the effects of and intensity fluctuations on ground-to-ground laser communications to reduce the effects on tactical communications in support of joint ARL/CECOM 6.2 research.

  - Conducted imaging experiments with artificially generated turbulence located between the object and imaging system. Achieved a recently developed synthetic imaging technique that creates a single image by combining the best focused segments of multiple images. Resultant image quality superior to the undistorted image obtained in the absence of the turbulence.

Total   4023

FY 2002 Planned Program

- 1468   - Provide more realistic beam propagation codes for eye protection from lasers.

  - Understand new display modalities.

  - Investigate and enhance organic light emission device lifetimes.

  - Explore limitations of engineered materials to provide eye protection to laser sources.

- 1077   - Validate applicability of the ScanMUSIC algorithm using measured data and determine the effects of noise clutter on its ability to resolve targets in cross-range.

  - Develop and validate EM modeling tools to rapidly predict the signatures of a variety of targets at VHF and UHF frequencies.

  - 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.

- 1661   - 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.

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

FY 2002 Planned Program (Continued)

    - Adapt 4-D multigrid microscale Nuclear, Biological, Chemical (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   4206

FY 2003 Planned Program

- 1436   - Use realistic nonlinear optical beam propagation models to design optical limiters.

    - Determine optimal engineered materials for optical limiter applications.

    - Design and fabricate emissive elements on flexible substrates with high efficiency and good color characteristics.

- 1244   - Investigate real-time implementations of S-MUSIC model in multi-function RF systems.

    - Create plan for extending electromagnetic signature prediction capability to L-band.

    - Investigate and research time-frequency signal processing for detection and classification of transients. Continue research in efficient encoding and processing schemes for distributed sensor networks.

- 1691   - Combine nonlinear image processing algorithms with Very Large Scale Integration/Micro Electo-Mechanical Systems(VLSI/MEMS) technology for small target tracking and image processing from non stationary platforms, supporting AMCOM/ARL joint research goals.

    - Design multiwavelength laser communications system to provide the high bandwidth, secure transfer of information on the battlefield.

    - Explore techniques to remotely calculate ready to render information for computationally intensive models such as NBC models, and distribute over tactical communications networks thereby improving the ability of the Commander to react to NBC events.

Total   4371

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

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

COST (In Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
H45 AIR MOBILITY	1965	9018	2193	2236	2276	2354	2405

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. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, Project reliance and supports the Objective Force transition path of the Transformation Campaign Plan (TCP). This program element contains no duplication with any effort within the Military Departments. Work is performed by the Army Materiel Command.

FY 2001 Accomplishments:

- 1965 - Prepared rotor aerodynamic and acoustic software codes using scalable software.

  - Conducted hover test using model blades equipped with oscillating blowing to control flow separation.

  - Analyzed aeroelastic coupling characteristics for improved rotor stability.

  - Validated analytical methods for on-blade control vibration characteristics.

  - Designed and fabricated a two dimensional (2D) variable droop leading edge airfoil to delay dynamic stall.

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

Total   1965

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

FY 2002 Planned Program

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

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

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

- 6922   - Conduct fundamental research for autonomous control of rotorcraft unmanned aerial vehicles.

     - Investigate active flow control impact on rotorcraft, and evaluate active twist rotor concepts using neural net closed loop controllers.

     - Using simulation, generate a synthetic vision database for sensor fusion requirements.

Total   9018

FY 2003 Planned Program

- 2193   - Design and fabricate a high lift 2D airfoil for low Reynolds number flow.

     Investigate advanced active flow control concepts to reduce fuselage drag and improve rotorcraft performance

     Develop computational fluid dynamics capability to investigate tiltrotor vortex ring state.

     Investigate turbulence model on helicopter drag predictions.

Total   2193

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)		February 2002

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

COST (In Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
H47 APPLIED PHYSICS RSCH	3125	3246	3557	3579	3653	3860	3951

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. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and Project Reliance. The program element contains no duplication with any effort within the Military Departments. Work is performed by the Army Materiel Command.   This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2001 Accomplishments:
- 1253   - Used microlaser models to predicted the threshold and energy output of lasers using various parameters for Er/Yb:glass with given pumping intensities.

    - Determined optical properties of electrically pumped laser and modulator structures.
    - Successfully modeled antimonide based superlattice and quantum dot IR detectors for high operating temperature.
    - Determined optical and electrical properties of semiconductor superlattice materials to optimize quantum cascade laser and detector arrays.

- 836   - Proved feasibility of new manganese cathode material for 2X energy density of Land Warrior battery at low temperatures.
    - Synthesized flame retardant electrolyte additive for non-flammable Li Ion batteries for FCS hybrid power sources.
- 1036   - Proved that new high-pressure pulsed-laser deposition (PLD) growth conditions provide conformal AlN coating for passivation of SiC diode structures.

    - Used a Low temperature PLD AlN as buffer layer to provide near-bulk lattice parameters in overlying AlN and to reduce stress in the underlying SiC-AlN buffer layer interface.

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

FY 2001 Accomplishments: (Continued)

- Showed that post deposition recrystallization of PLD AlN decreased interface traps by at least a factor of 10 for gate dielectric applications.

Total   3125

FY 2002 Planned Program

• 1412 - 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.

- Refine model of carrier transport in semiconductor superlattice materials based on optical, electrical and magnetic measurements.

• 982 - Initiate research to improve catalysts for compact hydrocarbon fuel reformers for fuel cell systems.

- Explore materials for ultra-high energy density Li/air battery for Land Warrior and FCS.

• 852 - Investigate alternative dielectrics for SiC device layers that are more robust than silicon dioxide.

- Develop a basic model of the SiC-insulator interface that will delineate between the different surface mobility components and that will agree with experimental data.

Total   3246

FY 2003 Planned Program

• 1147 - Investigate intersubband-based devices for integrated optoelectronic systems in the IR spectral region.

- Investigate remaining defects in IR detector structures and their effects on device performance, especially for high temperature operation.

• 1126 - Synthesize new polymeric electrolyte for all solid-state Li-ion battery for Land Warrior and hybrid power sources for the Objective Force.

- Formulate improved chemistry for high performance direct-methanol fuel cell for Land Warrior.

• 1284 - Investigate the long term effects of dielectric degradation on SiC power device performance and reliability for high-temperature high-power applications and devise models that will predict the device performance effects on motor-drive/power conversion application circuits.

Total   3557

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

February 2002

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

COST (In Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
H48 BATTLESPACE INFO & COMM RSC	6690	7057	7429	7597	7805	8206	8378

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. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and Project Reliance. The program element contains no duplication with any effort within the Military Departments. Work is performed by the Army Materiel Command.   This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2001 Accomplishments:

- 3860 - Completed development of efficient algorithms for Internet protocols for highly mobile tactical networks for experimental applications and transitioned technology for CECOM's MOSAIC ATD.

  - Evaluated final hierarchical digital modulation algorithms by testing, identifying and classifying complex signals for transitioning to CECOM classified program.

  - Finalized a mobile ad-hoc network to interconnect tactical units and higher echelons for improved information flow and transitioned technology for CECOM's MOSAIC ATD.

  - Validated the performance of source and channel coding for tactical communications in high bit error battlefield environments for transitioning to CECOM classified projects.

- 2830 - Validated hierarchical digital modulation algorithms for classification and identification of signals on battlefield.

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)	February 2002

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

FY 2001 Accomplishments: (Continued)

- Validated performance of spatial diversity combining algorithms for tactical communications for transitioning to CECOM classified programs.

- Validated intelligent agents for mission planning, rehearsal and status monitoring of a physical agent in support of the Advanced Battlefield Processing STO.

- Determined and displayed the state of physical or software agents through a 2D/3D battlespace situation display in support of the Advanced Battlefield Processing STO.

- Determined 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 in support of the Advanced Battlefield Processing STO.

- Validated the performance of natural language and context tracking agents that understand a speaker's intent while visualizing graphical information in support of the Advanced Battlefield Processing STO.

Total   6690

FY 2002 Planned Program

• 7057   - 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.

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

February 2002

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

FY 2002 Planned Program (Continued)

- 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   7057

FY 2003 Planned Program

- •   7429   - Investigate algorithms for the efficient detection, estimation, and synchronization of ultra -wide signal sources.

    - Assess wireless network vulnerabilities and secure key management.

    - Validate the robustness of intelligent agent-based techniques to assess wireless network vulnerabilities and secure key management.

    - Design validated primary key management techniques based on composite surrogate key structures for federations of ad hoc data management schemes and wireless information distribution schemes.

    - Pursue promising techniques to enhance the performance of ad-hoc networks that link unattended microsensors .

    - Publish a report defining the theoretical foundation for an architecture and control language for cooperating agents.

Total   7429

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit) | February 2002

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

COST (In Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
H52 EQUIP FOR THE SOLDIER	973	1005	1177	1179	1196	1262	1292

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. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and Project Reliance. The program element contains no duplication with any effort within the Military Departments. Work is performed by the US Army Natick Soldier Center, Natick, MA. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2001 Accomplishments:

-    973   - Prepared nonspherical and nonlinear nanoparticle precursors to evaluate their potential in improving the strength of composites for use in lightweight equipment to be carried or worn by soldiers.

           - Determined that molecular modeling programs correctly predict the one-dimensional strain in polymeric and polymer nanocomposite materials for use in body armor and other protective equipment.

           - Correlated military uniform (clothing) comfort with soldier performance by using a variety of clothing performance indicators.

           - Evaluated cognitive performance assessment methodologies using cold exposure as a stressor.

Total   973

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

FY 2002 Planned Program

- 1005   - Validate the utility of a model 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 peptides conducting polymer complexes for clothing and food sensor applications.

   - Transition models on high rate phenomena occurring during ballistic impact events to 6.2 nanocomposites program.

   - Validate cognitive testing paradigm for detection of food based performance enhancement under stressful conditions.

   - Validate biomechanical and motor control methodologies that will provide guidelines to improve load carriage and reduce soldier fatigue.

   - Determine dispersion in the binding of water molecules to various components of amorphous food systems as they relate to ration stability and safety.

   - Create a new mechanics based theory for fiber-to-fiber interfacial behavior that can provide guidelines for the development of improved fibrous materials for the soldier.

Total   1005

FY 2003 Planned Program

- 1177   - Mathematically model the small energy perturbation of foot takeoff as it relates to walking stability and the ability to enhance soldier performance by understanding locomotion.

   - Quantify the orientation of carbon nanotubes using electron microscopy and x-ray diffraction to assess their potential for use in body armor applications.

   - Tailor genetically engineered polypeptide conducting polymer complexes to form biosensors to detect different target organisms for ration preservation and safety.

   - Integrate cognitive performance paradigm into ongoing, related warrior performance efforts.

   - Develop new experiments to quantify and assess the mechanical behavior of hybrid (blended) yarns in conjunction with the new fiber-to-fiber theory to create prototypes of improved materials for the soldier.

   - Formulate and implement a novel computer based biomechanics model to assess gait and muscle control to further improve soldier performance.

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

FY 2003 Planned Program (Continued)

      - Validate model and use magnetic resonance imaging measurements to determine formulations that improve food quality and ensure safety.

Total   1177

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

February 2002

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

COST (In Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
H57 SCI PROB W/ MIL APPLIC	49784	52612	54699	55463	56747	58386	59578

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 800 research grants and contracts with leading academic researchers and approximately 1,600 graduate students yearly, and supports research at 227 institutions in 46 states. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and Project Reliance. The program element contains no duplication with any effort within the Military Departments. . Work is performed by the Army Research Office. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2001 Accomplishments:

- 23809   - Produced high impedance ground planes for enhanced performance of GPS, radar, and wireless systems.

     - Optimized beryllium-free amorphous alloy composites which will outperform depleted uranium penetrators.

     - Conducted theoretical chemistry studies of oxygen reduction catalysts to increase efficiency of small fuel cells for individual soldier power systems.

     - Devised an enzyme-based biosensor to detect anticholinesterase chemical nerve agents and their chemical precursors.

- 25975   - Utilized magnetorheological fluid based dampers for improved stability of bearingless helicopter rotorblades.

     - Designed 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.

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

February 2002

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

FY 2001 Accomplishments: (Continued)

- Devised new classes of smooth bivariate and trivariate macroelements for data compressed visualization of open and urban terrain and to calculate chem/bio agent dispersion.

- Established a sediment transport model to predict short-term beach conditions for amphibious operations and logistics-over-the-shore.

Total 49784

FY 2002 Planned Program

- 23612   - 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.

- 27000   - 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.

- 1000   This one year congressional add is for basic research to develop advanced target recognition techniques using nanotechnologies.

- 1000   This one year congressional add develops a center for basic optical research for military applications.

Total 52612

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

February 2002

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

FY 2003 Planned Program

- 24888
  - Create atom gyroscopes for passive, jam-proof navigation with an accuracy that exceeds GPS.

    - Devise an alternative to silicon-based electronic chips through the synthesis and assembly of molecules to form electronic circuits.

    - Conduct theoretical chemistry studies of hydrogen adsorption on carbon structures for safe, lightweight hydrogen storage devices for individual soldier power systems.

    - Use unique biomolecular combinatorial approaches to find peptides to nucleate electronic materials allowing enhancements in electronic transport and optical efficiency.

- 29811
  - Devise computational design methods based on new Chimera -related flow analysis techniques leading to enhanced helicopter and missile performance.

    - Assess whether using higher degree of Reed Solomon coding will lead to unequal data loss protection in compressed images yielding the highest image quality even when information packets are lost.

    - Conduct research in statistical decision and network theory for automatic data fusion for extremely low power, high bandwidth microsensor networks.

    - Create a physics-based model for prediction of the soil parameters that affect land mine sensor performance in different environments.

Total 54699

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

February 2002

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

COST (In Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
H66 ADV STRUCTURES RSCH	1445	1495	1678	1684	1715	1817	1862

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. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and Project Reliance. The program element contains no duplication with any effort within the Military Departments. . Work is performed by the Army Materiel Command. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2001 Accomplishments:
-     1445   - Completed analyses of Active Twist Rotor wind tunnel test data to understand the forward flight characteristics of a twist actuated active rotor system in 'open loop' configuration and to define requirements for the design of 'closed loop' configured experiments. This work will enhance vibration control in advanced rotorcraft.

  - Three main closed loop control laws were identified for implementation in the Active Twist Rotor (ATR). Identified major actuator concepts necessary for the next generation ATR design. This will lead to improved vibration control and aerodynamic performance of future advanced rotorcraft.

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

FY 2001 Accomplishments: (Continued)

- Incorporated active control and smart material analytical models into a comprehensive analysis that has resulted in improved vibration and stability predictions for advanced rotors.

- Performed aeroelastic response studies of active stability controlled tiltrotor systems, and modified analytical tools to allow for a complete modeling of the Quad Tiltrotor concept.

- Derived improved damage growth prediction methods to better understand skin/stringer failure modes and to enhance structural reliability of future rotorcraft platforms.

- Completed crippling assessments to validate strength and durability predictions for damaged carbon-rod reinforced structures, which will enhance life usage and maintenance of current and future Army platforms.

- Generated 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 rotorcraft.

Total   1445

FY 2002 Planned Program

• 1495   - 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.

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

FY 2002 Planned Program (Continued)

- 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   1495

FY 2003 Planned Program

•   1678   - Evaluate the performance characteristics of advanced actuators concepts identified for LCAR rotor configuration to enable the design of new rotors of lighter weight and increased reliability.

- Validate the capability of an actively-controlled stability augmentation rotor system model to improve the tiltrotor stability boundary.

- Validate predicted human occupant exposure loads with experimental data acquired in an "all composite" fuselage crash test to verify newly-coupled models and simulations.

- Establish ballot delamination test standards within ISO and ASTM to promote an improved understanding and usage of hybrid composite laminates by industry.

- Correlate residual strength predictions for low velocity impact damage to validate design criteria for composite sandwich panels and to promote greater use of these lightweight materials.

- Conduct reliability-based experiments to assess small crack fatigue life methodology for aging Army air and ground vehicles.

Total   1678

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

February 2002

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

COST (In Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
H67 ENVIRONMENTAL RESEARCH	3451	3613	3777	3833	3899	4033	4115

A. Mission Description and Budget Item Justification: The objective of this project is to focus basic research on innovative technologies for both industrial pollution prevention (P2) that directly supports the Army industrial base and for non-stockpile chemical warfare (CW) site remediation. The pollution prevention work invests in next generation manufacturing, maintenance, and disposal methods that will result in significantly reducing the usage of hazardous and toxic substances and their associated costs. The goal is to decrease the overall life-cycle costs of Army systems by 15-30% through the application of advanced pollution prevention technologies. The CW remediation efforts concentrate on the application of biotechnology in the characterization and physical clean up of agent contaminated soils and groundwater. 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. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan and Project Reliance. The program element contains no duplication with any effort within the Military Departments. Work is performed by the U.S. Army Armament, Research, Development and Engineering Center. This project supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2001 Accomplishments:

- 3451   - Produced CL-20 and military grade 2,4-dinitrotoluene at bench scale using new environmentally benign processes.

  - Applied selected coatings to medium and large caliber gun tubes that will be test fired.

  - Characterized microstructural and performance properties of ceramic materials produced by biomimetic processes.

  - Optimized soil ecotoxicological screening bioassays and predictive capabilities for labile CW agent compounds in soils.

  - Compared the chemical resistance and physical/thermal properties of monolayer topcoats to with heavy-metal based primer-topcoat systems.

Total   3451

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

FY 2002 Planned Program

- 3613   - 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   3613

FY 2003 Planned Program

- 3777   - Optimize processing parameters of biodegradable and recyclable nanocomposite systems.

  - Formulate treatment/delivery matrix for anti-CW agent.

  - Characterize performance of formaldehyde-free high performance adhesives derived from modified proteins.

  - Characterize variables affecting spin solution fiber properties.

Total   3777

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit) February 2002

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

COST (In Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
S13 SCI BS/MED RSH INF DIS	8927	9330	10780	11087	11316	11781	12037

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; McKesson Bioservices, Rockville MD, the Israeli Defense Force Medical Corps, Israel; and Kenya Medical Research Institute, Kenya. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and Project Reliance. The program element contains no duplication with any effort within the Military Departments. Work is performed by the Army Medical Research and Materiel Command. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2001 Accomplishments:

- 4720   -Produced Plasmodium. falciparum, a malaria parasite, for all Department of Defense (DoD)-sponsored genome-sequencing efforts. Developed and implemented methods to complete the falciparum DNA sequence by manually filling in the data gaps left by the contractor's automated sequencing effort. Assisted the DoD malaria consortium to construct and verify maps of the malaria genome, the first step in turning raw sequence into data that can be applied to vaccine and drug discovery efforts.

  -Characterized the proteins produced by malaria parasites at different stages in their life cycle and determined where in the parasite these proteins are found to identify new targets for vaccine and drug development.

  -Identified methods that the malaria parasite uses to develop drug resistance in order to avoid or combat this resistance in future drugs

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

  -Investigated new/improved approaches to prevention of diarrheal diseases, which are needed to protect and restore the health of soldiers.

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)	February 2002

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

FY 2001 Accomplishments: (Continued)

- 1556   -Evaluated the immune response to enterotoxigenic E. coli (ETEC) infection, a common cause of diarrhea, in United States military personnel on deployment in Egypt to identify proteins that will predict the effectiveness of candidate ETEC vaccines. Identified novel proteins that allow ETEC to adhere to the gut and cause disease for use as possible future vaccine components.

  -Compared different strains of Campylobacter, another common cause of diarrhea, for differences in their proteins and genetic sequences to determine the range of strain variation and identified factors by which these organisms cause disease to determine the best Camplyobacter proteins to use in future candidate vaccines.

- 2651   -Determined if the immune response to a previous dengue fever virus infection may be the cause of severe, life-threatening dengue disease in a subsequent infection, an important factor in designing a safe dengue vaccine. Validated a rapid, large volume test to measure effectiveness of dengue candidate vaccines. Identified proteins measurable in blood that reflect immune responses to infection with dengue fever virus, which can be used to develop tests to evaluate efficacy of vaccine candidates.

  -Conducted epidemiologic studies in Indonesia and Egypt of arboviruses, a common group of disease-causing viruses, determining the potential risk to service members in those regions.

  -Assessed the epidemiology of tick-borne diseases in Egypt and malaria in Thailand and Western Kenya to determine risk and recommend control measures in areas where our troops may deploy. Identified mosquito species that carry malaria in diverse regions of Africa (high altitude, urban, dry season) to develop vaccine study sites. Developed a standardized system for assessing dengue fever virus risk based on surveillance of mosquitoes that transmit dengue virus in Southeast Asia.

Total   8927

FY 2002 Planned Program
- 6318   -Investigate new or improved prevention and treatment methods for malaria necessary for protecting and restoring the health of soldiers.

  -Complete DNA sequencing of vivax malaria, the second most militarily important cause of malaria in soldiers. These findings will identify malarial proteins that could be important targets in vaccine and drug development.

  -Refine methods to find and measure unique proteins in the blood made in response to malaria and that can be used to measure immunity against malaria.

  -Conduct epidemiological studies to define the causes of diarrhea in Cairo, Egypt, Southeast Asia and Incirlik, Turkey to allow the selection of bacterial strains in vaccine candidates that provide the broadest protection, and to identify potential future site for vaccine field testing.

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

FY 2002 Planned Program (Continued)

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

-Discover novel compounds that inhibit life-essential pathways in the malaria parasite to determine potential antimalarial drug candidates.

-Identify methods the parasite uses to survive antimalarial drugs to develop drugs avoiding or delaying parasite resistance to future drugs.

- 962 -Conduct basic research to support prevention of disease from bacterial infections to ensure there is no adverse operational impact from these diseases on our forces.

-Define the range in natural strain variations of the organism that causes scrub typhus and that could affect the immune responses to these organisms in order to determine the necessary components of a broadly protective vaccine against this disease.

- 2050 -Conduct epidemiological studies to evaluate the different dengue strains, studying disease presentation and pathogenesis in Indonesia, Thailand, Peru and Venezuela, which will help to identify potential vaccine components, define the operational impact of dengue on the soldier and identify future potential field sites for testing vaccines and other countermeasures.

-Develop a computerized mosquito identification system and assess the epidemiology of malaria to determine risk of carrying disease and to recommend control measures in areas to which our troops may deploy, including Peru, Korea and Indonesia and to evaluate the risk of tick-borne diseases to troops in South America.

Total   9330

FY 2003 Planned Program

- 6176 -Investigate new or improved prevention and treatment methods for malaria necessary for protecting and restoring the health of soldiers.

-Provide annotated DNA sequence of the P. vivax malaria to research community to leverage the development of drugs and vaccines to combat malaria.

- Incorporate DoD supported malaria DNA sequencing data into the malaria vaccine and drug development programs to expedite the identification of future vaccines and drugs.

-Incorporate bioinformatics technology to effectively search genomic information to discover new approaches to solve military infectious disease problems.

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

February 2002

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

FY 2003 Planned Program (Continued)

-Develop DNA microarray technology to rapidly screen potential target genes involved in malaria parasite survival and targets for drug and vaccine development.

-Perform epidemiological and laboratory studies to identify tests that will predict whether a candidate malaria vaccine is protective.

-Continue discovery efforts for novel compounds that inhibit metabolic pathways in the malaria parasite (potential antimalarial drug candidates). Continue to develop new in vitro assays to more rapidly and reliably test drug toxicity and pharmacology, and assays to screen new drug targets. Identify additional malaria drug targets and mechanisms of the parasite's drug resistance in order to replace older drugs that have lost effectiveness due to resistance.

-Produce an assessment of the presence of malaria drug resistance in different regions of the world for the Commanders-in-Chief (CINCs) so that they can determine the best measures to protect their soldiers when deployed to a specific area of the world.

- 2036   -Investigate new or improved methods needed to protect and restore the health of soldiers from diarrheal diseases, including epidemiological studies and genomic technology.

-Identify new vaccine components to improve protection against diarrhea caused by Campylobacter, a common cause of diarrhea in soldiers.

-Perform epidemiological studies to identify tests that will predict whether a candidate ETEC or Campylobacter vaccine is protective.

- 2568   -Conduct necessary basic research to define, acquire, and evaluate DNA sequences for the sensitive and specific diagnosis of infectious diseases of military interest and that are adaptable to the 1st generation common diagnostics platform.

-Examine mechanisms to prevent viral diseases such as dengue fever necessary for protecting the health of soldiers.

-Conduct necessary basic research leading to the development of medical countermeasures against hemorrhagic fevers caused by Rift Valley fever virus and Lassa virus, which can threaten our soldiers when deployed to areas where these diseases are found.

-Assess insect-borne disease threats to operational forces and provide guidance for suppression of disease-causing insects in areas of military operations.

Total   10780

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)		February 2002

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

COST (In Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
S14 SCI BS/CBT CAS CARE RS	3917	4100	4446	4507	4591	4769	4874

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 nonbattle injuries, and provide military medical capabilities for far-forward medical/surgical care of battle and nonbattle 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 U.S. Army the Institute of Surgical Research. Another government contributor to this program in the area of ballistic head injuries is the Aberdeen Test Center. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and Project Reliance. The program element contains no duplication with any effort within the Military Departments. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2001 Accomplishments:

- 1817   -Confirmed that inflammatory proteins are activated in hemorrhagic shock.

  -Developed a flexible computer program that can duplicate the blood loss or blood pressure profile of an uncontrolled hemorrhage.

  -Verified that two blockers of inflammatory proteins block lung injury seen in starting/stopping the flow of blood to the gut.

  -Investigated methods to measure retinal vessel blood oxygen saturation to diagnose hemorrhage severity and better triage wounded soldiers.

- 1216   -Conducted basic research on novel methods to repair and prevent hard and soft tissue injuries by testing germ-killing biologics to improve wound healing.

  -Discovered antimicrobial/antiplaque compounds that have kill rates equal to advanced antibiotics.

- 884   -Discovered that an anti-inflammatory drug significantly reduced brain injury and improved recovery after trauma. Discovered that a sodium ion channel blocking drug showed great promise as a neuroprotection treatment.

Total   3917

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

FY 2002 Planned Program

- 1099 -Conduct basic research to enhance the resuscitation capabilities for combat medics by evaluating the extent of inflammation and the changes in extracellular electrolytes.   Conduct further research to identify adjuncts that can be added to resuscitation fluids to protect against injury due to hemorrhage and other trauma.

- 1204 -Conduct basic research on novel methods to repair and prevent hard and soft tissue injuries by identifying and developing 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 -Study 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 lifesaving treatment far forward.

Total   4100

FY 2003 Planned Program

- 2046 -Conduct basic research to enhance the resuscitation capabilities for combat medics by conducting tests of additional drugs to reduce inflammation after hemorrhage.

  -Complete evaluation of relationship between clotting and stimulation of life -threatening inflammation during hemorrhage to prevent adverse consequences. Identify additional cell protective agents that can be added to resuscitation fluids to protect against injury due to hemorrhage and other trauma.

- 1247 -Conduct basic research on novel methods to repair and prevent hard and soft tissue injuries by determining improved methods to treat penetrating extremity trauma at far-forward locations. Complete testing of the most promising antiplaque products on human oral tissue and bone cell cultures to assess toxicity and select candidate for further development.

- 1153 -Conduct basic research to produce physiological sensors and devices aimed at diagnosing and treating injuries. Complete evaluation of noninvasive physiological sensors suitable for incorporation into the Land Warrior ensemble and determine suitability for incorporation into the medic's diagnostic equipment to improve diagnosis, triage, and treatment.

Total   4446

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit) — February 2002

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

COST (In Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
S15 SCI BS/ARMY OP MED RSH	5346	5582	6262	6346	6478	6758	6910

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 of 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 nervous system modulation 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 U.S. Army Aeromedical Research Laboratory, the U.S. Army Research Institute of Environmental Medicine, and the Walter Reed Army Institute of Research and its overseas laboratories. Major contractor is McKesson Incorporated, Texas. Additionally, numerous Cooperative Research and Development Agreements (CRDAs) are held with universities and independent laboratories. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and Project Reliance. The program element contains no duplication with any effort within the Military Departments. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2001 Accomplishments:

- 1126 -Improved methods for studying changes in behavior and in physiology resulting from non-thermal energy absorption of radio frequency radiation. This research will help materiel developers for future combat systems, (e.g., body worn antenna) avoid biologically harmful frequencies and power mixes.

- 960 -Explored combined amino acid/carbohydrate supplements to enhancement muscle strength and muscle metabolism in men and women to develop principals of ration component performance enhancements.

- 982 -Examined the role of antioxidants 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.

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

FY 2001 Accomplishments: (Continued)

- 949 -Determined that the immune system was altered by cold stress combined with exercise to improve predictors of cold stress effects
- 1329 -Explored functional magnetic resonance imaging techniques to evaluate brain activity while performing cognitive tasks under sleep deprivation to demonstrate effectiveness of proposed future countermeasures.

Total 5346

FY 2002 Planned Program

- 5582 -Complete the assessment of the cardiovascular effects of ultra wide-band radiation and begin exploration of the interactions of neurotoxins and radio frequency radiation (RFR) on central nervous system physiology and function to identify potential health consequences of RFR and neurotoxin exposure.

  -Document the efficacy of consuming supplemental carbohydrate beverages for enhancing vigilance during simulated combat missions.

  -Utilize genomic or proteomic techniques to assess reproductive effects of environmental hazards during deployment.

  -Evaluate antifreeze proteins to protect skin cells and determine whether chronic heavy work impairs thermoregulation during sustained cold exposure.

  - Evaluate calcium channel blocker in reducing hypothermia mediated organ damage.

Total 5582

FY 2003 Planned Program

- 6262 -Explore and characterize mechanisms of brain cell physiology and morphology with RFR and neurotoxin exposure that may cause long-term health degradation inherent in neurodegenerative diseases.

  -Conduct field studies to validate models of water needs and to explore strategies to reduce water intake requirements while maintaining soldier and unit readiness. This research will provide direct support to the Objective Force by enhancing survivability of soldiers in adverse environments through the use of metabolic regulators.

  -Determine the effect of hypothermia and rewarming on heart rate variability to use as a possible predictor of cold injury. This research will serve to prevent non-freezing cold injuries during deployments to adverse environments.

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

FY 2003 Planned Program (Continued)

-Conduct studies to measure transmissible toxic effects in the offspring of animals exposed to environmental toxins and military relevant chemical compounds and mixtures. This research will enable identification of environmental hazards during deployment of the Objective Force.

-Explore brain imaging to determine whether increased cognitive load exacerbates the regional cerebral deactivations that characterize sleep deprivation. This research will enhance the cognitive performance of the Objective Force during sustained operations.

-Determine how the immune system functions during sustained cold-wet exposure and determine if altered by exhaustive exercise.

Total   6262

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

February 2002

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

COST (In Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
T22 SOIL & ROCK MECH	1815	1906	1939	1965	2002	2062	2103

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

FY 2001 Accomplishments:

- 1815   - Completed analytic approach for response of target joints and fractures to projectile penetration to support the Army Transformation.

  - Modeled soil response to transient loading patterns of wheeled and tracked vehicles.

  - Evaluated pavement interface, load, dynamic response, and traffic distribution models to realistically represent future aircraft effects on pavement performance.

  - Determined appropriate combinations of responsive/passive composite materials for camouflage, cover, and deception as a function of environment and facility.

  - Matured methods to assess performance of advanced binders for increasing durability of paving materials.

Total   1815

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)	February 2002

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

FY 2002 Planned Program

- 1906   - Perform confined split Hopkinson pressure bar experiments on Indiana limestone to investigate pressure effects during high loading rates.

  - Produce experimental quantity of responsive/passive camouflage, cover, and deception material.

  - Investigate fundamental soil reinforcement mechanisms for nontraditional stabilization additives.

Total   1906

FY 2003 Planned Program

- 1939   - Improve trajectory algorithms for new, advanced penetrators to support the Army Transformation.

  - Evaluate multispectral characteristics of experimental quantities of responsive/passive camouflage, cover, and deception material.

  - Produce physics-based generalized soil theory for large deformations in soil from maneuver operations.

  - Complete vehicular surface interactive models for Future Combat System (FCS) surface interaction models.

  - Mature first-generation reinforcement models describing the interaction between soil particles and nontraditional stabilizers.

  - Define appropriate use of high-loading rate data in simulating response of Salem limestone to high-velocity projectile penetration.

Total   1939

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

February 2002

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

COST (In Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
T23 BASIC RES MIL CONST	1534	1613	1641	1663	1691	1742	1779

A. Mission Description and Budget Item Justification: This project supports facilities research in forming a fundamental understanding of the long-term durability of composite materials, the behavior of structural elements, and collaborative design theories to support Army Installation Transformation. The project will lead to leap-ahead technologies to solve military-unique problems in the planning, programming, design, construction, and sustaining of deployed facilities (buildings, etc.) and energy and utility infrastructure. This project supports exploratory development efforts in program element 0602784A, projects T41 and T45. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan and Project Reliance. The program element contains no duplication with any effort within the Military Departments. Work is performed by the U.S. Army Engineer Research and Development Center. This project supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2001 Accomplishments:
- 1534   - Completed axiomatic collaboration design theory to improve design quality.

       - Formulated micro-mechanical failure models for Fiber Reinforced Polymer (FRP) composite materials for cost effective non-disruptive facility seismic rehabilitation.

Total   1534

FY 2002 Planned Program
- 1613   - Investigate ability of collaborative design theory to simulate the design process and product engineering conflict.

       - Enhance fundamental micromechanical stiffness and strength models of infrastructure FRP Composites for improved ductility of seismic connection.

Total   1613

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)	February 2002

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

FY 2003 Planned Program

- 1641   - Investigate algorithms to optimize facility planning/design processes to improve transformation requirements-match and increase throughput.

       - Formulate moisture/temperature material property transport models for long-term performance modeling of structural composite materials.

Total   1641

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

February 2002

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

COST (In Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
T24 SNOW/ICE & FROZEN SOIL	2346	2189	1244	1246	1257	1328	1354

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. These investigations lead to improved understanding of the terrestrial environments and near surface in all seasons. 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 thus provides the knowledge base for understanding and assessing environmental impacts critical to battlespace visualization. The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan and Project Reliance. The program element contains no duplication with any effort within the Military Departments. This work is performed by the U.S. Army Engineer Research and Development Center. This project supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2001 Accomplishments:

- 1137   - Parameterized complex behavior of boundary layer turbulent energy exchange over snow for validating sensor design parameters and performance expectation.

       - Investigated acoustic wave propagation in snow, frozen ground, and urban terrains for application to wide area munition sensor technology.

       - Determined the effectiveness of current decontamination solution "decon green" to destroy surrogate biological agents (anthrax type spores) in a winter environment for battlefield and Homeland Security areas.

- 1209   - This one year Congressional add (Project T24) completes efforts that identified degradation (fracturing) processes associated with freezing of composite materials and investigated the impact of cloud water content variability on aircraft icing. No additional funding is required to complete this effort.

Total   2346

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)	February 2002

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

FY 2002 Planned Program

- 1189   - Investigate terrain geometry and material properties controlling millimeter-wave signatures. This work will impact vehicle mounted obstacle detection systems.

  - Determine military unique seismic/acoustic signatures to improve sensor target detection and classification performance in urban areas and snow covered terrain.

  - Investigate sensor fusion strategies to measure aerosolized endospores in complex natural environments. This supports remote detection and identification.

- 1000   - This one year Congressional add (Project T24) completes efforts to investigate physical properties of snow effecting microwave extinction for deep snow conditions and frozen ground chemistry effecting the complex dielectric constant of soil. No additional funding is required to complete this project.

Total   2189

FY 2003 Planned Program

- 1244   - Investigate a new deformation modeling approach for snow and other deformable materials to formulate a physic-based theory. This effort supports conceptual vehicle mobility design and performance evaluation of wheeled and tracked vehicles.

  - Identify environmental enablers to ground-wave communication technologies as low-detectability (and wireless) alternatives to traditional airwave and wire communications.

  - Determine the physical property dynamics related to seasonal environmental transitions of electromagnetic signatures. This work supports model formulation to improve predictions of sensor performance in highly complex terrain.

Total   1244

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

February 2002

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

COST (In Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
T25 ENVIRONMENTAL RES-COE	4128	4551	4627	4691	4774	4918	5018

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 cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan and Project Reliance. The program element contains no duplication with any effort within the Military Departments. Work is performed by the U.S. Army Engineer Research and Development Center. This project supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2001 Accomplishments:

- 4128   - Completed 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.

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

    - Identified 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.

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

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

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

FY 2001 Accomplishments: (Continued)

- Completed 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.

- Completed 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.

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

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

- Determined 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.

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

- Developed 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.

Total   4128

FY 2002 Planned Program

• 3310   - 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 fromblast 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.

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

FY 2002 Planned Program (Continued)

- 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.

- 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.

- •   1241   - Establish basic understanding of physical, chemical, and biological phenomena specific to contaminant toxicity assessment and mineralization and to ecosystem maintenance, mitigation, and rehabilitation.

Total   4551

FY 2003 Planned Program

- •   1895   - Characterize large molecular weight degradation products on biodegradation of RDX for remediating contaminated environments.

- Establish adaptations to physiological stress response in endangered bird species to military versus non-military stressors to determine role of behavioral habituation in the physiological stress response of endangered avian species.

- Map genome traits of grasses shown to have improved establishment and resilience characteristics.

- Complete the determination of 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.

- Determine optimum experimental/numerical approaches to describe how various mixtures and concentrations of contaminant become more or less toxic to support the development of quantitative hazard/risk assessment methods.

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

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)	February 2002

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

FY 2003 Planned Program (Continued)

        - Complete investigation of how explosives vapors travel up through snow and frozen soil to describe optimum explosives vapors detection under a variety of environmental conditions.

        - Use natural soils to further determine how specific soil physical and chemical properties affect how much explosives contamination is accumulated and are toxic to soil invertebrates such as earthworms. This will serve as a basis for the development of risk-based site assessments of explosives contaminated sites.

        - Identify at the particle and sub-particle scale where and how TNT and TNT transformation products (nitroaromatics) are bound to soils and how this affect availability, binding, and toxicity to resident plants and animals.

-     2732   - Establish basic understanding of physical, chemical, and biological phenomena specific to contaminant toxicity assessment and mineralization and to ecosystem maintenance, mitigation, and rehabilitation.

Total   4627