PE NUMBER: 0602202F
PE TITLE: Human Effectiveness Applied Research

Exhibit R-2, RDT&E Budget Item Justification

DATE: February 2004

BUDGET ACTIVITY: 02 Applied Research

PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	75.229	87.143	71.483	74.724	86.961	79.517	81.008	0.000	0.000
1123	Warfighter Training	10.640	10.537	11.116	12.262	15.921	13.974	14.335	0.000	0.000
1710	Deployment and Sustainment	10.744	7.615	8.870	9.008	10.692	10.098	10.350	0.000	0.000
7184	Crew System Interface & Biodynamics	26.735	39.982	35.420	38.768	41.646	38.373	38.856	0.000	0.000
7757	Bioeffects and Protection	27.110	29.009	16.077	14.686	18.702	17.072	17.467	0.000	0.000

Note: In FY 2003, the protection program at Brooks City-Base, Texas, moved from Project 7184 to Project 7757 to align resources with the Air Force Research Laboratory organization. In FY 2003, space unique tasks in Project 7184 were transferred to PE 0602500F in conjunction with the Space Commission recommendation to consolidate all space unique activities.

(U) A. Mission Description and Budget Item Justification

This program establishes technical feasibility and develops technology for protecting and enhancing human effectiveness for Air Force weapon systems and for operational readiness. The program addresses warfighter training, deployment and sustainment of forces, crew system interface, biodynamic response, directed energy bioeffects, and crew protection. The Warfighter Training project focuses on the development and evaluation of new methods and technologies to enhance Air Force training and education. The Deployment and Sustainment project develops and evaluates technologies that will increase weapon systems and force supportability. The Crew System Interface and Biodynamics project develops and evaluates technologies that will improve the performance and combat effectiveness of humans. The Bioeffects and Protection project develops technologies to predict and mitigate the biological effects of aerospace stressors and directed energy on personnel and mission performance.
Note: In FY 2004, Congress added $1.5 million for Flexible Display and Integrated Communication Device for the Battlefield Air Operations (BAO), $1.4 million for Three-Dimensional (3-D) Auditory Display, $1.8 million for Special Operations Target Acquisition and Control Suite, $1.8 million for Direct Liquid Ethanol Delivery System (DLEDS) for USAF Special Operations Forces (SOF) Combat Control Team BAO Kit, $10.2 million for Integrated Medical Information Technology System (IMITS) Initiative, $1.0 million for Advanced Thermal Protection Systems (ATPS), $1.0 million for Nanoparticles for the Detection and Neutralization of Bioterrorist Agents, $1.0 million for Mobile Molecular Test Laboratory, and $1.4 million for Solid Electrolyte Oxygen Separator.
This program is in Budget Activity 2, Applied Research, since it develops and determines the technical feasibility and military utility of evolutionary and revolutionary technologies.

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(U) B. Program Change Summary ($ in Millions)

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	76.707	66.795	68.693
(U)	Current PBR/President's Budget	75.229	87.143	71.483
(U)	Total Adjustments	-1.478	20.348	
(U)	Congressional Program Reductions		-0.005	
	Congressional Rescissions		-0.747	
	Congressional Increases		21.100	
	Reprogrammings			
	SBIR/STTR Transfer	-1.478		
(U)	Significant Program Changes:			
	Not Applicable.			

Exhibit R-2a, RDT&E Project Justification			DATE: February 2004
BUDGET ACTIVITY: 02 Applied Research	PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research	PROJECT NUMBER AND TITLE: 1123 Warfighter Training	

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
1123 Warfighter Training	10.640	10.537	11.116	12.262	15.921	13.974	14.335	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops and evaluates new methods and technologies in support of Air Force training and education requirements. The efforts focus on aircrew training; technical training; mission rehearsal; training in support of complex decision-making; information warfare training; and warfare readiness training. It investigates the spectrum of new and advanced training and education technologies to design and implement training, and to evaluate training effectiveness. It evaluates desktop tutors, courseware development tools and technologies, assessment methodologies, and simulation technologies to achieve maximum learning effectiveness for specific needs at minimum cost. These technologies and methods will increase operational readiness by providing more effective methods and approaches to train and assess personnel. This project contributes to a more highly trained and flexible cadre of personnel at a reduced cost.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Research perceptual issues involving the development of new visual technologies to enhance Distributed Mission Operations environments. Research identifies the visual requirements necessary for realistic aircrew training and mission rehearsal, allowing Air Force warfighters to train as they intend to fight.	1.556	1.553	1.646
(U) In FY 2003: Assessed technical performance of advanced ultrahigh resolution image generation, ultrahigh resolution projectors, and collimating display screen technologies. Determined feasibility of these technology developments for the next generation Distributed Mission Training (DMT) simulator.			
(U) In FY 2004: Identify requirements for and evaluate the capabilities and performance of various visual system technologies. Define the visual requirements relevant to performing the DMT tasks, identify which visual system characteristics and parameters have significant perceptual effects, and determine how the visual system can be optimized to minimize artifacts and to maximize image quality. Identify functional requirements for deployable and helmet-mounted display technologies for fast jet visual simulation. Quantify the effect network time delays have on aircrew visual-task performance.			
(U) In FY 2005: Develop and apply techniques and devices to evaluate projector displays and visual system components. Evaluate existing and proposed Helmet-Mounted Displays (HMD) and deployable display technologies for use in visual simulation and training. Identify specifications of the functional requirements for deployable displays and HMDs for training and recommend features required beyond those in commercially available devices.			
(U)			
(U) MAJOR THRUST: Research new computer representation technologies used in distributed simulation-based training. Technologies include representation of the visual, electronic, and sensor world; the weather; and the behavior of computer-generated forces, threats, and larger wargaming models. Note: Representation technologies	2.030	0.000	0.000

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	research completed in FY 2003 enables the research in the next two major thrusts.			
(U)	In FY 2003: Improved rate of learning by developing pilot performance diagnostics for end game tactical engagements for use in mission debrief. Determined feasibility of using large constructive wargaming model as a manager of all participating entities in distributed combat exercises. Assessed existing high-fidelity weather models as weather servers for all players in a distributed training exercise. Analyzed methods for eliminating undesirable artifacts from the satellite source data used to build visualization tools and databases.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	MAJOR THRUST: Develop tools, strategies, and performance support methods for improving combat mission training, rehearsal, and operations for aircrews and command and control forces. Research provides the combat air forces and global strike operations with the empirical data and guidelines for improving the quality and effectiveness of both air and command and control Distributed Mission Training (DMT) and live flight training environments through the identification of competency-based training methods. Note: Representation technologies research from earlier major thrust enables training and rehearsal tools research in FY 2004.	5.798	7.774	4.987
(U)	In FY 2003: Completed validation of tools to facilitate continuous learning for critical air combat skills and linked these tools to skills in domains such as intelligence, surveillance, and reconnaissance, and information operations. Completed operational validation studies of metrics that identify and prioritize mission essential content that can be delivered in deployable, desktop training environments located in field settings. Identified mission essential competencies underlying air superiority and global attack skills. Developed DMT content and scenarios for expeditionary force spin-up training and rehearsal.			
(U)	In FY 2004: Complete specifications of mission essential competencies for operators in major air operations center divisions and teams. Complete preliminary training effectiveness evaluations with the Air Force Weapons School and an operational mission training center. Develop study plan for dynamic aerospace control training incorporating command and control, air combat, and coalition entities.			
(U)	In FY 2005: Complete guidelines for applying DMT to the Air Combat Command Ready Aircrew Program training and mission objectives based on identified competencies. Complete specification of mission essential competencies for operators in Air Operations Center specialty teams and unique positions. Develop competency-based behavioral models and representations of select operators for use in simulation-based training systems. Complete development of specification tools for coalition training and collaborative mission planning.			
(U)				
(U)	MAJOR THRUST: Explore performance improvement techniques for individuals and teams to enhance aerospace operational training in realistic mission training environments. Validate training principles, guidelines, and criteria to enhance command and control training exercises. Note: Training and rehearsal tools research from earlier major	1.256	1.210	4.483

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
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thrust enables performance improvement techniques research in FY 2005.

(U) In FY 2003: Validated mission essential competencies for selected Air Operations Center individuals and teams. Determined feasibility of using enhanced performance assessment tools in command and control training exercises.

(U) In FY 2004: Utilize quantitative data collection techniques to analyze the overall functional process, as well as individual component tasks. Devise techniques to overcome training process shortfalls or inefficiencies.

(U) In FY 2005: Enhance air and space operations through the development of training principles, guidelines, and criteria for use in synthetic training environments. Explore application of cognitive science principles for use in preparing and sustaining aerospace expeditionary forces.

(U) Total Cost	10.640	10.537	11.116

(U) C. Other Program Funding Summary ($ in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0602233N, Human Systems Technology.									
(U) PE 0602716A, Human Factors Engineering Technology.									
(U) PE 0602785A, Personnel Performance and Training Technologies.									
(U) PE 0603231F, Crew Systems and Personnel Protection Technology.									
(U) PE 0604227F, Distributed Mission Training (DMT).									
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE: February 2004
BUDGET ACTIVITY: 02 Applied Research	PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research	PROJECT NUMBER AND TITLE: 1710 Deployment and Sustainment	

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
1710 Deployment and Sustainment	10.744	7.615	8.870	9.008	10.692	10.098	10.350	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops technologies to support the enhancement of the deployment and sustainment capabilities critical to Agile Combat Support and Air Expeditionary Force (AEF) operations. The research focuses on technologies that have the potential to reduce the time required for units to plan, pack up, and deploy, and to reduce airlift requirements, while enhancing deployed capabilities. It investigates and evaluates technologies to enhance the sustainment of deployed forces in contingency operations and to improve logistics support for both combat and peacetime operations. It develops toxicological tools and technology to minimize the risks and mission impact to DoD personnel from exposure to hazardous chemicals, while also reducing weapon systems life cycle cost.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop logistics sustainment technology options and perform feasibility studies to support large-scale advanced technology development programs. These technologies will lead to more supportable weapon systems at reduced logistics support costs.	1.864	1.183	1.746
(U) In FY 2003: Developed transformation algorithms and interface requirements for virtual validation of maintenance technical order data. Developed artificial intelligence software components to realistically model team decision-making in synthetic environments.			
(U) In FY 2004: Complete development of transformation algorithms and interface requirements for virtual validation of maintenance technical order data. Develop software components to realistically model human interaction with synthetic team members. Develop advanced human-computer interface technology for logistics and control systems.			
(U) In FY 2005: Conduct research to establish the science base for simulation of cognitive behavior. Develop algorithms and interface requirements for logistics reachback in support of contingency operations. Develop software components to accurately model mixed initiative (human and synthetic actor) decision-making support.			
(U)			
(U) MAJOR THRUST: Develop logistics readiness technology options and perform feasibility studies to support large-scale advanced technology development programs. These technologies will lead to more efficient utilization of logistics resources for AEF operations.	1.770	2.592	1.896
(U) In FY 2003: Conducted feasibility studies and devised preliminary plans for the presentation of various types of information to maintenance and logistics personnel to include both the information presented and the platforms to be used. Defined technology requirements and component research areas necessary to support a completely automated maintenance environment.			
(U) In FY 2004: Continue to conduct feasibility and usability studies for the presentation of various types of information			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
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	to maintenance and logistics personnel to include both the information presented and the platforms to be used. Continue work to define the technology requirements and component research areas necessary to support a completely automated maintenance environment. Identify advanced simulation requirements and technology options for Air Force units to select the best options for using limited logistics resources in crisis action circumstances.			
(U)	In FY 2005: Examine new techniques to identify both functional and system requirements, as well as new information presentation techniques for future logistics and maintenance software tools. Continue working to define the requirements and component technologies necessary to support a more automated and responsive maintenance environment. Design foundational models for advanced simulation capabilities that optimize limited logistics resources during operations.			
(U)				
(U)	MAJOR THRUST: Develop, demonstrate, and apply predictive assessment models to determine the toxicological risks to warfighters if exposed to operational compounds and materials. This will improve the commanders' decision-making ability to properly balance mission and force protection requirements.	4.672	3.840	3.849
(U)	In FY 2003: Established biologically based approach for predicting skin irritation from dermal contact with fuels, solvents, and other hazardous chemicals used in the DoD. Developed innovative biotechnology techniques employing genomics and proteomics to identify exposure of animals to toxic substances and began to employ that information to develop human biologically based toxicity models.			
(U)	In FY 2004: Investigate the use of genomics, proteomics, and metabonomics to predict toxic combinations of chemicals and to measure exposures of warfighters to toxic chemicals before any adverse health effects occur. Develop simulation models to predict the effects upon the warfighter in different exposure situations.			
(U)	In FY 2005: Develop biotechnology procedures and computer simulation models to predict effects of toxic exposure on the warfighter and improve the protection of Air Force personnel. Develop and demonstrate algorithms to describe the function of a cell-like entity with the potential for improved logic, sensor, and bio-electromechanical capability for Air Force systems.			
(U)				
(U)	MAJOR THRUST: Develop Nuclear Magnetic Resonance (NMR) technologies that will identify warfighter exposure to toxic chemicals before they result in illness or a reduction in mission performance, thus greatly improving force protection and the probability of mission success. Note: Broken out from previous major thrust due to increased emphasis in this area.	0.000	0.000	1.379
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Conduct NMR studies to identify target-organ biomarkers in body fluids of the deployed warfighter exposed to hazardous agents. Validate target-organ NMR pattern recognition algorithms for early detection of the effects of unknown hazardous agents on Air Force personnel.			

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(U)				
(U)	CONGRESSIONAL ADD: Biotechnology - Cellular Dynamics and Engineering.	2.438	0.000	0.000
(U)	In FY 2003: Performed biotechnology cellular dynamics research through a not-for-profit collaboration with industry and affiliated universities within the facilities of the Air Force Research Laboratory. Researched and developed principles of integrated cellular control systems for use in innovative, cell-based technologies for Air Force applications.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	10.744	7.615	8.870

(U) C. Other Program Funding Summary ($ in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0602233N, Human Systems Technology.									
(U) PE 0602716A, Human Factors Engineering Technology.									
(U) PE 0603231F, Crew Systems and Personnel Protection Technology.									
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE: February 2004
BUDGET ACTIVITY: 02 Applied Research	PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research	PROJECT NUMBER AND TITLE: 7184 Crew System Interface & Biodynamics	

Cost ($ in Millions)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
7184	Crew System Interface & Biodynamics	26.735	39.982	35.420	38.768	41.646	38.373	38.856	0.000	0.000
	Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, the protection program at Brooks City-Base, Texas, moved from Project 7184 to Project 7757 to align resources with the Air Force Research Laboratory organization. In FY 2003, space unique tasks in Project 7184 were transferred to PE 0602500F in conjunction with the Space Commission recommendation to consolidate all space unique activities.

(U) A. Mission Description and Budget Item Justification

This project develops the technology required to improve human performance, biodynamic response, and survivability in operational environments. This is accomplished by defining the physical and cognitive parameters, capabilities, and limits of systems operators; determining human responses to operational stresses such as noise, impact, vibration, maneuvering acceleration, spatial disorientation, and workload; and optimizing the human-machine interface. The project produces human-centered design criteria, guidelines, and automated design tools for the development of effective crew-systems interface. It develops and assesses technologies for information display, human-centered information operations, team communications, and modeling and simulation. It conducts experiments and evaluations of control interfaces, crew station layout and functional integration, aircrew information processing, crash protection, and emergency escape technologies.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop interface technologies for multi-sensory adaptive controls and displays, performance metrics, and human speech processing and control solutions that promote intuitive interface design.	3.952	4.857	5.110

(U) In FY 2003: Evaluated methods for employing real-time measurement of crew workload as it changes with mission events to adjust automation and decision support in multi-ship, unmanned air vehicle missions. Developed concept for intelligent, on-line physical accommodation tools to optimize equipment fit, enabling future crew stations and equipment to adapt to human variability. Completed laboratory experiments exploring crew interface concepts for airborne command and control, demonstrated an advanced crew station for airborne early warning, and explored interface technologies for supervision of multiple autonomous unmanned air vehicles.

(U) In FY 2004: Demonstrate a real-time ability to use on-line estimates of crew workload and situation awareness to adjust automation during future unmanned combat air vehicle missions. Perform laboratory demonstration of multi-sensory display concepts and technology for virtual air command in airborne early warning missions, and continue to assess the impact of near-term and far-term autonomous vehicle capability on the remote interface and decision support requirements of intelligent unmanned air vehicles. Perform research on speech signal processing and speech-based countermeasures for information operations, and explore the concept of a robust stressed-speaker identification capability.

(U) In FY 2005: Demonstrate the feasibility of a situational awareness estimator to improve real-time task sharing during

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	multi-platform unmanned combat air vehicle missions. Continue to explore the decision support benefits of multi-sensory controls and displays for intelligent autonomous air vehicles and for multi-mission command and control aircraft, and extend their functionality beyond airborne early warning missions. Perform laboratory simulations to determine strike chain efficiencies achievable from network-centric interfaces that span airborne controllers, unmanned vehicles, and special forces on the ground. Continue research on speech signal processing and speech-based countermeasures for information operations and demonstrate a multimedia speech extraction interface.			
(U)				
(U)	MAJOR THRUST: Develop cognitive information technology for time-critical command and control to achieve common understanding at all echelons of information operations and improve decision-making and predictive battlespace awareness.	3.989	3.740	2.614
(U)	In FY 2003: Compared conceptual design options for a cognitive interface and knowledge repository to support information operations in the future Air Operations Center (AOC). Improved the ability to fuse imagery and signals intelligence in support of the Targets Under Trees program. Researched speech signal processing and speech-based countermeasures for information operations and commenced a multi-year program to demonstrate a robust stressed-speech identification capability including foreign language speech recognition.			
(U)	In FY 2004: Perform laboratory and field evaluations of a cognitive interface and knowledge repository to support information operations in the future AOC. Commence exploration of information, display, and course-of-action aids by analyzing information needs and by developing a combat operations visualization concept. Continue to support the Targets Under Trees program by evaluating target nomination advances in a field exercise.			
(U)	In FY 2005: Transition to advanced development a cognitive interface and knowledge repository to support information operations in the future AOC. Continue a multi-year exploration of information, display, and course-of-action aids by demonstrating a multi-mode information interface to speed air tasking orders.			
(U)				
(U)	MAJOR THRUST: Develop concepts for integrating human-computer interface technologies, by using models of human behavior, and real-time simulations to quantify operational benefits from new interface technologies.	3.208	3.497	3.851
(U)	In FY 2003: Developed simulation software for an integrated, unmanned air vehicle crew station. Developed operator-vehicle interface concepts for mobility using real-time, off-board data to assure tactical information dominance with minimum crew size. Explored control-display technology options for unmanned reconnaissance vehicles, and began to assess human performance requirements and fusion of on-board and off-board sensor data with imagery in a single display. Aggregated models of human perception, decision-making, and control in selected military combat scenarios.			
(U)	In FY 2004: Demonstrate an operator-vehicle interface for mobility using real-time, off-board data to assure tactical information dominance with minimum crew size. Demonstrate a control-display interface to reduce task load and channelized attention for single operator control of multiple unmanned combat air vehicles. Continue to evolve new			

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models of human perception, decision-making, and control, and explore model validation strategies.

(U) In FY 2005: Begin to research requirements and applications for cognitive decision-aiding technologies that will enable human supervision and control of swarming or distributed teams of semi-autonomous vehicles. Continue to explore a control-display concept that reduces task load and channelized attention for unmanned combat air vehicles, and evaluate its use for secondary missions of air refueling and electronic attack. Explore the practicality of human behavior models to reliably evaluate displays, develop fusion algorithms that combine on-board and off-board sensor data with imagery, and simulate the ability of a single operator to perform multiple tasks of target nomination.

(U)

(U) MAJOR THRUST: Develop visual display interface technologies, specifically Helmet-Mounted Displays (HMD), night vision technologies, and large flat-panel displays, and develop an understanding of the effects of vision through display optics, vehicle transparencies, and synthetic vision.	3.910	4.108	4.259

(U) In FY 2003: Demonstrated the ability to calibrate color displays in the field environment to permit evaluating operational system displays, and developed an approach to model image quality. Quantified the effects of binocular disparity and distortion, which negatively affect vision through helmet transparencies and windscreens. Determined feasibility and technical approach for exploiting color night vision in HMDs. Developed testing standards for large flat-panel displays.

(U) In FY 2004: Continue to quantify the effects of binocular disparity, lasers, and distortion through helmet visors and windscreens. Begin to develop target acquisition and location symbology for HMDs. Investigate helmet-mounted tracker technology requirements for HMDs to replace aircraft head-up displays. Begin to assess visual performance measures suitable for predicting display requirements under realistic viewing conditions.

(U) In FY 2005: Determine ways to reduce the negative effects of binocular disparity, lasers, and distortion through helmet visors. Continue to develop HMD target acquisition and location symbology to reduce decision uncertainty during targeting. Evaluate design options that permit HMDs to replace legacy head-up displays in aircraft, and explore HMD benefits in remote presence applications. Continue to assess visual performance measures suitable for predicting display requirements under realistic viewing conditions. Begin to develop algorithms to enhance vision electronically when using head-mounted solid-state imagers.

(U)

(U) MAJOR THRUST: Develop advanced audio display technologies, including three-dimensional (3-D) audio, active noise reduction, and related technologies that mitigate effects of noise and enhance performance in the operational environment.	2.968	3.583	3.418

(U) In FY 2003: Demonstrated feasibility of 3-D audio for security forces to localize threats and speed acoustic remote threat detection in perimeter defense. Recommended technologies, assessed technology risk, and created plan to develop a high performance (50 dB) hearing protection system. Integrated a dynamic noise model with real-time visualization of the sound field, usable for environmental analysis to characterize the noise environment around

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airfields, and usable for developing in-flight tactics in vectored thrust aircraft to minimize acoustic detection by adversaries.

(U) In FY 2004: Continue technology development for acoustic remote threat detection in perimeter defense and recommend auditory symbology for security forces. Characterize the expected acoustic noise reduction achievable with earplugs for a high performance (50 dB) hearing protection system. Continue to develop a dynamic noise model that can be integrated with real-time visualization of the sound field, usable for environmental analysis to characterize the noise environment around airfields, and usable for developing in-flight tactics in vectored thrust aircraft to minimize acoustic detection by adversaries.

(U) In FY 2005: Complete technology assessment of acoustic remote threat detection in perimeter defense, and explore the use of acoustic detection capabilities by special tactics forces. Demonstrate the feasibility of combining active noise reduction with 3-D audio communications for a high performance (50 dB) hearing protection system. Identify and develop a concept to validate the dynamic noise model in terms of lowering the cost of collecting acoustic data, and explore acoustic modeling for environmental analysis. Begin to analyze how to minimize acoustic detection of vectored thrust aircraft. Begin to develop virtual audio interface technology using dynamic audio/visual interaction for use with helmet-mounted displays.

(U)

(U) MAJOR THRUST: Develop integrated human-centered information operations technologies to provide quicker and more intuitive access to information, enhanced decision-making capabilities, and more effective training procedures.	0.713	5.947	6.003

(U) In FY 2003: Refined human perception management tools for potential weaponization in offensive and defensive counter-information operations. Developed concepts of operation for effects-based planning, demonstrations of next-generation planning and decision aids, and warfighter-tailored information visualizations that specifically focus on information operations.

(U) In FY 2004: Conduct research to develop, distribute, and synchronize knowledge, training, and decision-making among various team members, multiple support teams, and reachback locations via advanced collaboration technologies and environments in order to enhance predictive battlespace awareness within information operations. Determine feasibility and technical approach for developing adversary cultural decision models, and development of training techniques and tools for information warriors.

(U) In FY 2005: Conduct research to develop information operations natural collaboration links, training, cultural modeling, and predictive battlespace awareness capabilities. Develop proof-of concept technologies to specify, measure, and model key parameters.

(U)

(U) MAJOR THRUST: Develop human injury criteria and protective system technologies for use against risks encountered in crash and other hazardous environments. Research will develop technologies to ensure full aircrew population accommodation and safety during aircraft and vehicle operations including vibration, crashes, emergency	5.146	5.527	4.243

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escape, extended missions, and parachute opening shock.

(U) In FY 2003: Revised injury criteria based on data from actual mishaps with ejection seat data recorder. Developed adaptable restraint system technologies, ensuring safety and expedient accommodation of diverse warfighters in Air Force transportation platforms. Human performance research results from simulated dynamic flight environments will improve aircrew performance in the operational environment. Research provided cognitive performance and human information processing models that can be incorporated in war games and simulation-based acquisition models to accurately reflect the effects of physical stressors on human performance and mission effectiveness.

(U) In FY 2004: Revise injury criteria to account for variations in biodynamic response based on aircrew size and gender. Develop initial helmet weight and center of mass limits for symmetric and asymmetric Helmet-Mounted Display (HMD) systems based on crew performance in operational maneuvering environments. Human information processing in this dynamic environment will be quantified and applied to models that can be incorporated in wargaming and simulation-based acquisition models.

(U) In FY 2005: Investigate and evaluate technologies to ensure full aircrew population safety during aircraft and vehicle operations including vibration, crashes, emergency escape, extended mission, and parachute opening shock. Continue to revise injury criteria to account for variations in biodynamic response based on individual crewmember differences in size and gender. Investigate seating systems to improve crewmember comfort while maintaining safety during emergency escape or other mishap. Continue development of helmet weight and center of mass limits for symmetric and asymmetric HMD systems to ensure safety during emergency escape.

(U)

(U) MAJOR THRUST: Quantify and model the effects of aerospace stressors on pilot performance, cognitive function, and safety in dynamic flight environments. Develop design criteria to ensure effectiveness and safety of helmet-mounted systems during maneuvering acceleration. Note: Broken out from previous major thrust due to increased emphasis in this area.	0.000	0.000	3.222

(U) In FY 2003: Not Applicable.

(U) In FY 2004: Not Applicable.

(U) In FY 2005: Continue development of helmet-mounted systems design criteria for the full aircrew population based on crew performance in operational maneuvering environments. Refine models for human information processing in the dynamic environment and initiate incorporation into wargaming and simulation-based acquisition.

(U)

(U) MAJOR THRUST: Develop technologies to counter Spatial Disorientation (SD) and improve pilot performance, resulting in increased mission effectiveness and decreased loss of lives and aircraft lives due to SD mishaps.	1.872	2.280	2.700

(U) In FY 2003: Integrated emerging technologies such as three-dimensional (3-D) audio and pathway-in-the-sky displays to improve pilots' ability to maintain spatial orientation and to aid recognition and recovery from spatial disorientation if it should occur.

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602202F Human Effectiveness Applied Research**	PROJECT NUMBER AND TITLE **7184 Crew System Interface & Biodynamics**

(U)	In FY 2004: Pathway-in-the-sky symbology will be transitioned from a head-up display format to HMD simulator trials. Ground-based SD training criteria will be developed to better define training devices that can be procured for training purposes. Alternative HMD off-boresight flight symbology will be flight-tested, and 3-D audio, tactile stimulation, and intuitive flight displays will be integrated in motion-based flight simulator testing.			
(U)	In FY 2005: Complete flight-testing of Pathway-in-the-sky utilizing a HMD to complete the transition from Head-Up Display to HMD. Develop a syllabus for SD countermeasure training for the Integrated Panoramic Night Vision Goggles and specific recommendations for the optimum mix of visual, audio, and tactile cueing to avoid spatial disorientation.			
(U)				
(U)	CONGRESSIONAL ADD: Three-Dimensional (3-D) Audio Display Technology.	0.977	1.388	0.000
(U)	In FY 2003: Developed a low-cost PC-based 3-D audio display system for enhancing the safety of general aviation aircraft. Developed spatial audio symbology for increasing the situational awareness of general aviation pilots. Demonstrated benefits of 3-D audio cueing in general aviation flight operations using immersive flight simulations and tests.			
(U)	In FY 2004: Conduct flight demonstration of low-cost 3-D audio technology usable for collision avoidance, navigation, and situational awareness enhancement in general aviation aircraft. Develop improved audio icons permitting recognition of multiple, simultaneous, spatially localized warning sounds in tactical military aircraft. Conduct virtual simulations to explore when, where, and how 3-D audio technology should be used in conjunction with visual displays in fast jet aircraft.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Flexible Display and Integrated Communication Device for the Battlefield Air Operations (BAO).	0.000	1.487	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Initiate development of flexible display and integrated communications device technology for battlefield air operations. Formulate and develop a technology concept that extends the capabilities of special tactics/special forces units that operate on the ground in forward areas of battle in their role supporting close air support, air traffic control, and target identification/designation. Analyze and identify critical functions and their rollout priority using a series of proof-of-principle experimental systems. Fabricate breadboard components and commence validation in a laboratory environment.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Special Operations Target Acquisition and Control Suite.	0.000	1.784	0.000
(U)	In FY 2003: Not Applicable.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602202F Human Effectiveness Applied Research**	PROJECT NUMBER AND TITLE **7184 Crew System Interface & Biodynamics**

(U)	In FY 2004: Apply knowledge management software and display aids to improve target identification, analysis, and prosecution of time-sensitive fixed and mobile targets by Special Operations Forces while improving situational awareness. This will include custom software to simplify manual threat recognition and situation assessment. Research means to integrate sensor data with intelligence inputs, communication links, and computer equipment to rapidly determine threat level and priority.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Direct Liquid Ethanol Delivery System (DLEDS) for USAF Special Operations Forces (SOF) Combat Control Team Battlefield Air Operations (BAO) Kit.	0.000	1.784	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Demonstrate the feasibility of a DLEDS to enhance the effectiveness of SOF combat control teams in battlefield air operations. Included are radical extensions to battery life for wearable computers and peripheral equipment by means of fuel cells or other electrical power storage mechanisms. Explore lightweight and durable technologies to curtail stray electromagnetic emissions from wearable computers on the battlefield, and develop custom design options for wearable computers that are tailored for the warfighter.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	26.735	39.982	35.420

(U) C. Other Program Funding Summary ($ in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0602201F, Aerospace Flight Dynamics.									
(U) PE 0602204F, Aerospace Sensors.									
(U) PE 0602500F, Multi-disciplinary Space Technology.									
(U) PE 0602702F, Command, Control, and Communications.									
(U) PE 0603205F, Flight Vehicle Technology.									
(U) PE 0603231F, Crew Systems									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602202F Human Effectiveness Applied Research**	PROJECT NUMBER AND TITLE **7184 Crew System Interface & Biodynamics**

(U) C. Other Program Funding Summary ($ in Millions)

and Personnel Protection Technology.

(U) PE 0603245F, Flight Vehicle Technology Integration.

(U) PE 0604706F, Life Support Systems.

(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE: **February 2004**

BUDGET ACTIVITY: **02 Applied Research**

PE NUMBER AND TITLE: **0602202F Human Effectiveness Applied Research**

PROJECT NUMBER AND TITLE: **7757 Bioeffects and Protection**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
7757 Bioeffects and Protection	27.110	29.009	16.077	14.686	18.702	17.072	17.467	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, the protection program at Brooks City-Base, Texas, moved from Project 7184 to Project 7757 to align resources with the Air Force Research Laboratory organization.

(U) A. Mission Description and Budget Item Justification

This project predicts and mitigates the effects of exposure to radio frequency energy, high power microwaves, ultra-wideband pulsed fields, lasers, warfighter fatigue, altitude, and high, rapid-onset gravitational forces. The project enables the safe operational use of Air Force aerospace systems through technology developments that ameliorate/counter/exploit the biological effects of aerospace stressors including directed energy. It addresses areas such as safety, risk assessment, mission planning, countermeasures, and aircrew protection. The project also assesses the bioeffects of non-lethal directed energy technologies for force protection, special operations, military operations other than war, and peacekeeping applications.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Conduct laser optical bioeffects laboratory experiments and field research, enabling exploitation of laser technology while providing countermeasures for optical hazards/threats with and without laser eye protection.	5.567	5.368	5.402

(U) In FY 2003: Established feasibility of building a device to allow the evaluation of human vision impacts of multi-wavelength lasers. Completed study on the safety and effectiveness of emerging compact, ultrashort pulse laser technologies for both anti-materiel and non-lethal weapons applications. Developed an in vitro cell culture to conduct threshold damage studies which will reduce reliance on in vivo experimentation. Demonstrated optical technology for information warfare and perception management applications.

(U) In FY 2004: Begin developing technologies to evaluate human vision impacts of multi-wavelength lasers. Continue to investigate the safety and effectiveness of emerging compact, ultrashort pulse laser technologies for both anti-materiel and non-lethal weapons applications. Continue to explore new methods of conducting threshold damage studies to reduce reliance on in vivo experimentation. Develop bioeffects-based safety criteria for test, deployment, and use of high-energy laser systems.

(U) In FY 2005: Continue developing technologies to evaluate human vision impacts of multi-wavelength lasers. Begin development of technologies to improve combat vision and provide eye protection in an integrated concept. Continue to investigate the safety and effectiveness of emerging compact, ultrashort pulse laser technologies for both anti-material and non-lethal weapons applications. Continue to explore new methods of conducting threshold damage studies to reduce reliance on in vivo experimentation. Continue to develop bioeffects-based safety criteria for test, deployment, and use of high-energy laser systems.

(U)

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research	PROJECT NUMBER AND TITLE 7757 Bioeffects and Protection

(U)	MAJOR THRUST: Conduct radio frequency bioeffects laboratory experiments to enable safe exploitation of directed energy.	5.895	4.599	4.711
(U)	In FY 2003: Asessed the biological effects of high power microwave and nanosecond pulse emissions. Evaluated cellular effects of radio frequency energy. Completed the updated laboratory and field Radio Frequency Radiation (RFR) dosimetry tools for assessment of RFR exposure dose assessments by bioenvironmental engineering and occupational health personnel. Developed radio frequency and optical radiosensitive biotechnology tools to counter the proliferation of biological weapons of mass destruction.			
(U)	In FY 2004: Extend radio frequency dosimetry model to millimeter range. Evaluate bioeffects of high peak power and ultra-wideband microwaves on neural processing and performance. Complete evaluation of RFR personal recording device. Enhance and apply laboratory techniques and models to evaluate and optimize the safety and effectiveness of directed energy for non-lethal applications.			
(U)	In FY 2005: Enhance and apply laboratory techniques and models for efficient evaluation of human health and performance impact of exposure to high peak power and ultra-wideband microwaves being developed for anti-electronic and advanced radar applications. Use bioassessment techniques to reveal possible low-level and non-thermal effects of RFR. Integrate energy-deposition model with energy-distribution model for advanced dosimetry tools to assess human hazards to microwave exposure. Continue to conduct research to support scientifically based effectiveness, hazard, and safety criteria for millimeter waves in non-lethal applications.			
(U)				
(U)	MAJOR THRUST: Develop safety design criteria for portable active denial technology in support of the Air Expeditionary Force/Agile Combat Support initiative, enabling safe exploitation of directed energy weapons.	1.155	0.000	0.000
(U)	In FY 2003: Completed laboratory assessment of portable active denial technology. Assessed cognitive and psychosocial effects of non-lethal applications while attending to the needs of the intelligence community.			
(U)	In FY 2004: Not Applicable. Note: Technology transitioned to the Active Denial System Advanced Technology Concept Demonstration in FY 2004 and out.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	MAJOR THRUST: Develop biotechnologies for Air Force counterproliferation to accurately and affordably support the identification, detection, neutralization, and assessment of biological warfare agents for munitions options. Note: This major thrust grew out of the radio frequency bioeffects major thrust.	0.000	1.840	2.913
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Continue feasibility study, including scalability, of biological self-tracking and tracing simulants. Begin design of specific category simulants (i.e., bacterial, viral, and toxin), laboratory tests, and scale-up process.			
(U)	In FY 2005: Conduct feasibility studies investigating biological counterproliferation simulants for munitions options. Continue design of specific category simulants and development of innovative counterproliferation technologies.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004		
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602202F Human Effectiveness Applied Research**	PROJECT NUMBER AND TITLE **7757 Bioeffects and Protection**		
(U)				
(U) MAJOR THRUST: Develop technologies to alleviate the effects of warfighter fatigue. Results will extend and enhance vigilance, cognitive and physiological performance, and survivability in sustained and continuous (24/7) mission environments for all warfighters. Note: Aircrew protection research breaks out into different major thrust in FY 2005 to separate distinct technology areas.			3.471	2.728	2.314
(U) In FY 2003: Modeled and operationally validated the effects of fatigue on human performance and mission effectiveness to increase the accuracy and realism of current human behavior representations used in war games, simulations, training exercises, and information warfare planning activities.					
(U) In FY 2004: Continue development of model-based quantitative fatigue management capabilities for operational mission planning and performance assessment. Assess chemical contaminant penetration in aircrew breathing gases produced by an onboard oxygen generation system that has a partially deactivated molecular sieve. Continue investigating the effects of a break in oxygen prebreathe time on altitude decompression sickness risk. Quantify acceleration-induced degradation in pilot performance that can occur prior to reaching actual loss of consciousness.					
(U) In FY 2005: Continue development of counter-fatigue strategies to sustain warfighter performance during extended missions and continuous operations. Expand development of model-based quantitative fatigue management capabilities to include tactics, techniques and procedures to reduce fatigue-induced errors in vigilance-demanding command and control and information operations tasks.					
(U)					
(U) MAJOR THRUST: Develop technologies and procedures to counter physiological effects of high altitude flight, improve pilot performance under high, rapid-onset gravitational forces, and reduce deployment footprint and cost of oxygen systems. Research will enhance aircrew safety during global attack, global mobility, and special operations missions. Note: Breaks out from previous major thrust in FY 2005 to separate distinct technology areas.			0.000	0.000	0.737
(U) In FY 2003: Not Applicable.					
(U) In FY 2004: Not Applicable.					
(U) In FY 2005: Complete investigation of effects of break in oxygen prebreathe time on altitude decompression sickness risk. Explore emerging technologies and alternative G-protection concepts for their potential to improve performance, comfort, and operator acceptability of aircrew life support equipment. Continue assessment of chemical contaminant penetration in aircrew breathing gases produced by onboard oxygen generation system technologies. Continue quick-turn scientific consultations to resolve aircrew protection issues in ongoing flight operations.					
(U)					
(U) CONGRESSIONAL ADD: Rapid Detection of Biological Weapons of Mass Destruction.			4.195	0.000	0.000
(U) In FY 2003: Designed and developed improved probe kits to rapidly detect and identify an expanded category of biological warfare agents.					
(U) In FY 2004: Not Applicable.					

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602202F Human Effectiveness Applied Research**	PROJECT NUMBER AND TITLE **7757 Bioeffects and Protection**

(U) In FY 2005: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Solid Electrolyte Oxygen Separator.	6.827	1.388	0.000
(U) In FY 2003: Developed solid electrolyte oxygen separation technologies for aircraft and ground-based oxygen generating systems. Technologies will improve the reliability of oxygen generation, ensure an oxygen source free of chemical and biological agents, and reduce the deployment footprint associated with the current liquid oxygen infrastructure. Advanced state-of-the-art capabilities in oxygen generation by improving performance characteristics of the ion-separating ceramic membranes, increasing the liters of oxygen per minute produced by existing breadboard devices, and reducing the size, weight, and power requirements of those devices.			
(U) In FY 2004: Continue to advance solid electrolyte oxygen separation technologies for aircraft and ground-based oxygen generating systems to provide an oxygen source free of chemical and biological contaminants while reducing the deployment footprint associated with the current liquid oxygen infrastructure. Develop next generation (thin film) multi-cell electrolyte stacks and investigate their operating current and pressure limits. Incorporate upgraded components into a solid electrolyte oxygen separator technology breadboard device, increasing oxygen production to 33 liters per minute.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Integrated Medical Information Technology System (IMITS) Initiative.	0.000	10.113	0.000
(U) In FY 2003: Not Applicable.			
(U) In FY 2004: Continue IMITS and expand into Air Force clinics in the Pacific Rim.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Advanced Thermal Protection Systems (ATPS).	0.000	0.991	0.000
(U) In FY 2003: Not Applicable.			
(U) In FY 2004: Initiate Congressionally-directed effort for ATPS.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Nanoparticles for the Detection and Neutralization of Bioterrorist Agents.	0.000	0.991	0.000
(U) In FY 2003: Not Applicable.			
(U) In FY 2004: Develop nanoparticles directed to specifically detect and facilitate neutralization of potential bioterrorist agents. Apply DNA capture element technology to enable nanoparticles to track, recover, identify, and neutralize biological agents. Link DNA capture elements and nanoparticles and develop analytical methods to assure tagging of material even if the original biological agent is destroyed.			
(U) In FY 2005: Not Applicable.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research	PROJECT NUMBER AND TITLE 7757 Bioeffects and Protection

(U)				
(U)	CONGRESSIONAL ADD: Mobile Molecular Test Laboratory.	0.000	0.991	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Initiate Congressionally-directed effort for Mobile Molecular Test Laboratory.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	27.110	29.009	16.077

(U) C. Other Program Funding Summary ($ in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0602720A, Environmental Quality Technology.									
(U) PE 0603231F, Crew Systems and Personnel Protection Technology.									
(U) PE 0604703F, Aeromedical Systems Development.									
(U) PE 0604706F, Life Support Systems.									
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.